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Chapter 1

Introduction

Economic growth is the core topic for both economic researchers and economic policy makers. Thereby two questions are regarded as central: What are the factors that establish high growth? And how can sustainable growth, i.e. the avoidance of severe fluctuations, be achieved? Indeed, basically all areas of economics, from finance to labor economics, from development economics to industrial organization, from competition economics to environmental economics aim to achieve knowledge that directly (or indirectly) helps to understand and create growth that is both sufficient and sustainable.

My dissertation has the intention to add further insights to this knowledge. It is based on four research projects that are linked by two purposes. The first is to understand more about the 'soil' in terms of financial behavior that in a next step (unexamined here) can have impact on growth development. The second purpose is to learn more about the efficiency and constrains of discretionary fiscal and monetary policies, which were designed to stabilize growth.

The following passages present an overview and short summary of the chapters of this dissertation. Chapter 2 examines whether local cultural attitudes and behavior towards sinners, as established through religion, impacts over-indebtedness of individuals. So far, over-indebtedness of individuals has been attributed to unemployment, low education, financial illiteracy or age. In this chapter I emphasize an additional determining factor: Behavior towards delinquent debtors formed by Christian moralities. Over many centuries religion has been of great importance in forming behavior rules and corresponding norms

for persons that do not comply with them. Yet, whereas Catholicism is characterized by more diverse moral standards, indicating a more distinct forgiveness culture, Protestants do care more about rules, thus establishing a more distinct enforcement culture. I hence test the effect of religious denomination on over-indebtedness using county-level data for Germany. To approach endogeneity, I apply the distance to important churches (Cathedrals, Dome, Münster) and historical events as instruments for a counties' percentage of Catholics and Protestants. I find that more widespread Catholicism in an area indeed leads to a lower share of reported over-indebted persons. More widespread Protestantism in an area, however, is accompanied by higher over-indebtedness.

Chapter 3 expands on the findings of the second chapter by examining whether Christian moralities also impact the behavior of banks. It is also motivated by the established insights that Catholicism is characterized by more diverse moral standards and a stronger loyalty within small groups, whereas Protestants develop more reliable institutions for legal enforcement and are more willing to spend resources on monitoring. These insights give rise to expectations for banks being headquartered in areas more dominated by Protestantism (relative to Catholicism) to be less risky. Using a new dataset for Germany and applying the distance to default (z-score) as measure for banks risk, I document the existence of such a link between Christian moralities and the riskiness of banks. Consistently with this finding, banks in more Protestant areas have a lower return on assets, a reduced variance of returns and a lower share of non-interest income relative to total income. In my analysis, I control for several confounding factors such as local wealth, human capital, banking competition, urbanization and industry structure. The results are also robust in different sub-samples and to alternative measures of the independent variable. Furthermore, as in chapter 2, I address reverse causality by using the religion of territorial lords in 1624 and the distance to important churches as instrumental variables.

Chapter 4 turns to the analysis of the impact of discretionary measures, mandated by policy makers, on making growth sustainable. Thus, the chapter inquires the effects of the stimulus packages adopted by the German government during the Great Recession. To do so, I employ a standard medium-scale dynamic stochastic general equilibrium (DSGE) model extended by non-optimizing households and a detailed fiscal sector. In

particular, the dynamics of spending and revenue variables are modeled as feedback rules with respect to the cyclical component of output to account for their characteristics as automatic stabilizers. Based on the estimated rules, fiscal shocks are identified. According to the results, fiscal policy, in particular public consumption and transfers, stimulated the German economy during the Great Recession, albeit to a small extent, and was strongest when output was already expanding again. No considerable stimulating or contracting effects have been estimated on the revenue side.

Chapter 5, in turn, contributes on the research about discretionary monetary policy measures, by highlighting the importance of unbiased reaction functions of monetary policy rules estimates if interest rates reach the zero lower bound. Indeed, conventional estimates of monetary policy rule parameters can be severely biased if the estimation sample includes periods of low interest rates. Nominal interest rates cannot be negative, so that censored regression methods have to be used to achieve unbiased estimates. I therefore use IV-Tobit regressions to estimate monetary policy responses for Japan, the US and the Euro area. The estimation results show that the bias of conventional estimation methods is sizeable for the inflation response parameter, while it is very small for the output gap response and the interest rate smoothing parameter. I demonstrate how IV-Tobit regressions can be used to study the changes of policy coefficients when the zero lower bound is approached. Furthermore, I show how one can use IV-Tobit regressions to distinguish between counterfactual monetary policy responses, that the central bank would implement if there was no zero lower bound, and the actual monetary policy responses and provide estimates of both.

Chapter 2

'And forgive us our debts': Do Christian Moralities influence Over-Indebtedness of Individuals?

2.1 Introduction

Handling debt in a favorable way, i.e. without ending in insolvency, has been constituting a challenge for mankind since more than two thousand years. Indeed, already in the years the bible was written the question of debt, and arguments about debt, were important aspects of the political and everyday life. Negative experiences were made that left their marks. They explain why in Christian writings and prayers debt is repeatedly associated with guilt and sin. It is difficult to believe that in finance-experienced times of our days having debt should always be equivalent to being a sinner. Yet, the issue might be of importance in specific adverse cases, i.e. if a debtor has to repay but is unable to do so. In this situation the debtor has breached a norm and thus constitutes 'a sinner'. A central aspect of religion for many centuries, in turn, has been exactly to form behavior rules and corresponding norms for sinners, i.e. persons that do not comply with established rules. Thus, if these moralities are of influence, they should also impact the behavior towards

persons that find themselves in a situation of being unable to repay a promised allowance. However, there are important differences between the Christian denominations concerning among others the issue of grace. Catholicism is characterized by more diverse moral standards. A property that originates in the pronounced role of the Catholic Church as an institution and its traditions generated therein. This brought along a fine-tuning of moral standards. The latter is amplified by priests, who, during the confession of sins, have flexibility in arranging the degree of penalty. The resulting forgiveness culture contrasts with aspects of Protestantism. In the process of the Reformation, Protestants aimed to establish a reduced role of clerical institutions, emphasizing a concentration on original writings. Thus the Protestant moralities are characterized by more uniform standards. Accordingly, Protestants care more about rules; a property that is accompanied by a more distinct enforcement culture.

The role of attitudes towards delinquent debtors for financial outcomes is of general interest. It is important to gain a better understanding of factors that drive whether individuals come in a situation of being over-indebted. Religion and its incorporated attitudes should thereby be regarded as 'deep parameters' which stresses their potential time invariance. A fact that makes, of course, aware of severe rigidities for any attempts to implement the involved attitudes in fast way in other settings. Yet, our work contributes to the debate about behavior towards delinquent debtors and whether there is scope or necessity for e.g. regulation to adapt to local attitudes.

So far the impact of religion on finance has been mainly dealt with in terms of investment decisions. Renneboog and Spaenjers (2012) find evidence for the Netherlands that religious households are more inclined to save money than non-religious ones. Köbrich Leon and Pfeifer (2013) use German household data and show that Christians in comparison to non-religious individuals are more willing to take financial risks. Likewise, individuals with distinct religious backgrounds show distinct behavior concerning their probability to invest in specific assets like savings accounts, building contracts, life insurances or firm assets.

The nexus of religion and financial liabilities, in turn, has first received attention by Baele et al. (2014). They examine the relation between default rate of loans and

religion in Islamic finance. Using microdata for Pakistan they find Islamic loans being less likely to default during Ramadan and in cities where religious-political parties receive high share of votes. Georgarakos and Fürth (2015) explore the effect of social capital on household repayment behavior in Europe in the year 2000. They analyze data for European households and find that arrears are more common among households living in regions with a low fraction of religious people. In their analysis German regions are identified by federal states (Bundesländer). Unfortunately, for the latter only data for mortgage and rent payments but not for bills and credit were available.

We analyze the effect of religion on adverse outcomes of individuals' financial contract relations. The latter is obtained by data from a German credit reference agency that depicts the number of over-indebted people per region. These data include in addition to arrears also information from official list of debtors and of debt collection cases. Hence, we contribute to the analysis of linkages between Catholic and Protestant moralities and over-indebtedness. Furthermore, the study provides a comparison across German counties. Accordingly, the project presents answers to the central research question: Do local religiously induced moralities influence over-indebtedness of local individuals?

Germany is an ideal region to give answers to this question. Laws on credit and bankruptcy are uniform across all German regions, and due to the long tradition of credit reference agencies in the country, the data on over-indebtedness is solidly founded and reliable. Moreover, living in the homeland of Protestant Reformation, Protestants and Catholics nowadays are of similar size countrywide but at the same time are spread throughout the country heterogeneously. In addition, the countries rich religious history reveals incidents that give further insights into our research question.

However, endogeneity can be an issue for the analysis, as the extent of local over-indebtedness might impact views of individuals on the appropriate behavior which then transfers into these individual's choice of religious affiliation. For example Guiso et al. (2013) emphasize peer-group effects in the context of a decision whether to default on a mortgage or not by providing evidence that the social stigma associated with an action considered immoral decreases with the number of people doing it. Moreover, it is possible that a financially struggling individual could develop the will to save church taxes or

could become disappointed and loose faith. Both could result in terminating a religious affiliation. To cope with this reverse causality, we apply an instrumental variable approach. To capture the part of religion that should be independent to over-indebtedness we, first, use counties distance to the next important Catholic or Protestant church, i.e. churches named *Dom* or *Münster* or a *cathedral* or a *bishop sermon church*. We argue that areas for which the distance to such an important church is high should experience a lower share of persons being affiliated to the corresponding persuasion. Second, we use a instrument that is already established in the literature (Spenkuch, 2011) religion of a territorial lord in 1624.

Our empirical analysis reveals that religious affiliation indeed impacts the ratio of over-indebted people per county. As expected, the effect is opposite for both denominations. If the share of Catholics in a county outweighs the share of Protestants by an additional 10%, then ceteris paribus the share of persons being over-indebted in a county decreases by 0.04%. The finding takes a whole range of controls into account and is robust to alternative specifications of including religion in the regression set-up. Moreover, the effect stays also significant once endogeneity is taken into account. We conclude that Catholicism reduces the number of persons being over-indebted, whereas Protestantism actually exhibits a tendency promoting over-indebtedness.

The remainder of this chapter is structured as follows. Section 2.2 elaborates on the link between Christian moralities and the behavior towards delinquent debtors. Section 2.3 provides details of the main variables and a discussion on the control variables. Section 2.4 presents the results from OLS regressions. The robustness with respect to alternative specifications of including and measuring local religious affiliations is analyzed in section 2.5. Afterward, as further robustness, section 2.6 introduces the instrument variable set-up and the corresponding results. Finally, section 2.7 concludes.

2.2 Catholics and Protestants attitudes and behavior towards delinquent debtors

An astonishing similarity between the language used in religion and the language used in finance exists. In English the word *guilt* and *guilders* – the name of a former currency – is an example. *Redemption* and *redeemer* qualifies as a second example. In the German language there exists a close connection between the words for guilt and debt: the former is *Schuld* whereas the latter is *Schulden*. Yet, the feasible meaning of debt as something that has to be blamed is also observable within religious texts of the English language. The prayer Our Father in Heaven – that is of central importance in Christian worship – illustrates this in a clear manner. In the traditional version it was prayed: *"And forgive us our debts, as we forgive our debtors."* In the modern version these lines have changed to: *"Forgive us our sins, as we forgive those who sin against us."*[1]

However, these linkages should not come as a surprise. The mention of issues concerning debt might well reflect the happenings at the time the bible, the central source of Christian belief, has been written. In this context Wright (2012, p.347) reports that "Debt was quite a major problem in first-century Palestine".[2] Graeber (2011, p.80) states that "[t]he question of debt, and arguments about debt, ran through every aspect of the political life of the time." And indeed, the bible contains passages that deal with situations of indebted people. The parable of the unforgiving servant in Mt 18, 23-35 or Lk 7,41-42 is a example. Moreover, related to the downside-risks of debt, the issue of usury receives broad attention.[3]

Yet, the crucial point is not that words for debt are synonymous with those for sin or guilt. Indeed, Ingham (2004, as quoted by Graeber (2011)) notes that this is the case for all Indo-European languages. But crucial is that religiously educated people

[1] The traditional version stems from King James' Bible, the modern version goes back to the English Language Liturgical Consultation (1988).

[2] Josephus (75) in this context give insights. He writes about the wars against the Jews in 66 AD and reports that rebels burnt the contracts belonging to their creditors to dissolve their obligations for paying their debts. He states that this was done in order to gain the multitude of those who had been debtors indicating that the group of indebted people had to be large.

[3] This is the case in: Exodus 22:25; Psalms 15:5, 54:12; Jeremiah 9.6; Nehemiah 5:11; Deuteronomy 23:19-20.

are strongly familiarized with issues of sin and guilt; the text passages from the famous prayer Our Father have already shown this. Concurrently, such a religious education is often accompanied by a calling for grace. Grace then can be understood as demand for concession towards a sinner. Alternatively, - and of special interest for our economic context - grace can be defined as a behavior or attitude whereby exception to an rule is weighted higher than adherence to an rule. Together with insights from psychology (e.g. Jordan et al., 2015), which show that the awareness of guilt also supports readiness to forgive, these issues raise the question whether religiously educated people behave also differently when being partner within a financial contract and one partner does not comply to the rule?[4]

Of additional importance, however, is the existence of differences regarding grace and salvation between the two main Christian denominations (in Western Europe): Catholicism and Protestantism. Together with differences concerning the role of the church they offer preconditions to impact economic outcomes. Indeed, literature provides ample evidence suggesting that in general differences between Catholics and Protestants are prevalent. These differences concern characteristics and behavior, like work ethic, trust, contributions to public goods and attitude toward private ownership (Traunmüller, 2010; Guiso et al., 2003; Renneboog and Spaenjers, 2012; Benjamin et al., 2016).[5] Could such differences also be prevalent and relevant with respect to financial behavior?

In the following we provide insights into theological foundations of these differences and derive their potential of having an impact on private over-indebtedness. (A corresponding graphical overview is provided in Figure 2.1.) Central to Martin Luther's conflict with the Catholic church were his critique on selling of indulgences. In the following process of separation from the Catholic church after the year 1517, he and other reformers established their basic principles of Reformation, the so called four solas: *sola*

[4] Expecting an impact of religion on debt-behavior is not exceptional. Indeed, in its core it seems to have been kind of a common knowledge before. For example, Barro (1999, p.1137) already mentions a causal relationship. Without providing further details or references, he mentions in a parenthetically manner that "religious principles are dedicated, in part, toward curbing lavish expenditures and excessive debt".

[5] Moreover, Becker and Woessmann (2009a) indicate differences in literacy between Catholics and Protestants in Prussia around 1871. However, schooling nowadays is organized by the state and hence, the churches role for literacy should be evanescent.

gratia, *sola fide*, *solus christus* and *sola scriptura*.

Sola gratia thereby declares that salvation is possible by grace alone. Similarly, *sola fide* emphasizes the importance of faith in gaining salvation. Both contrast to Catholic views, according to whom salvation has to be gained within a process of becoming sinless. Hence, besides faith, Catholics have to additionally accomplish meritorious works (e.g. the fulfillment of the seven sacraments), Protestantism, in turn, contains stronger elements of predestination. This difference is illustrated in theological norms like confession and purgatory as well as in cultural traditions like carnival. The possibility and duty of oral confession of sins to a priest exists only in the Catholic church. According to Arruñada (2010), this confession of sins makes moral standards subject to fine-tuning by priests. Often sins are directly forgiven or there are degrees of freedom in negotiating compensating works. Purgatory, an intermediate state after death, highlights again the need for meritorious works as process of becoming sinless. Carnival is also a Catholic peculiarity. The reformers regarded fasting and the fasting period as redundant. Thus also the celebration of the preceding carnival, a time often associated to excess and sin, became redundant. These illustrations give indication of more diverse moral standards among Catholics which can be subsumed under the term forgiveness culture.

Solus christus assigns a stronger role to Christ (relative to clerical institutions) as he should be regarded as the only mediator between God and men. Similarly, *sola scriptura* declares the Bible to be the central reference and attaches the believers the ability to understand the writings. This contrasts to Catholicism which emphasizes the singular ability of the Catholic Church to interpret the Bible appropriately. According to Arruñada (2010), Protestantism is hence characterized by a debasement of moral enforcement conducted through the church. This debasement, however, is balanced by a stronger enforcement through legal, rather than moral, institutions. The result is that Protestants care more about rules and emphasize the importance of a legal enforcement culture. There is evidence strengthening the existence and relevance of such different Christian moralities. Arruñada (2010) examines survey data and shows that Protestants indeed develop more reliable institutions for legal enforcement and are more willing to spend resources on monitoring and punishing other members of the community. These

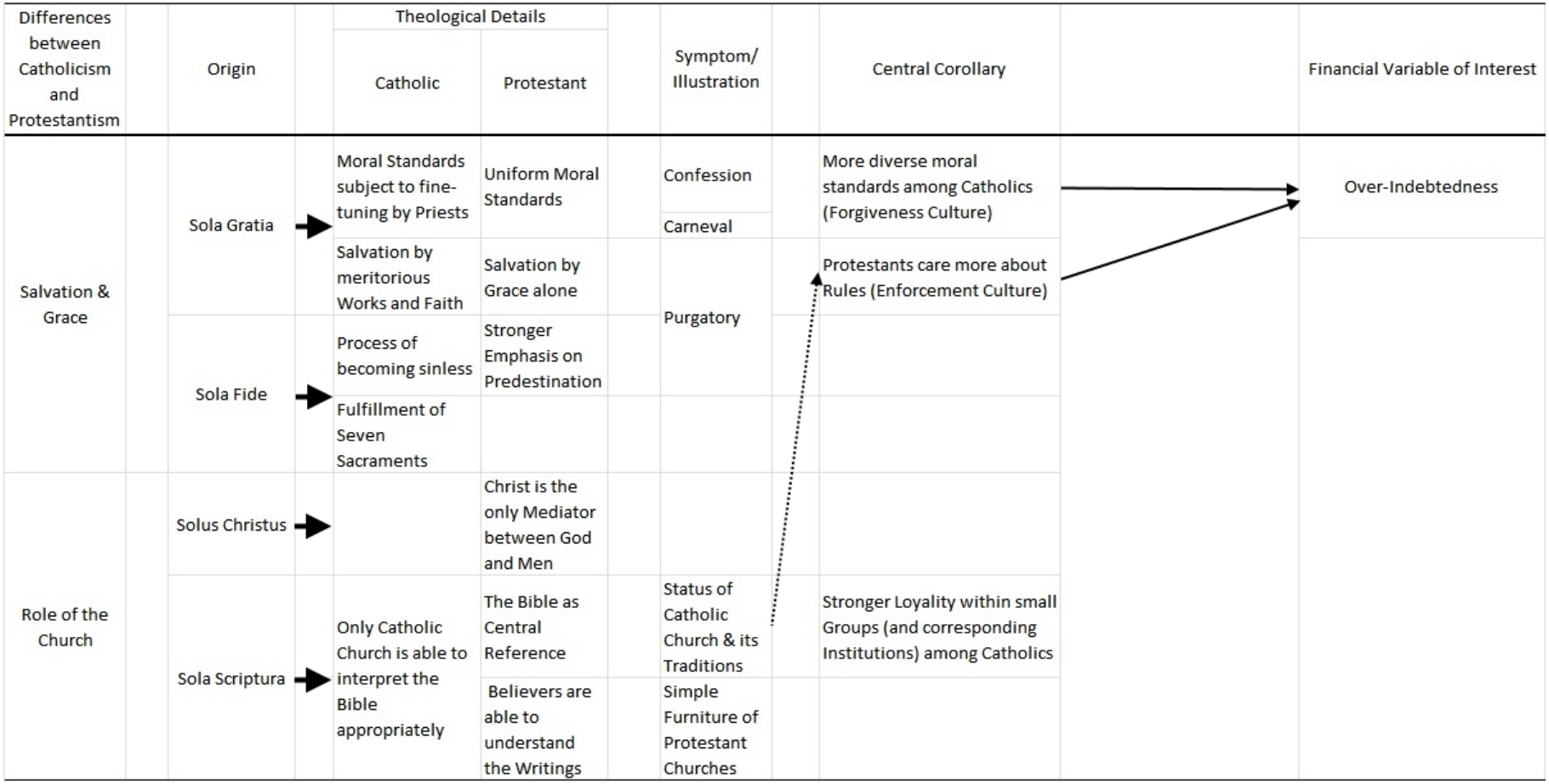


Figure 2.1: Differences between Catholicism and Protestantism and Effects on Over-Indebtedness
Source: Own illustration, based on findings by Arruñada (2010) and own research.

findings are also in line with a statement by Martin Luther who argues that : "the world needs a strict, hard, temporal government that will compel and constrain the wicked [. . .] to return what they borrow, even though a Christian ought not to demand it, or even hope to get it back." (Luther, 1524)

The above expounded facts and considerations result in our following empirically testable hypothesis:

> Catholic and Protestant affiliation influences over-indebtedness of individuals. The more an area is dominated by Catholicism relative to Protestantism the smaller is the ratio of over-indebted persons.

We assume that it is mainly the creditor side that drives the findings of an effect of denomination on over-indebtedness. We expect that a debtor who is delinquent (and hence near to or already 'de facto' over-indebted) has a higher likelihood of passing the threshold and being given the status of 'de jure' over-indebted if his creditor is Protestant. The reason for this is, again, the more distinct familiarization of the Protestant creditor within enforcement culture, relative to the Catholic forgiveness culture.

However, the effect could also stem from the debtor side. One possible alternative narrative would then be that a Catholic debtor fears the stigma of being over-indebted more than a Protestant debtor. Consistent with this narrative we would expect Catholics to ex ante take up less debt than Protestants. Yet, an examination of micro data does not allow this conclusion.[6]

A second possible effect from the debtors could stem from anticipation mechanisms. Accordingly, a debtor would rationally optimize over a potential forgiveness culture of his creditor. We regard this as unlikely. Being over-indebted goes along with strong adverse consequences. For example such a person is marked negatively within the credit reference

[6] The German Socio-Economic Panel study (SOEP) includes a question on religious affiliation in 2011 and on the size of personal debt in 2012. This allows out examining whether Protestants take up more debt than Catholics or Non-Religious. Based on 15000 observations, we find this not to be the case: Whereas among non-religious 20.3% have residual debts, for Protestants the number is less, namely 14.7%, but this is only slightly above Catholics for whom the ratio is 13.4%. A similar picture emerges concerning the amount of debt outstanding. Non-Religious rank first, as they exhibit residual debt of average 16986 Euro. Yet, for Protestants the number is 13252 Euro and, hence, less than the average 16185 Euro among Catholics.

agencies records, which severely impedes access to future financial contracts (e.g. for a car or real estate). Thus, we strongly assume that all recorded over-indebted persons within our data had the intention to avoid getting into the de jure status of being over-indebted, but then, however, were hit by a negative shock that puts them 'over the edge'.

Building on the latter, a third possible alternative narrative would be that Protestants have a higher likelihood of being hit by such a negative shock. To take account of such possible outside factors we include a wide range of control variables, among them age, local GDP, unemployment, divorce into our regression set-up. The high explanation power of our regressions accompanied by a significant effect of denomination, however, reduces such concerns strongly.

Finally, we reviewed literature whether different degrees of risk-aversion (a fourth possible alternative narrative) can be observed between Catholics and Protestants. The evidence, however, is mixed. Renneboog and Spaenjers (2012) find evidence for the Netherlands that Catholic households are less likely to invest in stocks and are more risk-averse. Kumar et al. (2011) and Shu et al. (2012), in turn, find for the US that Catholics (or firms in Catholic regions) exhibit less risk aversion than Protestants. The issue can also be regarded in relation to the theological considerations presented above. Then it should be expected that Catholics are actually less risk-averse as they live in a context of more diverse moral standards. This would make Catholics behave more risky and, hence, end up being more over-indebted. Our results indicate the opposite, thus indicating that an effect via debtors' risk-aversion is either not existent or massively outweighed by the effect of creditors' forgiveness culture.

We conclude, that, even though our data do not allow an exact disentangling, logical considerations indicate that the effect of denomination on over-indebtedness is driven mainly by the creditor and less by the debtor side.

2.3 Data

Germany is an ideal region for our research topic for several reasons. First, the laws on credit and bankruptcy are uniform across all German regions, hence issues of an 'unequal playing field' that arise in the context of cross-country studies are not of concern. Second,

Germany is the homeland of Martin Luther and hence of Protestantism. Third, Germany is a large country covering 80 million inhabitants where freedom of religion is granted by constitution. Fourth, Protestants, Catholics and persons that are non affiliated to a religious society are of equal size. Fifth, due to the long tradition of credit reference agencies in Germany, the data on over-indebtedness is solidly founded and reliable.[7] Sixth, due to its rich religious history, Germany is home of many impressing churches, which can be made use of within an instrumental variable approach.

Ideally, we would like to have information on an individual's – externally defined – state of over-indebtedness, her/his religion as well as on the religion of the corresponding creditor. Yet, such data – if they exist – are not publicly available. The only source that provides data on religiosity on an individual level in Germany and of which we are aware of is the German Socio-Economic Panel (SOEP). However, since the data does not contain information on over-indebtedness, the SOEP has not been used further in this study. Instead we conduct our analysis at the most disaggregated level where both data on over-indebtedness and data on religiosity were available: the 402 German counties. This is in line with previous studies on economic effects of religiosity using either country or state data (Lipford et al., 1993; Grier, 1997; Porta et al., 1997; Lipford and Tollison, 2003; Acemoglu et al., 2005; Noland, 2005; McCleary and Barro, 2006; Kanniainen and Pääkkönen, 2010) or county data (Hull and Bold, 1995; Hull, 2000; Boppart et al., 2008; Becker and Woessmann, 2009a, 2010; Adhikari and Agrawal, 2016; Spenkuch and Tillmann, 2015).

In the following we describe the origin and details of the data and motivate their importance in the context of an empirical study about over-indebtedness. Descriptive statistics are presented in Table 2.1. More details on data are provided in Appendix A.1.1.

Over-Indebtedness The credit reference agency *Creditreform*, collects micro data on over-indebtedness of consumers. Following their definition, over-indebtedness is existent

[7] The credit reference agency of our data was founded in 1871, the annual publication of over-indebtedness per county go way back to 2006.

if a debtor is unable to settle the sum of all accounts due for payment in the foreseeable future and no private wealth or credit opportunity is available to cover his living (Verband der Vereine Creditreform e.V., 2014). To capture this definition quantitatively – according to them – at least one of the following three criteria has to be fulfilled to determine whether a person is over-indebted. First, the person has be named on the official list of debtors (amtliches Schuldnerverzeichnis). This list covers individuals that underlie a prison sentence, affirmation in lieu of oath (Eidesstattliche Versicherung) or whom are in private insolvency. Second, the person is indicted within an undisputed private collection case (unstrittiger Inkassofall). Third, sustained delinquencies (nachhaltige Zahlungsstörungen) of private individuals, defined as at least two vain dunning letters (vergebliche Mahnungen) are recorded. The microdata is private, however, within yearly reports the development along the counties is reported. Accordingly, the ratio of over-indebted persons relative to the population above 18 years is available for each county.

Religion Data on religious affiliation is taken from the nation-wide census that took place in 2011. Survey participants were asked: "'Are you member of one of the following public-law religious societies?" Among the options for answers were 'Roman Catholic Church' and 'Evangelical Church'. This allows us to compute our main variable of interest, which is the difference between *share of Catholics* and *share of Protestants*: Δ*(Catholics,Protestants)*, in the following abbreviated as Δ(C,P). Another answer that was available in the survey was 'No member of a church', we use it as best available proxy to construct our control variable *share of Non-Religious*. Catholics, Protestants and Non-Religious constitute the three big 'denominations' in Germany. Other religions, i.e. *Orthodox*, *Jewish* or *Free Evangelicals* are of very small number. Muslim was not available as answer, hence members of Islam might have grouped themselves either in 'No member of a church' or *Others*.[8] The census was only conducted in 2011 and hence does not provide religion data for other years.

[8] Muslim as answer was not available, as in 2011 there was no nation-wide religious Muslim organization that was accepted by the state as a public-law religious society.

Economic Situation It is well-documented that *unemployment* is a major cause of becoming over-indebted. Besides that, we also included *real GDP per capita* to test to what degree economic wealth can explain over-indebtedness. Verband der Vereine Creditreform e.V. (2014) stresses that *divorced* people often run into debt problems, hence their ratio per county is added as a control.[9]

Education Lusardi and Tufano (2015); Campbell (2006) and Disney and Gathergood (2011) show that individuals that hold available skills attained by education, are better able to handle financial contracts. Accordingly, our regression set-up controls for the ratio of *highly qualified* within a county. To capture the other side of the skills distribution, *employees without an apprenticeship* have also been included.

Income distribution It could be expected that the income distribution has a positive effect on over-indebtedness. Especially, a high number of *person with a low income* could lead to higher ratio of debt-troubled people per county. Hence the number of persons earning less than 400 Euro per month, the so-called mini-jobbers are included as an explanatory variable. The aforementioned *real GDP per capita* and *highly qualified* constitute further variables covering this domain.

Demography Verband der Vereine Creditreform e.V. (2011) states that the over-indebtedness among people of middle age and elderly people is declining whereas there is a tendency to more over-indebtedness among young people. The occurrence of demographic effects on household finance is also acknowledged by Campbell (2006). Thus we included *average age* as an explanatory variable.

Sex Studies like Verband der Vereine Creditreform e.V. (2014) report that women have a lower likelihood than men to become over-indebted, therefore *women ratio* is included in the regression.

[9] However, *divorced* is itself influenced by religion. In the Catholic church marriage (matrimony) is one of the seven sacraments, which distinguishes it from the Protestants Church. Statistics show that Catholics are less likely to be divorced than Protestants.

Economic structure It is reasonable to argue that the economic structure of a region influences its persons debt behavior. *Self-employed* persons are more inclined to take up a credit, e.g. to finance an investment. Even though the firm constitutes an own entity, and the underlying data only concerns the debt situation of individuals, it might well be that persons whose firms have run into financial problems, are influenced also privately. To take account of the performance of self-employed we hence also added *firm insolvency ratios*.

Peer effects As emphasized by Gali (1994) the situation of related persons influences ones own consumption behavior. Therefore peer effects can provoke incentives to consume more or more expansive products to keep up with persons close to oneself. The more urban an area the more consumption possibilities exist. Moreover, the more dense people live, the more opportunities to watch people with differing consumption behavior and living styles are created. The latter in turn can induce a stronger will to consume a wider spectrum or higher quality of products. Our regression model thus incorporates urbanization-dummies identifying whether the area is a *major city*, an *urban county*, a *rural county with agglomerations* or *only sparsely populated*.

Regional politics Regional politics might be an important factor as well. This might concern economic policies as well as educational policies. Moreover, historical events, like the former division into East and West might have still an effect both on religion and on consumption behavior. Therefore *fixed effects* for all 16 *Bundesländer* are factored in.

Market power of regional credit suppliers Over-Indebtedness could also be driven by credit supply. As argued by Keeley (1990) strong competition could cause bank charter values to decline triggering an increase in assets and hence credit supply. We hence included a *Lerner-Index* for German counties as in Koetter (2013) or Inklaar et al. (2015). This index captures banking competition; the lower its number, the weaker is the market power of banks within the county.

Table 2.1: Descriptive statistics of the dependent and explanatory variables.

Variable	Mean	St.D.	Min.	Max.	N
Over-indebted persons rel. to population (%)	9.02	2.48	3.81	18.06	402
Δ(Catholics,Protestants)	1.60	37.05	-69.59	84.20	402
Non-Religious rel. to population (%)	30.65	22.5	4.38	85.21	402
Catholics rel. to population (%)	33.33	24.85	1.92	88.74	402
Protestants rel. to population (%)	31.73	17.51	4.55	75.88	402
Free (Evangelical) Churches (%)	0.76	0.81	0.00	6.22	402
Prot. incl. Free (Ev.) Churches (%)	32.49	17.85	4.55	76.66	402
Majority: Catholic (D)	0.46	0.50	0.00	1.00	402
Non-Catho. and Non-Prot. (%)	34.93	21.82	5.52	87.44	402
Unemployment rate (%)	6.39	3.13	1.2	16.4	402
Real GDP per capita in ten thousand euro	2.25	0.92	1.08	8.14	402
Divorced rel. to population (%)	6.89	1.2	3.8	10.4	402
Self-employed rel. to population (%)	11.78	2.74	3.8	20.1	402
Firm insolvencies rel. to all firms	3.94	2.19	0	13.45	402
High- qualified workers per 1000 inhabitants of work. age	4.71	3.67	0.70	32	402
Mini-jobbers per 1000 inhabitants of work. age	91.14	24.67	43.7	223	402
Workers without apprenticeship per 100 inhabitants of work. age (%)	7.18	3.27	2.3	25.5	402
Bank market power	0.48	0.09	0	0.85	402
Public debt per capita in thousand euro	9.69	4.38	2.2	28.64	402
Average age	41.52	1.69	36.91	46.88	402
Women rel. to population (%)	50.82	0.68	49.2	53.3	402
Major city (D)	0.17	0.37	0.00	1.00	402
Urban county (D)	0.34	0.47	0.00	1.00	402
Rural county (D)	0.25	0.43	0.00	1.00	402
Sparsely populated county (D)	0.24	0.43	0.00	1.00	402

2.4 Correlation Analysis

To get first insights whether there is a correlation between the regional importance of Catholicism relative to Protestantism and household over-indebtedness, we run a simple OLS-regression of the percental difference between Catholics and Protestants in county k, $\Delta(C,P)_k$, on the counties' share of over-indebted people. Afterward its relations are analyzed in an advanced correlation set-up that incorporates the controls described above. The later thus constitutes our baseline regression specification:

$$\begin{aligned} \textit{Over-Indebtedness}_k = c &+ \beta_1 \Delta(C,P)_k + \beta_2 NonReligious_k \\ &+ \beta_3 EconomicControls_k + \beta_4 EducationalControls_k \\ &+ \beta_5 DemographicControls_k + \beta_6 RegionalControls_k \\ &+ \mu_{State} + \epsilon_k \end{aligned} \tag{2.1}$$

The baseline regression set-up is motivated by the following factors. First, we aim to quantify the effect of Catholicism relative to Protestantism and simultaneously want to avoid any potential omitted variable bias that might arise from persons that are not religiously affiliated. However, since the sum of share of Catholics, Protestants and Non-Religious potentially equals one, which raises the issue of perfect multicollinearity, we are unable to include them all separately.[10] Thus, $\Delta(C,P)$ is our main variable of interest and *NonReligious* is included as a control variable. Second, we want to minimize any other potential omitted variable bias that might arise from other factors unrelated to religion. Thus, we included a wide range of control factors, which, according to other studies in this area and as discussed above in Section 2.3, can impact the probability of becoming over-indebted. An important identification assumption is that creditors and debtors are based in the same county. We expect that this is not true for all cases but for the vast majority. Any disturbance to this assumption hinders the identification and will be reflected in lower statistical significance.

Table 2.2 shows the results. The simple correlation analysis depicts a highly signif-

[10] We revisit this issue in our discussion on robustness (See Section 2.5).

icant effect for our main variable of interest. It states that if (the share of) Catholics outweigh (the share of) Protestants by an additional 10%, then ceteris paribus the share of persons being over-indebted in this county decreases by 0.26%. The direction of this effect stays robust if the above mentioned controls are taken into account. Importantly, the effect decreases from 0.26% to 0.04%, whereas the statistical significance is now given at the 5%-significance level. This result is thus in line with our deliberations and the resulting hypothesis which were presented above in Section 2.2. For Non-Religious no statistically significant relation can be detected. Concerning the other control variables the following can be observed. The more unemployed and self-employed persons per county, the higher the over-indebtedness. Also, a high number of firm insolvencies is correlated with over-indebtedness. Interestingly, the latter holds true for GDP p.C. as well. The ratio of high-qualified, the average age and the degree of how rural an area is, in turn, have a minimizing impact. The effect of low-income persons, women ratio, bank market power and public debt, however, turn out insignificant. Concerning goodness-of-fit, the advanced correlations can be regarded as satisfying, as they explain 87% of the cross-county variation of over-indebtedness.

A control variable that deserves special emphasis is the ratio of divorced persons per county. It is known that becoming divorced is often connected with facing adverse financial situations. A fact that is well reflected in our empirical analysis, as this control variable turns out positive and highly significant. Yet, there is also the issue that Catholics have a lower probability of being divorced than Protestants. Very likely this can be traced back to religion itself. Indeed, marriage (matrimony) is one of the seven sacraments in the Catholic church.[11] The Protestants Church instead knows only three sacraments and marriage it not one of those. A statistical pattern being in line with these explanations is observable in our data as well. Table A.1 in Appendix A.2 shows the correlation of $\Delta(C, P)$ with the other explanatory variables. Indeed, a strong statistically highly significant negative correlation between the relative dominance of Catholicism in an area and the ratio of divorced is observable. As a matter of fact, it hence has to be stressed that part of the effect that runs from Catholicism on over-indebtedness is captured by

[11] A sacrament is a Christian rite recognized as of accentuated importance and significance.

the *Divorced*-Variable. In our view, thus, the effect captured by $\Delta(C, P)$ has to be understood as measuring the lower bound of the aggregate effect of local denomination on over-indebtedness.

How big is the effect in terms of economic significance? To provide answers to this question, we provide insights from two approaches. First, we analyze the size of the coefficient of our main variable of interest in terms of one standard deviation. Doing the same for all other coefficients then allows a relative comparison. The standardized coefficient for the relative share of Catholics to Protestants concerning over-indebtedness is (-0.167). It states if $\Delta(C, P)$ raises by 37.05 %-points (i.e. one standard deviation) than the ratio of Over-Indebted decreases by 16.7 basis points. This constitutes approximately one ninth of the effect of unemployment (1.503 %-points) and one seventh of the effect of divorced (1.125), the two factors with the largest impacts. Comparing it to the variables High qualified (-0.557) and urbanization (0.352) the size is approximately one fourth and one half.[12] This would indicate a small but at the same time non-negligible role for relative religious affiliation. As a second approach, we computed the Adjusted R^2 of our regressions, once including and once excluding our religion variable. Afterwards this allows a comparison of the variation that can be explained and the contribution therein of religion. Under this approach the impact of religion is reported to be remarkably small. The explained variance of over-indebtedness decreases by 0.1% (from 0.868 to o.867) if $\Delta(C, P)$ is excluded from the regression.[13]

[12] Table A.2 in Appendix A.2 provides the full statistics.
[13] The corresponding Table A.3 is also given in Appendix A.2.

Table 2.2: Ordinary Least Square Regressions

	Over-Indebtedness	
Δ(Catholics,Protestants)	−0.026***	−0.004**
	(0.002)	(0.002)
Non-Religious		−0.011
		(0.009)
Unemployment		0.312***
		(0.047)
GDP p.C.		0.029**
		(0.014)
Divorced		0.940***
		(0.100)
Self-employed		0.092***
		(0.035)
Insolvencies		0.304***
		(0.053)
High qualified		−0.167***
		(0.033)
Low-income empl.		0.001
		(0.005)
Empl. w/o apprentice-		0.126***
ship		(0.036)
Avg. Age		−0.310***
		(0.064)
Women ratio		−0.139
		(0.139)
Bank market power		0.290
		(0.659)
Public debt p.C.		0.066
		(0.071)
Urban county (D)		−0.765***
		(0.234)
Rural county (D)		−0.790***
		(0.263)
Sparsely Pop. (D)		−0.840***
		(0.277)
State FE	No	Yes
Observations	402	402
R^2	0.15	0.87

,**, indicate significance at the 10%-, 5%- and 1%-level, respectively. Standard errors are based on the Huber-White sandwich estimator.**

2.5 Robustness I

This section examines whether our main findings are robust to alternative specifications of including and measuring religion. First, we test whether a more rough definition of local denomination is able to still replicate our main findings. Accordingly, we convert our variable on the percental difference in denomination into a binary variable. This variable named majority equals one if Catholics outweigh Protestants and zero vice versa. Column one in Table 2.3 reveals the robustness to this simplification. If a county has a Catholic majority than on average the ratio of over-indebted persons is decreased by 0.3%. In a next step, we disentangle $\Delta(C, P)$ again in its components, supplying regressions where the pure share of Catholics (or Protestants) is included besides the share of Non-Religious. This is helpful as it can reveal further insight, but simultaneously again avoids the issues of multicollinearity emphasized above. The results in the columns 2 and 3 confirm the findings that local Catholicism is correlated with lower over-indebtedness whereas Protestantism has a tendency to promote over-indebtedness. A further issue concerns the definition and measurement of the followers of Protestantism per county. In Germany the vast majority of Protestants is affiliated to the *Evangelische Kirche*, yet there are some Protestants that that belong to Evangelical Free Churches. Their size is rather small – 0.78% on average per county – and their followers are spread very heterogeneously across the country. Consistent with our approach to tackle endogeneity presented in the next section below we decided to not consider them explicitly in our baseline regression set-up. But, of course, it might be insightful and is necessary to examine whether Evangelical Free Churches impact our findings. Column 4 shows that the effect of Protestantism is basically unchanged if the are included in the measurement of it. As a second last analysis we aimed to learn whether our results are sensitive to a more explicit consideration of other religions within our control variables. Accordingly, we replaced the variable Non-Religious with a variable that captures the share of all persons being neither Catholic nor Protestant. Column 5 highlights that this variable is - as has been Non-Religious - statistically not significant. The coefficient $\Delta(C, P)$, in turn, remains of the same size and significance. Finally, we wondered whether the results might be biased by an unequal weighting of counties. In our baseline regression set-up

all counties have the same weight. However, it is known that they are of unequal size in terms of square kilometers and population size. Even though, part of the effect might be already captured by the state fixed effects, we also conducted a weighted regression whereby each observation was weighted by the log of the local population size. The result is presented in column 6. It can be seen that the effect is unchanged.

History reveals a further issue about religion in Germany that deserves additional attention: The division in East and West and its consequences. For a long time, i.e. from 1945 till 1990, the role and development of the Catholic and Protestant Church has been of great divergence between West Germany (i.e. the Federal Republic of Germany: FRG) and East Germany (i.e. the German Democratic Republic: GDR). Many Christians had been opponents to the Nazi movements and partly reduced activities in politics during that time. After the break-down of the Nazi regime and World War II Christian institutions have played a big role in reestablishing democracy in the RFG. Religion has also been positively announced in the constitution, and the state offered and established the service to collect the obligatory church taxes. Many social institutions like hospitals, kindergartens and schools have been run by religious institutions. In the GDR the situation was totally different. The communist regime fought against religious institutions in many ways. The outcomes of these incidents are prevalent till today: the number of religious affiliated persons is of much lower number in the areas of the former GDR compared to the areas of the old FRG. We hypothesize that the effect of local denomination should be more prevalent in the area of the old FRG as local social capital there should have been more influenced by the respective religious attitudes. To enable a further analysis we hence splitted the sample into East and West. In terms of the significance of the coefficient of our main variable of interest the results in Table 2.4 confirm the above formulated considerations. For the West the effect of the share of Catholics relative to Protestants on over-indebtedness is of similar size (-0.003) as in the full sample (-0.004), albeit of a slightly decreased significance. However, for the East the effect is stronger (-0.010) but insignificant. There are three factors that drive these results. First, the general lower religious affiliation rate in the East that makes a measurement (of religion on over-indebtedness), that already takes place on the county level,

Table 2.3: Robustness: Alternative Specifications of including Religion

	Over-Indebtedness					
	(1)	(2)	(3)	(4)	(5)	(6)
Δ(Catholics,Protestants)					−0.004**	−0.004**
					(0.002)	(0.002)
Majority: Catholic (D)	−0.309**					
	(0.154)					
Catholics (Share)		−0.009**				
		(0.004)				
Protestants (Share)			0.008**			
			(0.004)			
Prot. + Free Churches (Share)				0.008**		
				(0.004)		
Non-Religious (Share)	−0.012	−0.016	−0.007	−0.007		−0.012
	(0.010)	(0.010)	(0.009)	(0.009)		(0.010)
Non-Catho./Non-Prot. (Share)					−0.005	
					(0.009)	
Unemployment	0.312***	0.311***	0.312***	0.312***	0.311***	0.309***
	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)
GDP p.C.	0.031**	0.029**	0.028**	0.029**	0.028**	0.029**
	(0.015)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Divorced	0.946***	0.940***	0.941***	0.942***	0.915***	0.955***
	(0.100)	(0.100)	(0.101)	(0.100)	(0.102)	(0.100)
Self-employed	0.093***	0.092***	0.091***	0.091***	0.090**	0.095***
	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)
Insolvencies	0.302***	0.303***	0.304***	0.304***	0.306***	0.302***
	(0.054)	(0.053)	(0.053)	(0.053)	(0.053)	(0.053)
High qualified	−0.170***	−0.168***	−0.167***	−0.167***	−0.171***	−0.168***
	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.034)
Low-income empl.	0.001	0.001	0.001	0.001	0.002	0.001
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Empl. w/o apprentice-ship	0.126***	0.125***	0.128***	0.127***	0.130***	0.131***
	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
Avg. Age	−0.301***	−0.310***	−0.310***	−0.310***	−0.308***	−0.311***
	(0.064)	(0.064)	(0.064)	(0.064)	(0.065)	(0.065)
Women ratio	−0.135	−0.139	−0.138	−0.139	−0.137	−0.148
	(0.136)	(0.139)	(0.139)	(0.139)	(0.139)	(0.139)
Bank market power	0.278	0.300	0.280	0.284	0.273	0.318
	(0.663)	(0.659)	(0.659)	(0.659)	(0.661)	(0.661)
Public debt p.C.	0.061	0.066	0.066	0.066	0.066	0.064
	(0.071)	(0.071)	(0.072)	(0.071)	(0.071)	(0.073)
Urban county (D)	−0.778***	−0.765***	−0.766***	−0.769***	−0.767***	−0.779***
	(0.234)	(0.234)	(0.234)	(0.233)	(0.234)	(0.234)
Rural county (D)	−0.800***	−0.786***	−0.793***	−0.794***	−0.782***	−0.809***
	(0.265)	(0.263)	(0.263)	(0.263)	(0.264)	(0.263)
Sparsely Pop. (D)	−0.853***	−0.837***	−0.842***	−0.843***	−0.824***	−0.859***
	(0.280)	(0.277)	(0.277)	(0.277)	(0.278)	(0.278)
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	402	402	402	402	402	402
R^2	0.87	0.87	0.87	0.87	0.87	0.87

,**, indicate significance at the 10%-, 5%- and 1%-level, respectively. Standard errors are based on the Huber-White sandwich estimator.**

more prone to blur. Second, a less diversified religious affiliation pattern in the East, especially marked by the dominating strong unimportance of Catholicism in nearly all counties. Third, factor two is amplified by the fact that our regression set-up constitutes a "within-state between-county" analysis. As the 76 counties in the East are allotted to six states, exogenous variation is less distinct.

Table 2.4: Ordinary Least Square Regressions separated for West and East

	Over-Indebtedness	
	West	East
Δ(Catholics,Protestants)	−0.003*	−0.010
	(0.002)	(0.009)
Non-Religious	0.003	0.014
	(0.014)	(0.019)
Other Control Variables	Yes	Yes
State FE	Yes	Yes
Observations	325	76
R^2	0.89	0.78

,**, indicate significance at the 10%-, 5%- and 1%-level, respectively. Standard errors are based on the Huber-White sandwich estimator.**

2.6 Robustness II: Instrumental Variable Regression

In this section we conduct a further robustness analysis. The central idea is to apply instrumental variables and thus approaching two central threats to internal validity prevalent within our research design. First, there might be a simultaneous causality bias. Accordingly, not only would religion influence over-indebtedness - as argued above -, but being over-indebted would impact on an individual's choice of religious affiliation. Reasons for the latter might be a financially struggling individual's will to save church taxes or - in extreme case - his process of turning apostate. As being over-indebted can come along with a situation of many and very severe complex problems causing stress and frustration, the latter can not be excluded.[14] Second, an omitted variable bias might be

[14] A further argument for reverse causality can be made from a macroeconomic perspective. According to the theory of secularization, the importance of religion decreases with economic development (i.a. Höhener and Schaltegger, 2012). Hence, under the assumption that economic development is correlated to financial intermediation, areas with higher credit interactions would exhibit looser religious

present. In fact, both the decision not to join a religious affiliation and the situation of being over-indebted might be caused by unability (or unwillingness) to adjust to rules, be they formal or informal. The latter would constitute a factor that should be expected to be correlated with religion. However, it is unobserved and difficult to measure.[15]

To account for the endogeneity problem and eliminate the resulting bias, an instrument variable approach is applied.[16] To qualify as valid, the instruments are expected to fulfill two conditions: instrument relevance and instrument exogeneity. Accordingly, we aim to use variables that both have explaining power for the share of religious affiliated persons across German counties in the year 2011 and are not influenced by over-indebtedness of the same year. We use two instruments, one that derives from history and one that makes use of geographical conditions.

The first instrument is *religion of a territorial lord in 1624*. It has been originally introduced by Spenkuch (2011).[17] The background is as following. The start of Reformation by Luther in 1517, led to increasing conflicts between the territorial lords, their inhabitants and amongst both groups. Therefore in 1555 an Imperial Diet in Augsburg was organized that led to the Peace of Augsburg. Concerning religion, two resolutions were crucial: the *ius reformandi* and the *ius emigrandi*. The first one established the principle "Cuius regio, eius religio" stating that the religion of territorial lord is the official religion in his state and hence of all its inhabitants. The second resolution gave each inhabitant who had a diverging religion to his lord, the right to emigrate. As a consequence of this agreement, the unity of religion within individual states was strengthened, while at the same time a religious fragmentation of the German Lands took place (Spenkuch, 2011). Yet, the Thirty Years' War (1618-1648) led to area conquests and losses and hence to

affiliations.

[15] A further, and hence third, threat to internal validity might exist: error-in-measurement. In general the data for religion are regarded of good quality, yet they are based on surveys and projections thereof. It might be that religious persons have a diverging probability to be asked, if they stay at home more or less often. it might also be that affiliates of specific persuasions are less keen to answer questions about religiosity. Therefor religious affiliation might be measured with error.

[16] An alternative, yet more rough, approach to tackle at least the issue of reverse causality would be to examine the effect of religion lagged by one period on the over-indebtedness of the current period. Accordingly we conducted an analysis of our baseline regression set-up but using the depending and further control variables for the year 2012 and the religion data of 2011. The resulting coefficients are basically unchanged. They can be seen in Table A.5 in Appendix A.2.

[17] It has also been applied by Spenkuch and Tillmann (2015) .

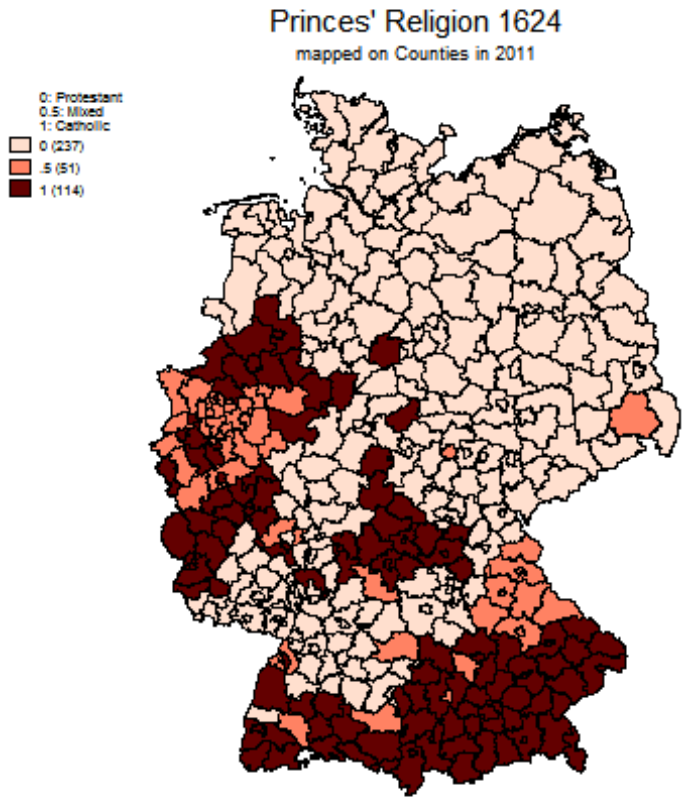


Figure 2.2: Religion of a territorial lord in 1624
This figure shows the religion of the territorial lord in 1624 mapped on the 402 existing counties in 2011. In 1624 more than a thousand independent territories were in existence. Accordingly, counties that are composed of territories of nonuniform religion are classified as mixed. For further details the interested reader is referred to Spenkuch (2011).

shifts of borders. To establish stability and a new status quo the Peace of Westphalia was signed in 1648. Concerning religion an agreement was taken that defined Catholic and Protestant territory according to the situation that has prevailed in 1624. A geographical overview of the situation around that time is given in Figure 2.2. It depicts the religion of territorial lord in 1624 mapped on German counties of the year 2011. Counties are either classified as Catholic, Protestant or – if composed of former territories of nonuniform religion – as mixed.

According to Cantoni (2014) the decades afterwards experienced no denominational changes for the vast majority of the territories, hence the status of religion of a territorial

lord was mainly not prone to further changes. Thus, reflecting the fact that religion is often "inherited" from parents, it is reasonable to expect that religion of a territorial lord in 1624 still influences the current share of Protestants and Catholics across German counties. This would classify the instrument as potentially relevant. Concerning the exogeneity of the instrument, again Cantoni (2014) provides insights. He shows that neither commercial activity nor wealth or strength of a territory – factors that would be candidates for omitted variables – predict whether a territory adopted the Reformation. However, within our research context the instrument has one potential shortcoming. It has only three parameter values (Catholic, Protestant, mixed) whereas the share of religious people of the different persuasions is a continuous variable ranging from low to very high percentage numbers. Therefore a second instrument is applied, one that has a wider range of parameter values.[18]

This instrument is distance to important churches. Its choice reflects and combines ideas of Becker and Woessmann (2009a) and Falck et al. (2011). Becker and Woessmann (2009a) used the distance to Wittenberg as an instrument for Protestantism in nineteenth-century Prussia. They argue that the Reformation dispersed concentrically around the place where Luther proclaimed his 95 Theses. As main reasons for a circular dispersion around the religious center they name the costs of traveling and of information diffusion through space. Accordingly, "there is a tendency for the impact to diminish with distance"(Becker and Woessmann, 2009a, p.557) and "the propensity to come to Wittenberg to listen to Luther and his successors likely declined with distance to Wittenberg" (p.558). Yet, political developments in the following centuries, especially the division of Germany after World War II, led to a hindered accessibility and declined importance of the place Wittenberg for spreading Protestantism.[19] Yet, there are other "religious centers" that play an outstanding role for the dispersion of belief: these are churches. Churches are the place where believing persons meet. It is the place where Priest give

[18] A further advantage of using a second instrument is that it allows for tests of overidentifying restrictions (Stock and Watson, 2012).

[19] This is reflected in the fact, that the county Wittenberg - with a share of Protestants of 19.3 % - took only rank 274 of all 402 German counties in 2011.
We also tested the explaining power of distance to Wittenberg for nowadays Protestantism. The coefficient turns out statistically insignificant thus affirming the declined importance.

their sermons and thus the central place for worshiping. As a matter of fact, each municipality is home to a church. However, their relative importance varies, depending on the historical past of the church, the dimensions of the parish and the quality of its leaders. Thus amongst all churches, there are some that have gained special attention. Attention in terms of attendances in worship service, of size and/or delegated clerical staff. It should be expected that these important churches have played a crucial and persistent role when it comes to spreading and renewing belief. Indeed, the importance might be valid both spiritually as administratively.

As characters to determine whether a church qualifies as important, we apply four criteria. These criteria are not exclusive, indeed some churches fulfill more than one criteria. To this end a church is characterized as important if it is named *Dom* or *Münster* or if it is a *cathedral* or a *bishop sermon church*. Applying these criteria yields a list of 110 Catholic churches and 89 Protestant churches (see appendix A.3). Figure 2.3 maps the municipalities that are home to such an important church.

Following the argumentation of Becker and Woessmann (2009a), we argue that there is a tendency for the impact to diminish with geographical distance. Accordingly, areas for which the distance to an important church is high should experience a lower share of persons being affiliated to the corresponding persuasion. Concerning the computation of the distances, we follow Falck et al. (2011), who were interested on each German counties distance to the nearest opera house.[20] Following their procedure, three steps are required. First, by using data of latitude and longitude each county's centroid is determined. Afterwards the distance in kilometers to the next important church can be derived.[21] Finally, the distance of counties that are home to an important church is defined as zero. Statistics of the computation are presented in Table 2.5.

[20] Bauer et al. (2015) point out weaknesses in their regression set-up, however, acknowledge geographical distance as a valid instrument.

[21] An exemplary graphical illustration of the procedure is presented in Figure A.1 in the Appendix A.3.

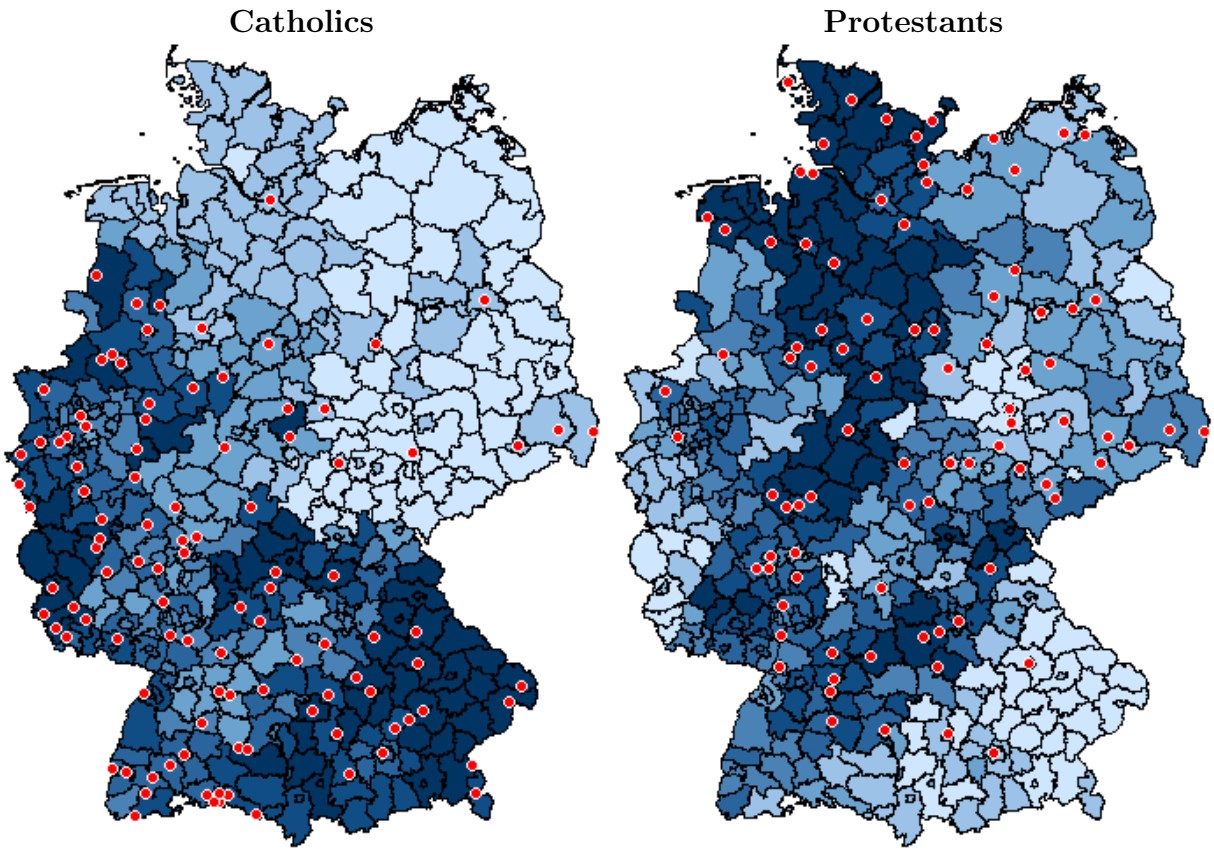
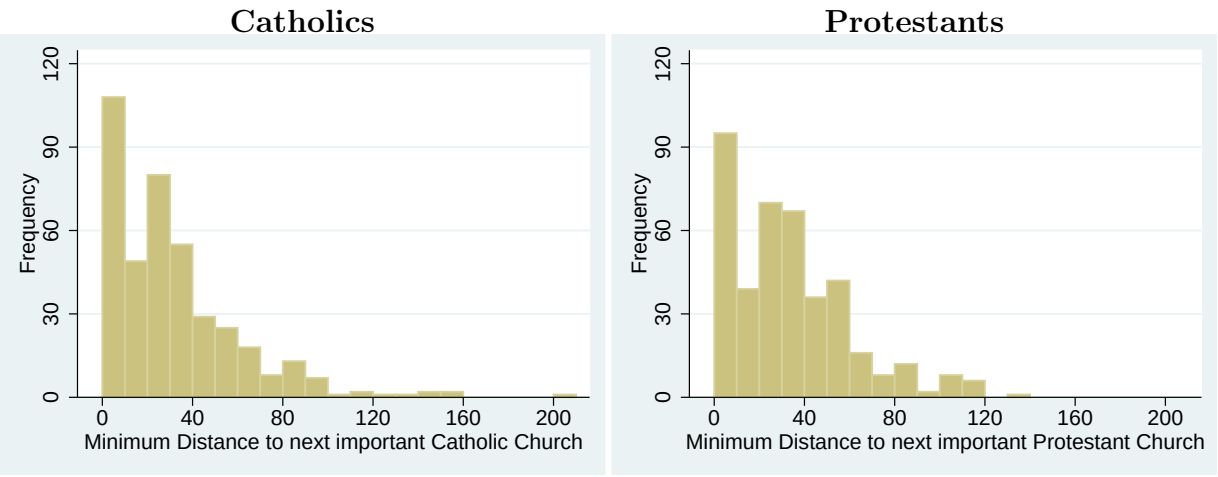


Figure 2.3: Important Churches

This figure maps the municipalities that are home to an important church within the German counties. For Catholics there are 110 important churches in 105 municipalities in 95 counties. For Protestants 89 important churches in 83 municipalities in 77 counties have been identified. The shading reflects the share of persons belonging to the respective persuasion. The darker the shading, the higher is the population with a Catholic or Protestant affiliation.



Mean	St.D.	Min.	Max.	N
30.72	29.98	0	202.14	402

Mean	St.D.	Min.	Max.	N
32.85	27.81	0	139.13	402

Table 2.5: Distance to Important Churches

Applying a measurement procedure for geographical distances similar to Falck et al. (2011), the distance of each of the 402 counties' centroid to the nearest important church (*Dom*, *Münster*, *cathedral*, *bishop sermon church*) is computed.

The instruments explained above allow us to establish our new regression set-up. In a first step (Equations 2.2 and 2.3), we identify each county's share of people that belong either to the Catholic or the Protestant persuasion by the exogenous variation generated by both instruments: the religion of a territorial lord in 1624 and the geographical distance to the next important church of the respective persuasion.

$$\begin{aligned}\widehat{Catholics}_k = \gamma_1 &Catholic\ Lord\ in\ 1624_k \\ &+ \gamma_2 Distance\ to\ next\ important\ Catholic\ church_k \\ &+ \gamma_3 OtherControls_k\end{aligned} \tag{2.2}$$

$$\begin{aligned}\widehat{Protestants}_k = \gamma_1 &Protestant\ Lord\ in\ 1624_k \\ &+ \gamma_2 Distance\ to\ next\ important\ Protestant\ church_k \\ &+ \gamma_3 OtherControls_k\end{aligned} \tag{2.3}$$

In a next step, the resulting exogenous share of Catholics and Protestants enable the generation of the exogenous share of Non-Religious, $\widehat{NonReligious}_k$, and the corresponding percental difference of Catholics and Protestants in each county, $\widehat{\Delta(C,P)}_k$.

$$\begin{aligned} \widehat{NonReligious}_k = NonReligious_k + Catholics_k - \widehat{Catholics}_k \\ + Protestants_k - \widehat{Protestants}_k \end{aligned} \tag{2.4}$$

$$\widehat{\Delta(C,P)}_k = \widehat{Catholics}_k - \widehat{Protestants}_k \tag{2.5}$$

Finally, Equation 2.6 yields the central regression of interest:

$$\begin{aligned} Over\text{-}Indebtedness_k = c + \beta_1 \widehat{\Delta(C,P)}_k + \beta_2 \widehat{NonReligious}_k \\ + \beta_3 EconomicControls_k + \beta_4 EducationalControls_k \\ + \beta_5 DemographicControls_k + \beta_6 RegionalControls_k \\ + \mu_{State} + \epsilon_k \end{aligned} \tag{2.6}$$

The corresponding results are presented in Table 2.6. It can be seen that the effect of Christian moralities on over-indebtedness is present also when endogeneity is taken into account. If (the exogenous share of) Catholics outweigh (the exogenous share of) Protestants by an additional 10%, then ceteris paribus the share of persons being over-indebted in this county decreases by 0.05%. Concerning the goodness-of-fit the second stage regression again explains 87% of the cross-county variation in over-indebtedness. The instruments turn out relevant for both Christian denominations. If current inhabitants' regional lord in 1624 has been Catholic (Protestant) a county's share of Catholics (Protestants) nowadays is 21% (18 %) higher. And for each kilometer a county's distance to the next important Catholic or Protestant church increases, the share of the corresponding religion's followers drops by 11 and 8 basis points respectively. The F-statistics for both first stage regressions are far above ten, affirming that the instruments are not weak.[22]

[22] cfr. Stock and Watson (2012, p.481)
A shortcoming of our step-wise instrumental variable regression set-up is that tests of underidentification and of instrument validity are not automatically available. To nevertheless gain some insights on these issues we used a simplified regression set-up that abstracts from a possible impact on the share of Non-Religious, i.e. that does not endogenize the share of Non-Religious. The results are available in Table A.6 in Appendix A.2. As, there, the corresponding p-values of the test of underidentification (which examines whether the excluded instruments are correlated with the endogenous regressors) are

The control variables reveal again the expected sign of directions. Unemployment, being divorced and self-employment raises over-indebtedness. The same holds true for the ratio of employees without an apprenticeship and the ratio of insolvencies among firms in a county. Age, a higher number of high qualified workers and the inverse degree of urbanization, in turn, dampens over-indebtedness. Public debt, regional banking competition, and the ratio of women prove to be insignificant.

far below the standard significant levels, the Null hypothesis of the equation being underidentified, is rejected. Moreover, Hansen's J-statistic reports p-values bigger than 0.10, hence the null hypothesis that the instruments are valid, i.e. uncorrelated with the error term, cannot be rejected. Although this results are not directly transferable to the above regression set-up, we take them as further indication that in general the instruments are suitable.

Table 2.6: Instrumental Variable Regression

	1st Stage		2nd Stage
	Catholics (Share)	Protestants (Share)	Over-Indebtedness
$\Delta(\widehat{\text{Catholics,Protestants}})$			−0.005*
			(0.003)
$\widehat{\text{Non-Religious}}$			−0.002
			(0.018)
Unemployment	0.489	−0.681*	0.311***
	(0.348)	(0.384)	(0.047)
GDP p.C.	0.140	−0.237*	0.029**
	(0.159)	(0.140)	(0.014)
Divorced	−3.395***	−0.903	0.896***
	(0.911)	(0.837)	(0.121)
Self-employed	0.972**	−0.814**	0.093**
	(0.426)	(0.410)	(0.037)
Insolvencies	0.353	−0.121	0.306***
	(0.401)	(0.440)	(0.053)
High qualified	−0.384	−0.211	−0.174***
	(0.244)	(0.278)	(0.035)
Low-income empl.	0.174***	−0.053	0.003
	(0.056)	(0.038)	(0.005)
Empl. w/o	0.213	0.174	0.128***
	(0.420)	(0.359)	(0.036)
Avg. Age	−1.149*	2.546***	−0.311***
	(0.640)	(0.647)	(0.066)
Women ratio	−2.531**	2.104**	−0.140
	(1.194)	(1.012)	(0.140)
Bank market power	6.273	−8.047	0.305
	(5.663)	(6.066)	(0.671)
Public debt p.C.	−0.747	1.004*	0.066
	(0.517)	(0.512)	(0.071)
Urban county (D)	−0.756	1.380	−0.771***
	(2.169)	(1.823)	(0.236)
Rural county (D)	0.090	4.660**	−0.777***
	(2.552)	(2.209)	(0.275)
Sparsely Pop. (D)	1.554	5.733**	−0.818***
	(2.771)	(2.399)	(0.296)
Religion 1624: Cath.(D)	21.030***		
	(2.193)		
Religion 1624: Prot.(D)		17.899***	
		(2.014)	
Min. Distance Cath.	−0.105***		
	(0.029)		
Min. Distance Prot.		−0.084***	
		(0.027)	
State FE	Yes	Yes	Yes
F-stat (1st stage)	122.5	48.1	
Observations	402	402	402
R^2	0.84	0.71	0.87

***, **, and *** denote significance at the 10, 5, and 1 percent level, respectively.**

2.7 Conclusion

The strong growth of finance and its beneficial usage in everyday life have been an important development of the last decades. However, an inherent nature of each financial contract is the possibility that a debtor gets in a situation in which he is unable to provide the arranged repayment to the creditor. Recent developments like the financial crisis and the public debt crises indicate that if such situations occur in large numbers then even severe real effects are possible. It is hence of great importance to examine mechanisms that avoid situations of over-indebtedness already ex ante. Central to these issues is the development of legal rules and institutions. This project, however, analyzes an additional, so far less examined factor: attitudes towards forgiveness and enforcement originating from a cultural context. More precisely, we exploit the fact that the two big Christian denominations in Western Europe, Catholicism and Protestantism, are characterized by diverging attitudes concerning the diversity of moral standards and the importance assigned to the adherence of rules.

Religion has played a very important role in establishing norms, rules and guidance over the last centuries. Under the assumption that religion has left a strong footprint in the minds of people – by education or just by a standardized behavior adopted or handed down from generation to generation –, we hence empirically analyzed whether the local importance of Catholicism relative to Protestantism influences the number of over-indebted persons in an area. The Catholic Church sets moral standards more in a context of fine-tuning through the confession of sins to a Priest and the possibility of forgiveness. Protestantism, in turn, assigns a reduced role to the clerical institutions. It is characterized by a debasement of moral enforcement conducted through the church, which, however, is balanced by a stronger enforcement through legal, rather than moral, institutions. Thus, Protestants care more about rules and emphasize the importance of a legal enforcement culture.

Using data for Germany, we show that the dominance of Catholicism relative to Protestantism in a county indeed reduces the local share of over-indebted persons. We furthermore demonstrate that these findings are robust to variations in the empirical regression set-up. We also approach a possible reverse causality by pursuing an instrumental

variable approach. We identify the exogenous variation of the relative local dominance of a denomination using the distance to important churches (Cathedrals, Dome, Münster) and local Lords' religion in the year 1624 as instruments. The results confirm the findings from the OLS regressions, hence showing that our outcome is not just an effect of over-indebted persons leaving or changing their denomination.

Our findings indicate several issues that deserve additional research in future projects. Among them is the issue of an existing interplay between forgiveness relative to an enforcement culture and institutional setting. For Germany the financial laws are uniform across the country and, hence, the institutional setting is of minor importance in this study. Yet, it might be of interest to analyze whether countries which are historically dominated by Protestantism developed institutions different to those in traditional Catholic countries. A second interesting issue would be to analyze whether the effects of religion are so distinct that they can also impact economic growth. There are several studies that examine the link between religion and growth within cross-country studies, yet, there disentangling religion from other confounding factors (e.g. institutional setting) is a challenge. Our data, in turn, can enable a within-country across-county analysis. Indeed, simple correlations, that resulted as a side product in the above empirical setting, give indication of a slightly higher GDP in counties dominated by Catholicism. A third interesting issue would be an analysis whether persons adjust their behavior already beforehand by taking a dominating enforcement or forgiveness culture into account. We describe that such a behavior is less to occur in the context of a special 'tail event' like over-indebtedness. However, more needs to be learned on how such a forgiveness culture is related to risk-aversion in general. Our study thus might be regarded as a staring point for future research on the effects of Christian moralities on financial behavior in special and economic outcomes in general.

Chapter 3

Christian Moralities and Banking Behavior: Does Local Denomination affect Bank Risk Taking?

3.1 Introduction

In the aftermath of the financial crisis there has been an extensive public debate on whether misguided incentives might have shaped banking behavior and outcomes. Indeed, since the start of the crisis there have been enormous efforts by national and international regulators to establish new rules, exactly with the intention to reshape incentives concerning financial intermediation. Yet, from a sociological perspective besides official rules, there also exist informal rules carried on by what can be named *culture*. Culture in this context can be defined as following: "If information acquisition is either imperfect or costly, then selection favors shortcuts to learning. Individuals, rather than using scarce resources to acquire all of the information needed for every decision to be made, will instead develop 'rules-of-thumb'. These shortcuts then become internalized as individuals come to believe that certain behaviors are the 'right' behaviors in certain situations."(Nunn, 2012, 2014). In general, these informal rules might be of bigger

importance than currently thought of.

Hence, we aim to shed new light on the role of culture for financial intermediation. We zoom in on one important aspect of culture, that is religion. Religion plays a central role when it comes to shaping attitudes and ethical norms. Furthermore, over centuries religious institutions, like the Catholic and Protestant Churches, have been of great importance in terms of establishing rules and guidelines for behaving concerning the interaction of individuals. This holds true in some aspects also for financial issues. For example, Graeber (2011) shows how conflicts about financial issues have been already prevalent around the years the bible was written and that thus several passages in the bible also discuss debt and repaying cases.

More precisely, we highlight the diverging moralities of the two big Christian denominations: Catholicism and Protestantism. Catholicism is characterized by more diverse moral standards as the seriousness of the offense is negotiated in a less centralized manner namely by Priest after confession. This fostered a distinct forgiveness culture. We would hence expect that customer and bank mangers of this belief are less risk-averse. Moreover, the status of the Church is of stronger importance in the Catholic denomination, which promote loyalty. A factor that supports the business of local banks with their core business of relationship lending. Protestants, in turn, care more about rules and are more willing to invest resources in monitoring. Thus we would expect that banks in Protestant areas are less risky.

Accordingly, our project aims to present answers to the central research question: Do Catholicism and Protestantism influence banking behavior in Germany? Doing so, we are able to generate new insights into the relation of religion-induced attitudes and their impact on financial intermediation. We thereby add to the existing literature on religion and banking for the US (Adhikari and Agrawal, 2016) and to the literature about financial intermediation by banks in Germany (i.a. Hackethal, 2004; Koetter, 2013). The project also relates to the existing literature on Islamic finance (Baele et al., 2014; Beck et al., 2013).

Germany is an ideal region to give answers to our research question. The banking sector is characterized by many small and medium sized banks with a dominant local

customer base. Savings banks, for example, are bound to the *Regionalprinzip* which assigns each of its banks an own region and hence limits their credit business locally. Volksbanken, the cooperative banks, have a local focus written down in their statutes. On the other hand, concerning religion, Germany has a long tradition of Catholicism but was also the "homeland" to the Protestant Reformation. Nowadays Catholics and Protestants are of similar size and at the same time spread throughout the country. Interestingly, the country's rich religious history reveals incidents that give further insights into our research question. In fact, we will apply the distribution of important churches (Cathedrals, Dome, Münster) and a local Lord's religion in 1624 to approach reverse causality. In addition, the legal system and banking regulation is uniform across all German regions, small differences that might be prevalent across states (*the Bundesländer*) can be easily controlled for. Moreover, there are no structural breaks that often impede examinations in cross-country studies, with the exception of aftereffects of the German reunification (which we control for in the robustness part).

Our empirical analysis reveals that religious affiliation indeed impacts banks' risk taking. Banks in counties that are relatively dominated by Catholicism are riskier as measured by the distance to default (z-score). If the difference between the share of Catholics and the share of Protestants at a county's population increases by 50 percentage points banks become riskier by about 0.1% (measured by means of the z-score). As potential driving factors of the diverging risk performance we present evidence that banks in more Catholic areas have a higher return on assets, a stronger variance in these returns, a higher share on non-interest income and (yet less robust) a stronger credit growth. The findings take a range of controls into account and also turn out robust if reverse causality and measurement errors are taken into account. We conclude that Catholicism affects local social capital in such a way that banks are characterized by higher risk together with stronger growth and higher returns, whereas Protestantism inhibits a tendency promoting banking behavior that is more 'prudent'.

Our project is closest to Adhikari and Agrawal (2016). They were the first to analyze whether local religiosity matters for risk-taking by banks. Examining publicly-listed banks in the US, they find that banks in more religious areas exhibit lower stock return

volatility and lower tail risk. They do not distinguish different religious affiliations. Since in the US the Evangelical and Protestant churches hold a majority, we explore the situation in Germany and go one step further by adding a detailed analysis on the effect of Catholicism relative to Protestantism on banking.

The remainder of the chapter is structured as follows. Section 3.2 elaborates on values and preferences induced by Catholic denomination in comparison to the Protestant denomination and possible impacts on banking. Section 3.3 provides details on our identification approach and the data, including a description of our new established dataset on local Catholic and Protestant affiliation. Section 3.4 explains the results from our main regressions. Extensive robustness analyses are presented in section 3.5. Our instrumental variable approach for examining reverse causality is introduced in section 3.6. Finally, section 3.7 concludes.

3.2 Catholics, Protestants and Banks

The idea that religion matters for economic outcomes has a long tradition. It can be traced back at least to Max Weber's work on the Protestant work ethic (Weber, 1904). Beyond work ethic, also the effect on attitudes has been stressed and seems to be kind of common knowledge. For example, Barro (1999, p.1137) mentions in a parenthetically manner that "religious principles are dedicated, in part, toward curbing lavish expenditures and excessive debt". In addition, possible effects on the attitudes towards creditor rights induced by a country's religion are reported (Stulz and Williamson, 2003).

Yet, the direction and the size of the effects might be different for different denominations. Indeed, literature provides ample evidence suggesting that in general differences between Catholics and Protestants are prevalent. These differences concern characteristics and behavior, like the above-mentioned work ethic, but also trust, contributions to public goods, attitude toward private ownership and adherence to rules (Benjamin et al., 2016; Traunmüller, 2010; Guiso et al., 2003; Arruñada, 2010; Renneboog and Spaenjers, 2012).

Could the moralities of Catholicism and Protestantism thus also matter for banking? Indeed the core business of banking touches on many issues religion is concerned with;

establishing trust among people, creating rules that dampen moral hazard and enabling long-run relations characterized by stability are examples. They can be subsumed under the term delegated monitoring.[1] The size and efficiency of delegated monitoring, in turn, might be influenced by cultural factors. In general, yet, a detailed examination of the links between culture and delegated monitoring is challenging. Obviously, banks' screening and monitoring efforts are largely unobservable (De Haas and Van Horen, 2010). However, the outcomes of bank behavior are observable thus enabling us to analyze the link between religion and the observable bank outcomes.

What characterizes the diverging moralities between Catholics and Protestants, and how do they effect the business of banks? As introduced in chapter 2 the start of the Reformation by Martin Luther in 1517 was subsequently accompanied by establishing theological foundations for the new church named Protestantism. Especially, the four scolas (*sola gratia*, *sola fide*, *solus christus* and *sola scriptura*) determined the differentiation of Protestantism from Catholicism. As described en detail in chapter 2 and illustrated also in Figure 3.1, these theological foundations established diverging moralities. In this context, Catholicism is characterized by more diverse moral standards. We would thus expect that Catholics are less risk-averse. Empirical evidence to this expectation is added by Shu et al. (2012), who find for the US that mutual funds located in low- Protestant or high-Catholic areas exhibit significantly higher fund return volatilities. Similarly, Kumar et al. (2011), again for the US, find that gambling propensity to be stronger in regions with higher concentrations of Catholics relative to Protestants.[2] If such effects are prevalent in Germany as well, then we would expect that local banks in Catholic areas are more risky and, due to more activity in trading and derivatives, have a higher share of non-interest income.[3] Since we would expect that the higher risk is compensated by higher return, those banks should also generate higher returns on average assets.

[1] Diamond (1984) was among the first emphasizing that the banking industry in its core can be characterized as a form of delegated monitoring.

[2] In these regions, investors exhibit a stronger propensity to hold lottery-type stocks, broad-based employee stock option plans are more popular, the initial day return following an initial public offering is higher, and the magnitude of the negative lottery-stock premium is larger (Kumar et al., 2011).

[3] Even more, as the Germany in comparison to the US is a bank-based instead of a market-based financial system, hence banks have a higher share of total financial intermediation.

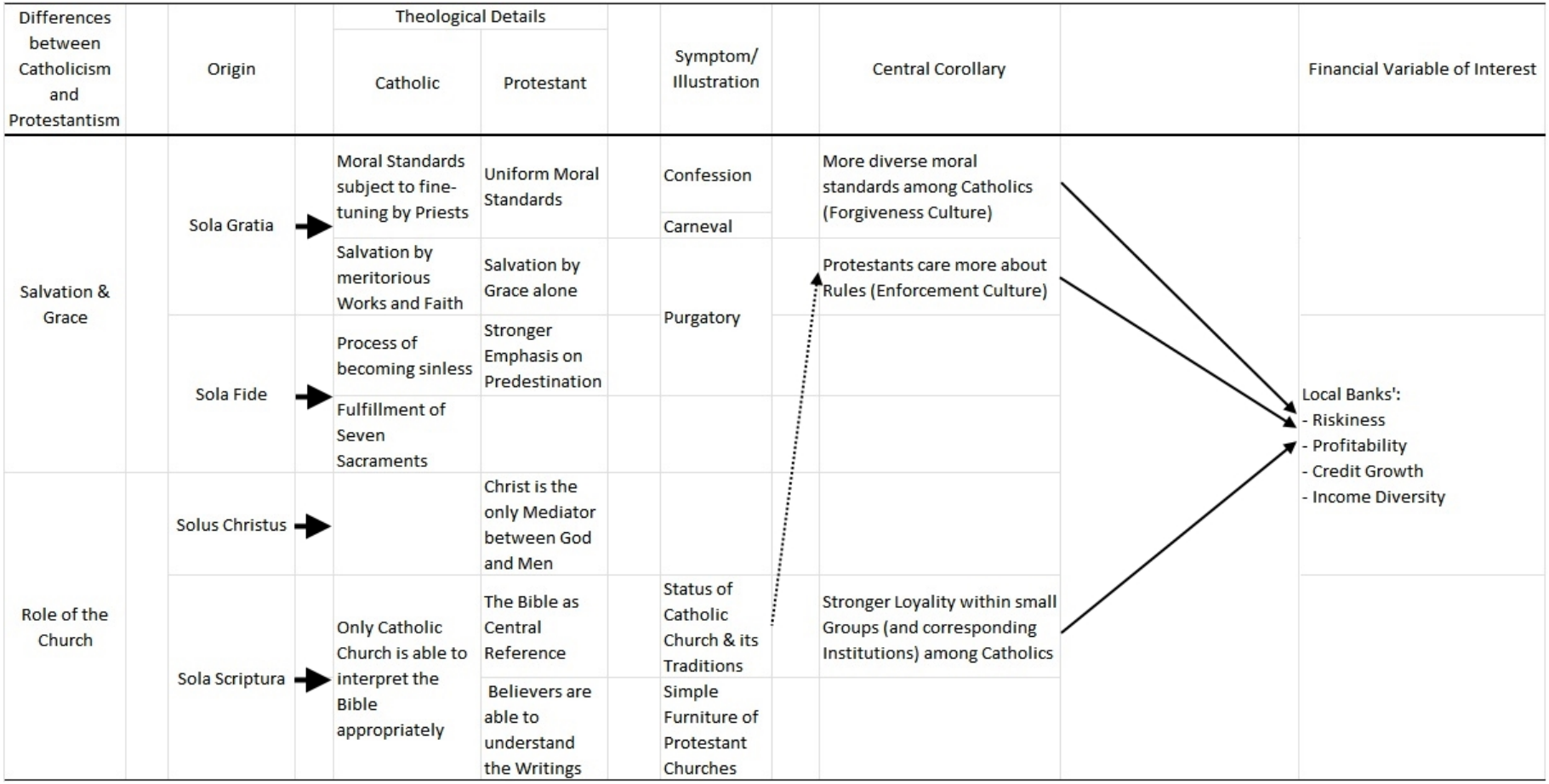


Figure 3.1: Differences between Catholicism and Protestantism and Effects on Local Banks
Source: Own illustration, based on findings by Arruñada (2010) and own research.

A further effect of Catholicism on banking could also stem from the fact that Catholics are used to be part of a big church with its traditions. According to Arruñada (2010) Catholics have a stronger loyalty within small groups. He reports that Catholic theology and practice facilitate personal transactions and that Catholicism is more protective of the family and small-group relationships. Banks characterized by relationship lending might benefit of or exploit such loyalty. For example the business model of cooperative banks emphasizes a feeling of solidarity and a tradition of helping each other.

Protestantism, in turn, might add an opposing effect. Its moralities are characterized by more uniform moral standards. The debasement of moral enforcement as conducted through the church is balanced by a stronger enforcement through legal institutions (Arruñada, 2010). Empirical evidence for this argument is provided by Arruñada (2010). He examined survey data and shows that Protestants indeed develop more reliable institutions for legal enforcement and are more willing to spend resources on monitoring and punishing other members of the community. Legal enforcement in Germany is conducted by public institutions, thus it should be homogeneous across the counties. However, it might well be that banks in more Protestant areas invest more resources in monitoring (which increases costs and decreases return) or due to the more intense screening better detect and thus reject more risky projects (that would make banks less risky).

Our central hypothesis can hence be summarized and stated as follows:

> The local presence of Catholic and Protestant moralities influence the performance of local banks. If an area is dominated more by Catholicism relative to Protestantism, then the local banks are riskier, have a higher return on assets, a higher credit growth and a higher share of non-interest income.

It has to be stressed that our analysis covers potential effects of religion on bank behavior from both the customer side as well as from the bank manager side.[4] Whereas our measure of local religiosity on the first view stresses the role of local customers, also effects of the local bank managers and, hence, their religion on the bank outcome are possible. For example, in the aftermath of the financial crisis there has been a

[4] The disposable data do not allow to disentangle both effects.

strong public debate that emphasized manager compensation and its effect on manager's incentives to take excessive risk.[5] And indeed there is evidence indicating a strong role of managers' style (Bertrand and Schoar, 2003; Hagendorff et al., 2016). Accordingly, banks' risk might well be explained to a larger extent by manager's fixed effects than other factors. Thus, it might well be that a bank manager's behavior is impacted by a personal cultural and religious background, which then is reflected in the bank's business behavior.

3.3 Research Design & Data

3.3.1 Research Design

We are interested in the effect of the local relative dominance of Catholicism relative to Protestantism on bank behavior. Accordingly we aim to regress different bank variables for bank i headquartered in county k at time t on the difference in the share of Catholics and Protestant, $\Delta(C, P)$, in county k at time t. Our main bank variable of interest is thereby the z-score.[6] In the regression we control for the share of local persons who are affiliated to another religion or are non-religious. We also control for individual bank features, especially the size of the bank, the banks' deposit ratio and type of the bank (Savings bank or cooperative bank).[7] Moreover, we control for other county-year variables that might influence an individual bank's risk. These are: the regional degree of bank competition, productivity, the age structure, the market size, the number of high-qualified employees, the ratio of women and the degree of urbanization. Moreover, as Rajan and Zingales (1998) have shown that financial dependence varies across industries, we also control for the relative importance of different industries within a county. To capture possible political impact factors, state-year fixed effects are included.[8] Clustering of the

[5] In this context Fahlenbrach and Stulz (2011) present evidence that compensation structure seems to be weakly related to banks performance during the crisis.

[6] The definition of the z-score is $log\left(\frac{RoAA+Equity/Assets}{\sigma_{RoAA}}\right)$.

[7] Perotti et al. (2009) indicate that the screening and monitoring intensity by banks depend on their funding.

[8] Other fixed effects especially bank-fixed effects are not feasible. Banks do not switch counties in our sample, hence a within bank analysis would analyze how the change of the relative share over time

standard errors in our baseline regression setup is done at the state level.[9] The results are robust to clustering on the county as well as on the bank level (see Appendix B.3).

$$\begin{aligned} Z - Score_{i,k,t} = c + \beta_1 \Delta(C,P)_{k,t} + \beta_2 Other/NonReligious_{i,t} \\ + \beta_3 BankControls_{i,t} + \beta_4 CountyControls_{k,t} \\ + \mu_{State \times year} + \epsilon_{i,k,t} \end{aligned} \tag{3.1}$$

In a next step, we aim to evaluate more detailed what factors drive the bank risk. Hence, we stepwise replace the z-score with its components i.e. the return on average assets, $RoAA_{i,k,t}$, the equity ratio, $Equity/Assets_{i,k,t}$, and the standard deviation of the return on average assets $\sigma^{RoAA}_{i,k,t}$. Moreover, we examine two further factors that are in strong relation to bank risk. These are year-on-year credit growth, $CreditGrowth_{i,k,t}$, and the share of non-interest income (amount of fees, trading, derivatives and asset sale income) in relation to the banks total assets, $NII/Assets_{i,k,t}$.

3.3.2 Bank Data

Data for banks are taken from the *Bureau van Dijk BankScope database* covering the years 2003 till 2012. As described above only banks that fall into the categorization of either being a cooperative bank or being a savings bank are kept.[10] Banks which later merged or ceased to exist have been included, however the observation for the pre-inactivity year has been dropped to avoid potential biased outliers. In the same context we furthermore follow the existing literature and dropped observations with extreme growth/decline of assets and loans (above 50%/ below -50%). Only unconsolidated statements, i.e., sub-

affects banks. Yet, this is not in our interest, even more as the central part of heterogeneity in our religion variable stems from cross-county variation.

[9] Most of our outcome variables are very stable over time. According to Petersen (2009), we need to account for autocorrelation of the standard errors over time within each bank (i.e. clustering at the bank level). However, banks within a county are also exposed to the same regional shocks, hence standard errors are most likely correlated between banks within a county and over time. The most conservative approach - which we apply -, however, is to consider that not only banks within a county but all banks in a state are correlated.

[10] Some cooperative banks are wrongly coded as savings bank in BankScope, we hence examined their name and status in detail and made corrections were necessary. Four banks were dropped as it is known that they are not predominantly local active (BBBank eG, Bank für Sozialwirtschaft, Deutsche Apotheker- und Ärztebank eG, S-Kreditpartner Gmbh).

sidiaries were kept. Finally, a winsorization at 0.01 was conducted. The coverage of the data is satisfying, a comparison to the official numbers on existing saving and cooperative banks from the official *Bankenstatistik* (e.g. Deutsche Bundesbank, 2012) reveals that our data includes, e.g. for the year 2012, 415 of the 423 existing Sparkassen and 1033 of the 1104 existing Volksbanken.[11] In terms of geographical coverage, the data enable an analysis for 390 of the 402 German counties.[12] The core of our analysis is thus based on 12119 bank-year observations.

3.3.3 Data on Catholics and Protestants

The 2011 census is used to obtain data on religious affiliation on county level. We are interested in the difference between the share of Catholics relative to the population per county and the corresponding share of Protestants, i.e. $\Delta(C, P)$. As can be seen in Figure 3.2, there is a pronounced heterogeneity both within Germany but also within states. In some counties, e.g. in East Bavaria the sum of Catholic majority is 84%, whereas in some counties in the Northwest the majority is -49% illustrating the dominance of Protestantism in this area.

To construct a panel we extrapolate the county observations of the year 2011 with the trend components of data from the Landeskirchen (Protestants) and Diözesen (Catholics) for the years 2003 till 2012.[13] As the church organizations also offered data on state level, each county-religion observations was assigned to the smallest area of the next highest level (i.e. Landeskirche or Diözese or state). In most cases this smallest area of the next level are the church districts. However, in some few cases, e.g. the Protestant *Nordkirche*, the church district area is bigger than the state area. Then the share of Protestants of the year 2011 in counties of this area has been extrapolated by their state's trend instead of the their Landeskirche trend. Furthermore, there were several

[11] A graphical representation, illustrating also the development over time is given in the Appendix B.1, Figure B.1.

[12] For possible banks headquartered in the other twelve counties – if existing – no bank data was reported in the database. Figure B.2 in the Appendix B.1 provides graphs on the number of saving banks and cooperative banks per county that are included in our analysis. For our research we use the cutting of the counties from the years 2011 onwards.

[13] The size and geographical cutting of these church district is depicted in Figure B.3 in Appendix B.1.

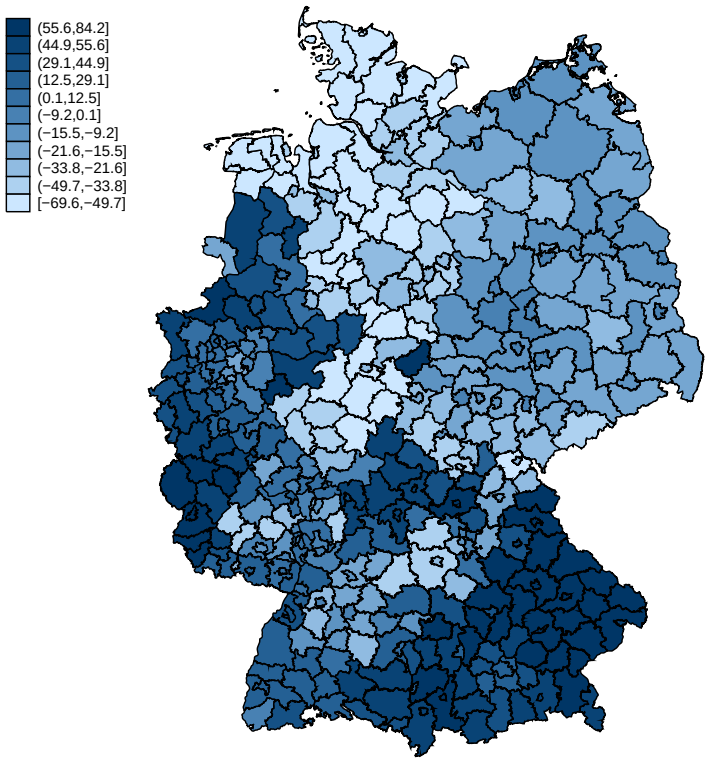


Figure 3.2: Share of Catholics minus share of Protestants ($\Delta(C, P)$) per county, 2011

cases where one county overlapps into more than one Landeskirche or Diözese. Due to data from *Evangelische Kirche Deutschlands* we had a key which municipality belongs to which county and Landeskirche/Diözese. Combining these data with data on population from *DeStatis* enabled us the computation of Landeskirche- and, respectively, Diözese-weighted county trends, thus factoring in this specificity. To enable to account for the share of persons who are neither Catholic nor Protestant, i.e. those belonging to another religious affiliation (Jews, Othodox, Muslims) or to none at all, we computed a variable named *Other/Non-Religious*.

3.3.4 Other Data on Counties

To tackle the issue of an omitted variable bias, we included a range of other control variables on the county level. Concerning banking competition the number of banks (saving, cooperative and commercial) per million inhabitants is included. It ranges from 1.2 till 77.3. As an alternative measure a Lerner-Index can be used, ranging from 0 to 1, with higher numbers implying greater market power. Concerning the average age of the population, the minimum is 34 years and the maximum is 47 years. The ratio of women among the population ranges from slightly above 49% up to 54%. The size of the local population is included (in logarithm) as a proxy for market size, the GDP per capital (also in logarithm) to account for local productivity. The ratio of highly qualifed within a county is considered as well. Moreover, urbanization-dummies identifying whether the area is a major city, an urban county, a rural county with agglomerations or only sparsely populated are factored in.

Table 3.1: Summary statistics

	N	Mean	S.D.	Min	Max
Ln(Z-score)	12119	4.986	1.352	2.103	8.648
RoAA (%)	12119	0.275	0.193	0.000	1.089
Equity Ratio (%)	12119	6.642	1.833	3.408	13.134
σ^{RoAA}	12119	0.105	0.159	0.001	0.999
Credit Growth (%)	12119	2.632	5.457	-14.286	33.996
Non-Int. Income / Total assets (%)	12119	0.891	0.331	0.113	2.141
$\Delta(C, P)$	3433	0.026	0.388	-0.749	0.901
Other/Non-Religious	3433	31.763	21.796	0.000	87.437
No. Banks per Mil.	3433	23.292	13.786	1.160	77.269
Lerner Index	3433	0.418	0.094	0.000	0.855
Ln(GDP p.c.)	3433	9.909	0.333	9.166	11.307
Average Age of Population	3433	40.680	1.783	34.876	47.334
Qualified	3433	4.288	3.272	0.600	25.700
Ln(Population Size)	3433	11.997	0.647	10.499	15.053
Female	3433	51.013	0.687	49.414	53.973
Major City	3433	0.170	0.376	0.000	1.000
Urban	3433	0.346	0.476	0.000	1.000
Rural	3433	0.251	0.434	0.000	1.000
Sparsely Pop.	3433	0.232	0.422	0.000	1.000
Agriculture	3433	0.014	0.014	0.000	0.079
Mining/Utility	3433	0.034	0.034	0.003	0.533
Manufacturing	3433	0.236	0.108	0.013	0.721
Construction	3433	0.050	0.021	0.007	0.196
Trade	3433	0.189	0.051	0.067	0.449
Finance	3433	0.245	0.051	0.077	0.506
Public	3433	0.231	0.069	0.056	0.529

This table reports the summary statistics of the sample which covers the years 2003 until 2012. The core of our analysis is based on 12119 bank-year and 3433 county-year observations.

3.4 Results

Our main interest is on the effect of religion on bank risk. Table 3.2 shows our results for z-score under 5 different specifications. In the first column the pure correlation between $\Delta(C, P)$ and z-score is shown. It can be seen that if the difference between Catholics and Protestants in a county increases by 0.1 (i.e. Catholics outweigh Protestants by an additional 10%), then on average the logarithm of the 'distance to default' of banks in this county decreases by 0.047.[14] The coefficient is statistically significant at the 1%-level. In the next column state-year fixed effects are included introducing our framework of conducting a 'within-state between-county' analysis. Then the baseline regression is augmented stepwise by bank controls (column 3), county controls (column 4) and industry controls (column 5). Even though the size of the coefficient decreases stepwise to 0.019, the statistical significance reduces only slightly, in the last column to the 5%-level. Concerning the significance of the controls, the following holds true. Banks with higher deposit ratios are less risky. Saving banks in general are less risky, too. If the population of a county is older on average than also its banks are more safer. The market size, i.e. the size of a counties population, in turn makes its banks riskier. If a counties agriculture sector increases relative to its public sector than its banks are more safe, whereas a large industry relative to the public sector ceteris paribus decreases the 'distance to default' of its counties banks. All other controls turn out to be not statistically significant. The latter holds also true for the GDP per capita and the number of banks per county.[15]

Next, we replace our left hand side variable z-score with its three components: the return on (average) assets (RoAA), the equity ratio and the rolling window last five years standard deviation of RoAA. Moreover, we include additionally year-on-year credit growth and the ratio of non-interest income relative to total assets as further left hand side variables.

The results are depicted in Table 3.3. They document a positive effect of local Catholi-

[14] The standard deviation of $\Delta(C, P)$ is 0.39.

[15] We also estimated a version whereby instead of using the number of banks per county as in the basic scenario we took the county-level banking competition measure, i.e. the Lerner-Index, constructed by Koetter (2013). The results for the religion variable are basically unchanged. Table B.2 in Appendix B.2 provides the estimation outcomes.

cism on the return on assets of this region's banks. If the difference between Catholics and Protestants in a county increases by 0.1 (i.e. Catholics outweigh Protestants by an additional 10%), then on average the return on assets (measured in %) increases by 0.002%. There is no statistical significant effect on the equity ratio, which is reasonable as the equity ratio is often determined by regulatory benchmarks. The coefficient for σ^{RoAA}, turns also out being positive and significant at the 5%-level. This indicates that even so 'Catholic banks' have a higher return on assets, this returns vary over time much more compared to Banks in areas that are dominated more by Protestantism. There is, however, no evidence that relatively more Catholic areas induce their banks to stronger growth of their loan books. The opposite holds true for the importance of the non-interest-income relative to total assets. An increase of $\Delta(C, P)$ by 0.1 leads to an rise of NII/assets (measured in %) by 0.011%.

Which control variables turn out of statistical significance in the regressions of the five risk components? RoAA is influenced positively by the importance of the local construction industry (relative to the public sector) and negatively by the bank size, the savings-bank-dummy, the age of the local population and if the county is urban (relative to being a major city). σ^{RoAA} decreases with the bank size, the average age and if the local mining/utility-industry rises (relative to the public sector). Credit growth reacts positive on the bank size, the ratio of women at the local population, when the county is rural or sparsely populated (relative to major cities). It is lower if the bank is a savings bank and the higher is the local average age. NII/assets rise with average local age and when the county is less urbanized. It decreases with the deposit ratio, local banking competition, a county's real GDP per capita, a county's population size and if the bank is a savings bank.

How big is the effect in terms of economic significance? To provide answers to this question, we provide insights from two approaches. First, we analyze the size of the coefficient of our main variable in terms of one standard deviation. Doing the same for all other coefficients then allows a relative comparison. The standardized coefficient for the relative share of Catholics concerning the z-score is (-)0.062 and thus lies slightly below the mean in the range of all significant right-hand-side coefficients which are:

deposit ratio (0.049), saving bank (0.110), age (0.077), agriculture (0.054), construction (-0.064).[16] This would indicate a non-negligible role for relative religious affiliation. As a second approach, we computed the R^2 of our regressions, once including and once excluding our religion variable. Afterwards this allows a comparison of the variation that can be explained and the contribution therein of religion. Under this approach the impact of religion is reported to be in tendency rather small, being 0.1% for z-score, 0.7% for the non-interest income share and zero or nearly zero for the others.[17]

[16] The results are similar for the other left-hand-side variables that are under examination. Table B.3 in Appendix B.2 provides the full statistics.
[17] The corresponding Table B.4 is given in Appendix B.2.

Table 3.2: Bank risk measured by z-score

	Z-Score				
	(1)	(2)	(3)	(4)	(5)
$\Delta(C, P)$	−0.473***	−0.448***	−0.349***	−0.245***	−0.192**
	(0.058)	(0.104)	(0.104)	(0.081)	(0.082)
Other/Non-Religious			0.003	0.004	0.005
			(0.003)	(0.003)	(0.003)
Ln(Bank Assets)			0.050	0.072	0.071
			(0.040)	(0.043)	(0.044)
Deposit ratio			0.007*	0.007*	0.008*
			(0.003)	(0.004)	(0.004)
Saving Bank			0.350**	0.314*	0.319*
			(0.160)	(0.154)	(0.155)
No. Banks per Mil.				0.002	0.002
				(0.003)	(0.003)
Ln(GDP p.c.)				−0.127	−0.241
				(0.145)	(0.160)
Avg. Age				0.061**	0.061**
				(0.027)	(0.026)
Qualified				0.005	0.009
				(0.008)	(0.011)
Ln(Pop.)				−0.109**	−0.107**
				(0.039)	(0.047)
Female				−0.042	−0.021
				(0.065)	(0.066)
Urban				0.206	0.198
				(0.118)	(0.127)
Rural				−0.008	−0.013
				(0.143)	(0.155)
Sparsely Pop.				−0.061	−0.046
				(0.136)	(0.167)
Agriculture					6.308***
					(1.575)
Mining/Utility					1.220
					(0.764)
Manufacturing					0.118
					(0.509)
Construction					−4.257***
					(1.085)
Trade					0.557
					(0.807)
Finance					−0.430
					(1.017)
State×Year FE	No	Yes	Yes	Yes	Yes
Observations	12119	12119	12119	12119	12119
Adj. R^2	0.018	0.010	0.031	0.038	0.042
Banks	1648	1648	1648	1648	1648
Counties	390	390	390	390	390
States	16	16	16	16	16

This table reports the effect on bank risk taking measure by Z-score. *, **, and * denote significance at the 10, 5, and 1 percent level, respectively.**

Table 3.3: Bank risk components

	RoAA	Equity/Assets	σ^{RoAA}	Credit Growth	NII/Assets
$\Delta(C, P)$	0.022**	−0.000	0.027**	0.572	0.106***
	(0.009)	(0.073)	(0.011)	(0.386)	(0.026)
Other/Non-Religious	−0.001	0.011	−0.001	0.009	0.000
	(0.001)	(0.007)	(0.000)	(0.026)	(0.001)
Ln(Bank Assets)	−0.013***	−0.305***	−0.012***	0.350***	−0.010
	(0.004)	(0.045)	(0.003)	(0.102)	(0.017)
Deposit ratio	0.001	0.020***	−0.000	−0.024	−0.002*
	(0.000)	(0.006)	(0.000)	(0.014)	(0.001)
Saving Bank	−0.113***	−0.196	−0.053	−1.752***	−0.234***
	(0.022)	(0.351)	(0.031)	(0.488)	(0.044)
No. Banks per Mil.	−0.000	0.000	−0.000	−0.008	−0.002*
	(0.000)	(0.006)	(0.000)	(0.016)	(0.001)
Ln(GDP p.c.)	−0.004	−0.150	0.015	0.297	−0.159***
	(0.034)	(0.540)	(0.020)	(0.301)	(0.045)
Avg. Age	−0.017**	−0.064**	−0.007***	−0.506***	0.019*
	(0.006)	(0.024)	(0.002)	(0.108)	(0.009)
Qualified	0.001	−0.003	−0.001	0.065***	0.009
	(0.002)	(0.044)	(0.001)	(0.017)	(0.006)
Ln(Pop.)	0.007	−0.242**	−0.001	0.271	−0.054**
	(0.005)	(0.087)	(0.003)	(0.331)	(0.022)
Female	0.005	−0.030	−0.002	0.474***	0.019
	(0.013)	(0.129)	(0.005)	(0.132)	(0.022)
Urban	−0.018*	0.179	−0.022	0.431*	0.068*
	(0.009)	(0.109)	(0.018)	(0.215)	(0.032)
Rural	−0.005	0.041	−0.014	0.819***	0.076**
	(0.011)	(0.116)	(0.016)	(0.253)	(0.028)
Sparsely Pop.	−0.016	0.013	−0.017	0.904***	0.105***
	(0.024)	(0.207)	(0.014)	(0.264)	(0.034)
Agriculture	−0.099	7.817**	−0.445*	6.038	−0.591
	(0.456)	(3.636)	(0.248)	(8.703)	(1.027)
Mining/Utility	0.011	−0.689	−0.196**	−1.137	0.135
	(0.115)	(1.891)	(0.086)	(4.186)	(0.185)
Manufacturing	0.039	−0.534	−0.015	−1.229	−0.074
	(0.086)	(1.713)	(0.064)	(1.993)	(0.130)
Construction	0.786***	2.765	0.345	14.368	0.252
	(0.165)	(1.644)	(0.283)	(9.049)	(0.694)
Trade	0.045	−0.500	−0.000	−0.161	0.084
	(0.105)	(1.190)	(0.082)	(3.603)	(0.220)
Finance	−0.039	−1.028	0.096	−2.308	−0.377*
	(0.140)	(1.672)	(0.129)	(2.309)	(0.202)
Observations	12119	12119	12119	12119	12119
Adj. R^2	0.156	0.132	0.068	0.035	0.163
Banks	1650	1650	1650	1650	1650
Counties	390	390	390	390	390
States	16	16	16	16	16

This table reports the effect on the components of bank risk. *, **, and * denote significance at the 10, 5, and 1 percent level, respectively.**

3.5 Robustness I

To analyze the sensitivity of our findings we conduct several additional regressions in which we vary specific factors. The results for our main variables of interest stay unchanged to these specifications. One exception, however, is credit growth. Its coefficient was insignificant in our baseline regression (often with p-values above but close to 10%). Yet, for some of the following specifications a statistically significant impact of the relative dominance of Catholicism on credit growth is revealed. Another exception is the return on average assets which becomes statistically insignificant in two specifications.

3.5.1 Construction of Religion Data

In a first step we are interested to examine whether the findings are sensitive to the religion data that we use and how we have constructed them. To see whether the effect of religion on banking is driven by the time variation, we collapse our sample along the time dimension thereby computing the mean values for all variables across the years 2003-2012. This enables a 'pure cross-section analysis' across banks. Table 3.4 shows the results remain robust.

Table 3.4: Bank Cross-Section Analysis

	Z-Score	RoAA	Equity/Assets	σ^{RoAA}	Credit Growth	NII/Assets
$\Delta(C,P)$	−0.238***	0.033***	0.153	0.029***	1.312***	0.092***
	(0.072)	(0.007)	(0.113)	(0.010)	(0.227)	(0.029)
Observations	1648	1648	1648	1648	1648	1648
Adj. R^2	0.057	0.228	0.177	0.087	0.096	0.182

This table reports the effect on z-score and the components of bank risk. For each observed bank the mean over time has been computed enabling a bank cross-section analysis. *, **, and * denote significance at the 10, 5, and 1 percent level, respectively.**

As some counties belong to the same Landeskirche and diocese, i.e. church district area, their trend of differences in religious shares, i.e. $\Delta(C,P)$, is the same (The level does vary, if it was different in 2011). Even most of this cross-section correlation is 'captured' in our conservative clustering baseline setting, i.e. clustering at the state level, an additional robust check is conducted in which we cluster the standard errors on the overlapping Landeskirche/Diocese-level. The results remain robust (see Table 3.5).

Table 3.5: Clustering on the church district level

	Z-Score	RoAA	Equity/Assets	σ^{RoAA}	Credit Growth	NII/Assets
$\Delta(C,P)$	−0.192*	0.022*	−0.000	0.027**	0.572*	0.106***
	(0.100)	(0.013)	(0.171)	(0.011)	(0.311)	(0.028)
Observations	12119	12119	12119	12119	12119	12119
Adj. R^2	0.042	0.156	0.132	0.068	0.035	0.163

This table reports the effect on z-score and the components of bank risk. Clustering is now done on the overlapping church districts level. *, **, and * denote significance at the 10, 5, and 1 percent level, respectively.**

As a third check we redefine our religion data in such a way that the dominant local religion, i.e. Catholic or Protestant, is defined by a dummy variable. Hence, instead of using the difference between the share of Catholics and the share of Protestants per county, we construct a dummy variable that takes the value of one if a counties majority is Catholic and zero if the counties majority is Protestant. As can be seen in Table 3.6 the results, with the exception of RoAA, remain robust.

Table 3.6: Alternative Religion Variable

	Z-Score	RoAA	Equity/Assets	σ^{RoAA}	Credit Growth	NII/Assets
Catholic Majority	−0.072***	0.004	0.045	0.010**	0.376	0.054***
	(0.023)	(0.003)	(0.029)	(0.004)	(0.225)	(0.009)
Observations	12119	12119	12119	12119	12119	12119
Adj. R^2	0.041	0.155	0.132	0.067	0.035	0.160

This table reports the effect on z-score and the components of bank risk. Religion is now a dummy variable depicting whether the majority of a county is Catholic (1) or Protestant (0). *, **, and * denote significance at the 10, 5, and 1 percent level, respectively.**

3.5.2 Sub-Samples

In a next step, we analyze the issue of East/West-Germany. For a long time, i.e. from 1945 till 1990, the role and development of the Catholic and Protestant Church has been of great divergence between West Germany (i.e. the Federal Republic of Germany: FRG) and East Germany (i.e. the German Democratic Republic: GDR). Many Christians had been opponents to the Nazi movements and partly reduced activities in politics during that time. After the break-down of the Nazi regime and World War II Christian institu-

tions have played a big role in reestablishing democracy in the RFG. Religion has also been positively announced in the constitution, and the state offered and established the service to collect the obligatory church taxes. Many social institutions like hospitals, kindergartens and schools have been run by religious institutions. In the GDR the situation was totally different. The communist regime fought against religious institutions in many ways. The outcomes of these incidents are prevalent till today: the number of religious affiliated persons is of much lower number in the areas of the former GDR compared to the areas of the old FRG. We hypothesize that our effect should be more prevalent in the area of the old FRG as local social capital should there have been more influenced by the respective religious attitudes. Table 3.7 shows the corresponding results.

Table 3.7: Analysis of West-German Banks

	Z-Score	RoAA	Equity/Assets	σ^{RoAA}	Credit Growth	NII/Assets
$\Delta(C,P)$	−0.158*	0.018	0.026	0.027**	0.377	0.118***
	(0.076)	(0.010)	(0.083)	(0.010)	(0.454)	(0.024)
Observations	11007	11007	11007	11007	11007	11007
Adj. R^2	0.061	0.178	0.144	0.082	0.038	0.154

This table reports the effect on z-score and the components of bank risk. Only banks that are headquartered in the area of former West-Germany (excl. Berlin) are considered. *, **, and * denote significance at the 10, 5, and 1 percent level, respectively.**

As a final step, we had again a closer look on the type of banks that are included in our sample. Among the 1648 banks there are nine banks which are either owned by a clerical organization or emphasize a possible central role of a specific type of religious/ethical thinking in their bank business model (e.g. by their name). As we examine mainly the effects of local religiosity, those banks might lead to a bias in our results. Indeed, Karl (2015) has shown that in general alternative banks (e.g. ethical, social or sustainable banking) are significantly more stable (in terms of z-score) than conventional counterparts. Hence, we aimed to test our results if those nine banks are excluded from the sample.[18] The results are depicted in Table 3.8. There is no change in terms of

[18] Those nine banks are: Evangelische Bank eG, Bank im Bistum Essen eG, Pax - Bank eG, DKM Darlehnskasse Muenster eG, Bank fuer Kirche und Caritas eG, Spar- Und Kreditbank des Bundes Freier Evangelischer Gemeinden, Spar-und Kreditbank Evangelisch-Freikirchlicher Gemeinden eG, Evangelische Kreditgenossenschaft eG, LIGA Bank eG.

significance, there is also no remarkable change in terms of the size of those coefficients. This is not surprising as these 'religous banks' constitute a very small number among the number of banks under observation. Indeed, due to their exclusion the original 12119 bank-year observations were only reduced by 71.

Table 3.8: Excluding Banks owned by Clerical Organizations and Banks with a distinct religious Bank Business Model

	Z-Score	RoAA	Equity/Assets	σ^{RoAA}	Credit Growth	NII/Assets
$\Delta(C,P)$	−0.195**	0.021**	−0.004	0.028**	0.573	0.107***
	(0.083)	(0.009)	(0.072)	(0.010)	(0.371)	(0.027)
Observations	12048	12048	12048	12048	12048	12048
Adj. R^2	0.042	0.157	0.128	0.069	0.034	0.170

This table reports the effect on z-score and the components of bank risk. Banks which are either owned by a clerical organization or emphasize a possible central role of a specific type of religious/ethical thinking in their bank business model are excluded. *, **, and * denote significance at the 10, 5, and 1 percent level, respectively.**

3.6 Robustness II: Reverse Causality

In the next step, we discuss a possible issue of reverse causality. Chapter 2 has examined how religion can impact households in their financial decision making. It was pointed out that the effect of local denomination on over-indebtedness of households might underlie an issue of reverse causality that has to be dealt with. We believe a similar issue might be prevalent concerning banks. The general point is that an effect of bank behavior on religious affiliation cannot be fully excluded. For example, the theory of secularization argues that the importance of religion decreases with economic development (i.a. Höhener and Schaltegger, 2012). Hence, under the assumption that financial intermediation is correlated to economic development (i.a. Levine, 2005), areas with higher credit interactions would exhibit looser religious affiliations. If this would be the mechanism that drives our findings, then the results presented before would just capture the effect of local financial development on importance attached to religion.

To tackle this issue and provide more evidence that it is the 'deep parameter' religion that impacts local finance, we apply two approaches. In the first one we repeat our

baseline panel regression, however, we lag all time-varying right-hand-side variables by one year. As can be seen in Table 3.9 the core results are robust.

Table 3.9: Analysis with lagged Religion, Bank and County Controls

	Z-Score	RoAA	Equity/Assets	σ^{RoAA}	Credit Growth	NII/Assets
$\Delta(C,P)$	−0.173**	0.022*	0.020	0.028**	0.639	0.100***
	(0.079)	(0.011)	(0.079)	(0.012)	(0.444)	(0.025)
Observations	10370	10370	10370	10370	10370	10370
Adj. R^2	0.061	0.162	0.125	0.080	0.039	0.161

This table reports the effect on z-score and the components of bank risk. All time-varying explaining variables are lagged by one year. *, **, and * denote significance at the 10, 5, and 1 percent level, respectively.**

The second approach makes use of instrumental variables. This approach is also recommendable as it does not only approach reverse causality issues but can also be understood as a remedy to tackle measurement errors (see also subsection 3.5.1). An instrumental variable approach is generally regarded as valid, if two central criteria are fulfilled: instrument relevance & instrument exogeneity. Hence, before the regression results are presented, we first elaborate more detailed on the instruments we apply, thereby discussing the criteria of instrument relevance. Moreover, we provide both reasoning and statistical insights on whether the instrument might be impacted by bank behavior, thus dealing with the criteria of instrument exogeneity.

As in Chapter 2, two types of instruments are used, one from a purely historical context: *Religion of a territorial lord in 1624*, and one from a geographical context: *the distance to important churches i.e. Cathedrals, Dome, Münster*.

The *religion of a territorial lord in 1624* illustrates the fragmentation of religion across Germany in the aftermath of the Thirty Years' War. The Peace of Augsburg in 1555 and the Peace of Westphalia in 1648 established the principle 'cuius regio, eius religio' ("whose realm, his religion") according to whom the religion of a territorial lord became the official religion in his state and, therefore, the religion of all people living within its confines.[19] Since religion of individuals is often inherited by parents the instrument has the potential of relevance. The latter holds also true for the second instrument. Churches play a

[19] The instrument has been established and introduced into the economic literature by Spenkuch (2011).

crucial and persistent role when it comes to spreading and renewing belief. Moreover, a circular dispersion around the religious center due to costs of traveling and of information diffusion through space is likely (see also Becker and Woessmann, 2009b). In general, the importance of impressing churches for spreading and renewing faith of the local population might be valid both spiritually and administratively.[20]

Both instruments also fulfill the criteria of instrument exogeneity. This is most obvious for *Religion of a territorial lord in 1624*. At the times the Peace of Westphalia was formulated, i.e. in 1648, none of the savings and cooperative banks has been existing yet.[21] Yet, the issue of exogeneity might be less obvious concerning *the distance to important churches i.e. Cathedrals, Dome, Münster*. Accordingly, local financial facilities might have had a positive impact on whether such tall and impressing churches of the type Dom or Münster have been built. Yet a more detailed analysis - that applies both reasoning and statistical evidence - shows that a structural decisive link going from the banks of our sample to the construction of those churches is not existing. Oldenbourg (1968) examines the origination of cathedrals in Western Europe. She comes to the conclusion that the size and pomp of cathedrals reveals a couple of very secular motives, for example, the arrogant proudness of the bishop or abbot under whose patronage the construction took place. Such proudness should be expected to be of very idiosyncratic nature. A statistical analysis furthermore shows that for the large majority of banks ($\approx 80\%$) it holds true that the start of the construction of the closest nearby important church began before the bank had been established (The corresponding graph can be seen in Figure B.5 in Appendix B.4). Accordingly, the possibility that those banks did decisively influence the establishment of important churches has to be refused. Even those important churches which have been built after the establishment of the local bank are – as the others – property of the dioceses and Landeskirchen.[22] It is widely known that in

[20] For a more extensive discussion on how important churches affect local religious affiliation see chapter 2.

[21] A fact, that can be documented by looking at the distribution of the foundation years of the banks in our sample (as far as available). The corresponding graphical analysis is presented in Figure B.4 in Appendix B.4.

[22] Landeskirchen is the official name of Protestant church district areas. Conceptually, they are similar to dioceses (their Catholic counterparts), however, geographically they are not congruent (see also Figure B.3 in Appendix B.1).

Germany the dioceses and Landeskirchen are very wealthy i.a. because of hugh land and estate ownership. They are hence not dependent on local finance. Even if they would temporarily be short of liquidity, due to their collateral it can be assumed that they would get credit also by non-local finance suppliers. Summing up, we see basically no reason that the behaviour of Sparkassen and Volksbanken could have decisively determined either whether a Lord in 1624 had adopted a Catholic or Protestant belief nor whether a large important church of the type Dom or Münster had been built.

Figure 3.3 provides an geographical overview of the applied instruments, Table 3.10 the corresponding summary statistics. A graphical illustration of the decreasing degree of religious affiliation with increasing circular distance to an important church at the example of the Regierungsbezirk Tübingen is presented in Figure A.1 in Appendix B.4.

Table 3.10: Instruments: Summary statistics

	N	Mean	Min	Max
Catholic Lord in 1624	390	0.36	0.00	1.00
Distance to next Important Catholic Church	390	30.70	0.00	202.14
Distance to next Important Protestant Church	390	33.06	0.00	139.13

This table reports the summary statistics of the applied instruments. In Germany there are in total 402 counties, however, in our bank data no headquarter of a bank has been reported for twelve counties.

The approach can be also summed up in terms of research design as introduced above in equation 3.1 (section 3.3). The general aim is to detect the exogenous part of $\Delta(C,P)_{k,t}$, i.e. $\widehat{\Delta(C,P)}_{k,t}$. Therefore, we instrument the possible endogenous relative share of Catholics with three exogenous variables: a dummy variable on the religion of a territorial lord in 1624 (Catholic=1, mixed =0.5, Protestant =0), the distance of that county (in kilometers) to the next important Catholic church and the distance of that county to the next important Protestant church.

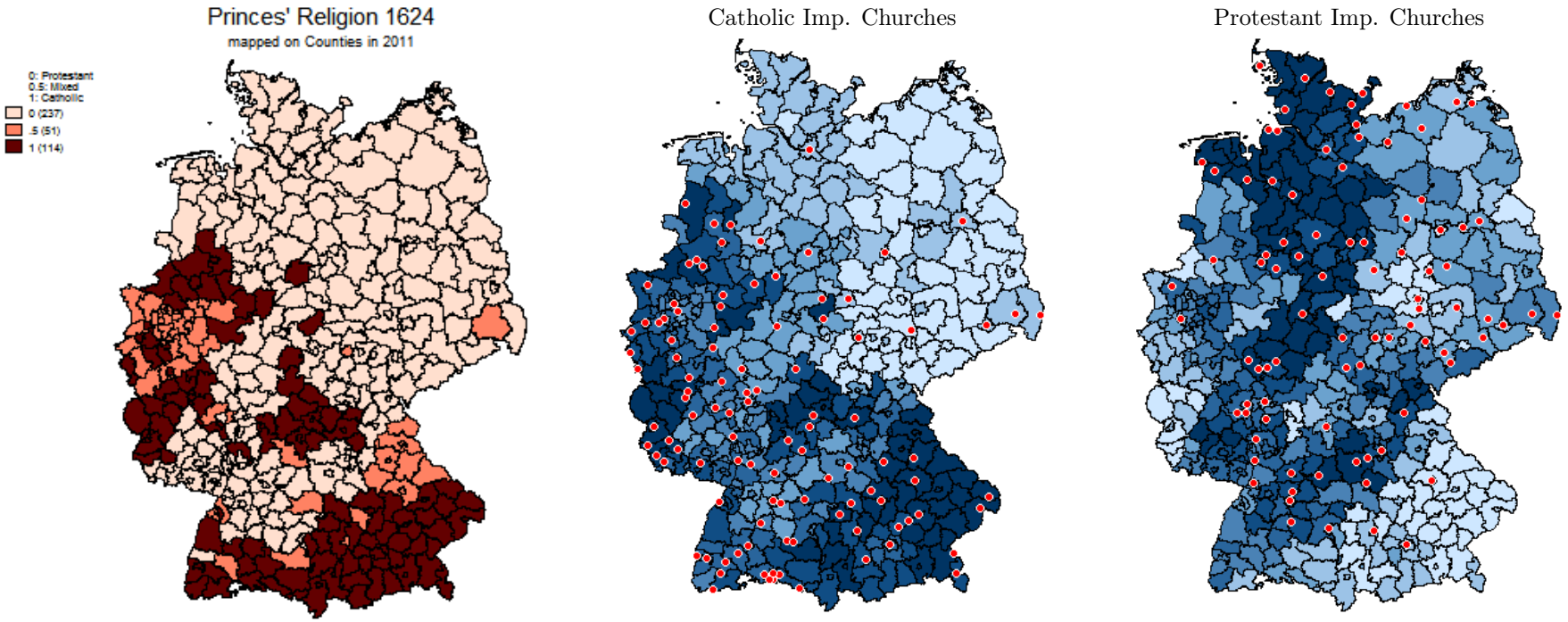


Figure 3.3: Instruments: Religion of a Territorial Lord in 1624 & Important Churches

In the first figure the religion of the territorial lord in 1624 is mapped on the 402 existing counties in 2011. In 1624 more than a thousand independent territories were in existence. Accordingly, counties that are composed of territories of nonuniform religiousness are classified as mixed. The other two figures map the municipalities that are home to an important church within the German counties (the red dots). For Catholics there are 110 important churches in 105 municipalities in 95 counties. For Protestants 89 important churches in 83 municipalities in 77 counties have been identified. The shading reflects the share of persons belonging to the respective persuasion for the year 2011. The darker the shading, the higher is the population with a Catholic or Protestant affiliation.

$$\begin{aligned}\Delta(C,P)_{k,t} = \gamma_1 \text{Catholic Lord in } 1624_k - \gamma_2 \text{Distance to Imp. Catholic Church}_k \\ + \gamma_3 \text{Distance to Imp. Protestant Church}_k + \beta_1 BankControls_{i,t} \\ + \beta_2 CountyControls_{k,t} + \mu_{State \times year} + \epsilon_{i,k,t}\end{aligned} \tag{3.2}$$

Table 3.11 shows the outcome of the first stage regression. It can be seen that all three instruments have strong explaining power. If the local Lord in 1624 had been Catholic, on average the share of Catholics relative to the share of Protestants is 0.30 higher. And for each additional 100 kilometer a county is more distant to an important Catholic church, its share decreases by 0.27, whereas it increases by 0.25 for each 100 kilometer distance to an equivalent important Protestant church. Further test statistics also confirm the eligibility of the suggested and applied instruments. The Sanderson-Windmeijer F-statistic is 45.13 giving evidence that our endogenous regressor is not weakly identified. The p-value of the Sanderson-Windmeijer chi-squared statistic is 0.00, indicating that the null of our endogenous regressor being underidentified has to be rejected.

Table 3.11: IV (2SLS) estimation: 1st-stage results

	$\Delta(C,P)$
Catholic Lord in 1624	0.3047***
Distance to next Important Catholic Church	-0.0027***
Distance to next Important Protestant Church	0.0025**
SW F-statistic	44.13
SW chi-squared statistic p-value	0.00
Observations	12119

This table reports the coefficients of the instruments and further test statistics of the first-stage regression of our 2SLS approach. *, **, and * denote significance at the 10, 5, and 1 percent level, respectively. The full table of the first-stage regression can be seen in Table B.7 in Appendix B.4.**

Results of the 2nd-stage are presented in Table 3.12. The findings concerning profitability, the variance of returns and the share of the share of the non-interest income are of nearly identical size and statistical significance to those in the baseline regressions. We see this as evidence, that for those bank performance indicators the documented effects of Catholic and Protestant moralities on banks' business are robust, even if re-

verse causality is taken into account. The findings on z-score and on the quity-ratio, however, are less definite. We find again a statistical significant negative effect of the local relative importance of Catholicism on a banks distance to default. Yet, the ratio of persons belonging to other religious affiliation or being non-religious is also reported to have statistical significant positive but very small impact. A potential explanation for this puzzle might be that the variable also captures Free Evangelicals.[23] This group is rather small but incorporates all Protestant moralities. This would bias the variable of Other/Non-Religious slightly towards Protestantism. A further puzzle is the same finding for the equity ratio of a bank. Besides the variable Other/Non-Religious also the variable $\Delta(C, P)$ is reported to be of positive and statistical significance. We conclude, that even though the analysis on reverse causality cannot confirm the results form the baseline regression analysis fully, they also do not reject our baseline research hypothesis either (the exception is again credit growth).

Table 3.12: IV (2SLS) estimation: 2nd-stage results

	Z-Score	RoAA	Equity/Assets	σ^{RoAA}	Credit Growth	NII/Assets
$\widehat{\Delta(C,P)}$	−0.124**	0.045***	0.303*	0.025***	0.480	0.205***
	(0.055)	(0.015)	(0.163)	(0.009)	(0.629)	(0.042)
Observations	12119	12119	12119	12119	12119	12119
Adj. R^2	0.132	0.237	0.349	0.160	0.152	0.328

This table reports the effect on z-score and the components of bank risk. *, **, and * denote significance at the 10, 5, and 1 percent level, respectively. The full table of the second-stage regression can be seen in Table B.8 in Appendix B.4.**

3.7 Conclusion

Culture might impact financial intermediation. In this research context we examined whether religion-induced moralities – forming a central aspect in culture – impact local social capital in such a way that a statistically significant effect on banking behavior can be detected. We established a new dataset that reports the share of either Catholic or

[23] Their time trend is difficult to capture, as they do not provide statistical information on regional distribution and over time. To construct our panel, we hence could not take them further into account.

Protestant affiliated inhabitants across the 402 German counties for the years 2003 till 2012. Our baseline panel regression afterwards have shown that indeed banks in counties that are relatively more dominated by Catholicism behave more risky, as their distance to defaut, i.e. their z-score, is lower. This behavior is founded by more volatile returns on assets as well as higher non-interest income. Some, yet weaker, evidence points to the fact that those banks also grow their loan books more rapidly, i.e. being characterized by stronger credit growth. There is also some evidence that this higher risk is accompanied by higher returns. We control for several bank-specific and county-specific variables to minimize a potential problem of an omitted variable bias. We presented evidence that our results are robust to several robustness specifications. In a further step, we also applied instrumental variables enabling an even more rigid tackling of potential issues like reverse causality and measurement error.

The documented effect of local Catholicism and Protestantism can be rationalized with the theological foundations of both denominations. Accordingly, Catholicism is characterized by more diverse moral standards yielding a reduced risk-aversion. Moreover, loyalty, which is fostered by the Catholic church among its followers might prepare a beneficial soil for relationship lending. Protestants, in turn, care more about rules and are more willing to invest resources in monitoring. Thus, a cultural might originate in which very risky projects are rejected earlier.

Whereas these findings foremost emphasize the existence of effect of culture on financial intermediation, they might also be relevant for regulation. On the one side they make aware of the to some small degree limited influence of regulation, as cultural values tend to develop over centuries. On the other hand they might interplay with and, hence, strengthen regulation, if local cultural norms are considered in a decentralized, i.e. a non-'One Size Fits All' regulation approach. Further research is yet needed to enable an evaluation of the relative size of the effect of informal rules relative to formal rules and to shed more light on the issue whether bank managers' or customers' Catholic and Protestants moralities matter more.

Chapter 4

The Effects of Fiscal Policy in an Estimated DSGE Model – The Case of the German Stimulus Packages during the Great Recession

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4.1 Introduction

The recession of 2008 and 2009 was the most severe contraction in Germany since the Second World War. Gross domestic product (GDP) fell by 5.1 percent in 2009, and the negative output gap amounted to 5 percent, a level that had not been reached since the 1973 oil crisis (Institut für Wirtschaftsforschung Halle & Kiel Economics, 2015). A number of other countries faced severe recessions as well. Consequently, there has been a revival of the discussion of the effects of fiscal stimulus packages on economic activity.

The origination of the crisis was in the financial sector. Consequently, financial support for individual banks and the banking sector overall was the initial focus, e.g., liquidity injections, loan guarantees, capital injections, asset purchases and nationalization. However, in light of anemic real growth and growth prospects, measures to counteract the

effects on the real economy gained prominence.

Prior to the year 2009, fiscal stimulus packages were regarded skeptically. Implementation lags as well as effectiveness lags often led to a pro-cyclical impact. Moreover, the effects of fiscal stimuli on the business cycle were not readily apparent both from a theoretical and empirical perspective. Monetary policy has been given a primary role in business cycle stabilization, but it has faced increasing constraints given the approaching zero lower interest rate bound.[1] Moreover, because of high and persistent underutilization of production capacity, potential adverse crowding-out effects from higher prices and interest rates induced by expansive fiscal policy became increasingly unlikely.

Accordingly, the German parliament enacted a series of measures to reduce the tax burden, increase social security transfers and spur investment; the 2009 and 2010 stimulus packages were the most prominent of these measures. In fact, discretionary fiscal policies during this time amounted to 104 billion euros.

The recessionary period lasted a relatively short period of time. In the spring of 2009, production growth was again positive. The recovery that followed was strong; in early 2011, the pre-crisis output level had been reached. Thus, the recovery was stronger than was expected in 2009.[2] However, the degree to which the recovery can be attributed to stimulus measures cannot be answered in a straightforward manner, and this question deserves further consideration.

This project contributes to the literature by systematically documenting the stimulus packages that were passed on the German economy from 2009 till 2012 and providing a detailed quantitative evaluation of their effects within a dynamic stochastic general equilibrium (DSGE) model. Besides evaluating the contributions of fiscal measures in comparison to other factors such as preference shocks and technology shocks, our approach additionally allows to analyze the effectiveness of different fiscal instruments relative to each other and hence enables to learn about suitable applications of these instrument in future recessions. To do so, we specify a rich but parsimonious open-economy DSGE model that distinguishes discretionary fiscal policy effects from those caused by auto-

[1] Unconventional monetary policies might provide a remedy in such a situation.
[2] See Projektgruppe Gemeinschaftsdiagnose (2009a,b) for macroeconomic forecasts of that time.

matic stabilizers. We use the benchmark model of Smets and Wouters (2003) and extend it by including non-optimizing households and foreign trade; in particular, we incorporate the fiscal authority in a rich way. In addition to public debt, we also account for three public income variables, i.e., consumption, capital and wage taxes, and three expenditure variables, namely, public consumption, public investment and transfers. Our work also borrows inspiration from Gali et al. (2007), who were the first to incorporate non-Ricardian ('rule-of-thumb') consumers who have no access to financial markets into a standard New-Keynesian general equilibrium model. The empirical evidence for the existence of such types of households is provided by Campbell and Mankiw (1989) and Zeldes (1989), for example.[3] The model is estimated with Bayesian techniques for German quarterly data from 1999 to 2012.

The results reveal a positive albeit small contribution from discretionary fiscal policies on the cyclical output component during the Great Recession. At maximum, the effect amounted to 0.8 percentage points. In light of the 5 percent decline in GDP, fiscal measures helped to offset the decline to some degree. However, given the impact of foreign and private shocks, in particular investment and preferences, fiscal policy proved to be of minor importance. In addition, its effects on output are estimated to have been the largest when the economy was already growing again.

A certain amount of research has been devoted to the estimation of DSGE models featuring a detailed fiscal sector prior to the financial crisis (e.g. Ratto et al. (2009)). With the subsequent implementation of stimulus packages, analysis of these measures has become more widespread. The domestic effects of fiscal stimulus packages have been evaluated by Coenen et al. (2012), among others. They demonstrate the effects of fiscal policies based on seven structural DSGE models used by policy-making institutions. The same holds true for the work of Cogan et al. (2010), who estimate a similar model for the United States; Bhattarai and Trzeciakiewicz (2017) conduct a comparable analysis for the United Kingdom. Gadatsch et al. (2015) analyze the effects of the German stimulus

[3] Further evidence or explanations for the motives of rule-of-thumb behavior are presented by Angeletos et al. (2001); Campbell and Mankiw (1990, 1991); Carroll (2001); Carroll and Kimball (2008); Coenen and Straub (2005). In addition, DSGE models with rule-of-thumb households have been used to identify fiscal policy shocks in structural VAR models (e.g. Kriwoluzky (2012)).

measures, however, with a particular focus on their international transmission. Cwik (2012) examines the macroeconomic implications of fiscal consolidation in the context of the newly introduced "debt brake". Our work takes place within a context of substantial literature on fiscal policies dealing inter alia with cross-country spillovers (Corsetti et al., 2010), the effect of crisis times (Müller, 2014; Flotho, 2015), spending reversals (Corsetti et al., 2012) and data frequency issues (Born and Müller, 2012).[4]

The remainder of the chapter is structured as follows. Section 4.2 provides an overview of the fiscal stimulus packages. Section 4.3 describes the details of our DSGE model with an emphasis on the fiscal sector. Section 4.4 elaborates on the data and our estimation strategy. In section 4.5, we present the empirical results on the effects of the fiscal stimulus packages. Next, section 4.6 analyzes the results in terms of their sensitivity. Finally, section 5.6 concludes.

4.2 The German stimulus packages

The German stimulus measures targeted three areas. The first was taxation, and accordingly, the measures were intended to reduce the tax burden. The second was social security transfers, which reflected the need to provide direct support to those households whose income and income prospects were subject to strong decreases. The third was investment; the intention was to provide either increased public investment or to incentivize households and entrepreneurs not to abandon planned investments.

In terms of implementation, the stimulus measures consisted of four packages that were successively enacted by the German parliament in October and November 2008 and in January and November 2009. Table 4.1 provides a detailed overview of each single measure arranged according to the four packages. Moreover, the volume of the measure (in billions of euros) is reported for each of the years from 2009 to 2012. The numbers presented state their nominal change to the year 2008, the last year before the start of the additional discretionary fiscal policies.

[4] A theoretical analysis of fiscal policy in its relation to public capital is provided by Gómez (2004). Rossi (2014) elaborates on determinacy properties of fiscal policy rules in a small-scale New Keynesian model.

Fiscal Measure	Classification	2009	2010	2011	2012
Package I					
Increase in children's allowance	Transfers/Labor Tax	2.3	2.2	2.2	2.2
Decrease in unemployment insurance premium	Labor Tax	4.0	4.0	2.0	2.0
Improved deductibility of health insurance premia	Labor Tax		8.1	10.5	10.6
Package II					
Transport infrastructure investments	Gov. Consumption/ Gov. Investment	1.0	1.0	-0.5	-0.5
Better financial deductibility for small- and medium-sized firms	Capital Tax	2.2	4.7	4.4	2.4
Tax exemption for new registered cars	Transfers	0.4	0.1		
Deductibility of craftsmen services	Consumption Tax	0.0	0.9	1.5	1.5
Program on building restoration	Gov. Investment	1.3	1.3	0.8	0.5
Package III					
Federal investments	Gov. Consumption/ Gov. Investment	2.0	2.0		
Federal and state investments	Gov. Consumption/ Gov. Investment	6.7	6.7		
Revision of car taxes	Transfers	0.1	0.2	0.4	0.4
Car scrapping incentive	Transfers	4.1	0.9		
Decrease in income tax	Labor Tax/Capital Tax	3.1	5.8	6.2	6.2
Children bonus	Transfers	1.5			
Increase in children's allowance for 6-13 years old	Transfers	0.2	0.3	0.3	0.3
Change of short-time work compensation	Labor Tax/Capital Tax	1.1	1.2	0.8	0.3
Program on qualifications for rehiring temporary workers	Gov. Consumption/ Gov. Investment	0.2	0.2		
Expansion on further education of low-qualified workers	Gov. Consumption/ Gov. Investment	0.2	0.2	0.1	0.0
Additional resources for employment qualification measures	Gov. Consumption/ Gov. Investment	1.0	1.0		
Decrease in state health insurance premia	Labor Tax	3.1	6.3	0.5	
Program on innovations in mid-sized companies	Transfers	0.3	0.3	0.3	0.0
Fostering of promising vehicle motors	Transfers	0.2	0.2	0.1	0.0
Package IV					
Increase in children's allowance	Transfers/Labor Tax		4.3	4.5	4.7
Decrease in VAT of lodging	Consumption Tax		0.8	1.0	1.0
Change of heritage and energy laws	Transfers		0.3	0.5	0.4
Change of depreciation allowances	Capital Tax		0.7	2.2	2.8
Total		35.0	53.7	37.8	34.8

Table 4.1: Fiscal stimulus measures and their announced volume
In billions of euro. The numbers reflect the nominal change in relation to the year 2008 and are based on Institut für Wirtschaftsforschung Halle & Kiel Economics (2015).

Modeling each single measure within a dynamic stochastic general equilibrium model would be very complex and thus likely unfeasible; nevertheless an analysis should be able to distinguish among different fiscal policy instruments. Our model takes this into account by incorporating six fiscal instruments (see section 4.3). Table 4.1 also provides a classification of each single measure concerning its representation in our model. Consistent with our framework, these are public consumption and investment, taxing revenues on consumption, private capital and labor and, finally, transfer payments.

4.3 The model

The model consists of six types of agents and blocks: Ricardian households, non-Ricardian households, monopolistically competitive producers, a domestic fiscal authority, a monetary authority, and an aggregated foreign block. Further, the model features two types of frictions. Real frictions originate from habit formation and adjustment costs for investment and capital utilization. Nominal frictions are caused by rigidities in prices and wages and their partial indexation to their respective past inflation rate. In this section, we describe the behavior of the agents and their linkages and explain the potential channels of fiscal policies. Because the model largely builds on the work of Smets and Wouters (2003), we focus on the additional features. The full set of log-linearized equations is presented in appendix C.2.

4.3.1 Households

The domestic economy is represented by a continuum of two types of private households. A share of $(1 - \mu)$ is assumed to have full access to financial markets and thus be able to optimize intertemporally. In the remainder of the chapter, we refer to this type of agent as Ricardian households or optimizers. The remaining households are assumed to be excluded from saving and borrowing. As a consequence, these types of households consume their entire disposable income each period. We refer to them as non-Ricardian or rule-of-thumb households.

Ricardian households Optimizing households maximize their lifetime utility

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t^r, L_t^r), \tag{4.1}$$

which is a function of consumption C_t^r and leisure $(1 - L_t^r)$

$$U(C_t^r, L_t^r) = \frac{\epsilon_t^P (C_t^r - hC_{t-1}^r)^{1-\sigma}}{1-\sigma} - \chi \frac{\epsilon_t^r}{1+\varphi} (L_t^r)^{1+\varphi}, \tag{4.2}$$

with h denoting the degree of habit persistence, L_t^r the hours worked and σ the intertemporal elasticity of substitution. The inverse Frisch elasticity φ reflects the elasticity of hours worked with respect to the real wage (when keeping marginal utility of wealth constant). χ is a scaling parameter to adjust the steady state of labor supply. ϵ^p and ϵ^l are shocks to consumption preferences and labor supply, respectively, that follow an AR(1) process in logs with i.i.d. normal shocks η^p and η^l. Households receive wage income W_t^r from labor, interest income on savings in domestic bonds B_t, income on real capital K_{t-1}^p rented to the production sector at the rental rate $r_{k,t}$, transfers TR_t from the government and profits Π_t from the firm sector. Income is spent on consumption C_t^r and investment I_t in private physical capital K_t^p. For the households' budget constraint, it thus follows:

$$\begin{aligned} P_t C_t^r (1 + \tau_t^c) \quad & + P_t I_t + B_t + \Psi(\omega_t) K_{t-1}^p = \\ & R_{t-1} B_{t-1} + r_{k,t} \left(1 - \tau_t^k\right) \omega_t K_{t-1}^p + \left(1 - \tau_t^w\right) W_t^r L_t^r + \Pi_t + TR_t, \end{aligned} \tag{4.3}$$

where P_t is the price level, τ_t^c, τ_t^k and τ_t^w denote taxes on consumption, capital and labor, R_t is the one-period gross nominal return on domestic government bonds, W_t is the nominal wage, ω_t specifies the degree of capital utilization, with $\Psi(\omega_t))$ being the cost associated with its variations. Following Christiano et al. (2005), we assume that in the steady state the capital utilization rate is $\bar{\omega} = 1$ and $\Psi((\bar{\omega})) = 0$. The accumulation of private physical capital is determined according to the following law of motion:

$$K_t^p = (1 - \delta) K_{t-1}^p + (1 - S(\cdot)) I_t, \tag{4.4}$$

where $S(\cdot)$ is the investment adjustment cost function:

$$S\left(\frac{\epsilon_t^i I_t}{I_{t-1}}\right) = \frac{\kappa}{2}\left(\frac{\epsilon_t^i I_t}{I_{t-1}} - 1\right)^2. \tag{4.5}$$

The function reflects the assumption that adjusting investment is costly. κ captures the investment adjustment cost, and ϵ_t^i, in turn, denotes the corresponding shock to these adjustment costs that follows a first-order autoregressive process (in logs): $\epsilon_t^i = \rho_i \epsilon_{t-1}^i + \eta_t^i$, where $\eta_t^i \sim \mathcal{N}(0, \sigma_i^2)$.

Ricardian households maximize their utility subject to their budget constraint and the capital accumulation function with respect to consumption, labor, bond holdings, investment, the size of next period's capital stock and its rate of utilization.[5]

Rule-of-thumb households Non-optimizing households are assumed to have no access to financial markets; thus, they do not own assets and do not have liabilities or conduct investments. Accordingly, their entire current income, which is composed of net labor income and transfer receipts from the government, is spent for consumption purposes:

$$(1 + \tau_t^c) C_t^n = (1 - \tau_t^w) L_t^n W_t^n + TR_t. \tag{4.6}$$

Household aggregation Because rule-of-thumb households constitute a share μ of total households, aggregate private consumption is given by:

$$C_t = \mu C_t^n + (1 - \mu) C_t^r.$$

Wage setting Households offer differentiated labor services and thus act as monopolistically competitive wage setters in the labor market. Each period, a random fraction of $1-\theta^w$ households is 'allowed' to optimize its wage, whereas the remaining fraction adjusts its wage according to a simple indexation rule, with the degree of indexation measured by $\omega^w \in [0, 1]$. An employment agency bundles the differentiated labor services according to a Dixit-Stiglitz-type function and sells the composite labor index to the production

[5] The first-order conditions are presented in Appendix C.1.

sector at the aggregate wage index W_t. Optimizing households will set their wage to $\tilde{W}_t$ taking into account the demand for their individual labor service and the probability of future adjustments. For the dynamics of the aggregate wage index, it then follows:

$$W_t = \left[(1-\theta^w) \left(\tilde{W}_t\right)^{-\frac{1}{\lambda^w}} + \theta^w \left(\left(\frac{P_{t-1}}{P_{t-2}}\right)^{\omega^w} W_{t-1} \right)^{-\frac{1}{\lambda^w}} \right]^{-\lambda^w}, \tag{4.7}$$

with $\lambda_W \in [0, \infty]$ being the net wage markup as a result of the households' market power.

We assume that non-Ricardian households will set their wage to the average wage of optimizing households and that the demand for labor services of non-optimizers is therefore the same as for the aggregate of Ricardian households. Consequently, labor hours and wages will be identical for both types of consumers, so that $L_t = L_t^r = L_t^n$ and $W_t = W_t^r = W_t^n$.

4.3.2 Firms

Production The economy consists of a continuum of firms $x \in [0, 1]$, each of which produces a differentiated good according to a Cobb-Douglas technology:

$$Y_t(x) = Z_t L_t(x)^{1-\alpha} (\omega_t K_{t-1}^p(x))^{\alpha} (K_{t-1}^g)^{\zeta} - \Xi, \tag{4.8}$$

where Z_t represents a shock to total factor productivity that follows a first-order autoregressive process (in logs): $z_t = \rho_z z_{t-1} + \eta_t^z$, where $\eta_t^z \sim \mathcal{N}(0, \sigma_z^2)$. K_{t-1}^g is the public capital stock, whereas Ξ measures the fixed cost of production.[6] The firm takes factor prices as given and minimizes the costs for a particular level of output subject to the production technology. Labor demand is identical for all firms and given by:

$$L_t = \frac{1-\alpha}{\alpha} K_{t-1}^p \frac{r_{k_t}}{W_t}, \tag{4.9}$$

[6] The assumption of increasing returns to scale with respect to public capital can be found in Baxter and King (1993), Glomm and Ravikumar (1997), Turnovsky (2004), and Leeper et al. (2010). The condition $\alpha + \zeta < 1$ is necessary to ensure a stable balanced growth path (see Turnovsky (2004)).

whereas marginal costs are:

$$MC_t = \left(\frac{1}{1-\alpha}\right)^{1-\alpha} \left(\frac{1}{\alpha}\right)^{\alpha} Z_t^{-1} K_{t-1}^{g^{-\zeta}}(x)\, W_t^{1-\alpha} r_{k,t}^{\alpha}. \tag{4.10}$$

The resulting profits of the firms are assumed to be passed on to the optimizing households as dividends.

Price setting Firms set their prices in a Calvo (1983) fashion. Each period, a random fraction $(1-\theta_p) \in [0,1]$ of firms adjust their prices to the optimal level $\tilde{P}_t$. Firms that are not able to adjust index their prices to past inflation, with the degree of indexation given by $\omega_P \in [0,1]$. Moreover, monopolistic competition leads to a gross markup $\lambda_p \in [1,\infty]$ of the optimal price over marginal cost for each producer x. Individual producers' goods are aggregated to a final goods index by competitive retail firms according to a Dixit-Stiglitz function. For the total price index, it follows from the demand for individual goods in the final goods index as well as the price setting behavior of adjusters and non-adjusters:

$$P_t = \left[(1-\theta_p)\tilde{P}_t^{\frac{1}{1-\lambda_p}} + \theta_p \left(\left(\frac{P_{t-1}}{P_{t-2}}\right)^{\omega_p} P_{t-1}\right)^{\frac{1}{1-\lambda_p}}\right]^{1-\lambda_p}. \tag{4.11}$$

4.3.3 Fiscal authority

The fiscal authority is characterized by eight variables: public consumption G_t^c, public investment G_t^i, tax rates on consumption τ_t^c, private capital income τ_t^k and labor income τ_t^W, transfer payments TR_t and the stock of public bonds issued B_t. Analogously to private capital, public capital is accumulated according to the following law of motion:

$$K_t^g = (1-\delta^g) K_{t-1}^g + G_t^i. \tag{4.12}$$

The government faces a real flow budget constraint that balances its expenses on interest and debt payments, transfers and consumption and investment with its revenues from taxes on consumption, wages and private capital and cash returns from bonds issued in

the current period. For the government budget constraint, it thus follows:

$$B_{t-1}R_{t-1} + TR_t + G_t^c + G_t^i = \tau_t^c C_t + \tau_t^k r_t^k \omega_t K_{t-1}^p + \tau_t^w W_t L_t + B_t. \tag{4.13}$$

We broadly follow Leeper et al. (2010) in specifying spending and revenue rules for the fiscal sector. Government expenditures on consumption and investment are assumed to respond in a countercyclical manner to deviations of output and debt from their respective steady states. To account for possible delays in the implementation of spending plans in reaction to economic developments, we consider the respective lagged values. Due to a large proportion of unemployment benefits in government transfers that are not subject to such delays, we specify the rule for this kind of fiscal expenditure in reaction to the contemporaneous cyclical component of hours worked. For the spending rule, it follows (in log-linear approximation):

$$g_t^c = -\rho_{gc,y} y_{t-1} - \rho_{c,b} b_{t-1} + \epsilon_t^{gc} \tag{4.14}$$

$$g_t^i = -\rho_{gi,y} y_{t-1} - \rho_{i,b} b_{t-1} + \epsilon_t^{gi} \tag{4.15}$$

$$tr_t = -\rho_{tr,l} l_t - \rho_{tr,b} b_{t-1} + \epsilon_t^{tr}, \tag{4.16}$$

where $\epsilon_t^{gc} = \rho_{gc}\,\epsilon_{t-1}^{gc} + \eta_t^{gc}$, $\epsilon_t^{gi} = \rho_{gi}\,\epsilon_{t-1}^{gi} + \eta_t^{gi}$ and $\epsilon_t^{tr} = \rho_{tr}\,\epsilon_{t-1}^{tr} + \eta_t^{tr}$, with η_t^{gc}, η_t^{gi} and η_t^{tr} being i.i.d. shocks with zero mean and variances $\sigma_{\eta gc}^2$, $\sigma_{\eta gi}^2$ and $\sigma_{\eta tr}^2$.

On the revenue side, consumption, labor and capital tax rates can also be assumed to adjust in a way that stabilizes the economy. Thus, feedback rules can be specified to react to deviations from the output trend. Similarly, if debt is above its steady-state value, the government is assumed to act in terms of a debt brake rule that forces it to increase taxes. Alternatively, in the case of a debt increase below trend, the government will make use of the leeway in the next period by lowering taxes.[7] In log-linear approximation, it

[7] From a technical perspective, including public debt in fiscal rules is a method to ensure stability.

follows that:

$$\tau_t^c = \rho_{\tau c,y} y_{t-1} + \rho_{\tau c,b} b_{t-1} + \epsilon_t^{\tau c} \tag{4.17}$$

$$\tau_t^w = \rho_{\tau w,y} y_{t-1} + \rho_{\tau w,b} b_{t-1} + \epsilon_t^{\tau w} \tag{4.18}$$

$$\tau_t^k = \rho_{\tau k,y} y_{t-1} + \rho_{\tau k,b} b_{t-1} + \epsilon_t^{\tau k}, \tag{4.19}$$

where $\epsilon_t^{\tau c} = \rho_{\tau c}\epsilon_{t-1}^{\tau c} + \eta_t^{\tau c}$, $\epsilon_t^{\tau w} = \rho_{\tau w}\epsilon_{t-1}^{\tau w} + \eta_t^{\tau w}$ and $\epsilon_t^{\tau k} = \rho_{\tau k}\epsilon_{t-1}^{\tau k} + \eta_t^{\tau k}$, with $\eta_t^{\tau k}$, $\eta_t^{\tau k}$ and $\eta_t^{\tau k}$ being i.i.d. shocks with zero mean and variances $\sigma_{\eta\tau c}^2$, $\sigma_{\eta\tau w}^2$ and $\sigma_{\eta\tau k}^2$.

4.3.4 Monetary policy

The monetary authority acts according to a feedback rule in the spirit of Taylor (1993). In addition, we allow for interest rate smoothing as in (Clarida et al., 2000). Because Germany is a member of a monetary union, its interest rate equals the one set by policy makers who consider the whole euro area. Accordingly, the Taylor rule specifies the interest rate as a reaction function of average (GDP-weighted) inflation rates and output gaps of Germany and the rest of the euro area (REA):

$$r_t = \rho_r r_{t-1} + (1-\rho_r)(\rho_\pi \pi_t^{EA} + \rho_y y_t^{EA}) + \eta_t^r, \tag{4.20}$$

where $\pi_t^{EA} = \phi^{DE}\pi_t + \left(1-\phi^{DE}\right)\pi_t^{REA}$, $y_t^{EA} = \phi^{DE} y_t + \left(1-\phi^{DE}\right) y_t^{REA}$, ϕ^{DE} is the share of German production in euro area GDP and $\eta_t^r \sim (0, \sigma_{\eta r}^2)$ captures non-systematic deviations of the interest rate from the monetary policy rule. We follow Justiniano and Preston (2010), among others, and model both REA variables as VAR(2) processes in

logs, with the area-wide interest rate considered as an endogenous component:[8]

$$\begin{bmatrix} y_t^{REA} \\ \pi_t^{REA} \end{bmatrix} = \rho_1 \begin{bmatrix} y_{t-1}^{REA} \\ \pi_{t-1}^{REA} \\ r_{t-1} \end{bmatrix} + \rho_2 \begin{bmatrix} y_{t-2}^{REA} \\ \pi_{t-2}^{REA} \\ r_{t-2} \end{bmatrix} + \begin{bmatrix} \eta_t^{y^{REA}} \\ \eta_t^{\pi^{REA}} \end{bmatrix}, \tag{4.21}$$

where ρ_1 and ρ_2 are 2×3 matrices of coefficients and $\eta_t^{y^{REA}}$ and $\eta_t^{\pi^{REA}}$ are i.i.d. normal shocks with zero mean and variances $\sigma^2_{\eta y^{REA}}$ and $\sigma^2_{\eta \pi^{REA}}$.

4.3.5 Goods market clearing

Goods market clearing requires the output produced net of utilization costs to equal the demand for private as well as public consumption and investment. To match the model equations with the observed data series and to account for the influence of trade on the German economy, we introduce the trade balance TB_t. Of course, exports and imports are in general endogenous variables. However, the decrease in German exports during the Great Recession was triggered exogenously. It then follows that:

$$Y_t = C_t + I_t + G^c t + G_t^i + TB_t + \Psi\left(\omega_t\right) K_{t-1}^p, \tag{4.22}$$

with the dynamics of the trade balance given by an AR(1) process in logs:[9]

$$tb_t = \rho_{tb}\, tb_{t-1} + \eta_t^{tb}, \tag{4.23}$$

with η_t^{tb} being an i.i.d. normal error term with zero mean and variance $\sigma^2_{\eta tb}$. We abstract from modeling any further channels for international spillovers, as government expenditures can almost entirely be assumed to be directed to spending on domestic goods.

[8] We are aware of the simplistic modeling of the foreign block. However, since for estimation we use time series for both REA variables we are able to account for their influence on the area-wide monetary policy without putting too much attention on international spillovers that are beyond the focus of this project.

[9] Similar to the modeling of the foreign block, our simplistic consideration of trade together with the use of the relevant time series for estimation allows us to gauge the impact of foreign shocks on the German economy without putting too much focus on international linkages.

4.3.6 Channels of fiscal policy

The policymakers have six discretionary policy measures at their disposal that can be grouped into two categories. Government consumption, government investment and government transfers constitute expenditure policy measures. Changes to the tax rates on wage income, capital and consumption represent revenue-based policy measures. Changes in these measures will eventually affect the consumption and investment behavior of Ricardian and non-Ricardian households and the output of the economy. In general, there is a wide variety of channels in which the policy measures work their way through the economy. We distinguish between direct and indirect effects, whereby indirect effects can be further subdivided along the channels of interest rates, labor and wages.

Direct effects occur via the households' budgets. That is, a decrease in the consumption tax rate will lead to a higher disposable real income for both types of households. In turn, a decrease in the wage tax rate will especially affect non-Ricardian households for whom the current wage income is of particular importance. The latter also holds true for transfer payments. If the government increases them, households' budgets will be directly affected.

Indirect effects via interest rates and prices are based on several factors that condition each other consecutively. On impact, a fiscal expenditure impulse will lead to a direct increase in output. As this additional demand has to be served by means of an increase in production – and labor constitutes the only input factor that can react immediately – working hours rise. Consequently, capital becomes a relatively scarce factor. Hence, the interest rate on capital rises, too. As the capital rental rate is a crucial part of a firm's cost, marginal costs rise. Obviously, an increase in the price level in general occurs as firms transform the higher costs into higher prices for goods. However, this will force monetary policy to react, as it is assumed that central banks respond to inflation and output developments. Because both rise, interest rates increase immediately. Accordingly, Ricardian households will, ceteris paribus, decrease consumption; that is, a crowding-out of private spending occurs. In addition, an increase in the shadow price of capital is expected to lead to a drop in private investment spending.

Another channel acts through indirect effects via labor. In this case, the non-Ricardian

households are the crucial agents. As before, a fiscal expenditure impulse induces a rise in output, and the reaction of capital is staggered because investments take a period to increase the capital stock. Thus, working hours need to increase. Non-Ricardians will hence consume more, as they have a higher disposable labor income.

Non-Ricardians are also crucial for explaining the effects of a fiscal impulse on the revenue side. That is, if the fiscal authority decides to lower consumption or labor tax rates, an indirect effect via wages will occur. However, the direction of the effect on consumption is ex ante inconclusive. On the one hand, the reduction in taxes causes the marginal rate of substitution between labor and consumption to fall. Hence, wages are expected to fall as well. On the other hand, households are able to spend more of their income as a result of the reduction in taxes. Estimation is thus necessary to determine which of the two effects predominates.

4.4 Estimation

4.4.1 Data and priors

For the Bayesian estimation of the model, 15 quarterly time series are used, including domestic series for GDP, private and government consumption, private and government investment, government transfers, effective tax rates for consumption, labor and capital income, hours, wages, and CPI inflation. In addition, we use the euro area short-term interest rate as well as series for GDP and inflation in the rest of the euro area. The latter two aggregates are constructed as evolving GDP-weighted averages of the respective EMU members' time series. German GDP aggregates as well as hours and wages are divided by the population time series to obtain per capita values and to remove the common trend in these series. Effective tax rates are calculated following Mendoza et al. (1994). To correctly account for the structural break resulting from the introduction of the single European monetary policy, all series are from 1999 to 2012. The cyclical components of the variables used for estimation are extracted by means of the Hodrick-Prescott filter.

Priors for the estimated parameters broadly reflect standard choices in the literature (Table 4.3). For the parameters of the REA variables VAR processes we follow Justiniano

Private capital depreciation rate	δ	0.0250
Public capital depreciation rate	δ_G	0.0250
Share of capital in production function	α	0.3200
Share of public capital in production function	ζ	0.1000
Steady-state wage markup parameter	λ_w	0.1500
Steady-state labor tax rate	τ_w	0.4428
Steady-state consumption tax rate	τ_c	0.2136
Steady-state capital tax rate	τ_k	0.1806
Steady-state private consumption to GDP ratio	C/Y	0.5788
Steady-state private investment to GDP ratio	I/Y	0.1686
Steady-state public consumption to GDP ratio	G^C/Y	0.1899
Steady-state public investment to GDP ratio	G^I/Y	0.0165
Steady-state transfer payments to GDP ratio	TR/Y	0.2081
Steady-state public debt to GDP ratio	B/Y	2.5868
Discount factor	β	0.9980
Steady-state return on capital	r^K	0.0336

Table 4.2: Calibrated model parameters

and Preston (2010) and center the priors narrowly around the respective coefficients obtained from individual pre-sample estimations. Some structural parameters that are difficult to be identified correctly are set according to the respective sample means or to values that are widely used in the relevant literature (Table 4.2). In particular, the depreciation rates for private and public capital are both set to $\delta = \delta^g = 0.025$, implying an annual depreciation of 10 percent, and the net wage markup parameter is set to $\lambda^w = 0.15$. The share of private capital in the production function α is calibrated to match the steady-state share of labor income to GDP to its sample average of 68 percent, whereas the elasticity of output to public capital ζ is set to 0.1 following Ratto et al. (2009).[10] The discount factor β is set to 0.998 to match the inverse of the average quarterly gross real interest rate over the sample period. In a similar way, the steady-state tax rates and the ratios of the GDP aggregates and public debt to output are set at their historical average ratios. Based on these numbers, the steady-state transfers to GDP ratio is obtained from the government budget constraint, and the private capital to GDP ratio is obtained from its law of motion.

[10] Meta-analyses of the contribution of public capital to output also conclude values of around 0.10 (e.g. Bom and Ligthart (2008), Núñez-Serrano and Velázquez (2017)).

The steady-state return on private capital r^K reflects the values for the steady-state capital tax rate, the private depreciation rate, and the discount factor β. Finally, marginal cost is calibrated to 0.8, implying a steady-state price markup over production costs of 25 percent. The remaining steady-state values are pinned down by estimated parameters.

4.4.2 Posterior means

Results for the posterior distribution of the estimated parameters and shock variances are presented in Table 4.3. Most of the values fall within the expected range. Concerning the relevant parameters for the assessment of fiscal policy, the estimation reveals a share of non-Ricardian households of slightly more than one-fifth, which is in line with the results of other studies for advanced countries (Bhattarai and Trzeciakiewicz, 2017; Iwata, 2009).

Posterior means for the reaction coefficients in the fiscal policy rules reveal strong dependence on the business cycle for four out of six instruments. In particular, all spending variables react in a heavily countercyclical manner. The dependence of the extent of public outlays on the output gap (or cyclical employment) is strongest for transfers followed by investment. Both of these findings reflect economic intuition. Transfers can be viewed as a prime example for automatic stabilizers, consisting of a large share of unemployment payments, whereas public investment spending is commonly regarded as a measure to stimulate economic activity in the context of fiscal stimulus packages. Government consumption, on the other hand, to a larger degree consists of outlays that are independent of the business cycle. Although many of the agreed upon measures to stimulate the economy fall into this spending category, their relative share of total government consumption is small. The smaller reaction coefficient of the output gap in the respective spending rule captures this fact accordingly. On the revenue side, capital taxes are estimated to react strongly to movements in the cyclical component of the output and thus to be set in a countercyclical manner. The same applies to the consumption tax rate but to a much smaller extent, i.e., statistically not different from zero, indicating that these undergo changes unsystematically. The effective labor tax rate, on the contrary, increases in an economic downturn and decreases during upturns. This finding reflects the fact that low-paid jobs that are taxed at a lower rate are more sensitive to the economic

		Prior			Posterior	
Parameter		Distr.	Mean	S.d.	Mean	Conf. Interval
Habit persistence	h	beta	0.50	0.10	0.3797	0.2447 0.5099
Share of non-Ricardians	μ	beta	0.30	0.10	0.2289	0.1092 0.3417
Consumption utility	σ	norm	1.00	0.38	1.2353	0.8154 1.6560
Labor utility	φ	norm	2.00	0.50	2.3399	1.6243 3.0636
Indexation prices	ω^p	beta	0.40	0.15	0.2702	0.1014 0.4382
Calvo parameter prices	θ^p	beta	0.50	0.10	0.8216	0.7796 0.8608
Indexation wages	ω^w	beta	0.40	0.15	0.3133	0.1061 0.5108
Calvo wages	θ^w	beta	0.50	0.10	0.2747	0.1846 0.3623
Fixed cost	ξ	norm	1.40	0.10	1.6076	1.4758 1.7343
Investment adj. cost	$\varkappa$	norm	4.00	1.50	3.5645	1.7432 5.3426
Capitl utilization adj.	κ	norm	0.40	0.10	0.4332	0.2721 0.5881
Interest rate smoothing	ρ_r	beta	0.80	0.10	0.8342	0.7757 0.8963
Taylor coeff. inflation	ρ_π	norm	1.50	0.10	1.4596	1.2964 1.6233
Taylor coeff. output	ρ_y	norm	0.10	0.05	0.0921	0.0214 0.1614
AR(1) trade balance	ρ_{tb}	beta	0.80	0.10	0.7859	0.6559 0.9207
AR(1) gov. consumption	ρ_{gc}	beta	0.80	0.10	0.7270	0.6004 0.8537
AR(1) gov. investment	ρ_{gi}	beta	0.80	0.10	0.5838	0.4357 0.7304
AR(1) gov. transfers	ρ_{tr}	beta	0.80	0.10	0.7199	0.6053 0.8383
AR(1) cons. tax rule	$\rho_{\tau c}$	beta	0.80	0.10	0.5533	0.3896 0.7206
AR(1) labor tax rule	$\rho_{\tau w}$	beta	0.80	0.10	0.6704	0.5127 0.8341
AR(1) capital tax rule	$\rho_{\tau k}$	beta	0.80	0.10	0.6700	0.5292 0.8178
Gov. Cons. Output Reac.	$\rho_{gc,y}$	norm	0.00	0.50	0.2016	0.0463 0.3510
Gov. Cons. Debt Reac.	$\rho_{gc,b}$	norm	0.00	0.50	0.0160	-0.1149 0.1452
Gov. Inv. Output Reac.	$\rho_{gi,y}$	norm	0.00	0.50	0.4643	0.1452 0.7804
Gov. Inv. Debt Reac.	$\rho_{gi,b}$	norm	0.00	0.50	0.1188	-0.0476 0.2800
Gov. Tran. Labor Reac.	$\rho_{tr,l}$	norm	0.00	0.50	0.5341	0.2972 0.7698
Gov. Tran. Debt Reac.	$\rho_{tr,b}$	norm	0.00	0.50	-0.0362	-0.1553 0.0865
Cons. Tax Output Reac.	$\rho_{\tau c,y}$	norm	0.00	0.50	0.0709	-0.0335 0.1710
Cons. Tax Debt Reac.	$\rho_{\tau c,b}$	norm	0.00	0.50	0.0225	-0.1020 0.1434
Labor Tax Output Reac.	$\rho_{\tau w,y}$	norm	0.00	0.50	-0.0434	-0.0939 0.0075
Labor Tax Debt Reac.	$\rho_{\tau w,b}$	norm	0.00	0.50	-0.0362	-0.1166 0.0445
Capital Tax Output Reac.	$\rho_{\tau k,y}$	norm	0.00	0.50	0.3393	0.1795 0.4965
Capitl Tax Debt Reac.	$\rho_{\tau k,b}$	norm	0.00	0.50	0.0899	-0.0533 0.2366
AR(1) technology shock	ρ_z	beta	0.80	0.10	0.6966	0.5980 0.7971
AR(1) investment shock	$\rho\varepsilon_i$	beta	0.80	0.10	0.7691	0.5995 0.9503
AR(1) preference shock	$\rho\varepsilon_p$	beta	0.80	0.10	0.5835	0.4405 0.7284
AR(1) labor supply shock	$\rho\varepsilon_l$	beta	0.80	0.10	0.5713	0.3963 0.7498
S.d. gov. consump. shock	η^{gc}	invg	0.01	2.00	0.0083	0.0070 0.0096
S.d. gov. investm. shock	η^{gi}	invg	0.01	2.00	0.0553	0.0464 0.0637
S.d. gov. transf. shock	η^{tr}	invg	0.01	2.00	0.0104	0.0088 0.0120
S.d. cons. tax shock	$\eta^{\tau c}$	invg	0.01	2.00	0.0060	0.0050 0.0070
S.d. labor tax shock	$\eta^{\tau w}$	invg	0.01	2.00	0.0027	0.0023 0.0031
S.d. capital tax shock	$\eta^{\tau k}$	invg	0.01	2.00	0.0095	0.0079 0.0110
S.d. trade balance shock	η^{tb}	invg	0.01	2.00	0.0348	0.0295 0.0401
S.d. technology shock	η^z	invg	0.01	2.00	0.0051	0.0042 0.0059
S.d. labor supply shock	η^l	invg	0.01	2.00	0.0474	0.0239 0.0711
S.d. investment shock	η^i	invg	0.01	2.00	0.0086	0.0023 0.0173
S.d. preference shock	η^p	invg	0.01	2.00	0.0200	0.0137 0.0260
S.d. monet. policy shock	η^r	invg	0.01	2.00	0.0013	0.0011 0.0015
S.d. capital price shock	η^q	invg	0.01	2.00	0.1147	0.0568 0.1706
S.d. cost push shock	η^{cp}	invg	0.01	2.00	0.0866	0.0477 0.1255
S.d. foreign output shock	η^{yrea}	invg	0.01	2.00	0.0053	0.0045 0.0061
S.d. foreign infl. shock	$\eta^{\pi_{rea}}$	invg	0.01	2.00	0.0025	0.0021 0.0028

Table 4.3: Priors and posteriors of model parameters and standard deviations of shocks

cycle. With a relatively higher share of slashed jobs in the lower tax rate segment, the effective tax rate, which reflects the average rate, consequently rises.

All six fiscal variables react only minimally to movements in the government debt level. However, it is considered in the fiscal rules primarily because of the need to render the variable stationary. An economic interpretation of the size of the respective reaction parameters is thus rather subdued. Finally, all six fiscal variables exhibit a medium-high degree of smoothing, with the respective AR(1) parameters ranging from 0.55 to 0.73.

4.4.3 Shock identification

Based on the estimates of the rules' parameters, smoothed shocks for all six fiscal variables are obtained and depicted in Figure 4.1. For the three spending variables, stimulating measures can be identified during the time of the stimulus packages. Measures that can be attributed to public consumption and transfers exceeded levels expected by the estimated rule by an average of around one per cent per quarter. Stimulus efforts in the area of government investment prove to be markedly higher. They exceed the levels implied by the respective rule by more than five percent in two of the eight quarters under consideration. On the revenue side, expansive measures can be identified for the labor tax rate, including social security contributions, but to a much lower extent. The effective consumption tax rate proved to be neither expansive nor restrictive in the time period under consideration. The capital tax rate, on the other hand, deviated from its implied long-run rule value in an expansive way in only one quarter – although the deviation was substantial.

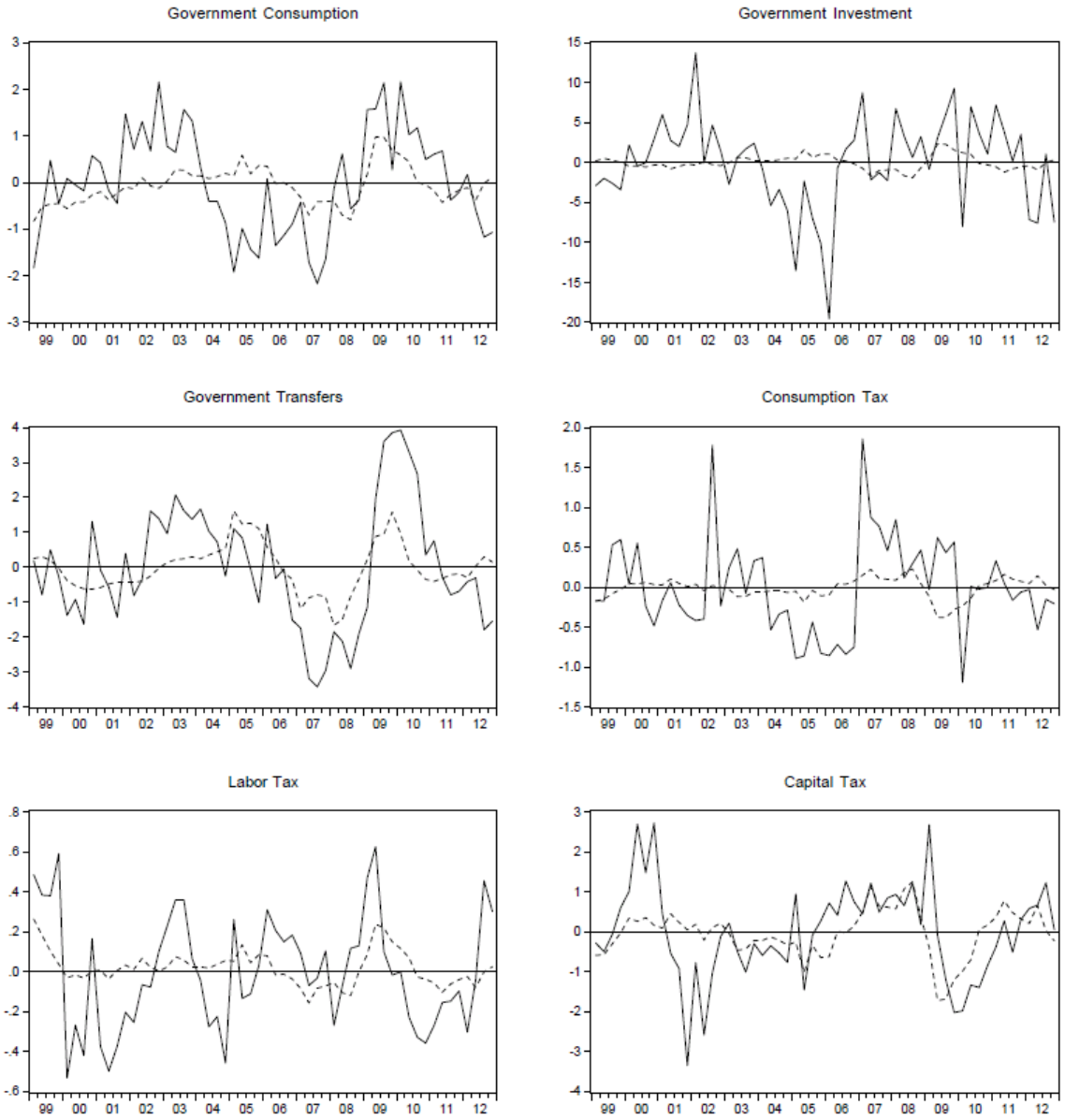

Figure 4.1: Deviations of fiscal spending variables from trend (solid lines) in percent and tax rates (solid lines) in percentage points and counterfactuals without fiscal shocks (dashed lines)

It is important to distinguish the smoothed fiscal shocks presented above from the official measures presented in Table 4.1. This is true for at least three reasons:

1. Implementation Lags. The announced numbers are precise at the moment when they are announced but might prove to be different as time moves on. For example, the planning horizon for a public investment might take more time than was originally foreseen, and hence, its start can be delayed.

2. Unknown Counterfactual. The corresponding spending and revenue patterns that would have occurred if fiscal stimulus packages had not been implemented are unknown. Discretionary public investment plans for several years ahead, for example, do not necessarily reflect the fact that some of the projects starting at a later point in time would have been financed by other resources in the future anyway. Moreover, the increased willingness to spend money that is a decisive feature of stimulus packages might incentivize client politics. If this were the case, projects would be financed that had been part of a political agenda for a long time but had not found enough support, e.g., due to political or economic reasons.

3. Detection of Discretion. Some of the measures included in the official announcements regarding fiscal stimuli involve a time horizon that is actually unrestricted, hence it is important to detect their discretionary component. The increase in the child allowance is an example. Compared to the base year 2008, official sources declare them with additional expenses of 2.3 billion in 2009 and 2.2 billion for all following years. However, from a growth and general equilibrium perspective, the effect on the economy should be temporary, i.e., large in 2009, small in 2010 and zero afterward.

Figure 4.2 compares the year-to-year change of the size of the official measures from Table 4.1 with the yearly average of the smoothed fiscal shocks. Additionally, we add the size of the measures induced by implied automatic stabilizers and by the inertia

assumption that underlies the models' fiscal reaction function. This can be demonstrated for public consumption:

$$c_t^G = \underbrace{\rho_{cy} y_{t-1} + \rho_{cd} d_{t-1} + \rho^{c^G} \epsilon_{t-1}^{c^G}}_{\text{Automatic Stabilizers}} + \underbrace{\eta_t^{c^G}}_{\text{Discretionary Fiscal Policy}} . \tag{4.24}$$

For several instruments and time periods, the sum of the models' shocks plus the automatic stabilizers reaches a size that is similar to the magnitude of the announced fiscal measures. However, due to the above mentioned reasons it is not surprising to see also several observations when this is not the case.

It is the advantage of the above presented approach to be able to analyze the actual discretionary fiscal policies. This is true for several reasons: i) the model compares the actual development to a counterfactual situation without fiscal stimulus packages. ii) By using data from the national account systems, the problem of implementation lags is considered, as these numbers reflect ex-post the actual spending at and for a specific point of time. iii) Moreover, this approach separates temporary policy measures from permanent policy measures by explicitly observing deviations from an underlying long-run trend.

In sum, it is thus obvious that our applied modeling and estimating approach provides an alternative view to identifying the size and effects of the announced fiscal discretionary policy measures. A direct comparison of identified shocks and the officially announced numbers is prone to misunderstanding and thus should be addressed carefully.

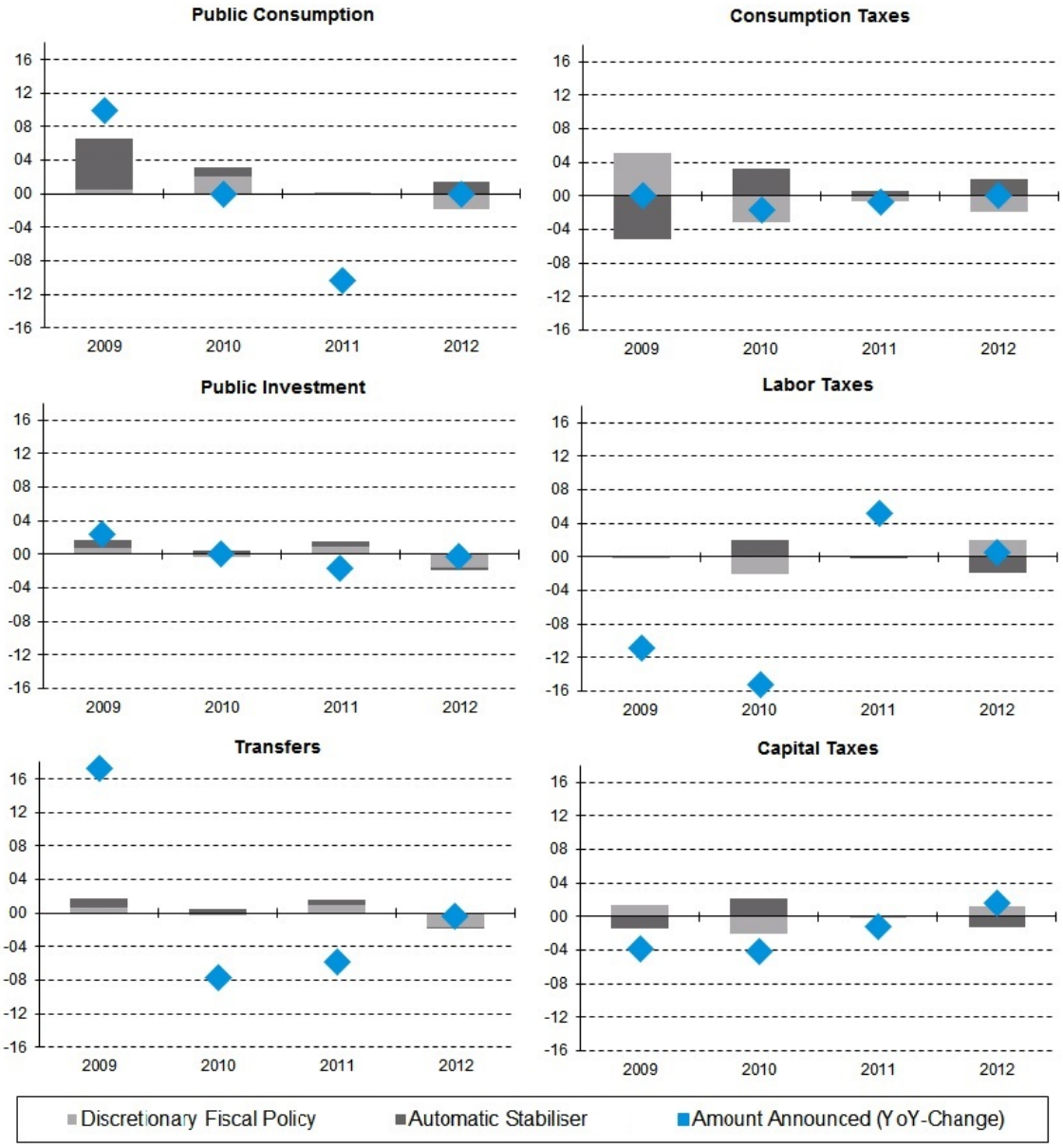

Figure 4.2: Discretionary fiscal measures: Yearly changes of amount announced vs. the models' shocks (in billions of euros)

This figure shows the year-on-year change in expenditures and revenues and the yearly average fiscal shocks as identified in the estimation process.

4.5 Effects of the stimulus packages

4.5.1 Impulse responses

In order to assess the effectiveness of different fiscal policy measures on German output, we perform impulse response analyses based on the estimated model and on the posterior estimates of the shocks' standard deviations in particular. To make the individual responses comparable to each other, we scale the shock sizes to a magnitude that corresponds to 1 percent of GDP. The impulse responses for positive spending and negative tax rate shocks over a horizon of 20 quarters are shown in Figure 4.3. In addition, we compute the respective impact and k-periods ahead cumulative present value multipliers (CPVM) according to the formula proposed by Mountford and Uhlig (2009):

$$CPVM^k = \frac{E_t \sum_{j=0}^{k} (1+R)^{-j} \Delta y_{t+j}}{E_t \sum_{j=0}^{k} (1+R)^{-j} \Delta f_{t+j}}, \tag{4.25}$$

with the respective fiscal variable f_t. The multipliers on impact as well as for selected horizons up to 5 years ahead are presented in Table 4.4.

All of the fiscal shocks considered have a positive effect on output on impact. However, the responses differ markedly in terms of size and duration. Government consumption shocks have the largest effect on impact (1.40 percent) and fade out after 8 quarters. The respective present value multiplier is the highest after 5 quarters (1.51) and reduces to 1.41 after five years. Government investment shocks have a smaller effect on impact (0.87) that turns negative in the following quarters as private activity is crowded out and higher wages from an increased productivity lead households to substitute work for leisure. As these effects reduce in the medium-term, however, the effect on output turns positive again. Due to the associated increase of the productive capital stock the overall positive effect on output is larger and more persistent compared to a government consumption shock. The cumulative present value multiplier is 1.67 after five years. The effectiveness of government investment depends crucially on the elasticity parameter of public capital in the production function that we have calibrated to 0.1. We provide an additional sensitivity analysis by estimating the model with the respective parameter set to 0.01.

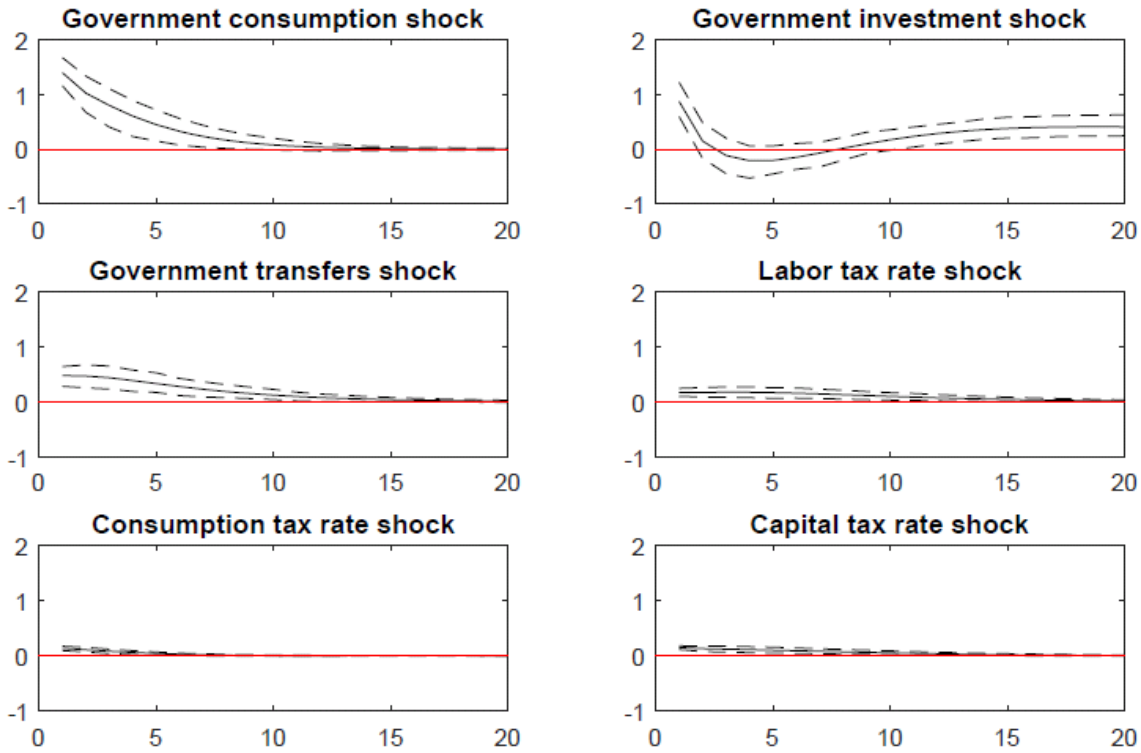

Figure 4.3: Impulse responses of output to fiscal shocks equal to 1 percent of GDP (in percent)

Whereas in that case the short-run crowding out and substitution effects are smaller than in the baseline case, the resulting long-run multiplier of 1.42 is only marginally smaller. In both cases, government investment spending proves to be the most effective measure. Transfer payments directly transfer to higher incomes and expenditures of non-Ricardian households and by that increase domestic output on impact by roughly 0.5 percent. The positive effects fade out after roughly three years, peaking at a cumulative present value multiplier of 0.94. Compared to the spending shocks, the multipliers of all tax rate shocks are smaller on impact as well as over the medium-term horizon. Reductions in the tax

Shock	Impact	1 year	2 years	3 years	4 years	5 years
Government consumption	1.40	1.50	1.50	1.46	1.42	1.41
Government investment	0.87	0.33	0.12	0.43	1.01	1.67
Government transfers	0.48	0.69	0.84	0.91	0.93	0.94
Labor tax rate	0.17	0.28	0.40	0.48	0.52	0.53
Consumption tax rate	0.14	0.18	0.20	0.20	0.20	0.20
Capital tax rate	0.15	0.21	0.29	0.34	0.36	0.37

Table 4.4: Impact and cumulative present value multipliers

rates on labor and capital income have a similar effect on impact (0.17 and 0.15) as they, both, effectively reduce the respective factor prices for intermediate goods producers and shift the composition of inputs to the relatively cheaper factor. In the case of a labor tax reduction, the increased demand for labor raises the incomes of households, in particular the non-Ricardians, and by that increasing consumption and output. In contrast, the reduction of the capital tax rate reduces demand for labor and the households' incomes, reducing the positive effects on consumption from lower prices. Increased investment by firms does not fully compensate for that. Consequently, over the medium-term horizon the multiplier of labor tax rate cuts (0.53) is remarkably higher than its capital tax rate equivalent (0.37). The effect of an equally-sized fiscal shock on output is the lowest for consumption taxes. Private households increase their consumption as the tax reduction increases their purchasing power. Optimizing households, however, take into account the tax rate's reverse dynamics in the following periods and in addition adjust their optimal choice of leisure and labor supply to the disfavor of the latter, limiting the expansionary effect on output that already fades after two years. On impact, consumption tax decreases have a multiplier of 0.14 and a cumulative present value multiplier of 0.20 after five years.

4.5.2 Historical decomposition

After the assessment of the general effectiveness of fiscal policy measures in the previous subsection, we now turn to the analysis of the effects of discretionary fiscal policy on output during the Great Recession. Figure 4.4 shows the historical decomposition of the German output gap from 1999 to 2012. The 16 shocks are grouped into four categories: foreign shocks, consisting of the trade balance shock and the deviations in GDP and inflation of the rest of the euro area from their respective long run dynamics; monetary policy shocks, which capture non-systematic deviations in the policy rate from the estimated Taylor rule; fiscal shocks, which contain the six fiscal rule disturbances; and domestic shocks, which include the remaining six shocks in the model.

Over the whole time period considered, fiscal shocks had only marginal effects on output. In none of the 56 quarters did fiscal shocks have an impact on output of more than one percentage point (Figure 4.5). Among the fiscal variables, the largest positive impact

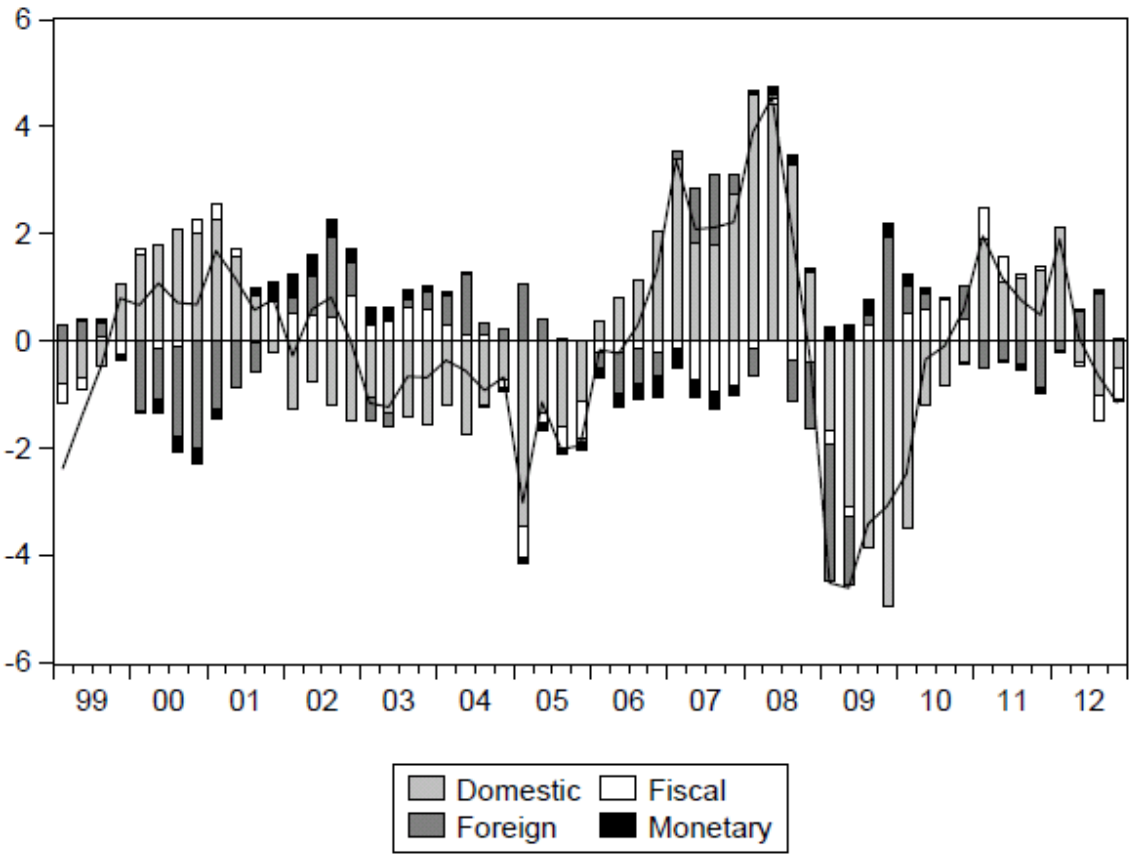

Figure 4.4: Historical decomposition of the German output gap (solid line): contribution of shocks in percentage points

Contributions of the 16 model shocks. Domestic shocks include all non-fiscal domestic disturbances, fiscal shocks contain the six fiscal rule disturbances, foreign shocks consist of the trade balance shock and shocks to the rest of the euro area GDP and inflation.

can be attributed to government consumption and thus the stimulating effects of measures such as resources for employment qualification measures, concessions for infrastructure investments, and renovations of school buildings.[11] In the first three quarters of 2009, public consumption expenditures positively influenced the output gap by around 0.3 percentage points on average. Although the identified positive shocks to government investment were much greater, its low share in the GDP of Germany resulted in a much lower and almost negligible impact in the specific quarters. By contrast, the historical decomposition of the output gap suggests that discretionary public investment spending

[11] Public investment in existing infrastructure was booked as government consumption in the German system of national accounts at that time.

curbed domestic production in all but two quarters between 2009 and 2010. Government transfers stimulated the German economy from the middle of 2009 well into mid-year 2011, with the largest impacts of around 0.4 percentage points in the first three quarters of 2010, indicating a positive effect from the car scrapping incentive and several types of allowances. On the revenue side, the positive and negative effects of the three model tax rates are neutralized over the quarters of interest. Whereas negative shocks to the consumption and capital tax rates are estimated to have contributed to the recovery from 2010 onward, the positive impact of the labor tax rate on output from the second quarter of 2010 suggests that reduced contributions to social security insurance eventually stimulated the economy. In total, the fiscal policy instruments under consideration had

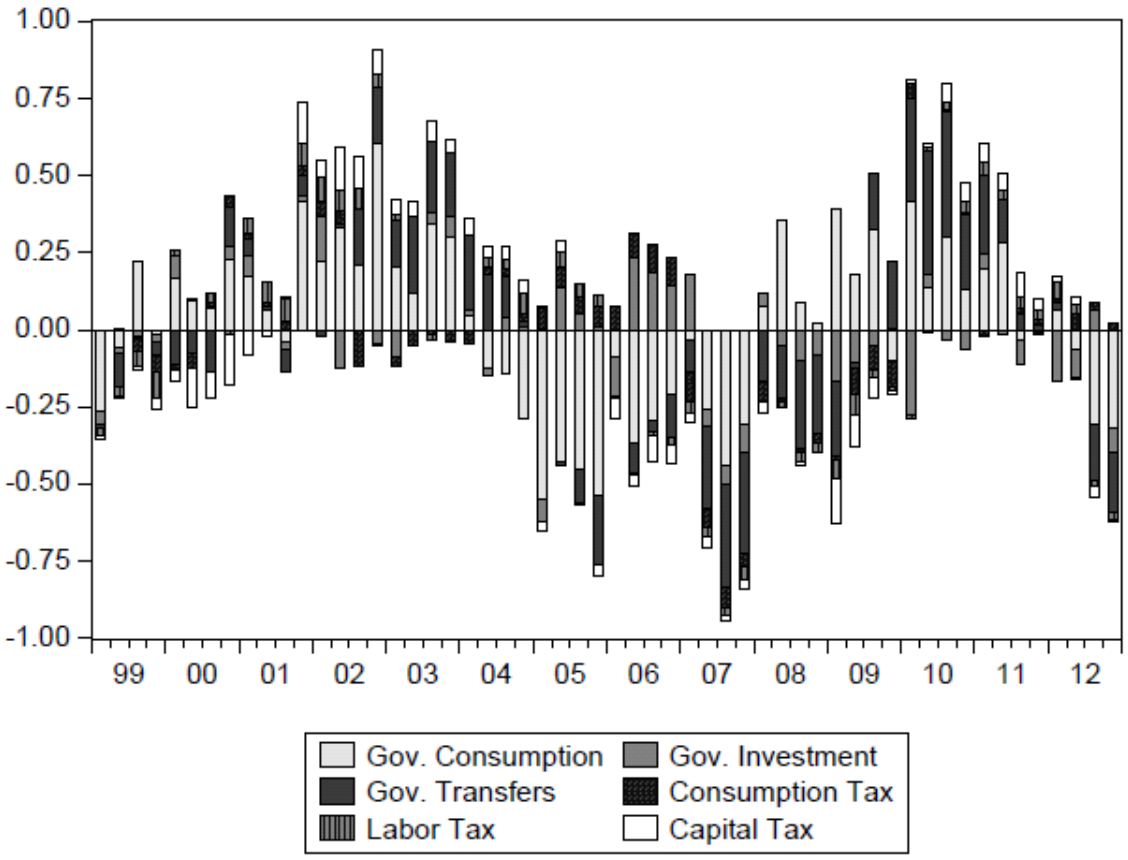

Figure 4.5: Historical decomposition of the German output gap: contribution of fiscal shocks in percentage points

an average positive impact on German output of 0.4 percentage points per quarter in the years 2009 and 2010. However, policy measures are not estimated to have prevented a larger downturn or to have offset the negative effects of other disturbances during that

time. In the first two quarters of 2009, discretionary shocks were negative as a result of the economic environment. The largest positive effects on output have been estimated starting from the beginning of 2010. Fiscal policy stimulated the economy considerably throughout that year, when GDP was growing again at an average of 1.1 percent. Thus, the overall positive effects were slight and not timely. The influence of foreign shocks was far greater, which is not surprising given the openness of the German economy. Estimation results suggest that the big drop in output in the first quarter of 2009 can primarily be attributed to negative foreign shocks, in particular a negative trade balance disturbance, reflecting lower external demand for German products and thus shrinking exports. On the other hand, the recovery in global trade that already started at the end of 2009 proved to be the major stimulus for the German economy throughout the year 2010. The shocks with the largest influence on output, however, are estimated to have been of domestic origin. Whereas over the whole sample shocks to the shadow rate of investment affected the output strongest, adverse preference shocks had an equally large negative impact during the most recent recession.

The effects of monetary policy shocks are observed as well. Reflecting the assumed behavior of business cycle smoothing as described by the Taylor rule, monetary policy in the euro area has decelerated output growth in Germany during boom times and supported the economy during troughs. This does not entirely hold true for the period of the Great Recession. However, in the year 2010, the impact of monetary policy was nearly equal in size to that of the fiscal policies.

4.6 Sensitivity analysis

As the results of the baseline model specification have been presented, this section now addresses sensitivity analysis. More precisely, we examine the degree to which the results are contingent upon the model setup. In particular, we test whether the assumption of non-Ricardian households in the economy is crucial for stimulus measures that are estimated to have been effective. Moreover, alternative fiscal reaction functions and their impact on the effectiveness of the fiscal policy measures will be provided. It proves to be the case that the findings of the baseline setup are qualitatively not sensitive with respect

to these changes in the model specification.

The first alternative model specification ('No RoT consumers') excludes rule-of-thumb consumers from the economy by setting ($\mu = 0$) prior to the estimation. From a theoretical perspective, the expectation would be that policy measures have a lower impact compared to the baseline setup due to the fact that the direct effects are lower – as non-Ricardian households, which spend all income immediately, are now 'substituted' by Ricardian households that are instead able to smooth consumption. Accordingly, these households would take intertemporal substitution into account and therefore spend only a partial amount of the additional income they receive from fiscal stimulus packages. Indeed, the estimation of this model specification confirms these considerations. Figure 4.6 shows that in most of the quarters of interest, the contribution of discretionary fiscal policy to the output gap is lower when excluding rule-of-thumb consumers. However, the difference is small and does not exceed 0.1 percentage points in all but one quarter. From a theoretical view, it is not surprising that the difference between both specifications is greatest for the quarters in which the smoothed shocks to government transfers were the largest.

The other alternative model specifications concern the design of fiscal reaction functions, as this might have a significant influence on the results. In the baseline specification, we assume that fiscal variables react to movements in the output gap, labor hours and the debt level; however, the authority could also consider additional variables. Based on the particular setup and the economic environment, different revenue and expenditure levels might be considered as rule based, thus leading to a different identification from shocks considered as discretionary policy.

For our alternative fiscal rules, we build on the work by Kliem and Kriwoluzky (2014) (KK) by adding hours worked, l_t, to the labor tax rule and private investment, i_t, to the capital tax rule ('KK rules'):

$$\tau_t^w = \rho_{\tau w,y} y_t + \rho_{\tau w,b} b_{t-1} + \rho_{\tau w,l} l_t + \epsilon_t^{\tau w} \tag{4.26}$$

$$\tau_t^k = \rho_{\tau k,y} y_t + \rho_{\tau k,b} b_{t-1} + \rho_{\tau k,i} i_t + \epsilon_t^{\tau k} \tag{4.27}$$

As a further alternative, we extend the rules proposed by KK by also adding hours worked to the government consumption rule as well as private investment to the public investment reaction function ('Extended KK rules'):

$$g_t^c = -\rho_{gc,y} y_{t-1} - \rho_{gc,b} b_{t-1} - \rho_{gc,l} l_t + \epsilon_t^{gc} \tag{4.28}$$

$$g_t^i = -\rho_{gi,y} y_{t-1} - \rho_{gi,b} b_{t-1} - \rho_{gi,i} i_t + \epsilon_t^{gi} \tag{4.29}$$

Figure 4.6 compares the results under these different model specifications. The first set of alternative fiscal rules ('KK rules') does not significantly alter the results. However, when hours worked and private investment are also introduced into the spending rules ('Extended KK rules'), the extent to which fiscal policy affects output during 2009 and 2010 is comparable to the specification with no rule-of-thumb consumers. This result stems from a higher proportion of government consumption and transfers being attributed to rule-based spending when the reduction in hours worked is taken into account. The share of discretionary expenditures identified by the respective smoothed shocks is hence lower for both variables, causing the overall stimulus and thus its effects to be smaller. As for the specification with no non-Ricardian households, however, the difference between the effects in the alternative and the baseline scenario is small, not exceeding 0.1 percentage points per quarter. The overall assessment of the effectiveness of fiscal policy remains unaffected by the estimation of different model specifications. Whereas its effects are estimated to have been negative during the quarters when the overall economy was contracting, fiscal policy stimulated domestic production at a time when it was already expanding again.

Generally, the results of our baseline scenario can thus be regarded as being not sensitive with respect to the inclusion of non-Ricardian households and alternative fiscal rule specifications.

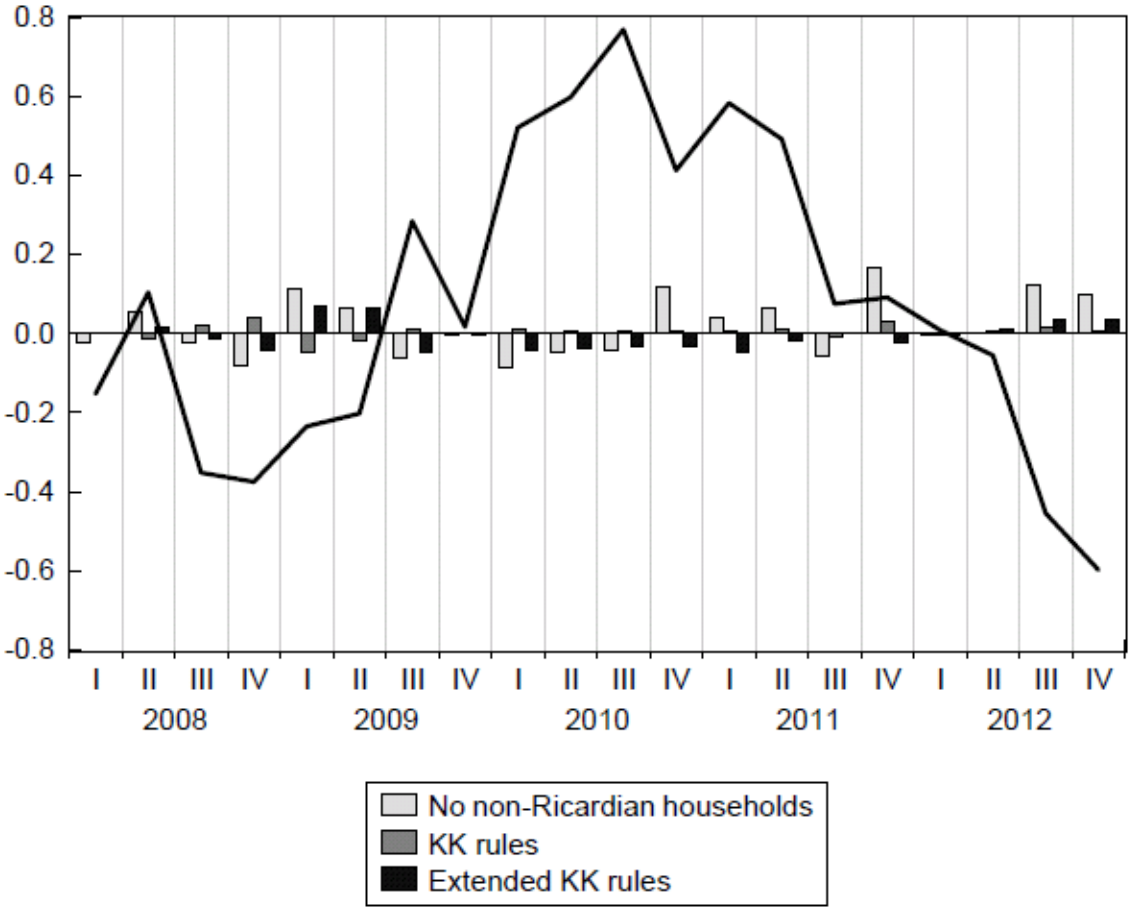

Figure 4.6: Contribution of fiscal shocks to output under the baseline specification (solid line) and deviations (bars) under different model specifications in percentage points

4.7 Conclusion

Similar to most other developed countries, the German government adopted several policy measures to mitigate the impact of the Great Recession on the domestic economy. In this project, we assess the effects of fiscal stimulus packages in the framework of an estimated DSGE model. To account for the cyclical behavior of fiscal variables, in particular the characteristics of automatic stabilizers, we specify six equations for the dynamics of spending and revenue variables as feedback rules. Based on these equations, we identify the actual fiscal shocks in contrast to the total changes in spending and revenue variables, which are also due to the automatic stabilization properties of the latter. Our estimates hint at the overall positive effects of fiscal policy on German output in the years 2009 and 2010, most of which can be attributed to government transfers and consumption.

Their total impact is, however, moderate compared to other domestic and foreign shocks. Moreover, fiscal policy is estimated to have been too restrictive at a time when it was supposed to support the shrinking domestic production, while the economy was stimulated the most when it started to expand again, although the output gap was still negative. The main results do not appear to be sensitive to the model specification, as alternative setups largely suggest similar effects.

Chapter 5

Estimating monetary policy rules when the zero lower bound on nominal interest rates is approached

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5.1 Introduction

Monetary policy rules have been studied by many researchers since Taylor (1993). He established the Taylor Rule which states that the interest rate set by the central bank can be explained as a linear function of two variables, inflation and the output gap. While the parameters of the original Taylor rule are calibrated, these coefficients can also be estimated. This is usually done by using ordinary least squares (OLS) or – in order to account for endogeneity problems with respect to inflation and the output gap – instrumental variables (IV) procedures like two-stage least squares (TSLS). These methods, however, do not yield consistent estimates if the dependent variable is censored. Interest rates cannot fall below zero so that the usage of least squares estimators is problematic. The resulting bias is neglectible only so long as interest rates are high enough that reaching the zero lower bound is unlikely.

Figure 5.1 shows a plot of short-term interest rates for Japan, the US and the Euro

area from 1983 to 2013. Interest rates have been close to zero in Japan since the late 1990s, in the US since the end of 2008 and in the Euro area since 2013. Thus, the zero lower bound has become a constraint for all three central banks. Hence, especially in recent

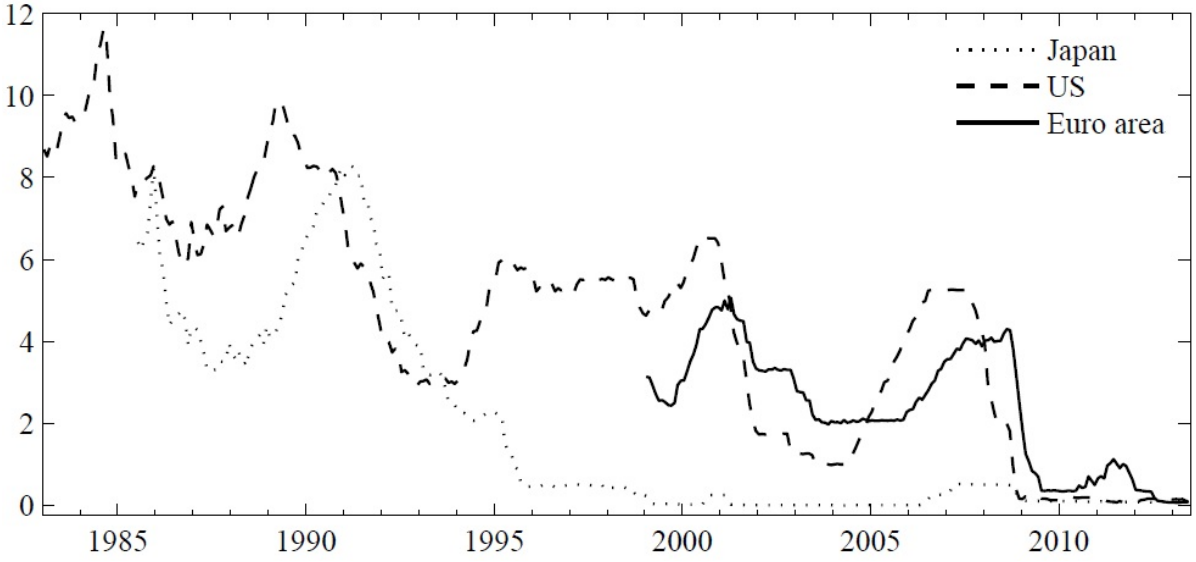

Figure 5.1: Policy rates in Japan, the US and the Euro area

times, estimating monetary policy rules with standard methods is prone to estimation bias. Standard methods would omit the obvious non-linearity that arises when the zero lower bound prevents the central bank to react to inflation and output gap dynamics as if there was no zero lower bound. We show how censored estimation methods—and in particular IV-Tobit estimation—can be used to achieve consistent parameter estimates.

An alternative way to deal with the nonlinearity at the zero lower bound is to use a particle filter, i.e. a sequential Monte Carlo filtering method, as it is done by Kitamura (2010). Others deal with the zero lower bound in a rational expectations general equilibrium setting. Aoki and Ueno (2012) emphasizes that within this class of models endogenous variables can be expressed as linear functions of expected future nominal rates. Accordingly, solving the entire model by nonlinear techniques is not necessary. Nevertheless, Hirose and Inoue (2013) provides evidence for the bias of monetary policy parameter estimates in DSGE models that do not consider the ZLB constraint. If the probability of hitting the ZLB rises, a larger bias results.

Kim and Pruitt (2013) make aware of the fact that the censoring problem can be

avoided by using data from surveys of economic forecasters. They exploit the fact that for the US one-year-ahead forecasts of the short rate stayed above zero until August 2011. This approach enables the continued application of conventional estimation techniques, however, only as long as the projected rates do not reach the ZLB.

Kato and Nishiyama (2005) and Kim and Mizen (2010) have been the first and, to the best of our knowledge, the only ones so far who applied the Tobit estimator to the estimation of monetary policy rules. Both papers focus on monetary policy in Japan, while we estimate monetary policy coefficients in addition for the US and the Euro area. In contrast to these previous papers, we account for the fact that most central banks change interest rates in a very gradual manner, which can be captured by including the lagged interest rate in the regression (see e.g. Clarida et al., 1998; Orphanides, 2001; Orphanides and Wieland, 2008). We also analyze how the estimated monetary policy responses change when the interest rate approaches zero and provide estimates for the shadow policy responses that the central bank would have implemented if there was no zero lower bound.

We find that conventional estimation techniques lead to a sizable bias in the estimated inflation response for all three economies, while the biases for the output gap response and the interest rate smoothing coefficients are small. TSLS regressions overestimate the inflation response for Japan and the Euro area and underestimate it for the US.

The IV-Tobit estimates of the shadow policy coefficients are larger than the estimates of the actual ones. The reason is that the latter mix policy coefficients in periods where the interest rate is far away from the zero lower bound—and policy can react as wanted to inflation and the output gap—and policy coefficients in periods of low interest rates where monetary policy is restricted by the zero lower bound.

We show that the size of policy coefficients depends directly on the estimated probability of observing an interest rate above zero conditional on inflation and the output gap. As long as this estimated probability is one, there is no change in monetary policy responses. This is the case for Japan until 1998, for the US until 2009 and for the Euro area until 2012 except for the year 2009. Once this estimated probability is below one, policy coefficients become smaller. Our estimates show that the zero lower bound implies

sharp restrictions for monetary policy responses in Japan and the US. While policy coefficients in the Euro area are currently smaller than usual, the restrictions are less tight than in Japan and the US.

Finally, we discuss whether the estimated change in policy coefficients when approaching zero interest rates is in line with predictions from theory. Overall, results in this project contribute to understand how the IV-Tobit approach can be applied to monetary policy rule estimation.

The remainder of the chapter is structured as follows. Section 5.2 introduces the IV-Tobit estimation method in the context of monetary policy rules. In section 5.3 we describe the data used for the estimation. In section 5.4 we first explain how the estimates can be interpreted using a simple specification without interest rate smoothing. Afterwards we present the estimation results for the more realistic case with interest rate smoothing and discuss these. Section 5.5 relates the estimation results to predictions from economic theory about monetary policy responses close to the zero lower bound. Finally, section 5.6 concludes.

5.2 Censored regression and monetary policy rules

In the seminal paper by Taylor (1993) the interest rate responds to a weighted average of deviations of inflation from an inflation target and of output from potential output. In later work it has been found that rules which include an interest rate smoothing term and specifications where monetary policy responds to expectations about inflation (see e.g. Clarida et al., 2000) provide a good description of actual monetary policy. A general specification of this type of rules that accounts for the zero lower bound is given by:

$$i_t^* = \rho i_{t-1} + (1-\rho)\left(\bar{r} + \bar{\pi} + \gamma\left(\pi_{t+h|t} - \bar{\pi}\right) + \delta y_t\right) + \epsilon_t, \tag{5.1}$$

$$i_t = max\left\{i_t^*, 0\right\}. \tag{5.2}$$

i_t denotes the nominal interest rate. i_t^* is a latent variable that can be interpreted as the interest rate that the central bank would have liked to implement, if there was no zero lower bound, i.e. a shadow interest rate. Consistent estimates of $E_t(i_t^*|x_t)$ can be

of interest to study shadow interest rate responses in addition to estimates of the actual ones, $E_t(i_t|x_t)$. $\bar{r}$ denotes the long-run real interest rate, $\bar{\pi}$ the targeted inflation rate, $\pi_{t+h|t}$ an inflation forecast for horizon h based on information in period t, y_t an output gap and ϵ_t a monetary policy shock. The parameter ρ stands for the degree of interest rate smoothing, γ is the inflation response and δ is the response to the output gap.

For simplicity we will work with a version of equation (5.1) that is linear in the parameters in what follows:

$$\begin{aligned} i_t^* &= \alpha_0 + \alpha_i i_{t-1} + \alpha_\pi \pi_{t+h|t} + \alpha_y y_t + \epsilon_t, && (5.3) \\ &= x_t\beta + \epsilon_t, && (5.4) \\ i_t &= max\left\{i_t^*, 0\right\}, && (5.5) \end{aligned}$$

with $\alpha_0 = (1-\rho)(\bar{r}+(1-\gamma)\bar{\pi})$, $\alpha_i = \rho$, $\alpha_\pi = (1-\rho)\gamma$, $\alpha_y = (1-\rho)\delta$, $x_t = (1, i_{t-1}, \pi_{t+h|t}, y_t)$ and $\beta = (\alpha_0, \alpha_i, \alpha_\pi, \alpha_y)'$.

If the interest rate is restricted to positive values, i.e. $i_t \geq 0$, then assuming $E(i_t|x_t) = x_t\beta$ would ignore the nonlinearity between i_t and x_t at the zero lower bound. Further, from an econometric point of view least squares estimates of β will be biased as demonstrated in Kim and Mizen (2010) if the truncation of i_t is ignored. Conventional techniques for the estimation of monetary policy rules cannot be used and even for historical analyses cutting the sample off before the zero lower bound is reached leads to inconsistent estimates (Wooldridge, 2010).

Assuming $\epsilon_t \sim N(0, \sigma^2)$ equations (5.3) to (5.5) resemble a standard censored Tobit model (Tobin, 1958) which can be consistently estimated as proven by Amemiya (1973). The conditional expected value for i_t is given by:

$$E(i_t|x_t) = P(i_t = 0|x_t)\ 0 + P(i_t > 0|x_t)\ E(i_t|x_t, i_t > 0). \quad (5.6)$$

$P(i_t > 0|x_t)$ can be written as a Probit model for the binary variable w which is defined as $w = 1$ if $i_t > 0, w = 0$ if $i_t = 0$ (the explanations here closely follow Wooldridge, 2010):

$$P(w = 1|x) = P(i_t^* > 0|x_t) = P(\epsilon_t > -x_t\beta|x_t) = P(\epsilon_t/\sigma > -x_t\beta/\sigma) = \Phi(x_t\beta/\sigma), \quad (5.7)$$

where $\Phi(.)$ denotes the *cdf* of the standard normal distribution. It can be shown that the last term of equation (5.6) is given by:

$$E(i_t|x_t, i_t > 0) = x_t\beta + E(\epsilon_t|\epsilon_t > -x_t\beta) = x_t\beta + \sigma\left[\frac{\phi(x_t\beta/\sigma)}{\Phi(x\beta/\sigma)}\right], \tag{5.8}$$

where $\phi(.)$ is the *pdf* of the standard normal distribution. Putting both terms together and simplifying we get a final expression for $E(i_t|x_t)$:

$$E(i_t|x_t) = \Phi(x_t\beta/\sigma)\left[x_t\beta + \sigma\frac{\phi(x_t\beta/\sigma)}{\Phi(x_t\beta/\sigma)}\right]. \tag{5.9}$$

In contrast to the latent model $E(i_t^*|x_t) = x_t\beta$, the conditional expectation $E(i_t|x_t)$ depends on the macroeconomic indicators x_t in a non-linear way.

5.2.1 Monetary policy responses when the zero lower bound is approached

While the interpretation of the right-hand side terms of equation (5.9) is difficult, the implied partial effects have a very intuitive interpretation. Wooldridge (2010) shows that after some simplification the partial effects can be written as:

$$\frac{\partial E(i_t|x_t)}{\partial x_{j,t}} = \Phi(x_t\beta/\sigma)\beta_j. \tag{5.10}$$

For comparison the partial effects of the latent model are simply given by:

$$\frac{\partial E(i_t^*|x_t)}{\partial x_{j,t}} = \beta_j. \tag{5.11}$$

The response of the interest rate to inflation in equation (5.10) does therefore not only depend on $\beta_3 = \alpha_\pi$ as in the uncensored monetary policy rule, but it also depends non-linearly on the scale factor $\Phi(x_t\beta/\sigma)$. The estimated scale factor denotes the estimated probability of observing a positive interest rate for a given x_t: $\Phi(x_t\hat{\beta}/\hat{\sigma}) = \hat{P}(i_t > 0|x_t)$. If $\Phi(x_t\hat{\beta}/\hat{\sigma})$ is close to one, then hitting the zero lower bound becomes unlikely and the partial effect $\Phi(x_t\beta/\sigma)\beta_j$ approaches β_j. $\Phi(x_t\hat{\beta}/\hat{\sigma})$ can be expected to increase with the

values of the inflation forecast, the output gap and the lagged interest rate.

Kato and Nishiyama (2005) and Kim and Mizen (2010) use the Tobit estimator to achieve consistent estimates of β for monetary policy rules for Japan. Our analysis shows, however, that there are several other interesting parameters that can additionally be analyzed to study how monetary policy changes when the zero lower bound on nominal interest rates is approached. The objects of interest are:

1. *Partial effect in the latent model*: $\hat{\beta}$ denotes the estimated shadow policy response. In contrast to OLS the Tobit model yields consistent estimates of $\hat{\beta}$.

2. *Partial effect evaluated at the sample mean*: $\Phi(\bar{x}\hat{\beta}/\hat{\sigma})\hat{\beta}_j$ denotes the estimated actual monetary policy response evaluated at the sample mean $\bar{x}$ taking into account the zero lower bound. This object is, however, only partially informative as it mixes policy reactions when the zero lower bound is binding and during other times. Therefore, it is useful to study the policy responses at different values of x_t directly.

3. *Partial effect at different values of* x_t: $\Phi(x_t\hat{\beta}/\hat{\sigma})\hat{\beta}_j$ is an estimate of monetary policy responses for different realizations of the lagged interest rate, the inflation forecast and the output gap. It shows how monetary policy responses change when the zero lower bound is approached because inflation expectations are low and/or a recession occurs. When the probability of hitting the zero lower bound is low then $\Phi(x_t\hat{\beta}/\hat{\sigma})\hat{\beta}_j$ approaches $\hat{\beta}_j$.

5.2.2 IV-Tobit estimation

While the Tobit-model solves the non-linearity problem induced by the zero lower bound on nominal interest rates, the usual endogeneity problem caused by the two-way interaction of the interest rate with expected inflation and the output gap persists. To solve this we use an IV-version of the Tobit estimator. Here, one can either run a two-step estimation (Newey, 1987) or a full maximum likelihood estimation that includes the instruments directly. The disadvantage of the two-step estimator is that it gives no estimate of σ which we need to compute estimates of $\Phi(x_t\beta/\sigma)$. Therefore, we use the full max-

imum likelihood estimator for which standard conditional maximum likelihood theory can be used to construct standard errors and test statistics. We use the Hubert-White estimator to get Heteroscedasticity-consistent standard errors.

5.3 Data

We use monthly data for Japan, the US and the Euro area. The policy rate for Japan is the uncollateralized overnight call rate which is directly available from the Bank of Japan. Data is available from July 1985 onwards, thus the sample includes 335 observations from 1985M7 to 2013M5. Regarding the inflation rate we compute year-on-year inflation rates based on the CPI index. As GDP data is not available on a monthly frequency we use industrial production instead. The output gap is computed using the HP-filter. Inflation and industrial production data are obtained from the OECD database.

For the US we also use CPI-inflation and industrial production data provided by the OECD. The effective federal funds rate is used as a proxy of the policy instrument. The sample for the US starts in 1983M1 and goes through 2013M6, which yields 366 observations. We do not start earlier to avoid a structural break in monetary policy responses to inflation and the output gap before and after Paul Volcker was chairman of the Fed.

As the Euro was introduced in 1999, we use monthly data for the Euro area from 1999M1 to 2013M6, which results in 174 observations. Data for CPI-inflation, industrial production and the EONIA rate are taken from the ECB data warehouse.

We follow Clarida et al. (1998) and Kim and Mizen (2010) and use 12-months-ahead ex-post inflation rates to approximate expected inflation. IV-estimators control for possible measurement error bias owing to the approximation of inflation forecasts with ex-post observations (see e.g. Clarida et al., 1998). We also experimented with forecasts of both, inflation and the output gap (see e.g. Orphanides, 2001) and we document in which cases the resulting estimates are similar and in which cases they differ from the baseline results.

Through the construction of expected inflation measures we lose twelve observations for each sample. In addition six further observations are lost because we use six lags of inflation and the output gap as instruments. These lagged variables are correlated with

expected inflation and the output gap. They can be assumed to not be influenced by the period t interest rate as they refer to macroeconomic developments in periods $t-1$ to $t-6$.

5.4 Estimation results

We start with the estimation of the simple case without interest rate smoothing, i.e. $\alpha_i = 0$, to demonstrate how the different estimated objects can be used to describe monetary policy above the zero lower bound and also when approaching the zero lower bound. This case has also been studied by Kato and Nishiyama (2005) and Kim and Mizen (2010) for Japan. Afterwards, we study the more realistic case without restriction on the interest rate smoothing parameter.

5.4.1 A simple benchmark case without interest rate smoothing

Table 5.1 shows the estimated partial effects for the case without interest rate smoothing. The first column for each of the three economies refers to the TSLS-estimates of equations (5.3) to (5.5). The second column shows the unbiased counterpart estimated at $E(i_t^*|x_t)$ which is informative if the interest rate is well above zero. At low interest rates, this estimate can be interpreted as the shadow interest rate response that the central bank would have implemented if there was no zero lower bound. Finally, the third column shows the estimates for $E(i_t|x_t)$ evaluated at the sample mean $\bar{x}$. We will study $E(i_t|x_t)$ for alternative values of x_t below. The table further shows estimates of σ and the number of observations.

The estimates show that the Taylor principle of increasing the nominal interest rate more than one-to-one in response to changes in inflation is fulfilled for all three central banks. The inflation response coefficients are well above one and they are highly significant. The output gap coefficient estimates are insignificant and close to zero for Japan. Similarly, Clarida et al. (1998), Kuttner and Posen (2004) and Kim and Mizen (2010) find a response to the output gap for Japan that is insignificant on the 5% level. The output gap responses are positive and significant for the US. For the Euro area we

	Japan			US			Euro area		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	TSLS	*IV-Tobit*	*IV-Tobit*	*TSLS*	*IV-Tobit*	*IV-Tobit*	*TSLS*	*IV-Tobit*	*IV-Tobit*
	$E(i_t\|x_t)$	$E(i_t^*\|x_t)$	$E(i_t\|\bar{x})$	$E(i_t\|x_t)$	$E(i_t^*\|x_t)$	$E(i_t\|\bar{x})$	$E(i_t\|x_t)$	$E(i_t^*\|x_t)$	$E(i_t\|\bar{x})$
	$\hat{\beta}_j^{\text{TSLS}}$	$\hat{\beta}_j$	$\Phi(\bar{x}\hat{\beta}/\hat{\sigma})\hat{\beta}_j$	$\hat{\beta}_j^{\text{TSLS}}$	$\hat{\beta}_j$	$\Phi(\bar{x}\hat{\beta}/\hat{\sigma})\hat{\beta}_j$	$\hat{\beta}_j^{\text{TSLS}}$	$\hat{\beta}_j$	$\Phi(\bar{x}\hat{\beta}/\hat{\sigma})\hat{\beta}_j$
inflation response	2.689***	2.843***	2.118***	1.838***	3.557***	3.096***	2.903***	2.929***	2.641***
	(0.182)	(0.500)	(0.400)	(0.243)	(0.293)	(0.240)	(0.728)	(0.166)	(0.169)
output gap response	-0.038	-0.041	-0.031	0.453***	0.433***	0.376**	-0.770***	-0.799***	-0.720***
	(0.032)	(0.048)	(0.035)	(0.073)	(0.167)	(0.147)	(0.159)	(0.077)	(0.084)
constant	0.605***	0.531**		-0.674	-5.628***		-3.598**	-3.649***	
	(0.148)	(0.235)		(0.723)	(0.961)		(1.504)	(0.387)	
$\hat{\sigma}$			2.663			4.117			1.940
Observations	317	317	317	348	348	348	156	156	156

*,**,*** indicate significance at the 10%-, 5%- and 1%-level, respectively.

Table 5.1: Monetary policy rule parameter estimates without interest rate smoothing for Japan, the US and the Euro area.

use a slightly different specification than for Japan and the US. We include an ex-post output gap forecast—constructed in the same way as the inflation forecast—instead of the actual output gap. Using outcomes instead of forecasts for the output gap would yield a significant negative inflation coefficient. We regard this as implausible. With the output gap forecast specification the inflation coefficient has the expected sign, but the output gap coefficient turns out to be negative and significant. So, overall the results without interest rate smoothing for the Euro area have to be interpreted with caution as these are signs for possible misspecification. The more realistic results with interest rate smoothing which are discussed in the next section yield plausible parameter estimates for the inflation and the output gap response.

For all three central banks the inflation response parameter is higher for the IV-Tobit estimates ($\hat{\alpha}_\pi$) than for the TSLS estimates ($\hat{\alpha}_\pi^{\text{TSLS}}$). Intuitively, the larger IV-Tobit estimates make sense as the TSLS estimates include periods where the interest rate needs to stay constant even if inflation decreases further, which lowers estimates of the inflation response. The differences between the TSLS and IV-Tobit estimates are largest for the US and smallest for the Euro area. For the Euro area the zero lower bound is not binding yet and due to the construction of the inflation forecasts we lose the last 12 observations with the interest rate observations close to zero. The difference between the TSLS and IV-Tobit estimates of α_y are small for all three economies. The bias thus mainly shows up in the inflation response parameter estimates.

Comparing the TSLS estimates with interest rate responses estimated at $E_t(i_t|\bar{x})$ using IV-Tobit which correctly includes the non-linearity, confirms the upward bias of conventional estimates found by Kim and Mizen (2010) for Japan.[1] TSLS Euro area estimates also show an upward bias, while the bias for the US estimates is negative.[2] These differences in the inflation response coefficients and to a much smaller extent in the output gap response coefficients show that the estimation of monetary policy rules for these samples leads to unreliable estimates if the zero lower bound is not taken into

[1] The sample mean for inflation is 0.4%, 3% and 2.1% for Japan, the US and the Euro area, respectively. The sample mean of the output gap is 0 by construction for all three economies.

[2] We refer the reader to Kim and Mizen (2010) for the exact econometric conditions for the bias to be positive or negative.

account.

Finally, when comparing the second and third column, the results show that the shadow interest rate responses, $\hat{\beta}$, to inflation and in the case of the US also to the output gap are always larger than the actual ones, $\Phi(\bar{x}\hat{\beta}/\hat{\sigma})\hat{\beta}$. This intuitively makes sense, because the actual interest rate response estimates take into account the constraints on monetary policy that prevent central banks from reacting as strongly to inflation and the output gap as they desire.

The analysis so far has shown how the Tobit framework can be used to achieve consistent estimates of monetary policy rule parameters. These techniques can hence be used in the future to conduct historical monetary policy analysis. Now, we go one step further and study how the policy response parameters change, when the interest rate approaches the zero lower bound.

The solid line in figure 5.2 shows the estimated inflation response for different values of inflation: $\Phi((1, \pi_t, \bar{y})\hat{\beta}/\hat{\sigma})\hat{\alpha}_\pi$. For the output gap we again take the sample mean. The circles mark the estimated inflation response at the sample mean as shown in table 5.1. For comparison the dotted lines show the shadow inflation responses, i.e. $\hat{\alpha}_\pi$ estimated at $E(i_t^*|x_t)$, and the dashed-dotted lines show the (biased) TSLS estimates $\hat{\alpha}_\pi^{\text{TSLS}}$. Both do not depend on the level of inflation so that they are depicted as horizontal lines.

The solid line reveals the full non-linearity of the inflation response when the zero lower bound is approached as a result of decreasing inflation. Very low inflation rates are usually accompanied by very low interest rates, so that central banks cannot react to these by decreasing the policy rate further. The estimated inflation response parameter therefore converges to zero. Comparing the solid line with the TSLS estimates shows that for most inflation rates the TSLS estimates are upward biased for Japan and the Euro area. Only for inflation rates above about 1.3% the bias becomes negative for Japan. For the Euro area the bias diminishes for inflation rates above 2.5%. For the US the bias is negative for inflation above 1.5% and positive for inflation rates below 1.5%. Comparing the solid lines with the shadow inflation responses (dotted lines) shows that already for inflation rates below 2% for Japan, below 4% for the US and below 2.5% for the Euro area the actual inflation responses start to deviate from the shadow responses. So, at

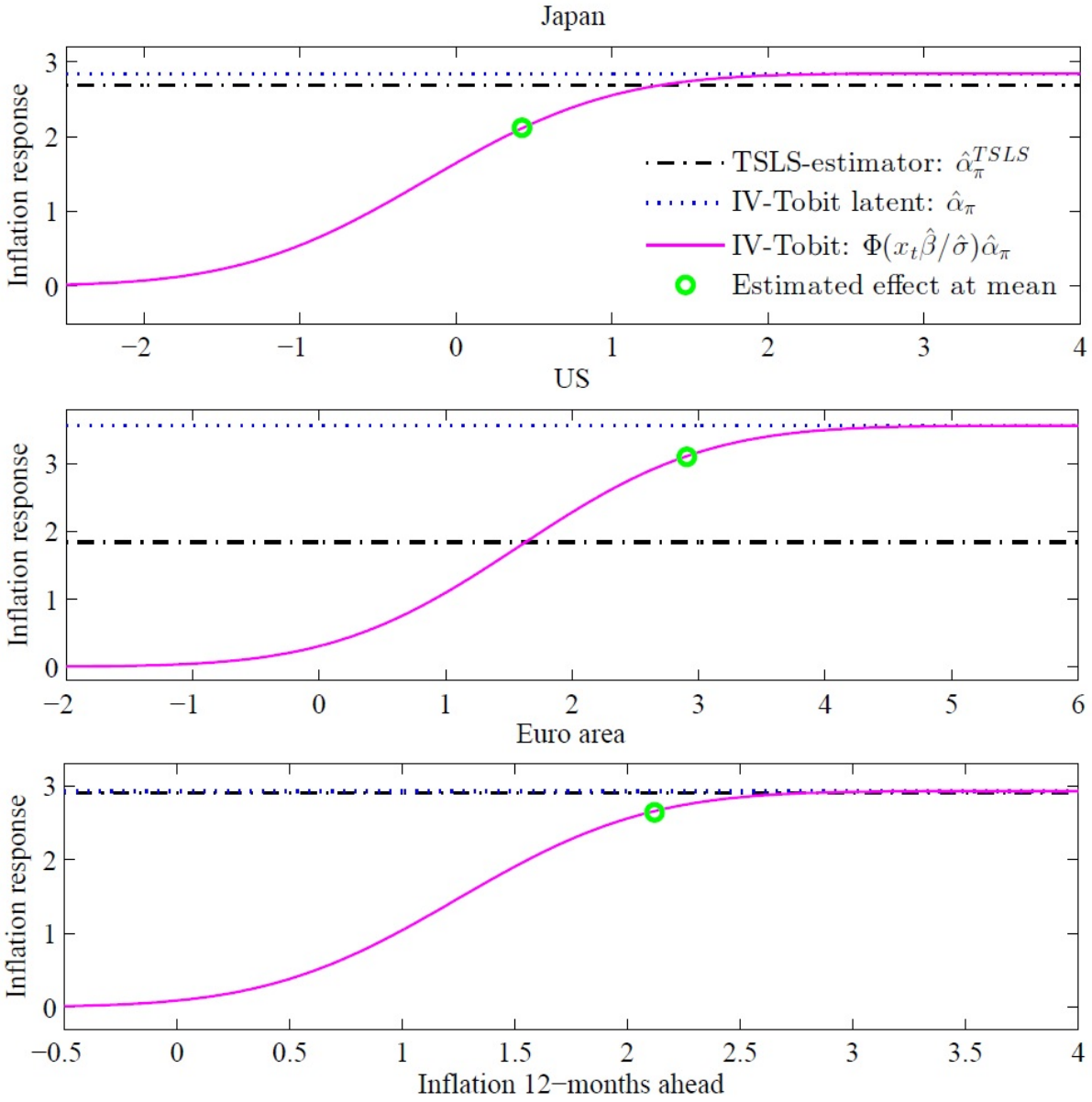

Figure 5.2: Inflation responses for different levels of inflation

least for monetary policy rule estimates without interest rate smoothing accounting for the non-linearity induced by the zero lower bound is of importance, not only directly at the zero lower bound but also above. Actual policy responses deviate from the shadow responses even for inflation rates as high as the sample means (sample means of inflation are indicated by the circles).

Finally, we can check what the different parameter estimates imply for the fitted interest rate. Figure 5.3 shows a scatter plot of the observed interest rates and the

inflation forecasts together with the fitted interest rate for different levels of inflation (the output gap is hold constant at the sample mean). The solid lines show the implied interest

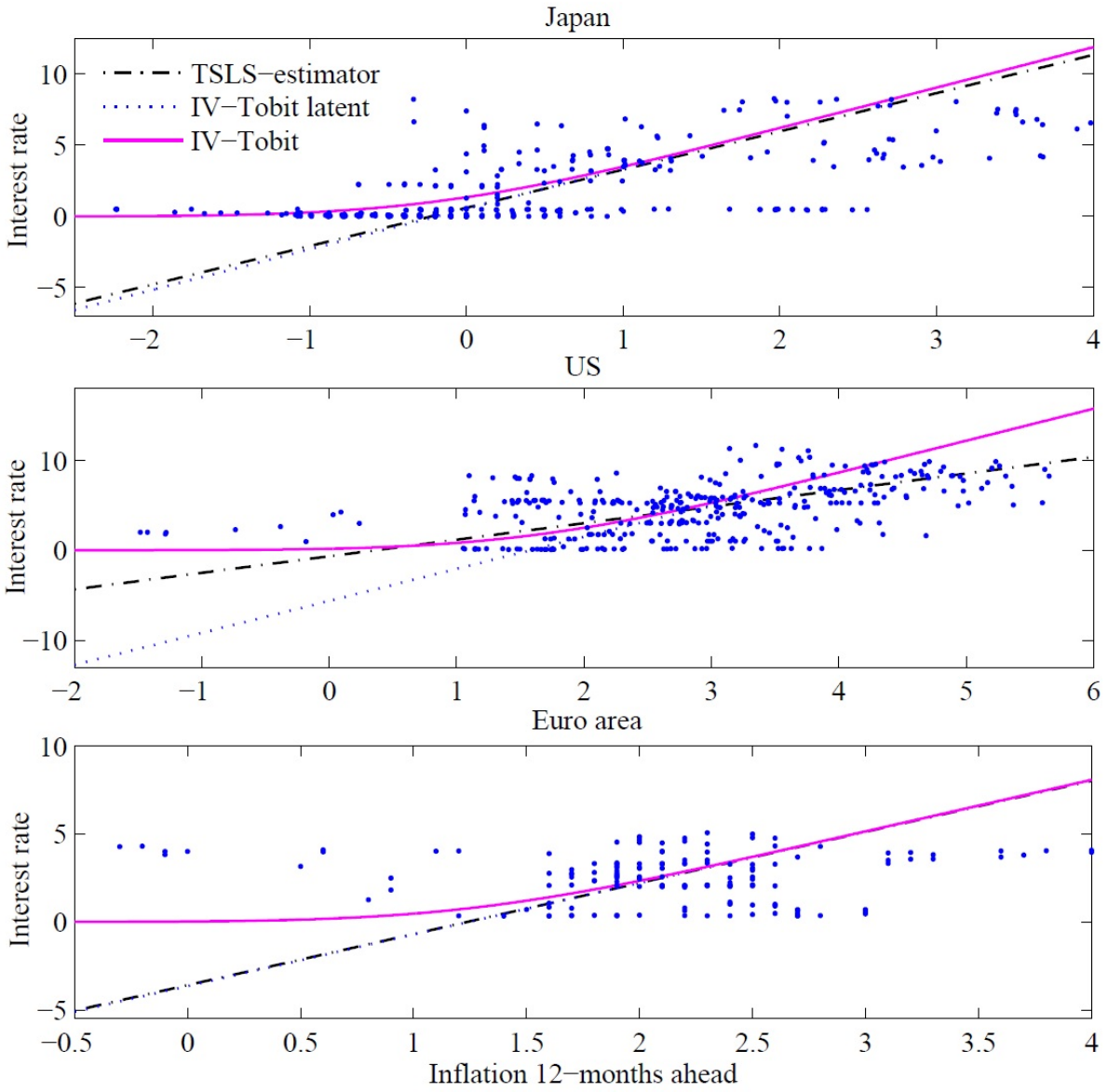

Figure 5.3: Expected central bank rate for different inflation expectations

rates when taking into account the non-linearity induced by the zero lower bound. The two straight lines show the fitted interest rates implied by the TSLS estimates (dashed-dotted) and the implied latent or shadow interest rate $\hat{i}_t^*$ (dotted). The difference between the two is particularly large for the US reflecting the large bias of the TSLS estimates in this case. The fit even for the fully non-linear IV-Tobit estimator is not particularly good, because we hold the output gap fixed at zero, while low inflation and low interest

rates are often observed for negative output gaps. For inflation rates above about 1% for Japan and above about 2% for the US and the Euro area the IV-Tobit estimates for $\hat{i}_t$ and $\hat{i}_t^*$ coincide as $\hat{P}(i_t > 0|x_t) \longrightarrow 1$. Yet even below these values the linear estimates do not provide a good description of actual interest rate responses. For inflation rates below 0% for Japan and below 1% for the US and the Euro area the TSLS estimates imply negative interest rates and the unbiased IV-Tobit estimates for $\hat{i}_t^*$ confirm that the central banks would have set negative interest rates if they could. In contrast, the IV-Tobit estimates for $\hat{i}_t$ take into account the zero lower bound and converge to zero for low positive and negative inflation rates.

5.4.2 Monetary policy rule estimates with interest rate smoothing

Having demonstrated the non-linearities of monetary policy responses when the interest rate approaches zero for the simple case without interest rate smoothing, we now turn to the more realistic estimates with interest rate smoothing. Table 5.2 shows the estimated partial effects. The table is structured exactly as for the case without interest rate smoothing but additionally reports the estimated response to the lagged interest rate.[3]

It is apparent that the response to the lagged interest rate is large and highly significant for all three economies. The ECB sets interest rates most gradually with a coefficient very close to one. The interest rate smoothing coefficient is only slightly lower for the US, but quite a bit lower for Japan. The inflation response is positive and highly significant for all three central banks. From the table it is not clear whether the Taylor principle is satisfied because we report estimates of $\alpha_\pi = (1-\rho)\gamma$. If the structural inflation response coefficient $\gamma = \alpha_\pi/(1-\rho)$ is computed it can be seen that the Taylor principle is fulfilled for all three central banks. The structural inflation response coefficient is largest for the Euro area owing to the very large estimate of ρ in the denominator:

[3] For the case with interest rate smoothing there are no miss-specification problems for the Euro area estimates leading to negative inflation response estimates as in the previous section so that we can report estimates for all three economies for the baseline specification where the interest rate responds to forecasts of inflation, but to outcomes of the output gap.

	Japan			US			Euro area		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	TSLS	*IV-Tobit*	*IV-Tobit*	*TSLS*	*IV-Tobit*	*IV-Tobit*	*TSLS*	*IV-Tobit*	*IV-Tobit*
	$E(i_t\|x_t)$	$E(i_t^*\|x_t)$	$E(i_t\|\bar{x})$	$E(i_t\|x_t)$	$E(i_t^*\|x_t)$	$E(i_t\|\bar{x})$	$E(i_t\|x_t)$	$E(i_t^*\|x_t)$	$E(i_t\|\bar{x})$
	$\hat{\beta}_j^{\text{TSLS}}$	$\hat{\beta}_j$	$\Phi(\bar{x}\hat{\beta}/\hat{\sigma})\hat{\beta}_j$	$\hat{\beta}_j^{\text{TSLS}}$	$\hat{\beta}_j$	$\Phi(\bar{x}\hat{\beta}/\hat{\sigma})\hat{\beta}_j$	$\hat{\beta}_j^{\text{TSLS}}$	$\hat{\beta}_j$	$\Phi(\bar{x}\hat{\beta}/\hat{\sigma})\hat{\beta}_j$
inflation response	0.255***	0.360***	0.360***	0.095***	0.137***	0.137***	0.151***	0.225***	0.225***
	(0.068)	(0.127)	(0.127)	(0.032)	(0.004)	(0.004)	(0.042)	(0.002)	(0.002)
output gap response	-0.002	-0.003	-0.003	0.016*	0.020***	0.019***	0.018***	0.017***	0.017***
	(0.003)	(0.096)	(0.096)	(0.008)	(0.006)	(0.006)	(0.005)	(0.000)	(0.000)
interest rate response	0.900***	0.865***	0.865***	0.975***	0.966***	0.966***	0.991***	0.997***	0.997***
	(0.024)	(0.026)	(0.026)	(0.009)	(0.003)	(0.003)	(0.011)	(0.001)	(0.001)
constant	0.043**	0.059		-0.185***	-0.264***		-0.316***	-0.486***	
	(0.018)	(0.395)		(0.065)	(0.029)		(0.100)	(0.004)	
$\hat{\sigma}$			0.320			0.247			0.193
Observations	317	317	317	348	348	348	156	156	156

*,**,*** indicate significance at the 10%-, 5%- and 1%-level, respectively.

Table 5.2: Monetary policy rule parameter estimates with interest rate smoothing for Japan, the US and the Euro area.

$\hat{\gamma}^{EA} = 0.225/(1 - 0.997) = 75$. For the US and Japan the coefficients are smaller and in a more reasonable range: $\hat{\gamma}^{US} = 4.03$, $\hat{\gamma}^{JAP} = 2.67$. The output gap response is close to zero and insignificant for Japan, but positive and highly significant for the US and the Euro area. The estimation results are roughly in line with what previous literature has found for rules with an interest rate smoothing term.

Comparing the TSLS and IV-Tobit estimates ($\hat{\beta}^{\text{TSLS}}$ and $\hat{\beta}$) shows that the TSLS estimates are biased. In contrast to the results without interest rate smoothing, the bias of the inflation response is now negative for all three central banks. As in the previous section the bias of the output gap response estimates is very small. Regarding the interest rate smoothing coefficient, the TSLS estimates overestimate the degree of interest rate smoothing somewhat for Japan and the US and underestimate it for the Euro area.

Comparing the shadow interest rate responses, $E(i_t^*|x_t)$, with the actual ones evaluated at the sample mean, $E(i_t|\bar{x})$, shows that there is no difference at all. These results are very different from the estimation results without interest rate smoothing in the previous section. The explanation is that the IV-Tobit estimates are evaluated at the sample mean of x_t. The sample mean for the interest rate which is included in x_t via the lagged interest rate is quite a bit above zero (1.79%, 4.56% and 2.33% for Japan, the US and the Euro area). Thus at the sample mean the IV-Tobit estimates cannot reveal any non-linearities as the central banks can implement monetary policy without restrictions. Therefore, we now turn to the evaluation of the interest rate responses at different values for x_t including those close to zero to study the non-linearity of policy responses.

Figure 5.4 shows how the inflation response changes with the level of expected inflation. We hold the output gap constant at zero and the interest rate at 0.25%. Holding the interest rate constant at the sample mean would prevent any non-linearities in the graph as this is too far away from the zero lower bound to change the inflation response even for deflationary forecasts.

In Japan, since the mid-1990s when the interest rate approached zero actual observed inflation has been in a range from about -2% to 2%. The graph shows that for this range the inflation response varies from 0 to 0.4 and coincides with the shadow response only for inflation rates above 1%. For the US observed inflation ranges from about -2% to

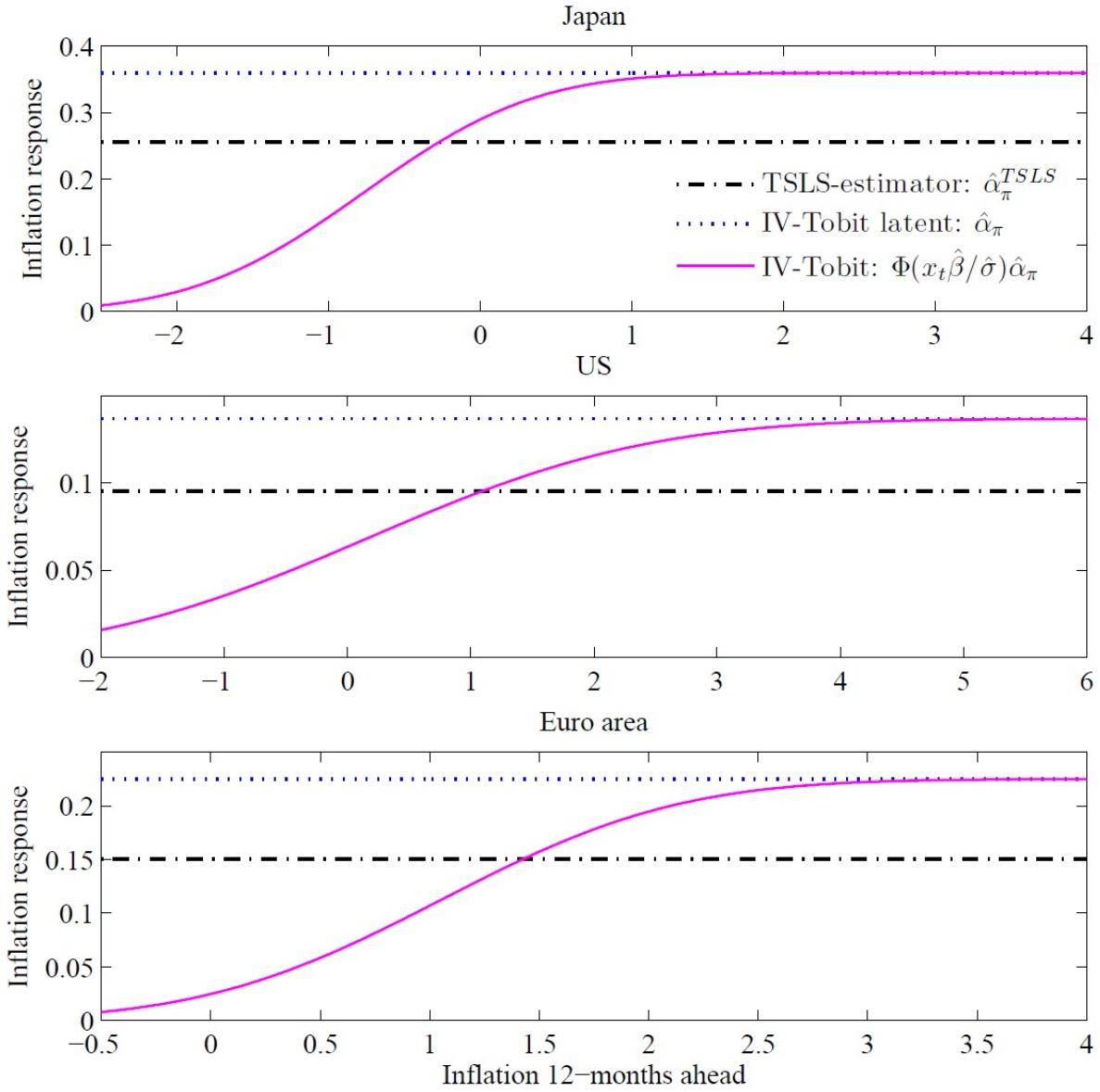

Figure 5.4: Inflation responses for different levels of inflation

4% since the zero lower bound became an issue in 2010. For this whole range the actual inflation response is lower than the shadow response and is close to zero for $\pi_{t+12|t} = -2\%$. Finally, inflation rates for the Euro area for the two periods of low interest rates from the middle of 2009 to the end of 2010 and again from 2012 onwards range from about 1.5% to 3%. For this range the actual inflation responses are lower than the shadow responses, though they do not reach zero.

So far, we have studied non-linearities close to the zero lower bound caused by different inflation forecasts in isolation. To study how monetary policy responses change when the

zero lower bound is approached not only through changes in inflation, but the combination of previously low interest rates, changes in inflation forecasts and changes in the output gap, we compute the partial effects for each point in time t evaluated at the specific values i_{t-1}, $\pi_{t+12|t}$ and y_t. In addition we can compute the estimated probability of observing an interest rate above zero given the lagged interest rate, the inflation forecast and the output gap: $\Phi(x_t\hat{\beta}/\hat{\sigma}) = \hat{P}(i_t > 0|x_t)$. The monetary policy responses at each point in time equal this probability times the estimated policy response parameters $\hat{\alpha}_i$, $\hat{\alpha}_\pi$ and $\hat{\alpha}_y$ as shown in equation (5.10).

Figure 5.5 shows the results for Japan. In addition to the policy response coefficients and the estimated probability of observing a strictly positive interest rate given x_t the figure also shows data for the three macroeconomic variables contained in x_t. The first graph of figure 5.5 shows the estimated probability of observing an interest rate above zero, $\Phi(x_t\hat{\beta}/\hat{\sigma})$. This term was equal to one until 1998. The second graph shows the nominal interest rate. It dropped to 0.5% in 1995. This was, however, not sufficient to change the monetary policy response as can be seen in the third, fifth and seventh graph of the figure. In 1998 the decrease in the inflation forecast led to a drop in the probability of the interest rate being above zero. From this point onwards the smoothing coefficient, the inflation response and the output gap response are lower than the shadow responses that were in place until 1998. In 1999 following further interest rate decreases the probability of hitting the zero lower bound increased and the monetary policy responses to inflation and the output gap approached values close to zero. Additionally the interest rate smoothing coefficient decreased substantially. From then on there is only one minor change in the interest rate. The interest rate increased from values close to zero to up to 0.5% between the middle of 2006 and the end of 2008. During this period $\hat{P}(i_t > 0|x_t)$ went back to one and actual monetary policy responses were equal to the shadow responses. For the remaining periods $\hat{P}(i_t > 0|x_t)$ and hence the strength of monetary policy responses closely reflect the inflation developments. While there are large movements in the output gap as well—in particular the output gap dropped below -20% during the financial crisis—this has almost no impact on the policy response as the estimates show no reaction of the Japanese policy rate to the output gap.

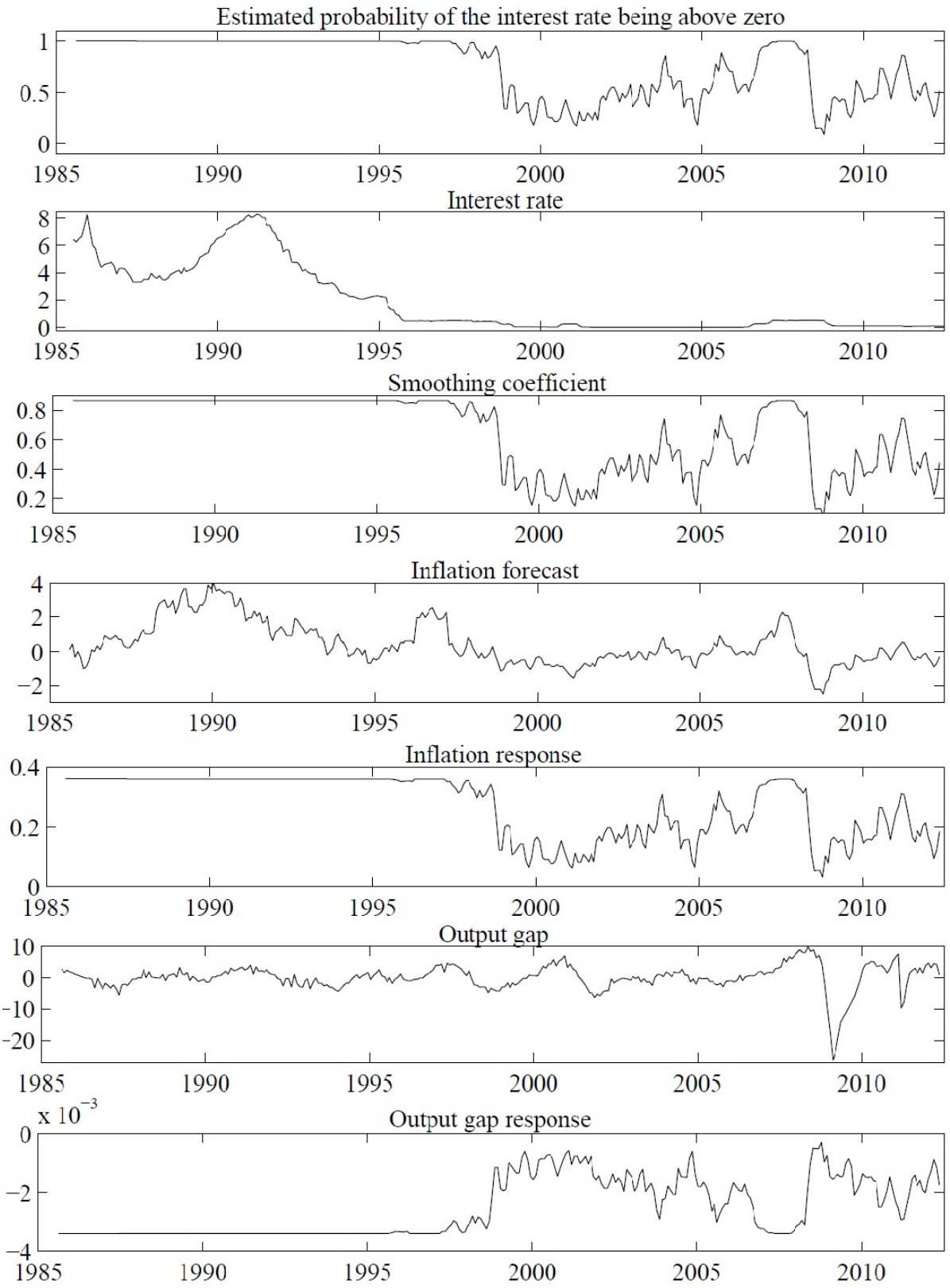

Figure 5.5: Monetary policy responses for Japan over time

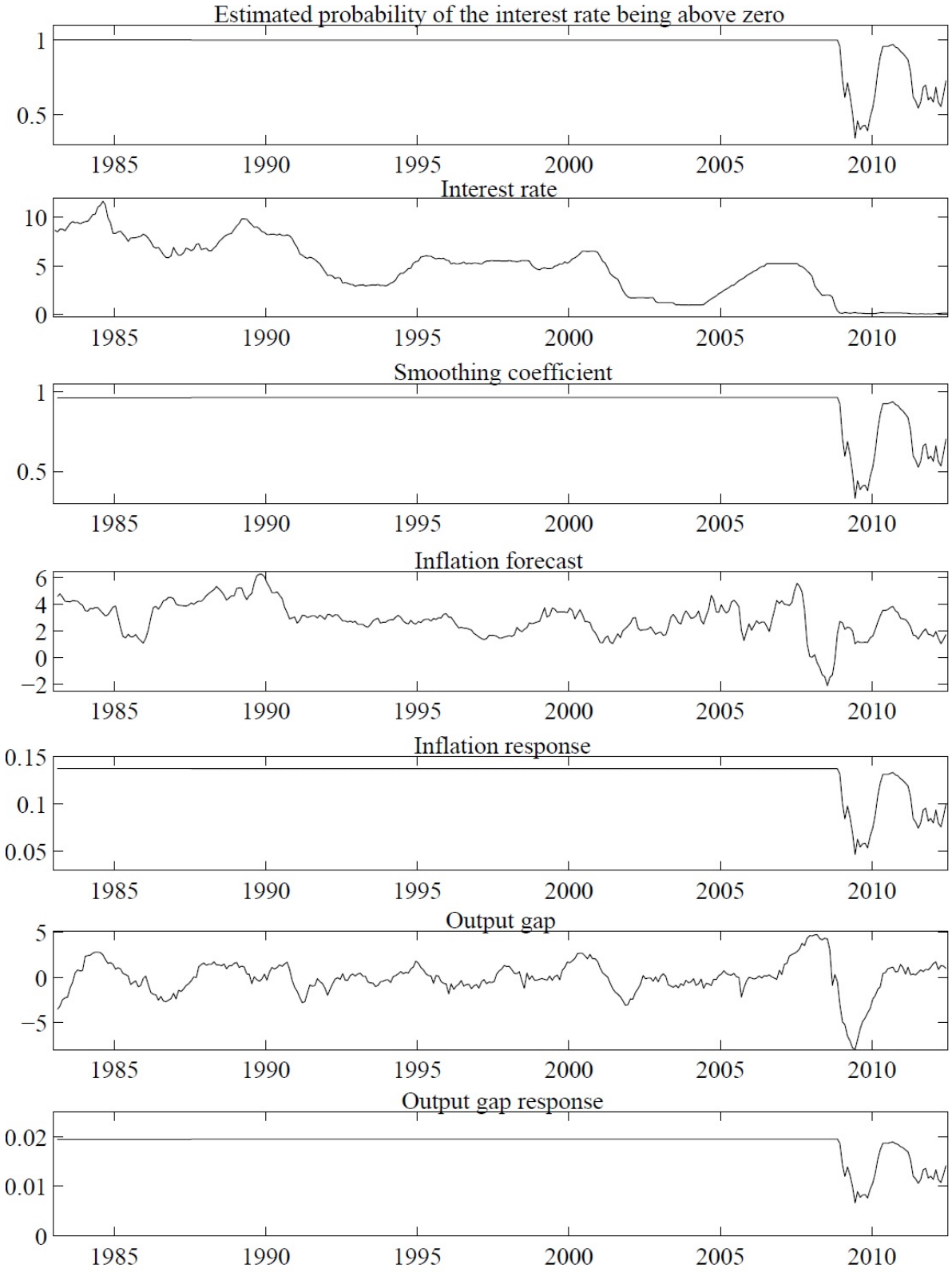

Figure 5.6: Monetary policy responses for the US over time

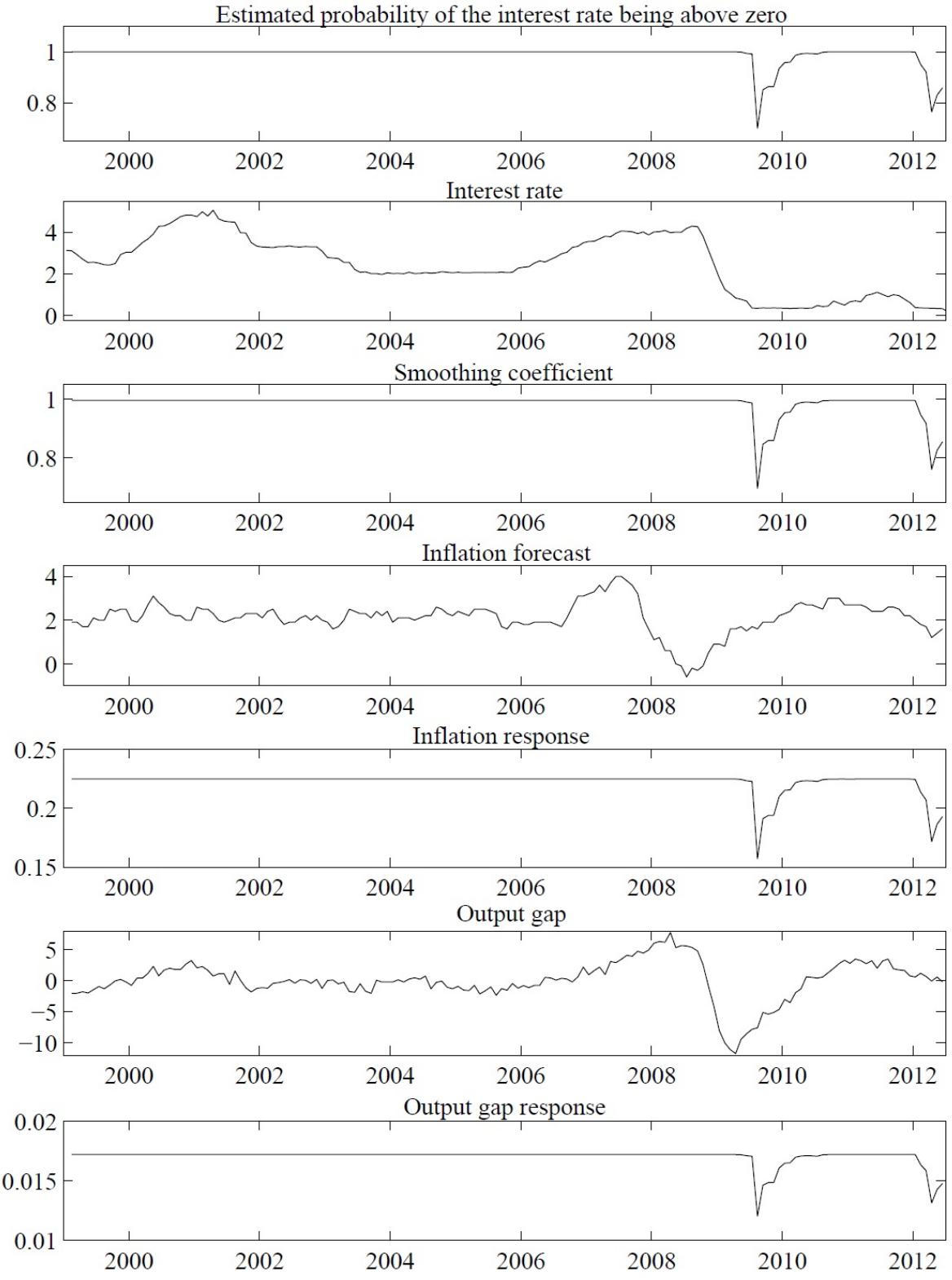

Figure 5.7: Monetary policy responses for the Euro area over time

Figure 5.6 shows that the US central bank was able to implement the interest rate responses without restrictions for the largest part of the sample. Only since 2009 the estimated probability of the interest rate being above zero deviates from one and dropped sharply in 2009 because of the highly negative output gap caused by the financial crisis and the following interest rate reductions. Interestingly, the drop in the inflation forecast for 2009 that occurred in 2008 did not reduce the probability of the interest rate staying above zero. Here, the limitations of the approach of approximating forecasts with actual ex-post inflation observations becomes visible. Actual inflation forecasts in 2008 for 2009 were probably not as pessimistic and therefore the interest rate was only lowered once the financial crisis caused the large negative output gap in 2009. The drop in the probability of the interest rate being above zero led to a change in the monetary policy responses. The inflation response decreased from 0.14 to 0.05 and the output gap response dropped from 0.02 to 0.01.[4] In 2010 inflation forecasts increased again (because of the actual inflation increase in 2011) and the probability of the interest rate being above zero returned to values close to one. Accordingly, the policy responses to the lagged interest rate, inflation and the output gap increased. However, the interest rate smoothing coefficient was so large, that despite this increase in inflation the interest rate remained at zero. After 2010 the probability of the interest rate being above zero was closely related to inflation and output gap dynamics and equaled about 0.6. Inflation remained somewhat below 2% and the estimated output gap was around 1%. Any future decrease of inflation or the output gap would decrease the probability of the interest rate being above zero even further and lower monetary policy responses to inflation and the output gap.

Finally, figure 5.7 shows monetary policy responses over time for the Euro area. It is apparent that the zero lower bound has changed monetary policy responses only to some extent in 2009 and from 2012 onwards. In 2009 the output gap was low owing to the financial crisis and the ECB lowered the interest rate accordingly. The probability of the interest rate being above zero dropped from 1 to 0.7. Accordingly, the inflation response decreased from 0.23 to 0.15. In 2010 the increase in inflation and the output

[4] One should keep in mind that these are combined coefficients that include $1-\rho$ and not the structural coefficients. Though these coefficients seem to be very small, their effect is amplified over time through interest rate smoothing.

gap led to normal interest rate responses again and the interest rate increased slightly in 2011. In 2012 the ECB lowered the interest rate again as the inflation forecast and the output gap decreased because of the weak economic dynamics caused by the sovereign debt crisis. The probability of the interest rate being above zero dropped to about 0.8 so that monetary policy responses were weakened somewhat. They are, however, in contrast to some periods in Japan and the US still largely above zero.

5.5 The IV-Tobit estimates and predictions from economic theory

The estimation results of the previous section showed that actual policy responses to inflation, the output gap and the lagged interest rate will start to deviate from the shadow responses, once the estimated probability of observing strictly positive interest rates conditional on the lagged interest rate, the inflation forecast and the output gap decreases below one. The estimated monetary policy responses decrease proportionally to this probability when the zero lower bound is approached. By definition the IV-Tobit estimates of monetary policy responses must become smaller when the zero lower bound is approached and cannot become larger.

Now, we want to compare this finding with predictions from economic theory on optimal monetary policy responses when the zero lower bound is approached. Orphanides and Wieland (2000), Kato and Nishiyama (2005), Adam and Billi (2006) and Oda and Nagahata (2008) find that the reaction to inflation and the output gap should increase when the danger of reaching the zero lower bound becomes larger to decrease the interest rate pre-emptively. For example Orphanides and Wieland (2000) find that in a model where the optimal inflation response coefficient equals 2 in the absence of the zero lower bound, when accounting for the zero lower bound the inflation response increases gradually to a coefficient of almost 3 when inflation decreases from 3% to 0.5%. If inflation drops even further then the inflation response decreases very quickly and converges to zero as the zero lower bound on nominal interest rates is approached. Similar results are obtained by the other cited papers.

Such predictions from theory cannot be captured or tested using the Tobit approach applied to an otherwise linear policy rule. The Tobit approach can only capture the final convergence of policy responses to zero when the zero lower bound is approached. There are two important assumptions for the Tobit approach that prevent an increase in policy responses. First, it is assumed that the shadow interest rate that would be implemented if there was no zero lower bound is a linear function of the lagged interest rate, inflation and the output gap. The linearity prevents any systematic changes in shadow interest rate responses when the zero lower bound is approached. Second, it is assumed that the monetary policy shock to the shadow interest rate is normally distributed. This prevents any discretionary asymmetric policy responses when the zero lower bound is approached.

One possibility to check for pre-emptive interest rate decreases when approaching the zero lower bound is to include non-linear terms in the equation for the shadow interest rate. Kato and Nishiyama (2005) include squared terms of inflation and the output gap and estimate indeed negative coefficients for these using Tobit regression without instruments. So, the response of the interest rate to inflation increases if inflation decreases. As they do not provide estimates of the inflation response for different levels of inflation it remains unclear, whether these negative coefficients or the decrease of $\Phi(x_t\hat{\beta}/\hat{\sigma})$ dominate when approaching the zero lower bound. So, the results could imply a decrease or an increase in the inflation and output gap responses when interest rates are low.

We also included squares of inflation and the output gap in our IV-Tobit estimates of a rule without interest rate smoothing and in contrast to Kato and Nishiyama (2005) also in a rule with interest rate smoothing. For the rule without interest rate smoothing we find a negative, but insignificant coefficient on squared inflation for Japan, a positive significant coefficient for the US and the Euro area. The coefficients on the squared output gap are positive and significant for Japan, negative and insignificant for the US and negative and significant for the Euro area. Some of the estimates of the remaining parameters were, however, hardly plausible so that we are very careful in interpreting these results. For the more realistic specification with interest rate smoothing, the estimator had convergence problems for all three economies. Already without the squared inflation and output gap terms, the maximization of the likelihood for the IV-Tobit model is not easy and can lead

to numerical problems. As it is not clear whether the IV-Tobit approach with additional squared terms of inflation and the output gap can deliver reliable results we discuss in the following two other approaches that might be useful to test for pre-emptive interest rate decreases near the zero lower bound.

Gerlach (2011) estimates a monetary policy rule for the ECB for the period 1999 to 2009 using an ordered Logit model. To study whether interest rate decreases from 4.25% in September 2008 to 1% in May 2009 were standard responses to worsening macroeconomic conditions or whether in addition interest rates were decreased pre-emptively, he allows for a smooth transition from one policy response parameter set to the next (see Teräsvirta, 2004, for an explanation of the smooth transition approach). He indeed finds a change in the monetary policy rule. The parameter on the lagged interest rate increased substantially, making it more likely that a decrease in the interest rate is followed by another one. While this result indicates pre-emptive interest rates decrases, Gerlach finds no change in the output response.[5] Gerlach and Lewis (2014) use the smooth transition regression method to estimate a monetary policy rule for the ECB from 1999 to 2010. They find a change in monetary policy in 2008 and a lower interest rate than implied by the pre-crisis rule after 2008. Before 2008 monetary policy responses to inflation and the output gap are significant with the expected sign, but not afterwards, so that pre-emptive interest rate decreases were not caused by larger policy responses to inflation and the output gap.

Another possibility to test for larger inflation and output gap responses when the zero lower bound is approached is to use censored quantile regression. Chevapatrakul et al. (2009) and Wolters (2012) show that uncensored quantile regression can be used to analyse asymmetric deviations of monetary policy responses from a linear rule. Using this framework one can estimate policy response parameters for each quantile of the conditional interest rate distribution. This includes cases where the interest rate is set higher or lower than on average given inflation and output gap developments. While the work of Chevapatrakul et al. (2009) and Wolters (2012) using quantile regression is useful

[5] He dropped inflation altogether from the equation as the estimated inflation responses were insignificant.

to capture asymmetric reactions to inflation and the output gap in normal times, their method needs to be extended to a censored quantile regression approach to guarantee unbiased estimates in samples with low interest rates.

5.6 Conclusion

We have shown how the IV-Tobit estimator can be used to achieve consistent estimates of monetary policy rule parameters accounting for the zero lower bound on nominal interest rates. The approach has been applied to three large economies: Japan, the US and the Euro area. In all three economies policy rates have reached values close to zero in recent years. The comparison of the IV-Tobit estimates with conventional two-stage least squares estimates shows that the latter are biased. In addition, we have demonstrated how estimated monetary policy responses change when the zero lower bound is approached and how they deviate from the shadow responses that the central bank would implement if there was no zero lower bound.

Overall, the analysis in this chapter is useful to understand how the IV-Tobit estimator can be used in the future for the estimation of monetary policy rules in samples that include low interest rates. Researchers do not need to wait until there are enough new observations of interest rates above the zero lower bound, but they can use the entire sample including periods of almost zero interest rates. We have shown how the various parameters can be interpreted as policy responses in normal times, shadow policy responses that the central bank would implement if there was no zero lower bound and actual estimated policy responses when the zero lower bound is approached.

Chapter 6

Concluding Remarks

This dissertation has presented the results of four research projects. Their purpose was to add further insights on the links between Christian moralities and financial behavior and to learn more about the efficiency and constrains of discretionary policy measures.

A comprehensive empirical analysis of the relative dominance of Catholicism to Protestantism across German counties has revealed a statistically significant effect of religion on local over-indebtedness of individuals and on local bank behavior. Accordingly, the more Catholic an area, relative to Protestantism, the smaller is the share of over-indebted people and the riskier are cooperative and savings banks headquartered in this area. These results might seem inconsistent on the first view: Should the reduced risk-aversion among Catholics, yielding more risky banks, not be accompanied by a more reckless behavior that leads to more people failing to repay their debts? This question, on the first view, seemed to indicate a puzzle. However, a detailed examination of the theological and historically grown differences between Catholic and Protestant moralities revealed important insights and provided the answers. Accordingly, the existence of the duty and culture to confess sins to a Priest among Catholics established a fine-tuning on moral issues that led to a more detailed differentiation and hence more diverse moral standards. The empirical results strongly indicate that such a flexibility towards moral standards implies specific economic and financial behaviors. Thus, on the one hand, banks are able to generate more diverse business that is accompanied by higher returns together with increased risk. On the other hand, these norms seem to be able to generate more diversified solutions for

persons which are in situations of approaching over-indebtedness - a forgiveness culture - , thus reducing the number of those finally ending up being over-indebted. Accordingly, the Catholic culture seems to be able to generate behavior that incentivizes the taking of risk but also avoids negative outcomes related to it.

Yet, it should be stated that my analysis on the link between Christian moralities and financial behavior (i.e. chapters 2 and 3) touches on boundaries that can also be understood as shortcomings. An understanding of these shortcomings, however, is necessary both to understand limits for a generalization of my results and to point out issues that could be addressed in future studies. First, it has to mentioned that the empirical analysis is constrained by the fact that the inclusion of county fixed effects is not feasible. Such county fixed effects would ideally capture all other effects that are important on the county level and would therefore allow an even more precise identification of the effect of religion on financial behavior. Yet, as it also became obvious through the application of the instruments exploiting the historical context, the relative dominance of Catholicism or Protestantism in an area does not vary strongly across time. Thus an application of fixed effects is not feasible in the setting applied. Second, our data do not allow to distinguish whether the effect stems from the creditor (bank manager) side or the debtor (bank customer) side. On both issues, more could be learned if further data on a more micro-level would be available. Ideally, they would allow a more detailed analysis on the denomination of a debtor, creditor, bank manager and bank customer on their financial behavior. If these data would contain cases of persons moving between counties also county fixed effects could be applied. Therefore, it is my hope, that future research can built upon the results I established during my research, and expand on them.

The second part of my dissertation has zoomed in on issues of discretionary policies. It has been learned that fiscal policies did contribute to dampen growth reversals during the recent recessionary period. Most of the effects thereby can be attributed to government transfers and consumption. The total impact of government spending, however, is moderate compared to other domestic and foreign shocks. A word of warning, concerning this study, is that these results should be regarded as holding preeminently true for Germany under this specific time period. However, reflecting on the findings in chapters 2

and 3, which emphasized culture as an relevant factor, one should be cautious in drawing policy recommendations for other countries. Even though our findings on the size of the effect and on the efficiency of the different fiscal measures are of high importance and strong interest for others, cultural factors and historically grown circumstances in other countries, might yield other conclusions on the appropriateness or the optimal size of fiscal measures. However, I hope that our analysis framework can work as a role model for other researchers being interested on the evaluation of fiscal stimulus programs in different countries.

As a further work in the context of discretionary policies, I have covered the topic of estimating monetary reaction functions when the zero lower bound is reached. It was empirically demonstrated that an ordinary (least squares) estimation of such reaction functions is biased if the data contains many observations that are at or close to the zero lower bound. Instead, IV-Tobit estimators are then recommended to achieve unbiased parameter estimates. This is important as monetary reaction functions have been a very prominent tool in understanding and analyzing monetary policy, especially in the decade before the the start of the financial crisis. Since then, yet, they have lost importance as interest rates were set to zero. Instead unconventional monetary policies moved into the focus of policy makers and financial markets participants. However, as soon as the reduction of unconventional monetary policies (tapering) advances and positive rates might become feasible again, an analysis of 'appropriate' interest rates in the vein of original monetary reaction functions will become of importance again. Any such examination, however, will face the challenge to include the many observations of zero or nearby zero interest rates. It is my hope that the insights, as they have been gained and presented in this dissertation, will then constitute a helpful device to achieve unbiased estimates.

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Appendix A

A.1 Data

A.1.1 Data Description

Religion concerns the affiliation to one of the following religious groups in Germany: Protestants, Catholics, other or no affiliation. Data comes from *Zensus 2011*, it allows the computation of shares (i.e. relative to population) for each German county.

Unemployment is represented by the rate of unemployed persons relative to 100 inhabitants of working age. The data is taken from *DeStatis*.

Real GDP per capita is from *DeStatis*.

High- qualified workers ratio is defined as Graduates from universities and applied universities per 1000 employees who are subject to mandatory social insurance contribution. The source is *Beschäftigtenstatistik der Bundesagentur für Arbeit*.

Mini-jobbers ratio is defined as persons earning less than 400 Euro per month per 1000 inhabitants of working age. Work that is done while making an apprenticeship is thereby excluded. The source is *Beschäftigtenstatistik der Bundesagentur für Arbeit*.

Workers without apprenticeship. This variable is provided as relative to 100 employees who are subject to mandatory social insurance contribution by *Beschäftigtenstatistik der Bundesagentur für Arbeit*.

Self-employed is defined as self-employed persons per 100 inhabitants of working age. Source is *Arbeitskreis Erwerbstätigenrechnung des Bundes und der Länder, Eurostat Regio Datenbank*.

Bank market power is measured with a Lerner-Index. The index ranges from a high of 1 to a low of 0, with higher numbers implying greater market power. Source is Koetter (2013)

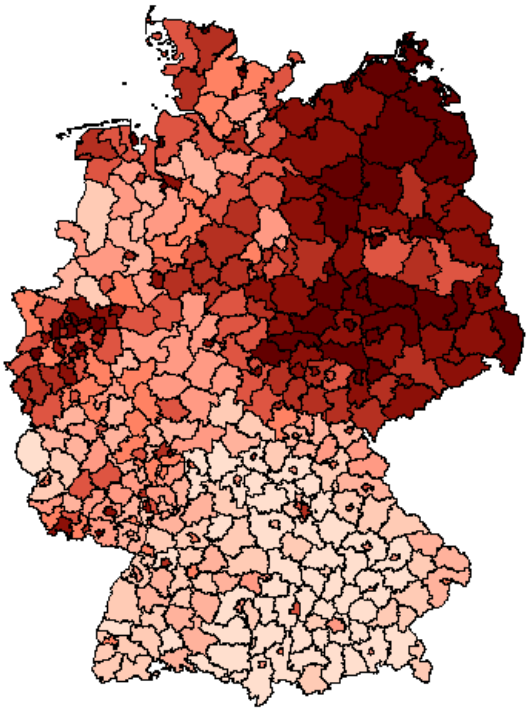
Public debt per capita is the sum of tho kinds of debt (per capita): Municipal, i.e. the mean across all municipalities within the county, and of the Bundesland. Source is *Statistik über Schulden des Bundes und der Länder* and *DeStatis*.

Average age is computed by multiplying the ratio of inhabitants that belong to the available age groups 18-25, 25-30, 30-50, 50-65, older than 65 with the respective mean of these age groups. Source is *Fortschreibung des Bevölkerungsstandes des Bundes und der Länder*.

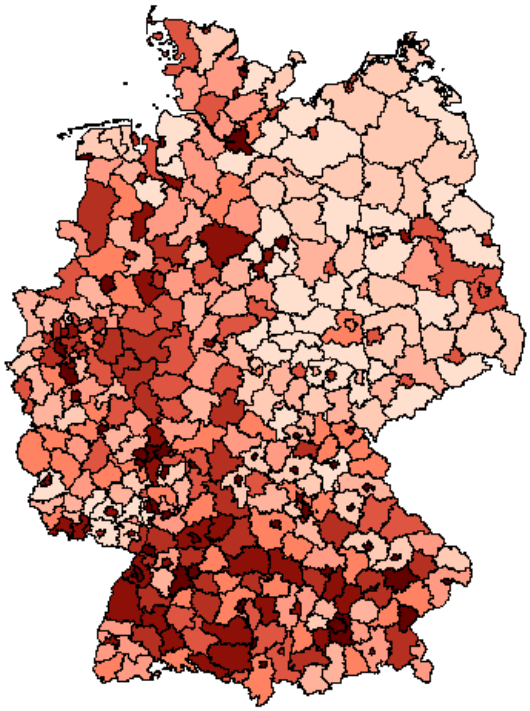
Women ratio is the share of women at the population. Source is *DeStatis* .

For details on the methods and procedures of the Zensus 2011 the interested reader is referred to Statistisches Bundesamt (2015). In 2011 a district reform took place in the Bundesland Mecklenburg-Vorpommern, reducing its numbers of counties from 18 to 8. For some of the above mentioned variables, data was only available for the former counties. Where this was the case, we computed the sum or population-weighted mean to get the data for the new counties.

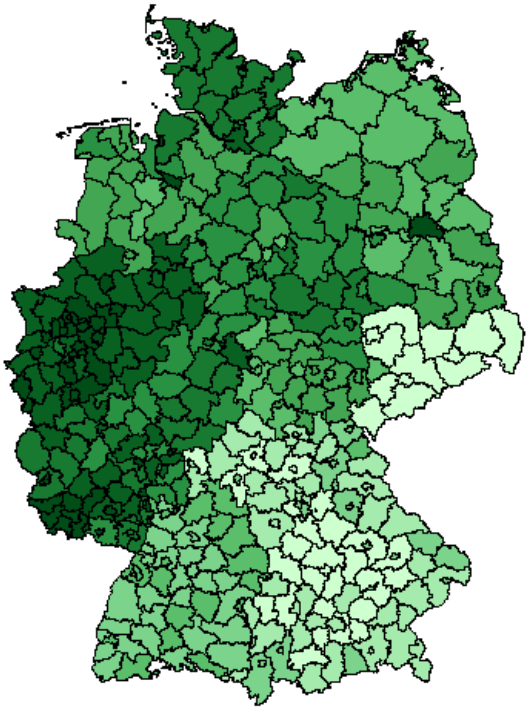
A.1.2 Maps of selected Control-Variables



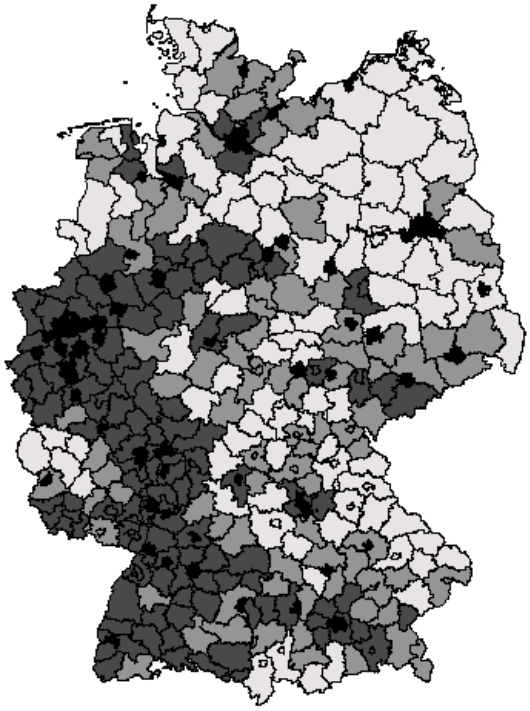
Unemployment Rate



Real GDP per capita



Public debt per capita



Urbanization

A.2 Empirical Analysis

Table A.1: Correlation of $\Delta(C, P)$ with the other explanatory variables

	$\Delta(C, P)$
$\Delta(C, P)$	1.000
Non-Religious (Share)	-0.368***
Unemployment	-0.412***
GDP p.C.	0.161**
Divorced	-0.328***
Self-employed	0.145**
Insolvencies	-0.321***
High qualified	-0.009
Low-income empl.	0.193***
Empl. w/o apprenticeship	0.250***
Avg. Age	-0.354***
Women ratio	-0.118*
Bank market power	-0.191***
Public debt p.C.	-0.256***
Major City (D)	-0.019
Urban county (D)	0.071
Rural county (D)	0.01
Sparsely Pop. (D)	-0.072

***, **, and *** denote significance at the 10, 5, and 1 percent level, respectively.**

Table A.2: Standardized coefficients of the OLS regression

	Over-Indebtedness
Δ(Catholics,Protestants)	-0.167^{**}
Non-Religious	-0.269
Unemployment	1.503^{***}
GDP p.C.	0.233^{**}
Divorced	1.125^{***}
Self-employed	0.255^{***}
Insolvencies	0.650^{***}
High qualified	-0.557^{***}
Low-income empl.	0.032
Empl. w/o	0.438^{***}
Avg. Age	-0.581^{***}
Women ratio	-0.096
Bank market power	0.027
Public debt p.C.	0.282
Urban county (D)	-0.352^{***}
Rural county (D)	-0.329^{***}
Sparsely Pop. (D)	-0.343^{***}
Observations	402
R^2	0.87

***, **, and *** denote significance at the 10, 5, and 1 percent level, respectively.**

Table A.3: R^2 of OLS regression with and without $\Delta(C, P)$

	Over-Indebtedness	
	(1)	(2)
Δ(Catholics,Protestants)	−0.004**	
	(0.002)	
Non-Religious	−0.011	−0.009
	(0.009)	(0.009)
Unemployment	0.312***	0.310***
	(0.047)	(0.047)
GDP p.C.	0.029**	0.024*
	(0.014)	(0.014)
Divorced	0.940***	0.946***
	(0.100)	(0.102)
Self-employed	0.092***	0.081**
	(0.035)	(0.035)
Insolvencies	0.304***	0.306***
	(0.053)	(0.054)
High qualified	−0.167***	−0.162***
	(0.033)	(0.033)
Low-income empl.	0.001	−0.001
	(0.005)	(0.004)
Empl. w/o	0.126***	0.136***
	(0.036)	(0.035)
Avg. Age	−0.310***	−0.286***
	(0.064)	(0.064)
Women ratio	−0.139	−0.119
	(0.139)	(0.139)
Bank market power	0.290	0.162
	(0.659)	(0.656)
Public debt p.C.	0.066	0.069
	(0.071)	(0.072)
Urban county (D)	−0.765***	−0.748***
	(0.234)	(0.234)
Rural county (D)	−0.790***	−0.753***
	(0.263)	(0.262)
Sparsely Pop. (D)	−0.840***	−0.787***
	(0.277)	(0.275)
State FE	Yes	Yes
Observations	402	402
R^2	0.879	0.877
Adj. R^2	0.868	0.867

***, **, and *** denote significance at the 10, 5, and 1 percent level, respectively.**

Table A.4: Ordinary Least Square Regressions separated for West and East

	Over-Indebtedness	
	(1)	(2)
	West	East
Δ(Catholics,Protestants)	−0.003*	−0.010
	(0.002)	(0.009)
Non-Religious	0.003	0.014
	(0.014)	(0.019)
Unemployment	0.526***	0.129*
	(0.059)	(0.071)
GDP p.C.	0.031**	−0.030
	(0.013)	(0.049)
Divorced	0.683***	0.685**
	(0.112)	(0.267)
Self-employed	0.113***	−0.085
	(0.035)	(0.149)
Insolvencies	0.237***	0.250*
	(0.056)	(0.144)
High qualified	−0.154***	−0.313***
	(0.033)	(0.081)
Low-income empl.	0.004	−0.018
	(0.005)	(0.016)
Empl. w/o	0.128***	0.553**
	(0.037)	(0.226)
Avg. Age	−0.210***	−0.550***
	(0.065)	(0.128)
Women ratio	−0.204	0.389
	(0.141)	(0.429)
Bank market power	−0.339	0.893
	(0.778)	(1.019)
Public debt p.C.	−0.009	0.534*
	(0.071)	(0.306)
Urban county (D)	−0.527**	−0.787
	(0.243)	(0.738)
Rural county (D)	−0.592**	−0.956
	(0.281)	(0.596)
Sparsely Pop. (D)	−0.679**	−0.803
	(0.288)	(0.649)
State FE	Yes	Yes
Observations	325	76
R^2	0.89	0.78

,**, indicate significance at the 10%-, 5%- and 1%-level, respectively. Standard errors are based on the Huber-White sandwich estimator.**

Table A.5: Ordinary Least Square Regressions for the year 2012 with religion variables of the year 2011

	Over-Indebtedness
Δ(Catholics,Protestants)	−0.004*
	(0.002)
Non-Religious	−0.016
	(0.011)
Unemployment	0.344***
	(0.046)
GDP p.C.	0.026*
	(0.014)
Divorced	0.952***
	(0.111)
Self-employed	0.109***
	(0.039)
Insolvencies	0.384***
	(0.060)
High qualified	−0.150***
	(0.028)
Low-income empl.	−0.003
	(0.005)
Empl. w/o	0.206***
	(0.046)
Avg. Age	−0.281***
	(0.063)
Women ratio	−0.168
	(0.139)
Bank market power	0.518
	(0.778)
Public debt p.C.	−0.088
	(0.173)
Urban county (D)	−0.690***
	(0.227)
Rural county (D)	−0.743***
	(0.259)
Sparsely Pop. (D)	−0.778***
	(0.272)
State FE	Yes
Observations	402
R^2	0.88

,**, indicate significance at the 10%-, 5%- and 1%-level, respectively. Standard errors are based on the Huber-White sandwich estimator.**

Table A.6: Instrumental Variable Regression (Simplified Approach)

	Δ(C,P)	Over-Indebtedness
Δ(Catholics,Protestants)		−0.006*
		(0.003)
Non-Religious (Share)	−0.208	−0.012
	(0.189)	(0.009)
Unemployment	1.325*	0.312***
	(0.681)	(0.044)
GDP p.C.	0.413	0.030**
	(0.283)	(0.014)
Divorced	−1.525	0.938***
	(1.684)	(0.096)
Self-employed	1.870**	0.095***
	(0.772)	(0.034)
Insolvencies	0.459	0.303***
	(0.808)	(0.051)
High qualified	−0.053	−0.169***
	(0.490)	(0.032)
Low-income empl.	0.198**	0.002
	(0.086)	(0.005)
Empl. w/o	−0.110	0.123***
	(0.703)	(0.035)
Avg. Age	−3.570***	−0.318***
	(1.191)	(0.064)
Women ratio	−4.886**	−0.145
	(2.108)	(0.132)
Bank market power	14.109	0.330
	(10.948)	(0.633)
Public debt p.C.	−2.074**	0.065
	(0.933)	(0.068)
Urban county (D)	−2.829	−0.771***
	(3.691)	(0.226)
Rural county (D)	−7.160	−0.802***
	(4.395)	(0.256)
Sparsely Pop. (D)	−5.767	−0.856***
	(4.733)	(0.270)
Religion 1624: Cath.(D)	34.294***	
	(4.083)	
Min. Distance Cath.	−0.235***	
	(0.052)	
Min. Distance Prot.	0.195***	
	(0.053)	
State FE	Yes	Yes
F-stat (1st stage)	64.36	
Hansen J-Stat p-val.	0.818	
Underindent. p-val.	0.000	
Observations	402	402
R^2	0.76	0.86

***, **, and *** denote significance at the 10, 5, and 1 percent level, respectively.**

A.3 Important Churches

A.3.1 Data Sources & Preparation

A church is defined as an important church if at least one of the following four criteria is fulfilled: i) church is a *Dom* ii) church is a *Münster* iii) church is a Catholic bishop seat and hence a *Kathedrale* or *Konkathedrale* iv) Church is a *sermon place of a Protestant Bishop*. Data for *Dome*, *Münster* and *Kathedralen* are from Wikipedia (2015a) and Wikipedia (2015b) and have been as far as possible cross-checked by other sources like Imhof and Kunz (2012). The origin of *sermon places of a Protestant Bishop* is Hoheisel (2015). Only sermon churches that have beared this name after 1950 have been included. Concerning *Dome*, only those churches have been included that have still been actively used as church in the years after 1950. Concerning *Münster*, churches that where pure monastery churches have not been considered.

A.3.2 An exemplary graphical Illustration

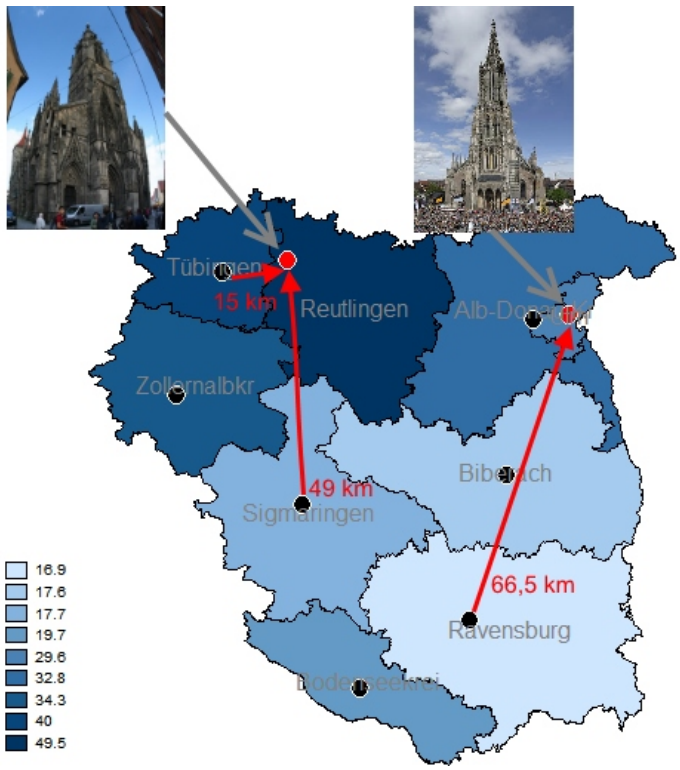


Figure A.1: Example: Protestants, Reg.-Bezirk Tübingen, 2011
This figure shows the two important Protestant churches in the Regierungsbezirk Tübingen (Marienkirche Reutlingen, Ulmer Münster) and the share of Protestants in 2011 in the corresponding counties. The darker the shading, the higher is the population with a Protestant affiliation. Moreover, exemplary the distance (in kilometers) from a counties centroid to the next important church is illustrated.

A.3.3 Catholics

For Catholics 110 important churches in 105 municipalities in 95 counties could be identified.

Countynumber	*Municipalityname*	*Churchname*	*Type*
2000	Hamburg	Neuer Mariendom	Dom u. Kathedrale
3152	Duderstadt	Eichsfelder Dom	Dom

3254	Hildesheim	Hildesheimer Dom	Dom u. Kathedrale
3404	Osnabrück	Dom St. Peter	Dom u. Kathedrale
3454	Haren (Ems)	Emsland-Dom	Dom
3459	Ankum	Artländer Dom St. Nikolaus	Dom
3460	Damme	Dammer Dom	Dom
5111	Düsseldorf	Rather Dom	Dom
5113	Essen	Essener Münster	Münster u. Kathedrale
5116	Mönchengladbach	Münster St. Vitus	Münster
5158	Velbert-Neviges	Nevigeser Wallfahrtsdom	Dom
5162	Neuss	Quirinusmünster Neuss	Münster
5170	Xanten	St. Viktor	Dom
5314	Bonn	Bonner Münster	Münster
5315	Köln	Kölner Dom	Dom u. Kathedrale
5334	Aachen	Aachener Kaiserdom	Dom u. Kathedrale
5334	Kalterherberg	Eifeldom, "Kaffeedom"	Dom
5370	Heinsberg	Selfkantdom	Dom
5515	Münster (Westfalen)	St.-Paulus-Dom	Dom u. Kathedrale
5558	Billerbeck	Ludgerus-Dom	Dom
5566	Altenberg (Bergisches Land)	Altenberger Dom, Bergischer Dom	Dom
5762	Marienmünster in Westfalen	Abtei Marienmünster	Münster
5770	Minden	Mindener Dom	Dom
5774	Paderborn	Dom St. Liborius	Dom u. Kathedrale
5958	Neheim	Sauerländer Dom (Neheim)	Dom
5966	Attendorn	Sauerländer Dom	Dom
5974	Soest	St.-Patrokli-Dom	Dom
6412	Frankfurt	Kaiserdom St. Bartholomäus	Dom

6434	Bad Homburg-Kirdorf	„Taunusdom“	Dom
6439	Geisenheim (Hessen)	„Rheingauer Dom“	Dom
6440	Ilbenstadt	„Dom der Wetterau“: Basilika Maria St. Petrus u. Paulus	Dom
6532	Wetzlar	Wetzlarer Dom	Dom
6533	Limburg an der Lahn	Limburger Dom	Dom u. Kathedrale
6631	Fulda	Fuldaer Dom	Dom u. Kathedrale
6634	Fritzlar	Fritzlarer Dom	Dom
7132	Niederfischbach	Siegerländer Dom	Dom
7135	Karden	"Moseldom"	Dom
7137	Andernach	Mariendom: Maria Himmelfahrt	Dom
7137	Münstermaifeld	Münster St. Martin und Severus	Münster
7140	Ravengiersburg	Hunsrückdom	Dom
7211	Trier	Trierer Dom	Dom u. Kathedrale
7315	Mainz	Mainzer Dom	Dom u. Kathedrale
7315	Mainz-Gonsenheim	Rheinhessendom	Dom
7318	Speyer	Speyerer Kaiserdom	Dom u. Kathedrale
7319	Worms	Wormser Kaiserdom	Dom
7340	Waldfischbach	„Westpfälzerdom“ St. Joseph	Dom
8111	Stuttgart	Domkirche St. Eberhard	Dom u. Konkathedrale
8116	Esslingen am Neckar	Münster St. Paul	Münster
8121	Heilbronn	Deutschordensmünster St. Peter und Paul	Münster
8128	Bad Mergentheim	Münster St. Johannes Baptist	Münster
8136	Schwäbisch Gmünd	Heilig-Kreuz-Münster	Münster

8216	Münster Schwarzach		Münster
8225	Hardheim	„Erftaldom“: römisch-katholische Pfarrkirche St. Alban	Dom
8226	Rauenberg	„Dom des Angelbachtals“	Dom
8311	Freiburg im Breisgau	Freiburger Münster	Münster u. Kathedrale
8315	Breisach	Münster St. Stephan	Münster
8315	Neustadt im Schwarzwald	Neustädter Münster	Münster
8325	Rottweil	Heiligkreuz-Münster	Münster
8326	Villingen	Liebfrauenmünster	Münster
8335	Insel Reichenau (Bodensee)	Marienmünster	Münster
8335	Konstanz	Konstanzer Münster „Unserer Lieben Frau“	Münster
8335	Radolfzell am Bodensee	Münster Unserer Lieben Frau	Münster
8337	Bad Säckingen	Münster St. Fridolin Fridolinsmünster	Münster
8337	St. Blasien	„Schwarzwälder Dom“	Dom
8415	Zwiefalten	Münster Unserer Lieben Frau	Münster
8416	Rottenburg am Neckar	Rottenburger Dom St. Martin	Dom u. Kathedrale
8425	Obermarchtal	Münster St. Peter und Paul	Münster
8435	Salem (Baden)	Salemer Münster	Münster
8435	Überlingen	Überlinger Münster	Münster
9161	Ingolstadt	Münster Zur Schönen Unserer Lieben Frau	Münster
9162	München	Dom zu Unserer Lieben Frau	Dom u. Kathedrale

9172	Bad Reichenhall	Münster St. Zeno	Münster
9176	Eichstätt	Dom St. Salvator und St. Willibald	Dom u. Kathedrale
9178	Freising	Freisinger Dom	Dom u. Konkathedrale
9178	Freising	St. Andrä	Münster
9178	Moosburg an der Isar	Kastulusmünster	Münster
9181	Dießen am Ammersee	Marienmünster Dießen	Münster
9189	Fridolfing	"Dom vom Salzachtal": Pfarrkirche Mariä Himmelfahrt	Dom
9261	Landshut	Münster St. Martin	Münster
9262	Passau	Passauer Dom	Dom u. Kathedrale
9272	Waldkirchen	"Bayerwalddom" oder "Dom des Bayerischen Waldes": St. Peter und Paul	Dom
9362	Regensburg	Niedermünster Regensburg	Münster
9362	Regensburg	Regensburger Dom	Dom u. Kathedrale
9373	Neumarkt in der Oberpfalz	Münster St. Johannes der Täufer	Münster
9376	Schwandorf	Marienmünster auf dem Kreuzberg	Münster
9461	Bamberg	Bamberger Dom (Kaiserdom)	Dom u. Kathedrale
9571	Dinkelsbühl	Münster St. Georg	Münster
9571	Wolframs-Eschenbach	Liebfrauenmünster	Münster
9663	Würzburg	Neumünster St. Johannes Evangelist	Münster
9663	Würzburg	Würzburger Dom	Dom u. Kathedrale
9679	Hausen bei Würzburg	Münster Fährbrück	Münster

9761	Augsburg	Augsburger Dom	Dom u. Kathedrale
9773	Dillingen an der Donau	St. Peter	Konkathedrale
9776	Lindau (Bodensee)	Münster Unserer Lieben Frau	Münster
9779	Donauwörth	Liebfrauenmünster	Münster
10041	Püttlingen	Köllertaldom	Dom
10042	Mettlach	Liutwinusdom	Dom
10044	Dillingen	Saardom	Dom
10046	Bliesen	Bliestaldom: St. Remigiuskirche	Dom
10046	Nonnweiler	Hochwalddom	Dom
10046	St. Wendel	Wendelsdom	Dom
11000	Berlin (D)	St. Hedwigs-Kathedrale	Kathedrale
14612	Dresden	Kathedrale St. Trinitatis (Katholische Hofkirche)	Kathedrale
14625	Bautzen	Dom St. Petri	Dom u. Konkathedrale
14626	Görlitz	Kathedrale St. Jakobus	Kathedrale
15003	Magdeburg	Sankt-Sebastian-Kirche	Kathedrale
15084	Zeitz	Zeitzer Dom	Dom
16051	Erfurt	Erfurter Dom	Dom u. Kathedrale
16061	Effelder	Eichsfelder Dom	Dom
16062	Nordhausen	Nordhäuser Dom	Dom

A.3.4 Protestants

For Protestants 89 important churches in 83 municipalities in 77 counties could be identified.

Countynumber	*Municipalityname*	*Churchname*	*Type*
1002	Kiel	Nikolaikirche, „Nikolaidom“	Dom u. Bishop sermon place
1003	Lübeck	Lübecker Dom	Dom u. Bishop sermon place
1051	Meldorf	Meldorfer Dom	Dom
1053	Ratzeburg	Ratzeburger Dom	Dom
1054	Insel Föhr	Friesendom: Pfarrkirche St. Johannis in Nieblum	Dom
1055	Eutin	Ehem. Kollegiatsstiftskirche St. Michaelis	Bishop sermon place
1055	Oldenburg in Holstein	St.-Johannis-Kirche, Oldenburger Dom	Dom
1059	Schleswig	Schleswiger Dom	Dom u. Bishop sermon place
2000	Hamburg	Hauptkirche St. Michaelis	Bishop sermon place
3101	Braunschweig	Dom, ehem. Kollegiatsstiftskirche SS. Blasius, Johannes der Täufer und Thomas Becket	Dom u. Bishop sermon place
3154	Königslutter	Kaiserdom	Dom
3155	Einbeck	Münsterkirche St. Alexandri	Münster
3241	Hannover	Marktkirche SS. Jakobi und Georgii	Bishop sermon place
3252	Hameln	Münster St. Bonifatius	Münster
3257	Bückeburg	Stadtkirche	Bishop sermon place

3352	Cuxhaven	Altenbruch: Bauerndom St. Nicolai	Dom
3352	Cuxhaven	Lüdingworth: Bauerndom St. Jacobi	Dom
3352	Otterndorf	Bauerndom St. Severi	Dom
3355	Bardowick bei Lüneburg	Dom zu Bardowick St. Peter und Paul	Dom
3361	Verden	Verdener Dom	Dom
3402	Emden	Große Kirche SS. Cosmas und Damian	Bishop sermon place
3403	Oldenburg	St. Lambertikirche	Bishop sermon place
3457	Leer	Große Kirche	Bishop sermon place
4011	Bremen	Dom, ehem. Kathedrale St. Petri	Dom u. Bishop sermon place
5111	Düsseldorf	Johanneskirche	Bishop sermon place
5170	Wesel	Willibrordi-Dom	Dom
5566	Altenberg (Bergisches Land)	Altenberger Dom, Bergischer Dom	Dom
5711	Bielefeld	Neustädter Marienkirche, „Ravensberger Dom“	Dom u. Bishop sermon place
5758	Herford	Herforder Münster	Münster
5766	Detmold	Erlöserkirche (bis 1947 St. Vitus geweiht)	Bishop sermon place
6411	Darmstadt	Pauluskirche	Bishop sermon place
6411	Darmstadt	Stadtkirche St. Maria	Bishop sermon place
6412	Frankfurt Am Main	St. Katharinenkirche	Bishop sermon place
6414	Wiesbaden	Marktkirche (ehem. St. Mauritius), „Nassauischer Landesdom“	Dom u. Bishop sermon place

6431	Lampertheim (Hessen)	„Dom des Rieds“	Dom
6531	Giessen	Johanneskirche	Bishop sermon place
6531	Londorf (Hessen)	„Dom der Rabenau“	Dom
6532	Herborn	Stadtkirche	Bishop sermon place
6532	Wetzlar	Wetzlarer Dom	Dom
6611	Kassel	Ehem. Stiftskirche SS. Martin und Elisabeth, „Martinsdom“	Dom u. Bishop sermon place
7315	Mainz	Altmünster	Münster
7315	Mainz	Christuskirche, „Evangelischer Dom“	Dom u. Bishop sermon place
7318	Speyer	Protestations-Gedächtniskirche	Bishop sermon place
7339	Ingelheim	"Selztaldom ": evangelische Pfarrkirche im Stadtteil Großwinternheim	Dom
8111	Stuttgart	Ehem. Stiftskirche Hl. Kreuz	Bishop sermon place
8118	Ludwigsburg	Stadtkirche	Bishop sermon place
8121	Heilbronn	Kilianskirche	Bishop sermon place
8127	Schwäbisch Hall	Stadtpfarrkirche St. Michael, „Münster“	Münster u. Bishop sermon place
8212	Karlsruhe	Stadtkirche, „Cathedrale des Landes Baden“	Bishop sermon place
8415	Reutlingen	Marienkirche	Bishop sermon place
8421	Ulm	Münster (ehem. Unserer Lieben Frau)	Münster u. Bishop sermon place
9162	München	St. Matthäuskirche	Bishop sermon place
9362	Regensburg	Dreieinigkeitskirche	Bishop sermon place
9462	Bayreuth	Stadtkirche Hll. Dreifaltigkeit	Bishop sermon place

9561	Ansbach	St. Gumbertuskirche	Bishop sermon place
9564	Nürnberg	St. Lorenzkirche	Bishop sermon place
9571	Heilsbronn	Münster Heilsbronn	Münster
9577	Heidenheim (Mittelfranken)	Münster St. Wunibald	Münster
9663	Würzburg	St. Johanniskirche	Bishop sermon place
9761	Augsburg	St. Ulrichskirche	Bishop sermon place
11000	Berlin	Kaiser-Wilhelm-Gedächtniskirche	Bishop sermon place
11000	Berlin	St. Marienkirche	Bishop sermon place
11000	Berlin (D)	Oberpfarr- und Domkirche zu Berlin (Berliner Dom)	Dom
12051	Brandenburg	Dom St. Peter und Paul	Dom
13004	Schwerin	Dom, ehem. Kathedrale SS. Maria und Johannes Evangelist	Dom u. Bishop sermon place
13072	Bad Doberan	Doberaner Münster	Münster
13072	Güstrow	Güstrower Dom	Dom
13073	Grimmen	Marienkirche	Bishop sermon place
13075	Greifswald	Dom, ehem. Kollegiatsstiftskirche St. Nikolai	Dom u. Bishop sermon place
14521	Schneeberg	Bergmannsdom: St.-Wolfgangs-Kirche	Dom
14522	Freiberg	Freiberger Dom Sankt Marien	Dom
14524	Zwickau	Marienkirche	Dom
14612	Dresden	Kreuzkirche	Bishop sermon place
14625	Bautzen	Dom St. Petri	Dom

14626	Görlitz	Hauptstadtpfarrkirche SS. Peter und Paul	Bishop sermon place
14627	Meißen	Meißner Dom auf der Albrechtsburg	Dom u. Bishop sermon place
14729	Wurzen	Stiftskirche (Dom) St. Marien	Dom
15001	Dessau	St. Johanniskirche	Bishop sermon place
15001	Dessau	Stadtkirche St. Marien	Bishop sermon place
15002	Halle (Saale)	Hallescher Dom	Dom
15003	Magdeburg	Dom St. Mauritius und Katharina	Dom u. Bishop sermon place
15084	Naumburg	Naumburger Dom	Dom
15085	Halberstadt	Dom zu Halberstadt	Dom
15088	Merseburg	Merseburger Dom	Dom
15090	Havelberg	Havelberger Dom	Dom
15090	Stendal	Dom St. Nikolaus	Dom
16052	Gera	Johanniskirche	Bishop sermon place
16055	Weimar	Stadtkirche SS. Peter und Paul, „Herderkirche“	Bishop sermon place
16056	Eisenach	Georgenkirche	Bishop sermon place

Appendix B

B.1 Supplement on Data

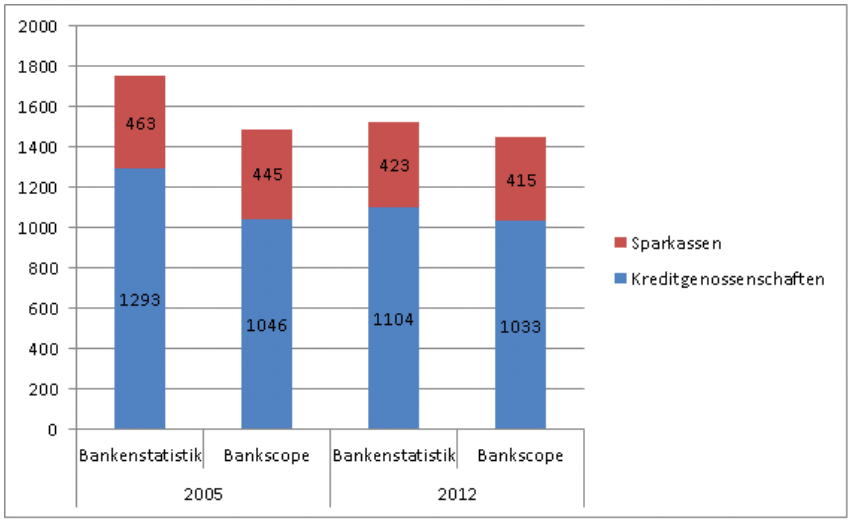
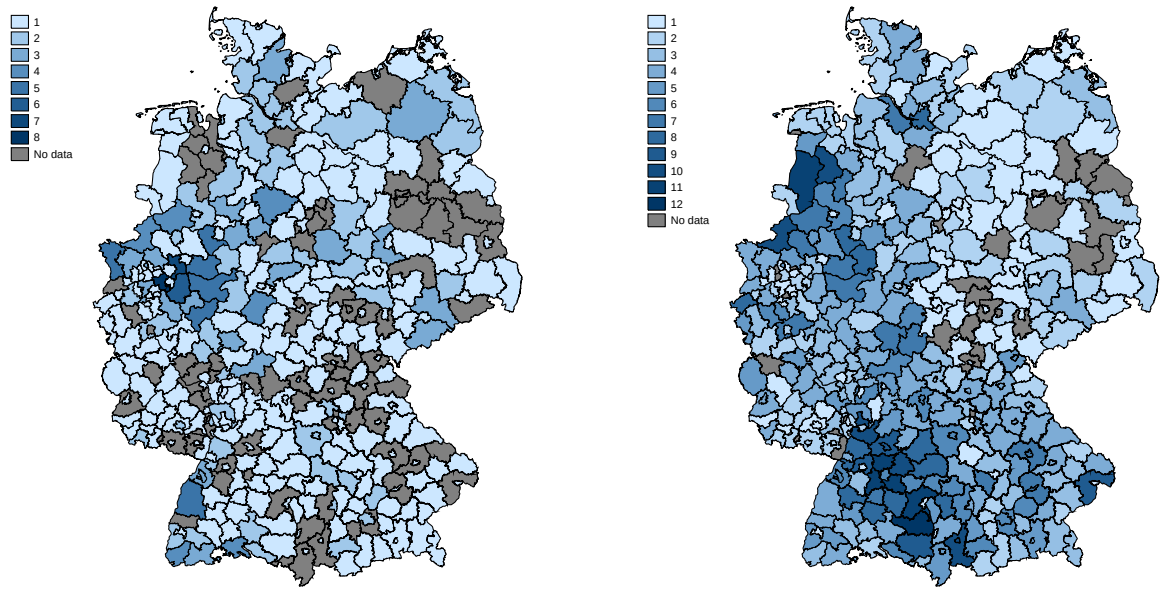


Figure B.1: Comparison of the number of existing banks and those covered in the sample

This figure illustrates the number of existing banks, documented in Deutsche Bundesbank (2005, 2012), and the number of banks included by our data source *BankScope*. Examplarily, a year near the beginning of our sample and at the end of our sample is provided. The numbers are subdivided in the bank categories savings banks and cooperative banks.



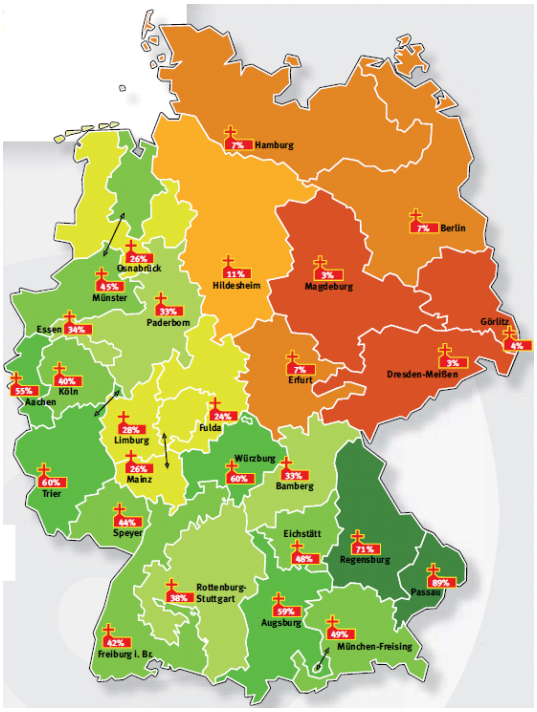
# of Sparkassen **# of Volksbanken**

Figure B.2: The number of banks within their categories per county
This figure illustrates the number of savings banks and cooperative banks per county included in our sample for the period 2003 till 2012. Accordingly, if two cooperatives in a county merged to a new bank, they are counted as three. In total there are 402 counties in Germany. The 12 counties for which no headquarter of a bank has been reported are Coburg (Landeskreis), Dahme-Spreewald, Erlangen, Frankenthal (Pfalz), Greiz, Neustadt an der Weinstraße, Oberhavel, Sömmerda, Potsdam, Potsdam-Mittelmark, Weimarer Land, Zweibrücken.

Table B.1: Variables Definition

Variable	Definition	Source	Unit
RoAA	Return on average assets	bankscope	% (share)
Equity Ratio	Equity divided by total assets	bankscope	% (share)
Credit Growth	yearly change of gross loans	bankscope	% (growth)
σ^{RoAA}	rolling window standard deviation of RoAA over the current and the last four years	bankscope/ own computation	-
NII/Assets	Non-interest income (amount of fees, trading, derivatives and asset sale income) divided by total assets	bankscope/ own computation	% (share)
No. Banks per Mil.	Sum of saving, cooperative and commercial banks per 1 million county inhabitants	bankscope/ own computation	per 1 Mil.
Bank market power	Lerner-Index ranging from a high of 1 to a low of 0, with higher numbers implying greater market power	Koetter (2013)	-
Real GDP per capita	Gross domestic product divided by the GDP deflator	*DeStatis*	in euro
Av. Age	the ratio of inhabitants that belong to the available age groups 18-25, 25-30, 30-50, 50-65, older than 65 multiplied with the respective mean of these age groups	Fortschreibung des Bevölkerungsstandes des Bundes und der Länder	years
Qualified	Graduates from universities and applied universities per 1000 employees who are subject to mandatory social insurance contribution	Beschäftigtenstatistik der Bundesagentur für Arbeit	per 1000
Pop.	Population per county	*DeStatis*	
Female	share of women at the population	*DeStatis*	% (share)
Urbanization	Dummy-cathegorization along: major city, urban county, rural county with agglomerations or county that is only sparsely populated	Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR)	0-1 dummy
Industry Shares	The share of each of the seven industries: Agriculture, Mining/Utility, Manufacturing, Construction, Trade, Finance, Public	*DeStatis*/ own computation	share

Notes: This table reports the definition, source and reporting unit of the variables in the sample.



The 27 Cath. (Erz-)Bistümer (Deutsche Bischofskonferenz, 2012, p.9)

The 20 Prot. Landeskirchen (Evangelische Kirche Deutschland , 2012, p.7)

Figure B.3: The size and geographical cutting of church districts by denomination

B.2 Supplement on Results

Table B.2: Alternative Measure of Regional Bank Competition

	Z-Score	RoAA	Equity/Assets	σ^{RoAA}	Credit Growth	NII/Assets
$\Delta(C, P)$	−0.186**	0.019*	−0.020	0.026**	0.557	0.107***
	(0.082)	(0.010)	(0.088)	(0.011)	(0.382)	(0.026)
Lerner Index	−0.657	0.433***	2.769***	0.124***	1.433	−0.160
	(0.486)	(0.075)	(0.649)	(0.035)	(0.905)	(0.123)
Observations	12119	12119	12119	12119	12119	12119
Adj. R^2	0.042	0.169	0.139	0.070	0.035	0.161

This table reports the effect on z-score and the components of bank risk. The variable on number of banks per county is now substituted through an alternative measure of regional bank competition: the Lerner-Index from Koetter (2013). *, **, and * denote significance at the 10, 5, and 1 percent level, respectively.**

Table B.3: Beta Coefficients

	Z-Score	RoAA	Equity/Assets	σ^{RoAA}	Credit Growth	NII/Assets
$\Delta(C,P)$	−0.055**	0.044**	−0.000	0.066**	0.040	0.124***
	(0.023)	(0.018)	(0.015)	(0.026)	(0.027)	(0.030)
Other/Non-Reli.	0.059	−0.057	0.109	−0.066	0.029	0.013
	(0.040)	(0.061)	(0.072)	(0.052)	(0.085)	(0.055)
Ln(Bank Assets)	0.065	−0.081***	−0.206***	−0.095***	0.079***	−0.036
	(0.040)	(0.027)	(0.030)	(0.026)	(0.023)	(0.064)
Deposit ratio (%)	0.049*	0.028	0.093***	−0.023	−0.038	−0.054*
	(0.025)	(0.021)	(0.027)	(0.024)	(0.023)	(0.029)
Saving Bank	0.109*	−0.271***	−0.050	−0.154	−0.149***	−0.327***
	(0.053)	(0.054)	(0.089)	(0.090)	(0.041)	(0.062)
No. Banks per Mil.	0.019	−0.004	0.003	−0.005	−0.022	−0.074*
	(0.033)	(0.015)	(0.047)	(0.019)	(0.040)	(0.035)
Ln(GDP p.c.)	−0.054	−0.007	−0.025	0.029	0.016	−0.145***
	(0.036)	(0.054)	(0.089)	(0.037)	(0.017)	(0.041)
Avg. Age	0.074**	−0.143**	−0.058**	−0.069***	−0.154***	0.096*
	(0.031)	(0.056)	(0.022)	(0.019)	(0.033)	(0.046)
Qualified	0.021	0.022	−0.005	−0.016	0.037***	0.090
	(0.025)	(0.037)	(0.076)	(0.021)	(0.010)	(0.061)
Ln(Pop.)	−0.052**	0.025	−0.086**	−0.006	0.032	−0.106**
	(0.022)	(0.017)	(0.031)	(0.014)	(0.039)	(0.043)
Female	−0.010	0.017	−0.010	−0.006	0.055***	0.036
	(0.031)	(0.042)	(0.044)	(0.019)	(0.015)	(0.043)
Urban	0.073	−0.047*	0.049	−0.070	0.039*	0.102*
	(0.047)	(0.023)	(0.030)	(0.056)	(0.020)	(0.048)
Rural	−0.004	−0.011	0.009	−0.038	0.064***	0.098**
	(0.049)	(0.025)	(0.027)	(0.042)	(0.020)	(0.036)
Sparsely Pop.	−0.013	−0.033	0.003	−0.042	0.063***	0.121***
	(0.047)	(0.048)	(0.043)	(0.032)	(0.018)	(0.039)
Agriculture	0.059***	−0.007	0.054**	−0.036*	0.014	−0.023
	(0.015)	(0.030)	(0.025)	(0.020)	(0.020)	(0.040)
Mining/Utility	0.029	0.002	−0.012	−0.039**	−0.007	0.013
	(0.018)	(0.019)	(0.033)	(0.017)	(0.025)	(0.018)
Manufacturing	0.009	0.021	−0.031	−0.010	−0.024	−0.024
	(0.040)	(0.048)	(0.100)	(0.043)	(0.039)	(0.042)
Construction	−0.064***	0.083***	0.031	0.044	0.054	0.016
	(0.016)	(0.017)	(0.018)	(0.036)	(0.034)	(0.043)
Trade	0.021	0.012	−0.014	−0.000	−0.002	0.013
	(0.031)	(0.028)	(0.033)	(0.027)	(0.034)	(0.034)
Finance	−0.016	−0.010	−0.028	0.030	−0.021	−0.056*
	(0.037)	(0.036)	(0.045)	(0.040)	(0.021)	(0.030)
Observations	12119	12119	12119	12119	12119	12119
Adj. R^2	0.042	0.156	0.132	0.068	0.035	0.163

This table reports the effect on z-score and the components of bank risk. The coefficients are standardized, i.e. they depict the effect of an increase of the explaining variables by one standard deviation. *, **, and * denote significance at the 10, 5, and 1 percent level, respectively.**

Table B.4: Comparison of R^2 if $\Delta(C, P)$ is included vs. excluded

	Z-Score	RoAA	Equity/Assets	σ^{RoAA}	Credit Growth	NII/Assets
Adj. R^2 with $\Delta(C, P)$	0.042	0.156	0.132	0.068	0.035	0.163
Adj. R^2 without $\Delta(C, P)$	0.041	0.155	0.132	0.066	0.035	0.156

This table reports the adjusted R^2 for our baseline panel specification if $\Delta(C, P)$ is included (as in the regressions above) and if $\Delta(C, P)$ is excluded.

B.3 Supplement on Robustness I

Table B.5: Clustering on the county level

	Z-Score	RoAA	Equity/Assets	σ^{RoAA}	Credit Growth	NII/Assets
$\Delta(C,P)$	−0.192**	0.022	−0.000	0.027***	0.572*	0.106***
	(0.088)	(0.014)	(0.146)	(0.010)	(0.319)	(0.024)
Observations	12119	12119	12119	12119	12119	12119
Adj. R^2	0.042	0.156	0.132	0.068	0.035	0.163

This table reports the effect on z-score and the components of bank risk. Clustering is now done on the county level. *, **, and * denote significance at the 10, 5, and 1 percent level, respectively.**

Table B.6: Clustering on the bank level

	Z-Score	RoAA	Equity/Assets	σ^{RoAA}	Credit Growth	NII/Assets
$\Delta(C,P)$	−0.192**	0.022*	−0.000	0.027***	0.572**	0.106***
	(0.096)	(0.013)	(0.139)	(0.010)	(0.272)	(0.023)
Observations	12119	12119	12119	12119	12119	12119
Adj. R^2	0.042	0.156	0.132	0.068	0.035	0.163

This table reports the effect on z-score and the components of bank risk. Clustering is now done on the bank level. *, **, and * denote significance at the 10, 5, and 1 percent level, respectively.**

B.4 Supplement on Robustness II: Reverse Causality

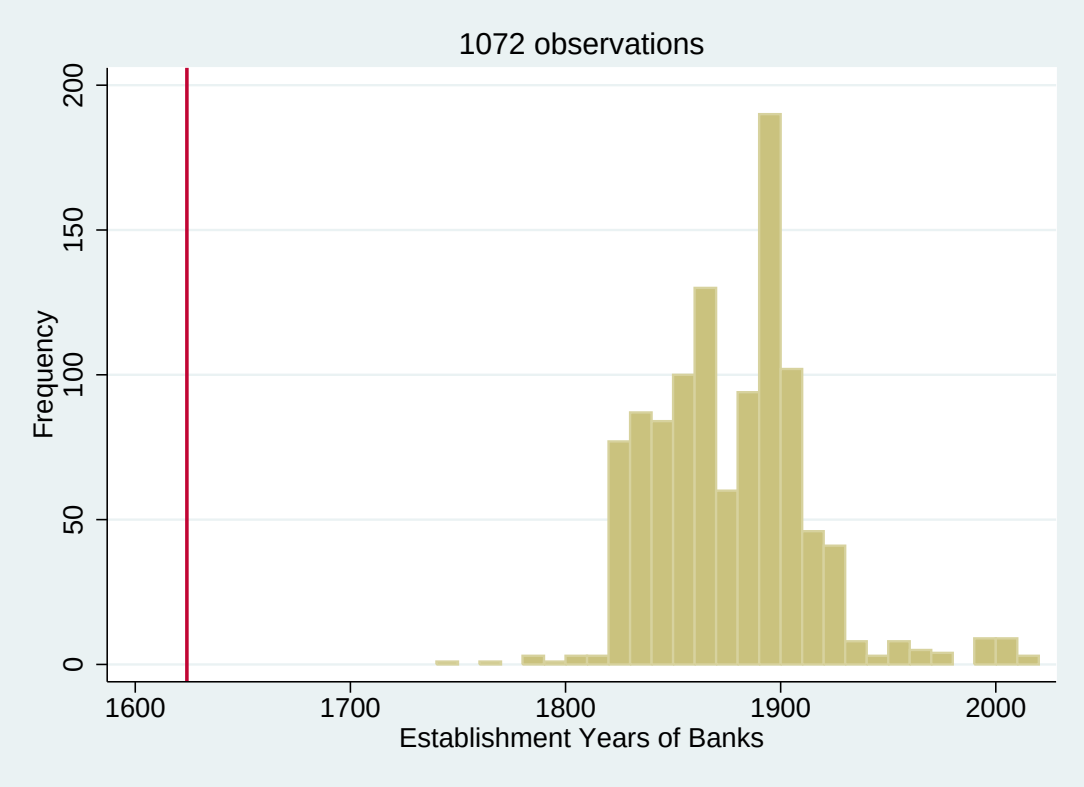


Figure B.4: Banks' Foundation Years

This figure shows the distribution of the banks' foundation years in comparison to the year 1624. For this year the Lords territory and thus the religion of the corresponding territorial lords and their subjects has been decided on within the Peace of Westphalia in 1648. As all banks were founded afterwards an influence of those banks on the decisionmaking process in 1648 can be excluded. The number of observation is smaller then the number applied in the regression analyses (1648 observations). This stems from the fact that the foundation year could not be detected for all banks, however the available data are representative for the whole sample.

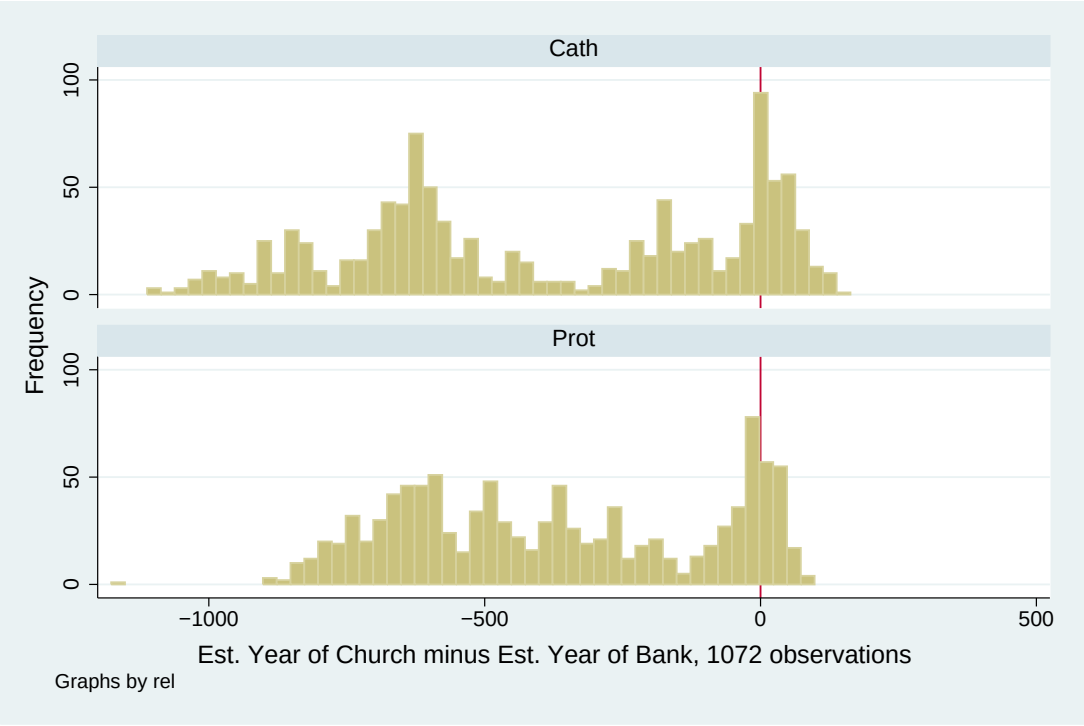


Figure B.5: Time Interval between a Bank's Foundation Year and the Start of Construction of the nearby Important Church

This figure shows the distribution of the time intervals for each bank's foundation year relative to the start of construction of its closest important church. This is done separately for Catholic and Protestant important churches. The large majority of observations is below zero indicating that the start of the construction of the nearby church began before the bank has been established. Accordingly, the possibility that those banks did decisively influence the establishment of important churches has to be refused.

Table B.7: IV (2SLS) estimation: 1st-stage results

	$\Delta C, P)$
Other/Non-Religious	−0.007**
	(0.003)
Ln(Bank Assets)	0.011**
	(0.004)
Deposit ratio	−0.000
	(0.001)
Saving Bank	−0.048***
	(0.005)
No. Banks per Mil.	0.001
	(0.001)
Ln(GDP p.c.)	0.235**
	(0.088)
Avg. Age	−0.045*
	(0.024)
Qualified	0.000
	(0.008)
Ln(Pop.)	−0.006
	(0.028)
Female	−0.042
	(0.030)
Urban	−0.056
	(0.034)
Rural	−0.118***
	(0.035)
Sparsely Pop.	−0.138***
	(0.043)
Agriculture	−0.010
	(1.379)
Mining/Utility	0.442
	(0.371)
Manufacturing	0.020
	(0.268)
Construction	3.067***
	(0.511)
Trade	−0.050
	(0.313)
Finance	0.475
	(0.581)
Catholic Lord in 1624	0.305***
	(0.043)
Distance to next Important Catholic Church	−0.003***
	(0.001)
Distance to next Important Protestant Church	0.002***
	(0.001)
Observations	12119
Adj. R^2	0.605

This table reports the outcome of the first-stage regression of our 2SLS approach. *, **, and * denote significance at the 10, 5, and 1 percent level, respectively.**

Table B.8: IV (2SLS) estimation: 2nd-stage results

	Z-Score	RoAA	Equity/Assets	σ^{RoAA}	Credit Growth	NII/Assets
$\widehat{\Delta(C,P)}$	−0.124**	0.045***	0.303*	0.025***	0.480	0.205***
	(0.055)	(0.015)	(0.163)	(0.009)	(0.629)	(0.042)
Other/Non-Reli.	0.005*	−0.000	0.016**	−0.001	0.007	0.002
	(0.003)	(0.001)	(0.007)	(0.000)	(0.029)	(0.001)
Ln(Bank Assets)	0.070*	−0.013***	−0.309***	−0.012***	0.351***	−0.011
	(0.042)	(0.004)	(0.044)	(0.003)	(0.099)	(0.017)
Deposit ratio	0.008**	0.001	0.020***	−0.000	−0.024*	−0.002*
	(0.004)	(0.000)	(0.006)	(0.000)	(0.014)	(0.001)
Saving Bank	0.323**	−0.112***	−0.181	−0.053*	−1.757***	−0.228***
	(0.147)	(0.021)	(0.344)	(0.030)	(0.482)	(0.043)
No. Banks per Mil.	0.002	−0.000	0.000	−0.000	−0.008	−0.002**
	(0.003)	(0.000)	(0.006)	(0.000)	(0.015)	(0.001)
Ln(GDP p.c.)	−0.259	−0.011	−0.233	0.016	0.322	−0.186***
	(0.171)	(0.031)	(0.511)	(0.019)	(0.344)	(0.053)
Avg. Age	0.065**	−0.015**	−0.044	−0.007***	−0.512***	0.026**
	(0.025)	(0.007)	(0.028)	(0.001)	(0.126)	(0.011)
Qualified	0.009	0.001	−0.003	−0.001	0.065***	0.009
	(0.010)	(0.002)	(0.043)	(0.001)	(0.017)	(0.007)
Ln(Pop.)	−0.109**	0.007	−0.252***	−0.001	0.274	−0.057**
	(0.048)	(0.005)	(0.092)	(0.003)	(0.316)	(0.022)
Female	−0.020	0.006	−0.025	−0.002	0.472***	0.021
	(0.063)	(0.012)	(0.123)	(0.005)	(0.123)	(0.020)
Urban	0.200	−0.017**	0.189*	−0.022	0.428**	0.071**
	(0.123)	(0.009)	(0.106)	(0.017)	(0.208)	(0.030)
Rural	−0.007	−0.003	0.066	−0.014	0.811***	0.085***
	(0.147)	(0.011)	(0.118)	(0.015)	(0.238)	(0.029)
Sparsely Pop.	−0.034	−0.012	0.066	−0.018	0.888***	0.122***
	(0.153)	(0.022)	(0.201)	(0.013)	(0.230)	(0.035)
Agriculture	6.452***	−0.049	8.462**	−0.450*	5.843	−0.380
	(1.642)	(0.429)	(3.499)	(0.235)	(8.617)	(0.983)
Mining/Utility	1.176*	−0.004	−0.885	−0.194**	−1.077	0.072
	(0.714)	(0.108)	(1.787)	(0.082)	(4.261)	(0.218)
Manufacturing	0.131	0.043	−0.477	−0.016	−1.247	−0.055
	(0.505)	(0.077)	(1.585)	(0.063)	(1.872)	(0.131)
Construction	−4.548***	0.685***	1.465	0.355	14.761	−0.172
	(0.918)	(0.167)	(1.933)	(0.285)	(10.406)	(0.739)
Trade	0.561	0.046	−0.485	−0.001	−0.166	0.088
	(0.800)	(0.106)	(1.183)	(0.080)	(3.441)	(0.195)
Finance	−0.435	−0.041	−1.051	0.096	−2.301	−0.384
	(1.026)	(0.122)	(1.559)	(0.126)	(2.202)	(0.257)
Observations	12119	12119	12119	12119	12119	12119
Adj. R^2	0.132	0.237	0.349	0.160	0.152	0.328

This table reports the outcome of the second-stage regression of our 2SLS approach. *, **, and * denote significance at the 10, 5, and 1 percent level, respectively.**

Appendix C

C.1 First order conditions

FOC of optimizing households wrt. consumption:

$$\epsilon_t^p \left(C_t^r - hC_{t-1}^r\right)^{-\sigma} = \left(1 + \tau_t^c\right) \lambda_t \tag{C.1}$$

FOC of optimizing households wrt. investment:

$$\begin{aligned} Q_t S' \left(\frac{\epsilon_t^i I_t}{I_{t-1}}\right) \frac{\epsilon_t^i I_t}{I_{t-1}} - \quad & \beta E_t Q_{+1} \frac{\lambda_{t+1}}{\lambda_t} S' \left(\frac{\epsilon_{t+1}^i I_{t+1}}{I_t}\right) \left(\frac{\epsilon_{t+1}^i I_{t+1}}{I_t}\right) \frac{I_{t+1}}{I_t} + 1 = \\ & Q_t \left(1 - S\left(\frac{\epsilon_t^i I_t}{I_{t-1}}\right)\right) \end{aligned} \tag{C.2}$$

FOC of optimizing households wrt. labor

$$\epsilon_t^p \epsilon_t^l L_t^{\varphi} = -(1 - \tau_t^w) \lambda_t \frac{W_t}{P_t} \tag{C.3}$$

FOC of optimizing households wrt. bond holdings:

$$\lambda_t P_t = \lambda_{t+1} P_{t+1} \beta R_t \tag{C.4}$$

FOC of optimizing households wrt. next period's capital stock:

$$Q_t = \beta \frac{\lambda_{t+1}}{\lambda_t} \left(r_{t+1}^K + Q_{t+1} \left(1 - \delta\right)\right) \tag{C.5}$$

FOC of optimizing households wrt. the capital utilization rate:

$$\Psi' \left(\omega_t\right) = \left(1 - \tau_t^k\right) r_t^k \tag{C.6}$$

C.2 Log linearized equations

C.2.1 Households

Consumption Euler equation of optimizing households:

$$\begin{aligned} c_t^r = \; & \tfrac{1}{1+h} c_{t+1}^r + \tfrac{h}{1+h} c_{t-1}^r + \tfrac{1-h}{\sigma(1+h)} \tfrac{\bar{\tau}^c}{1+\bar{\tau}^c} \left(\tau_{t+1}^c - \tau_t^c\right) - \tfrac{1-h}{\sigma(1+h)} \left(r_t - \pi_{t+1}\right) \\ & + \tfrac{1-h}{\sigma(1+h)} \left(\epsilon_t^p - \epsilon_{t+1}^p\right) \end{aligned} \tag{C.7}$$

Consumption of rule-of-thumb households:

$$c_t^n = \; \tfrac{1}{1+\bar{\tau}^c} \left(\left(\tfrac{\bar{W}\bar{L}}{\bar{Y}} \left((1-\bar{\tau}^w) \left(w_t + l_t\right) - \bar{\tau}^w \tau_t^w \right) + \tfrac{\bar{T}\bar{R}}{\bar{Y}} \, tr_t \right) \tfrac{1}{\frac{\bar{C}^n}{\bar{Y}}} - \bar{\tau}^c \, \tau_t^c \right) \tag{C.8}$$

Aggregate consumption:

$$c_t = c_t^r \; (1-\mu) \; \frac{\bar{C}^r}{\bar{C}} + c_t^n \, \mu \, \frac{\bar{C}^n}{\bar{C}} \tag{C.9}$$

Wage dynamics:

$$\begin{aligned} w_t = \; & \tfrac{\beta}{1+\beta} \, w_{t+1} + \tfrac{1}{1+\beta} \, w_{t-1} + \pi_{t+1} \tfrac{\beta}{1+\beta} - \pi_t \tfrac{1+\beta\,\omega^w}{1+\beta} + \pi_{t-1} \tfrac{\omega^w}{1+\beta} - \tfrac{1}{1+\beta} \\ & \tfrac{(1-\beta\,\theta^w)(1-\theta^w)}{\theta^w \left(1+\frac{\varphi\,(1+\lambda^w)}{\lambda^w}\right)} \; (w_t - mrs_t) \end{aligned} \tag{C.10}$$

Marginal rate of substitution (between consumption and labor):

$$mrs_t = \varphi \, l_t + \frac{\sigma}{1-h} \; \left(c_t^r - h \, c_{t-1}^r\right) + \tau_t^w \, \frac{\bar{\tau}^w}{1-\bar{\tau}^w} + \frac{\bar{\tau}^c}{1+\bar{\tau}^c} \, \tau_t^c + \epsilon_t^l \tag{C.11}$$

Private investment Euler equation:

$$i_t = tq_t \, \frac{1}{\varkappa \; (1+\beta)} + \frac{1}{1+\beta} \, i_{t-1} + \frac{\beta}{1+\beta} \, i_{t+1} - \frac{1}{1+\beta} \; \left(\beta \, \epsilon_{t+1}^i - \epsilon_t^i\right) \tag{C.12}$$

where $\varkappa = 1/S"(1) > 0$

Shadow cost of private capital:

$$\begin{aligned} q_t = \; & \tfrac{\bar{r}^k \left(1-\bar{\tau}^k\right)}{1-\delta+\bar{r}^k \left(1-\bar{\tau}^k\right)} \left(r_{t+1}^k - \tfrac{\bar{\tau}^k}{1-\bar{\tau}^k} \, \tau_{t+1}^k \right) + \tfrac{1-\delta}{1-\delta+\bar{r}^k \left(1-\bar{\tau}^k\right)} \, q_{t+1} \\ & + \pi_{t+1} - r_t + \eta_t^q \end{aligned} \tag{C.13}$$

Capital utilization:

$$\omega_t = \frac{1}{\kappa}\left(r_t^k - \frac{\bar{\tau}^k}{1-\bar{\tau}^k}\,\tau_t^k\right) \tag{C.14}$$

where: $\kappa = \Psi'(1)/\Psi''(1)$.

Privat capital law of motion:

$$k_t^p = (1-\delta)\; k_{t-1}^p + \delta\, i_t \tag{C.15}$$

C.2.2 Firms

Marginal cost:

$$mc_t = (1-\alpha)\; w_t + \alpha\, r_t^k - z_t - \zeta\, k_{t-1}^g \tag{C.16}$$

Labor demand:

$$l_t = k_{t-1}^p + \omega_t + r_t^k - w_t \tag{C.17}$$

Phillips curve:

$$\pi_t = \pi_{t+1}\,\frac{\beta}{1+\beta\,\omega^p} + \frac{\omega^p}{1+\beta\,\omega^p}\,\pi_{t-1} + \frac{(1-\beta\,\theta^p)\;(1-\theta^p)}{(1+\beta\,\omega^p)\;\theta^p}\;(mc_t + \eta_t^{cp}) \tag{C.18}$$

C.2.3 Fiscal authority

Government consumption:

$$g_t^c = y_{t-1}\;(-\rho_{gc,y}) - b_{t-1}\,\rho_{gc,b} + \epsilon_t^{gc} \tag{C.19}$$

Government investment:

$$g_t^i = (-\rho_{gi,y})\; y_{t-1} - \rho_{gi,b}\, b_{t-1} + \epsilon_t^{gi} \tag{C.20}$$

Government transfers:

$$tr_t = l_t\;(-\rho_{tr,l}) - b_{t-1}\,\rho_{tr,b} + \epsilon_t^{tr} \tag{C.21}$$

Consumption tax rate:

$$\tau_t^c = \rho_{\tau c,y} y_{t-1} + \rho_{\tau c,b} b_{t-1} + \epsilon_t^{\tau c} \tag{C.22}$$

Labor tax rate:

$$\tau_t^w = \rho_{\tau w,y} y_{t-1} + \rho_{\tau w,b} b_{t-1} + \epsilon_t^{\tau w} \tag{C.23}$$

Capital tax rate:

$$\tau_t^k = \rho_{\tau k,y} y_{t-1} + \rho_{\tau k,b} b_{t-1} + \epsilon_t^{\tau k} \tag{C.24}$$

Public capital law of motion:

$$k_t^g = (1 - \delta^g)\, k_{t-1}^g + \delta^g g_t^i \tag{C.25}$$

Government budget constraint:

$$\begin{aligned} \tfrac{\bar{B}}{\bar{Y}} b_t = \; & \tfrac{T\bar{R}}{\bar{Y}}\, tr_t + \tfrac{\bar{B}}{\bar{Y}}\, \tfrac{1}{\beta}\, (b_{t-1} + r_{t-1} - \pi_t) + \tfrac{\bar{G}^c}{\bar{Y}}\, g_t^c + \tfrac{\bar{G}^i}{\bar{Y}}\, g_t^i - \bar{\tau}^c\, \tfrac{\bar{C}}{\bar{Y}}\, (\tau_t^c + c_t) \\ & - \bar{\tau}^w\, \tfrac{\bar{W}\bar{L}}{\bar{Y}}\, (l_t + w_t + \tau_t^w) - \bar{r}^k\, \bar{\tau}^k\, \tfrac{\bar{K}}{\bar{Y}}\, \left(k_{t-1}^p + \omega_t + r_t^k + \tau_t^k\right) \end{aligned} \tag{C.26}$$

C.2.4 Monetary authority and euro area aggregates

Taylor Rule:

$$r_t = \rho_r r_{t-1} + (1 - \rho_r)\rho_\pi \pi_{EA,t} + \rho_y y_{EA,t} + \eta_t^r \tag{C.27}$$

Euro area inflation:

$$\pi_{EA,t} = \phi^{DE} \pi + \left(1 - \phi^{DE}\right) \pi_t^{REA} \tag{C.28}$$

Euro area output gap:

$$y_{EA,t} = \phi^{DE} y + \left(1 - \phi^{DE}\right) y_t^{REA} \tag{C.29}$$

C.2.5 Aggregation and market clearing

Production function (from (4.8)):

$$y_t = \xi\, \left(\zeta\, k_{t-1}^g + z_t + \alpha\, k_{t-1}^p + \alpha\, \omega_t + (1 - \alpha)\; l_t\right) \tag{C.30}$$

where $\xi = 1 + \Phi/\bar{Y}$.

Technology:

$$z_t = \rho_z z_{t-1} + \eta_t^z \tag{C.31}$$

Goods market clearing:

$$\begin{aligned} y_t = \; & \tfrac{\bar{C}}{\bar{I}} c_t + \tfrac{\delta \bar{K}}{\bar{Y}} i_t + \tfrac{\bar{G}^c}{\bar{Y}} g_t^c + \tfrac{\bar{G}^i}{\bar{Y}} g_t^i + \omega_t \left(1 - \bar{\tau}^k\right) \bar{r}^k \tfrac{\bar{K}}{\bar{Y}} \\ & + \left(1 - \tfrac{\bar{C}}{\bar{C}} - \tfrac{\delta \bar{K}}{\bar{Y}} - \tfrac{\bar{G}^c}{\bar{Y}} - \tfrac{\bar{G}^i}{\bar{Y}} - \left(1 - \bar{\tau}^k\right) \bar{r}^k \tfrac{\bar{K}}{\bar{Y}}\right) tb_t \end{aligned} \tag{C.32}$$

C.2.6 Shocks and AR(1) processes

Technology shock:

$$z_t = \rho_z \, z_{t-1} + \eta_t^z \tag{C.33}$$

Investment shock:

$$\epsilon_t^i = \rho_i \, \epsilon_{t-1}^i + \eta_t^i \tag{C.34}$$

Preference shock:

$$\epsilon_t^p = \rho_p \, \epsilon_{t-1}^p + \eta_t^p \tag{C.35}$$

Labor supply shock:

$$\epsilon_t^l = \rho_l \, \epsilon_{t-1}^l + \eta_t^l \tag{C.36}$$

Government consumption shock:

$$\epsilon_t^{gc} = \rho_{gc} \, \epsilon_{t-1}^{gc} + \eta_t^{gc} \tag{C.37}$$

Government investment shock:

$$\epsilon_t^{gi} = \rho_{gi} \, \epsilon_{t-1}^{gi} + \eta_t^{gi} \tag{C.38}$$

Government transfer shock:

$$\epsilon_t^{tr} = \rho_{tr} \, \epsilon_{t-1}^{tr} + \eta_t^{tr} \tag{C.39}$$

Consumption tax rate shock:

$$\epsilon_t^{\tau c} = \rho_{\tau c} \, \epsilon_{t-1}^{\tau c} + \eta_t^{\tau c} \tag{C.40}$$

Labor tax rate shock:

$$\epsilon_t^{\tau w} = \rho_{\tau w} \, \epsilon_{t-1}^{\tau w} + \eta_t^{\tau w} \tag{C.41}$$

Capital tax rate shock:

$$\epsilon_t^{\tau k} = \rho_{\tau k}\, \epsilon_{t-1}^{\tau k} + \eta_t^{\tau k} \tag{C.42}$$

Trade balance:

$$tb_t = \rho_{tb}\, tb_{t-1} + \eta_t^{tb} \tag{C.43}$$

C.3 Steady state relationships

The interest rate:

$$\bar{r} = \frac{1}{\beta} \tag{C.44}$$

The marginal cost:

$$\bar{mc} = 0.80 \tag{C.45}$$

Labor supply:

$$\bar{l} = \frac{1}{3} \tag{C.46}$$

Mark-up:

$$\xi = \frac{1}{\bar{mc}} \tag{C.47}$$

Privat rental rate of capital:

$$\bar{r}_k = \frac{1}{1-\bar{\tau}_k}\left(\frac{1}{\beta} - (1-\delta)\right) \tag{C.48}$$

Wage:

$$\bar{w} = \left(\frac{\delta^g\,(1-\alpha)}{\frac{\bar{G}^i}{\bar{Y}}\,\bar{L}}\right)^{\frac{\zeta}{\zeta-(1-\alpha)}} \left(\chi\left(\frac{1}{1-\alpha}\right)^{1-\alpha}\left(\frac{1}{\alpha}\right)^{\alpha}\bar{r}_k^{\alpha}\right)^{\frac{1}{\zeta-(1-\alpha)}} \tag{C.49}$$

Capital stock:

$$\bar{K}^p = \bar{L}\,\frac{\alpha}{1-\alpha}\,\frac{\bar{W}}{\bar{r}^k} \tag{C.50}$$

Production:

$$\begin{aligned}\bar{Y} = \;& \bar{r}_k^{\alpha}\,\left(\tfrac{1}{\alpha}\right)^{\alpha}\left(\tfrac{1}{1-\alpha}\right)^{1-\alpha}\bar{K}^{\alpha}\,\bar{L}^{1-\alpha}\times \\ & \left(\left(\frac{\delta^g\,(1-\alpha)}{\frac{\bar{G}^i}{\bar{Y}}\,\bar{L}}\right)^{\frac{\zeta}{\zeta-(1-\alpha)}}\left(\chi\left(\tfrac{1}{1-\alpha}\right)^{1-\alpha}\left(\tfrac{1}{\alpha}\right)^{\alpha}\bar{r}_k^{\alpha}\right)^{\frac{1}{\zeta-(1-\alpha)}}\right)^{1-\alpha}\end{aligned} \tag{C.51}$$

Consumption of optimizing households:

$$\begin{aligned}\bar{C}^r = \; & \frac{\bar{W}\bar{L}}{(1+\bar{\tau}^c)(1-\mu)} \left(\frac{1}{1-\alpha}\left(1-\frac{\bar{B}}{\bar{Y}}(1-\bar{r})+\frac{\bar{TR}}{\bar{Y}}\right)\right. \\ & \left. -\left(\bar{r}^k\,\bar{\tau}^k+\delta\right)\frac{\alpha}{1-\alpha}\frac{1}{\bar{r}^k}-\bar{\tau}^w-\mu\left(1-\bar{\tau}^w+\frac{1}{1-\alpha}\frac{\bar{TR}}{\bar{Y}}\right)\right)\end{aligned} \tag{C.52}$$

Consumption of non-optimizing households:

$$\bar{C}^n = \frac{1}{1+\bar{\tau}^c}\left(\bar{W}\bar{L}(1-\bar{\tau}^w)+\frac{\bar{TR}}{\bar{Y}}\bar{Y}\right) \tag{C.53}$$

Total consumption:

$$\bar{C} = (1-\mu)\,\bar{C}^r + \mu\,\bar{C}^n \tag{C.54}$$

Public capital stock:

$$\bar{K}^g = \left(\chi\,\bar{r}_k^{\alpha}\left(\frac{1}{1-\alpha}\right)^{1-\alpha}\left(\frac{1}{\alpha}\right)^{\alpha}\bar{W}^{1-\alpha}\right)^{\frac{1}{\zeta}} \tag{C.55}$$

C.4 Priors and posteriors

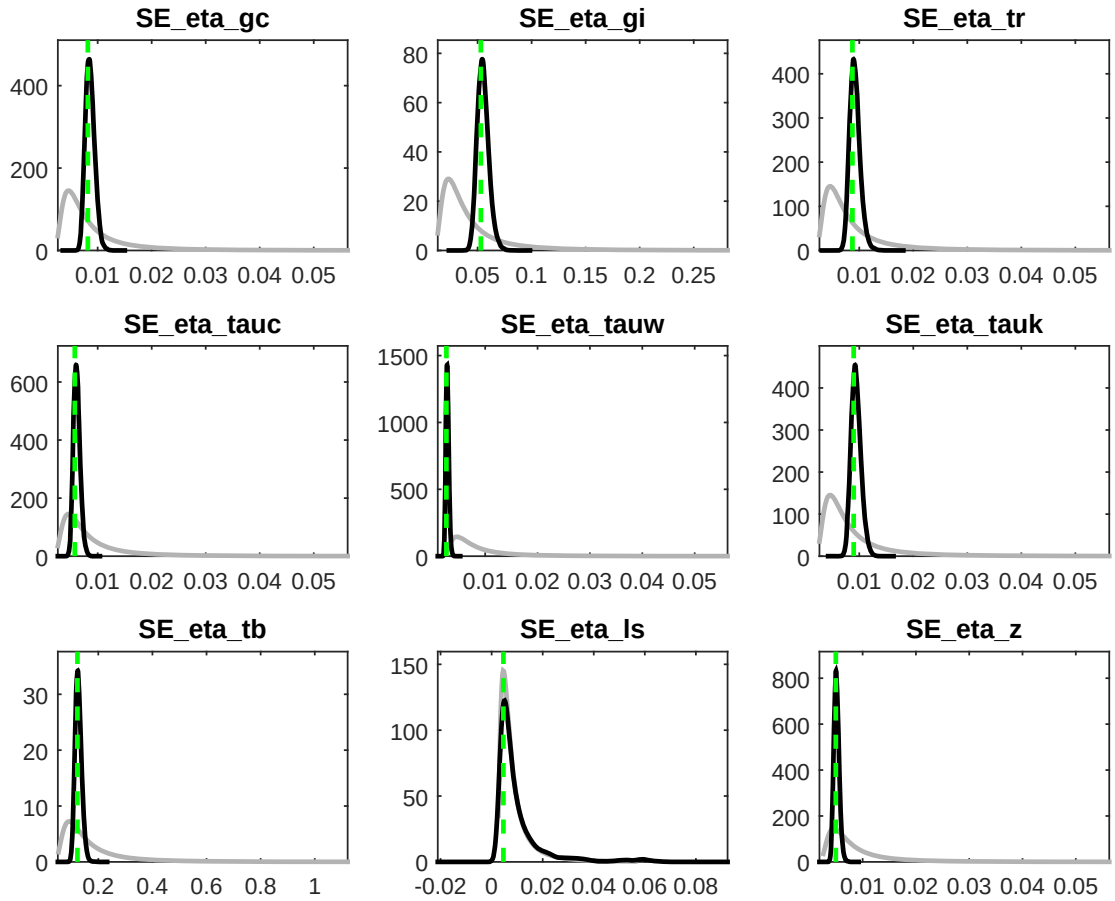


Figure C.1: Priors and posteriors

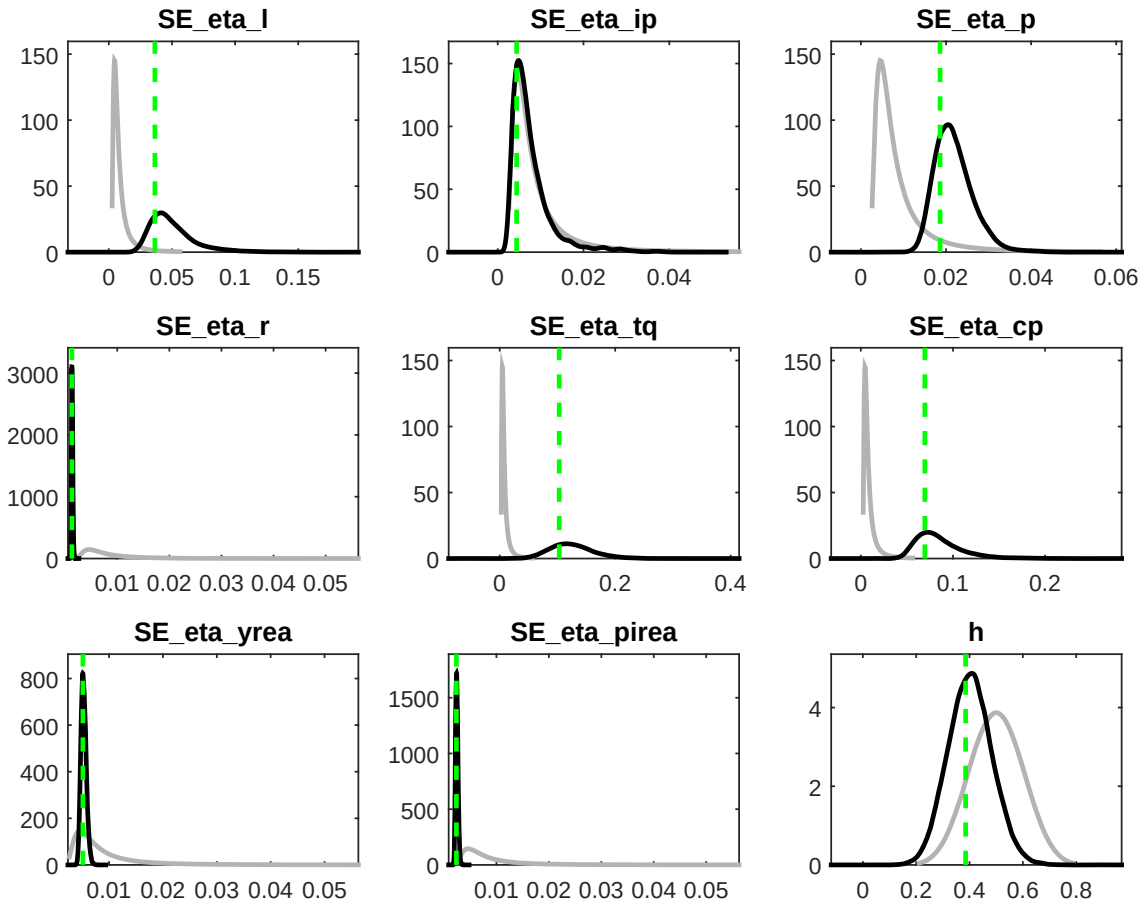


Figure C.2: Priors and posteriors (cont.)

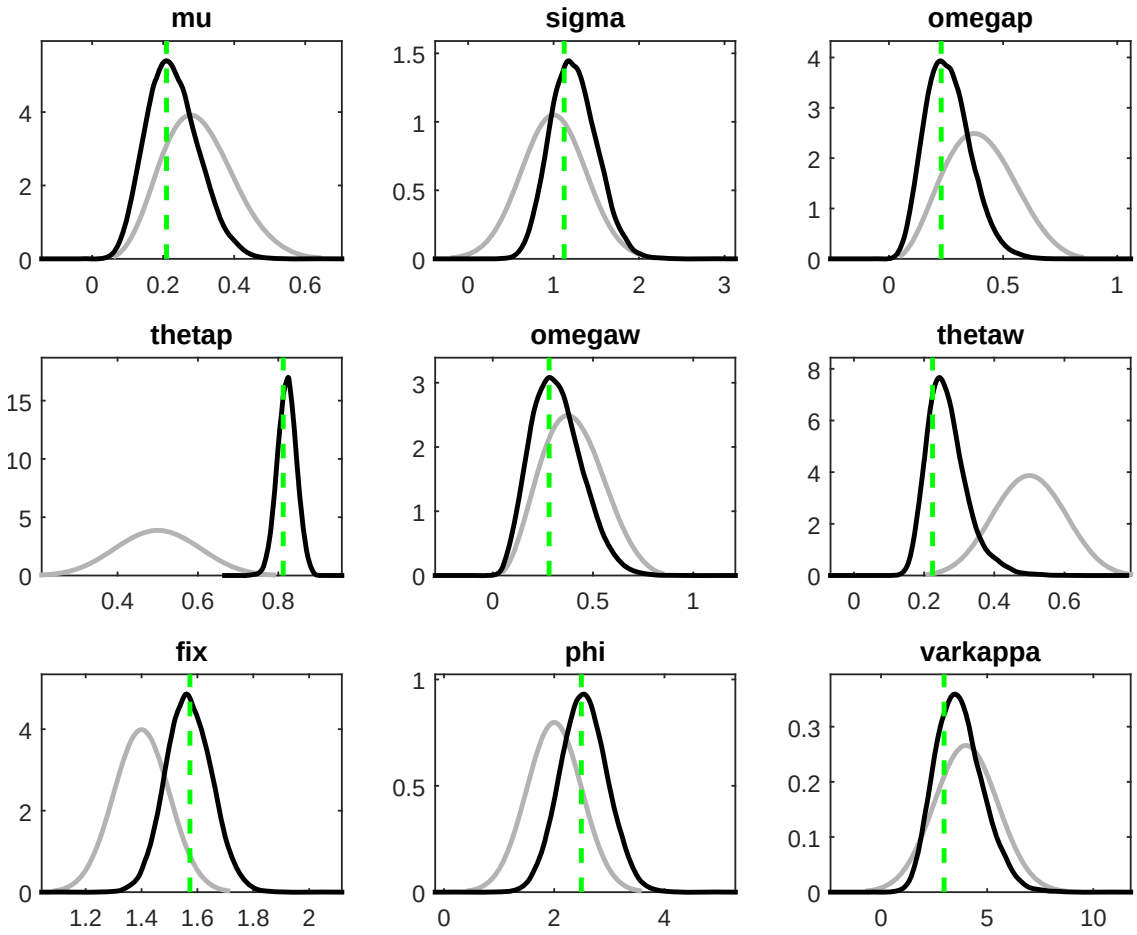


Figure C.3: Priors and posteriors (cont.)

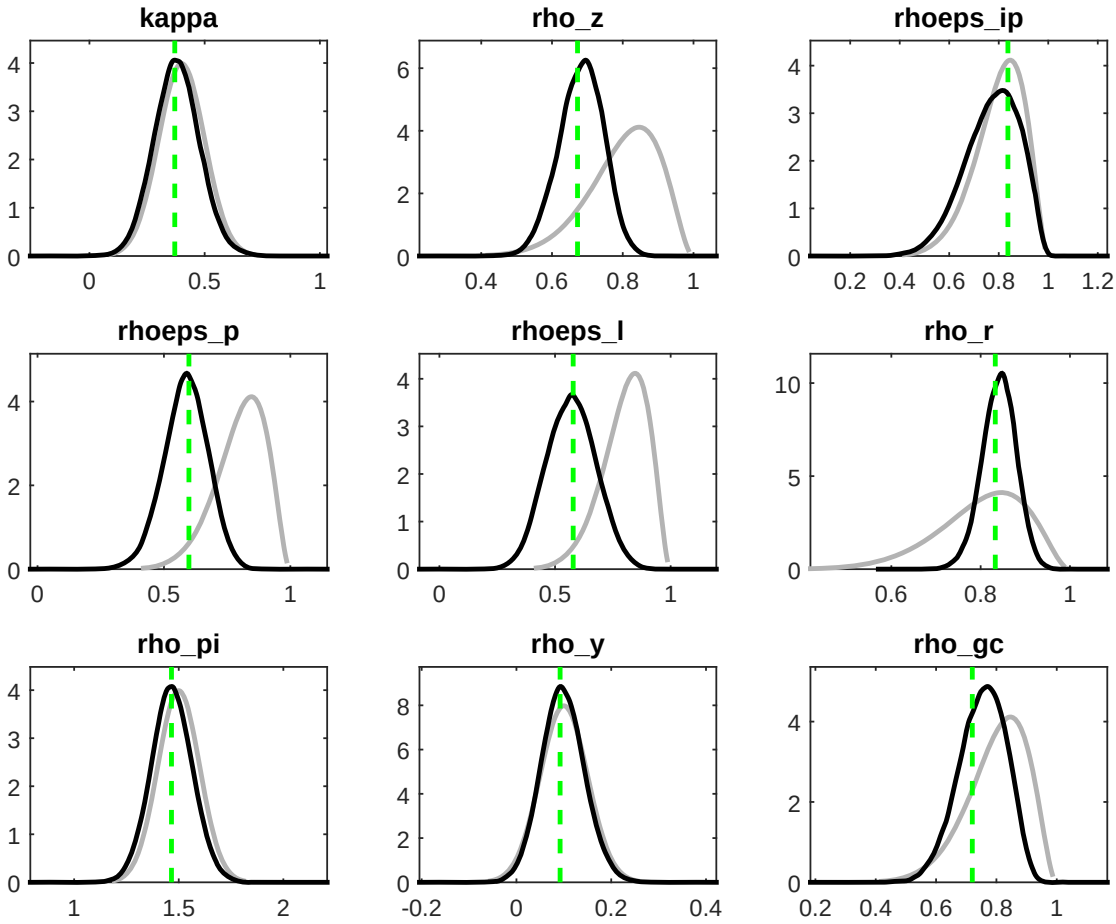


Figure C.4: Priors and posteriors (cont.)

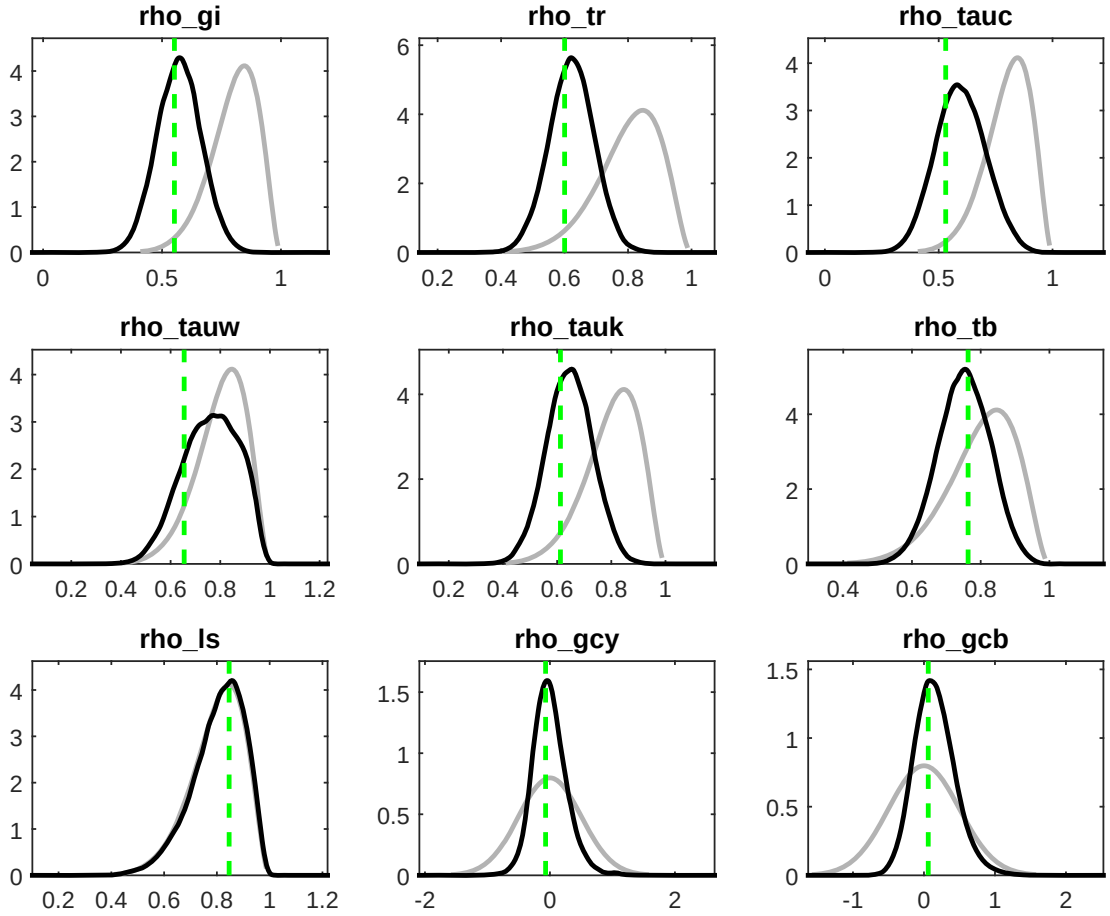


Figure C.5: Priors and posteriors (cont.)

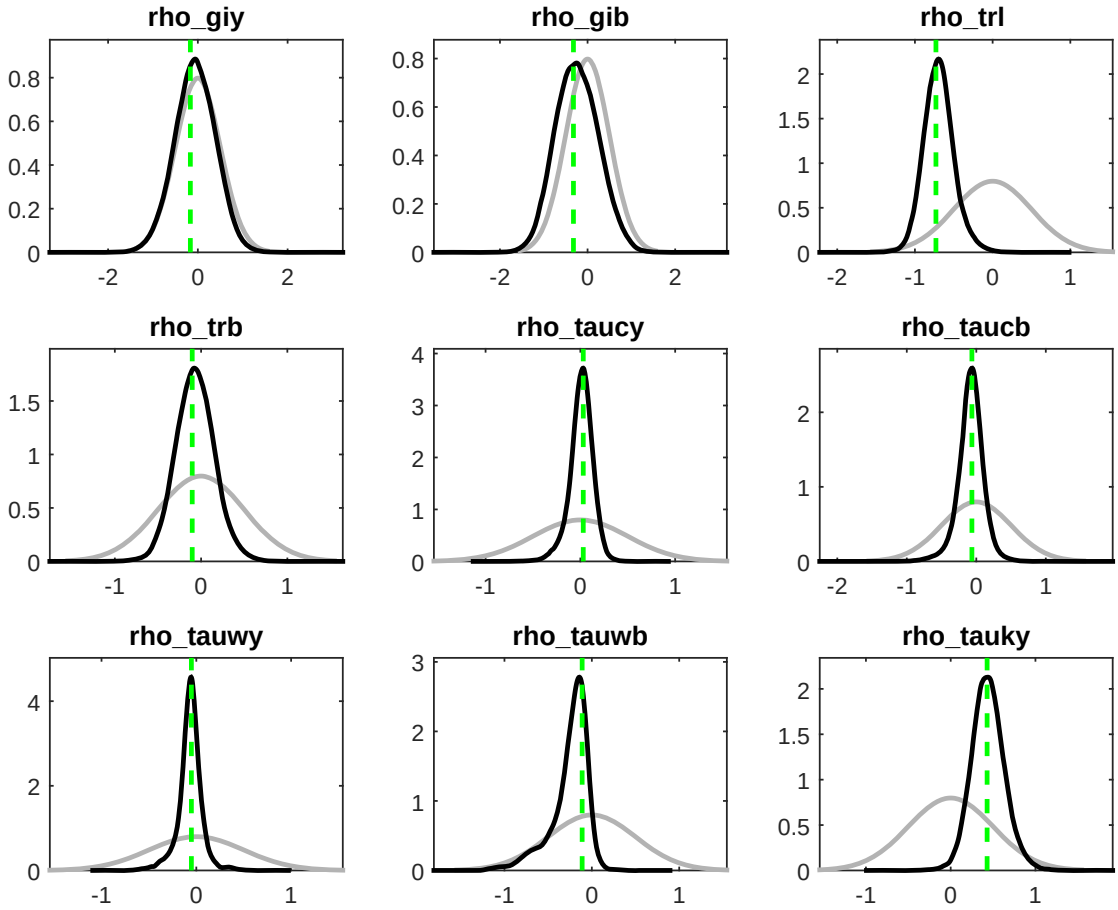


Figure C.6: Priors and posteriors (cont.)

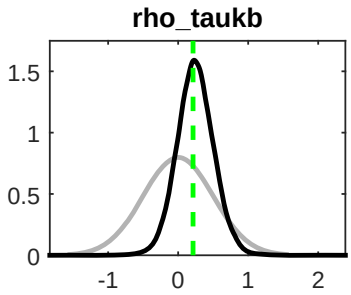


Figure C.7: Priors and posteriors (cont.)

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