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May, 2017

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A Model of the Market for Bank Credit: The Case of Germany

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Abstract

Since the financial crisis there exists a widespread discussion about the role of banking in a monetary economy. We contribute to this discussion by presenting a basic model of the banking sector which models banks as originators of credit without owning pre-collected savings or reserves beforehand. Additionally, we estimate an empirical model of the German credit market for non-financial corporations in a disequilibrium framework. Empirically, we detect a significant role for the variables that are chosen on the basis of our price-theoretic model.

Keywords: Credit, Money Supply, Money Multiplier.
JEL codes: E510.

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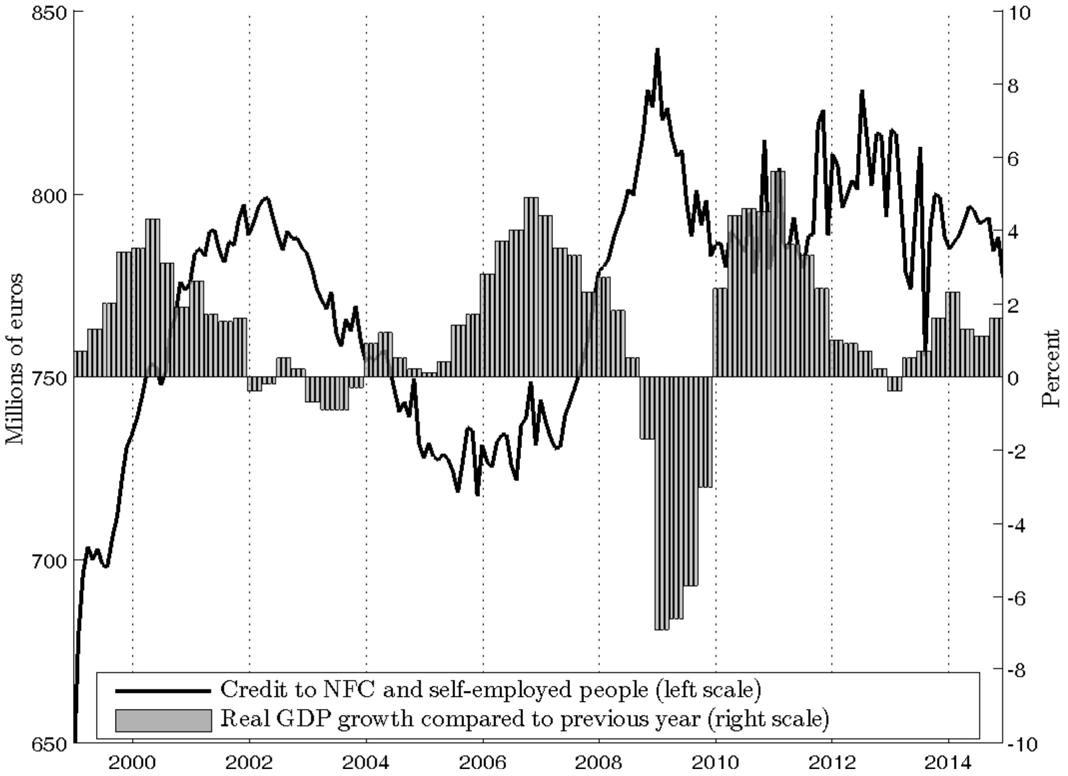
1 Introduction

We present a basic model that illustrates the process of credit creation in a monetary economy. In our model, credit is determined by the interaction of three sectors: banks, non-banks and the central bank. The model features two markets: the market for bank credit and, connected by a multiplier relation, the market for high-powered money. In a first step, credit volume is determined by supply and demand on the market for bank credit and, in a second step, banks demand a fraction of the credit volume in form of high-powered money from the central bank. This modeling design of banks is much closer to banks' daily business practice. As a fact, banks do not need a specific amount of reserves or pre-collected savings beforehand in order to extend credit. When a bank makes a loan, it simply credits the customer's account with a bank deposit equal to the size of the loan (McLeay et al., 2014). This introduces, in contrast to the predominant view of banks as intermediaries, the idea of banks as creators of credit.

In addition to presenting our model, we push our analysis further and verify the veracity of our model by estimating a credit market. More precisely, we estimate the German market for firm credit from January 1999 until December 2014, where demand and supply factors are chosen on the basis of our theoretic model. On account of information imperfections on credit markets (Stiglitz and Weiss, 1981) and disturbances emanating from other sectors of the economy, it is unlikely that supply and demand on the market for bank loans are equal at every point in time. We take this feature into account by analyzing the credit market in a disequilibrium framework estimated with bayesian methods. Beyond evaluating our theoretic model, the disequilibrium framework also allows us to identify episodes on the German credit market that were characterized by demand or supply overhang.

Figure 1 displays the evolution of the credit to non-financial firms and self-employed people and real GDP growth during our sample period. Unsurprisingly, the evolution of credit is closely linked to the business cycle, where GDP growth seems to lead movements in credit. Focusing on the evolution of real GDP growth, Germany experienced a short recovery at the beginning of our sample, between 1999 and 2001, before entering a recessionary phase that lasted until 2005/2006. Then, for a short period, the German economy accelerated until the financial crisis erupted in 2007/2008. Whereas other European countries struggled to recover from the financial crisis, Germany bounced back relatively quickly and regained its pre-crisis GDP level from the first quarter of 2008 in the first quarter of 2011.

Figure 1: Bank credit to non-financial corporations and self-employed people and real GDP growth



Source: Bundesbank and OECD.

Moving on to the development of credit, the short economic recovery around 1999 and 2000 is reflected by an increase in credit. Credit peaked locally in the first quarter of 2002 with a credit volume of approximately 800 million euros, before a decline set in that went on until late 2005. The negative credit growth fell in a period where Germany performed poorly in economic terms which led the incumbent government to reform the welfare system and the labor market (Agenda 2010). From 2006 until the crisis, credit exploded and increased from 730 million to 840 million euros in the first quarter of 2009. Then, in 2009, Germany's bank credit market for firms experienced a strong drop in credit growth. The financial crisis that had started in the U.S. had finally spilled over to Europe. The crisis increased the uncertainty about counter-party risks among banks which resulted into a freeze of the interbank market. The fear of a melt-down of the financial system with devastating consequences for the real economy led the ECB to take, in addition to standard monetary easing measures, non-standard measures to protect the functioning of the financial system. As liquidity dried up on funding markets, the ECB introduced liquidity and funding measures like the long-term refinancing operations (LTROs) and purchased assets in malfunctioning market segments, e.g., Covered Bonds Purchase Program (CBPP). On the national level, the German government ensured the banks' solvency with guarantees and supported aggregate demand with an economic stimulus plan in 2009.

Applying the disequilibrium model to the German market for firm credit, we are able to capture the economic episodes in Germany fairly well. Our model predicts that at the beginning of the millennium credit demand, i.e. the firm sector, was lagging behind credit supply which coincides with the recessionary environment of the German economy at that time. Thereafter, during the run-up to the crisis and afterwards, credit supply, i.e., the banking sector, was the constraining market side and prevented a stronger credit expansion. Our results are supported on a microeconomic level. The Kredithürde of the ifo-institute, which reflects the borrowing conditions of German firms, indicates worsening credit conditions after the financial crisis. This result is confirmed by Rottmann and Wollmershäuser (2013). They develop a bank credit supply indicator, based on the responses by firms from the Ifo Business Survey, which suggests a tightening of credit supply after the crisis.

Furthermore, the regression results confirm the relevance of our model's main determinants. Our model motivates a role for economic activity and for various funding costs of banks and firms, which includes lending rates, bond rates and the refinancing rate. Quantitatively and qualitatively, we find plausible and significant results for the factors determining credit supply and demand. Our contribution extends into several dimensions. First, we present an aggregate model of the market for bank loans, where banks back their credit business with a variety of refinancing sources. This includes in addition to refinancing via the central bank and deposits, the bond market and equity market. Second, in our model, the logical order places banks' credit business in front of refinancing operations, which is the adequate description banking today. Third, we estimate a market for German firm credit in a disequilibrium framework and, in addition to testing our model, identify episodes of excess demand and supply on the loan market. And fourth, we show that the evolution of bank credit can be well captured with prices which gives support the price-theoretic approach of our model.[1]

The paper is organized as follows. Section 2 contains an overview of related literature. Section 3 illustrates the theoretic model for the banking sector. Section 4 discusses our econometric approach and section 5 provides the estimation results. Section 6 concludes.

[1]Price-theoretic means that it is not quantities, such as deposits and equity, that play the leading role in extending credit but rather differentials in prices.

2 Literature Review

Our theoretic model builds on the work by Bofinger and Schächter (1995). Close to this model design is the work of Winker (1996) who also models an aggregate market for bank loans where banks behave as profit-maximizing firms (Freixas and Rochet, 2008). Most importantly, our model design is consistent with the view of banks as creators of credit, in contrast to the mainstream view of banks as intermediaries of credit. In short, intermediary banks lend out funds that they collected before making the loan.[2] This assumes that some entity in the economy has put funds, that can be lent out, to disposition by, e.g., saving more. In contrast, viewing banks as creators of credit reverses causality: making a loan creates, as a balance sheet reflex, deposits on the bank's liability side. Therefore, the extension of credit depends on the willingness of banks to loan money and not on the abstinence of some household epitomized by saving more. The misconception of seeing saving as the source or prerequisite for expenses of any sort is strengthened further by a misinterpretation of the savings-investment identity. The identity is interpreted causally, where causality runs from saving to investment. However, it is not higher saving that is needed for funding new investments but rather additional financing possibilities. A deeper digression into the difference between saving and financing is provided by Borio and Disyatat (2011, 2015) and Lindner (2012). Therefore, since banks are able to make loans by pure will, their credit business is not constrained or relaxed by pre-collected savings or reserves.[3] Causality goes in reverse order: in a first step, the bank makes a loan and, in a second step, the necessary reserves are procured after credit business has taken place. Our model describes this process accurately by placing credit business in first place. Werner (2014) actually proves that this is the way banks do business, by carrying out a field experiment that documents this practice. Making a distinction between the two models of banking is not only of mere academic interest. Disyatat (2008, 2011) underlines that the understanding of how banks function and the modeling of banks impact policy implications in an important way. Finally, Jakab and Kumhof (2015) contribute to this area of research by developing a state-of-the-art DSGE-model that includes banks as creators of credit, instead of intermediaries, and illustrate the implications of the modeling choice of banks in the framework of a DSGE-model. As an aside, it is stunning that these insights

[2] This is the correct description, of course, for financial institutions other than banks.

[3] This does not mean that banks serve every demand for credit. Banks have to survive in a competitive environment where bad decisions push them out of the business.

were well known among economists and central bankers from the early 20th century, but did not get incorporated into mainstream economics.[4]

The empirical study and estimation of markets for bank loans started in the early 1970s. In the beginning, markets were estimated by assuming them to be in equilibrium, but as evidence on the possibility of credit rationing accumulated, economists adopted the disequilibrium framework. In this case, demand and supply do not even each other out at every instant of time and one market force prevails over the other. Therefore, both sides of the market, demand and supply, are analyzed separately. An early work represents Laffont and Garcia (1977) who estimate a disequilibrium model for the supply and demand of chartered banks' loans to business firms in Canada. Building on their work and on others, the disequilibrium approach became a standard tool for answering questions relating to the credit market, which resulted into a broad body of work.[5] Among recent studies that apply the disequilibrium framework is Everaert et al. (2015). They study countries in Central, Eastern and Southeastern Europe which experienced a credit boom-bust cycle in the last decade. Their goal is to find out whether demand or supply factors were the more important driving forces during this period. For Latvia, Poland and Romania, they find constraints on the credit demand side for the period from 2003 to 2012. In contrast, Lithuania and Montenegro seemed to be the object of changing demand and supply regimes. Especially after crisis events, scholars studied the question whether economic conditions were aggravated further by a shortage in credit supply, i.e., a credit crunch. In particular, the financial crisis of 2007 incurred heavy strains in banking sectors that probably led banks to curb the supply of credit. Reznakova and Kapounek (2014), for example, test for a credit crunch of the Czech credit market after the financial crisis. They conclude that the decrease in credit after the crisis can be related to low economic and investment activity which rejects the hypothesis of a credit crunch. Vouldis (2015) analyzes the Greek credit market on a disaggregated level (short- and long-term business loans, consumer loans and mortgages) between 2003 and 2011. He finds that during the boom before the crash, demand for credit exceeded the supply of credit and as the debt crisis intensified, constraints on the supply side led to a decrease in credit.

Turning to Germany, several authors studied the German credit market for episodes of

[4] Jakab and Kumhof (2015) list many statements from central bankers and economists of the early 20th century that describe banks as creators of credit. In academia, this view was pursued vigorously only outside of mainstream. See, e.g., Lavoie (1984); Asimakopulos (1986); Davidson (1986) and Palley (1996).

[5] A non-exhaustive list is: Ito and Ueda (1981); King (1986); Kugler (1987); Martin (1990), and Pazarbasioglu (1997).

disequilibrium and credit crunches. Beginning with Nehls and Schmidt (2003), they study loans to enterprises and self-employed workers in the period from 1980 until 2002. On the supply side they distinguish between an aggregated banking sector and different banking groups. The authors find evidence for excess credit demand in 2002. Especially the behavior of big banks contributed to supply constraints of aggregate credit. Boysen-Hogrefe et al. (2010) modify the model of Nehls and Schmidt (2003) and estimate a coefficient-varying disequilibrium model for loan supply and demand for non-financial corporations between 1970 and 2009. In addition, they evaluate what effects a change in equity regulations would imply for the development of credit. Furthermore, they examine the effect of credit growth on economic growth. Contributing to research on supply side shortages of credit during the financial crisis, Erdogan (2010) analyzes the German market for bank credit from 1991 until 2009 for non-financial corporations. She finds that a liquidity injection into the German banking system at the end of 2008 helped to overcome supply constraints in Germany. Schmidt and Zwick (2012) support her findings. Additionally, Schmidt and Zwick (2012) update their earlier model (Nehls and Schmidt (2003)) for different banking groups between 1990 and 2011 with the result that banks with high impairments during the financial crisis cut their supply more than the others.

3 A simple model for the banking market

We introduce a model for the credit market which builds on Bofinger and Schächter (1995). The model provides a framework to analyze the process of credit creation in a bank-based economy. The model features two markets, the market for bank loans and the market for high-powered money, which are linked by a multiplier relation. On the market for bank loans, banks provide credit that the non-banking sector uses for finance. By setting the refinancing rate for banks, the central bank influences the banks' funding costs and, therefore, has a direct effect on the supply of credit. The interaction of credit demand and supply on the market for bank loans yields the equilibrium quantity of credit and price, i.e., the market rate for credit. Banks then need to acquire a fraction of their granted credit, pinned down by the multiplier, in form of central bank money on the market for high-powered money. On the market for high-powered money, the central bank acts as the sole supplier of base money and meets the banks' demand for central bank money at a fixed price (refinancing rate).

Extending the model in Bofinger and Schächter (1995), banks have a richer set of refinancing instruments at their hands to fund their credit business. This includes, in addition to deposits and credit from the central bank, the issuance of bonds and holdings of equity. Expanding the set of financial instruments makes a distinction between the two monetary aggregates, money and credit, reasonable. The defining characteristic between the two is their maturity structure as bank liabilities. Whereas money is short-term debt and held in form of deposits at the banks' account, credit includes also longer-term debt such as equity and bonds.

The next steps include a presentation of each market and their participants. After describing the structure of the model in more detail, we briefly discuss how a disequilibrium on the credit market can be rationalized in our framework.

3.1 Credit Market

Supply of bank loans

The model follows an industrial-organization approach which is characterized by profit maximization of each bank. Banks do so by choosing the amount of credit that maximizes their profit. The asset side of the bank's balance sheet reveals the revenues from credit business and the liability side, which consists of the refinancing sources of banks (equity, bonds, deposits and central bank credit), exposes the refinancing costs (cf. Table 1).[6] Taking into account all revenues and costs, the profit function for one representative bank j is equal to:

$$\pi_B^j = i_B Cr_{B/NB}^j - i_D D^j - i_R(Cr_{CB/B}^j - R^j) - i_E E^j - i_{NB} B^j - O^j - V_B^j,$$
$$\text{with } V_B^j = c_B \times (Cr_{B/NB}^j)^2.$$

The revenue $i_B Cr_{B/NB}^j$ stems from the credit business. $Cr_{B/NB}^j$ denotes the credit from banks to non-banks, which is provided at the bank interest rate of i_B. The costs associated with the credit business are the sum of the interest paid on deposits $i_D D$, the net refinancing from the Central bank $i_R(Cr_{CB/B} - R)$, equity costs $i_E E$, refinancing at the non-banking market $i_{NB} B$, operational costs O and credit risk costs V_B.[7] According to Fuhrmann (1987), Cosimano (1988), Freixas and Rochet (2008), we assume that the credit

[6] The balance sheets of all sectors are presented in section 7.1.
[7] The characteristics of V_B ensure a concave profit function with a unique optimum.

risk costs increase disproportionately in the amount of credit. The component c_B depends positively on the credit default probability and negatively on income. The operational costs consist of, among others, screening and monitoring. The balance sheet of one representative bank reads as follows:

Table 1: Bank's balance sheet

Assets	Liabilities
Credit from Banks to Non-banks $Cr_{B/NB}$	Equity E
	Bonds B
Reserves R	Deposits D
	Credit from Central Bank to Banks $Cr_{CB/B}$

Banks refinance their business via equity, bonds, deposits and credit from the central bank. They use these funds for granting credit and holding minimum reserves at the central bank. To simplify the profit function, we take the balance sheet identity of a bank and substitute:

$$Cr^j_{CB/B} - R^j = Cr^j_{B/NB} - D^j - E^j - B^j. \tag{1}$$

Furthermore, we assume that a fixed proportion of bank credit to the non-banking sector is backed by equity, as it is required in the Basel Regulations. An additional fraction of credit is hold in form of bonds which serves the reduction of interest rate risk. Interest rate risk emanates from the maturity mismatch between assets and liabilities on the bank's balance sheet. Thus, we set:

$$\begin{aligned} \eta^E &= \frac{E^j}{Cr^j_{B/NB}} \quad \text{and} \\ \eta^B &= \frac{B^j}{Cr^j_{B/NB}}. \end{aligned}$$

Substituting η^E, η^B and (1) into the profit function, we get:

$$\pi^j_B = (i_B - i_R - \eta^E(i_E - i_R) - \eta^B(i_{NB} - i_R))Cr^j_{B/NB} - (i_D - i_R)D^j - O^j - c_B(Cr^j_{B/NB})^2.$$

For deriving the optimal credit supply of one representative bank, we take the first-order condition of the profit function with respect to the credit volume, $Cr^j_{B/NB}$, which yields:

$$Cr^j_{B/NB} = \frac{(i_B - i_R) - \eta^E(i_E - i_R) - \eta^B(i_{NB} - i_R)}{2c_B}.$$

Assuming that there are n identical banks, total credit supply is equal to:

$$Cr^S_{B/NB} = \sum_{j=1}^{n} Cr^j_{B/NB} = \frac{[(i_B - i_R) - \eta^E(i_E - i_R) - \eta^B(i_{NB} - i_R)]n}{2c_B}. \tag{2}$$

Demand for bank loans

Each sector (public and private) demands credit in order to invest or consume. We model income and the cost for credit as key determinants of our credit demand. Additionally, the possibility to choose between different types of financing affects credit demand. This might not be the case for households and small and medium-sized enterprises which obtain their financing only via banks, but larger enterprises might choose the type of financing that suits their needs best. This possibly includes going to the non-banking market.[8] Hence, we introduce substiutability between different sources of financing according to Singh and Vives (1984), Wied-Nebbeling (1997), Ledvina and Sircar (2011). These considerations motivate the following form for the demand of bank loans:

$$Cr^D_B = a - bi_B + d(i_{NB} - i_B), \tag{3}$$

$$\text{with } a = \mu + \gamma Y.$$

The demand for bank credit depends negatively on the interest rate for bank credit, i_B, and positively on income, Y, and on the price differential of the two credit categories, non-bank and bank credit, $(i_{NB} - i_B)$. According to Ledvina and Sircar (2011), the substitutability implies three different relationships between the market for bank credit and bonds:

- independent loans $d = 0$: The price differential between bank and non-bank credit does not influence the demand for bank credit.
- differentiated loans $d \in (0, \infty)$: The price differential between bank and non-bank credit does influence the demand for bank credit.

[8] We assume a homogeneous bond market and therefore banks and non-banks face the same bond rate.

- homogeneous loans/perfect substitutes $d \to \infty$: The two types of financing are perfect substitutes. Hence, theoretically, if there is a price difference between the two credit categories, the sector which offers the lowest price serves the whole demand.

In an institutional sense, the banking sector is a key driver of economic activity due to the function as the supplier of money. The non-banking sector operates on top of the banking sector by intermediating financial claims that the banking sector has created before. Therefore, in a sense, the banking sector is a prerequisite for the non-banking sector.

Equilibrium

The market for bank loans is in equilibrium if the supply of bank loans (equation (2)) is equal to the demand for bank loans (equation (3)).[9] Hence, we get the following equilibrium credit volume and interest rate:

$$\begin{aligned} Cr^*_{B/NB} &= \frac{a - (b+d)(i_R + \eta^E(i_E - i_R) + \eta^B(i_{NB} - i_R))}{1 + 2c_B(b+d)}, \\ i^*_B &= \frac{2c_B(a + d i_{NB}) + (i_R + \eta^E(i_E - i_R) + \eta^B(i_{NB} - i_R))}{1 + 2c_B(b+d)}. \end{aligned}$$

3.2 Bank credit multiplier

After the derivation of the equilibrium amount of credit on the banking market, we are interested in the amount of high-powered money that corresponds to this credit volume. In economic textbooks, the relation of money to high-powered money is called the money multiplier. However, the multiplier in our model is not to be confounded with the common textbook money multiplier. Here, the bank credit multiplier, m_B, which extends beyond the standard money multiplier by including a wider array of refinancing instruments, is defined as the ratio of credit from banks to non-banks, $Cr_{B/NB}$, to high-powered money, H:

$$m_B = \frac{Cr_{B/NB}}{H}.$$

By making use of the following equality:

$$Cr_{B/NB} = \frac{M}{1 - \eta^E - \eta^B},$$

[9] Here, for simplifying matters, we set the number of banks, n, equal to one.

and the fact that money, M, consists of cash, C, and deposits, D:

$$M = C + D,$$

as well as that high-powered money, H, includes cash, C, and reserves, R:

$$H = C + R,$$

the bank credit multiplier can be written as:

$$m_B = \frac{Cr_{B/NB}}{H} = \left(\frac{C + D}{C + R}\right)\left(\frac{1}{1 - \eta^E - \eta^B}\right).$$

Additionally, we suppose that the public holds a fixed proportion of deposits in cash:

$$C = h \times D,$$

where h is the cash holding coefficient of the public.

Furthermore, the banking sector is obliged to hold reserves as a fraction of deposits:

$$R = r \times D,$$

where r is the minimum reserve requirements determined by the central bank.

Including all these facts in the bank credit multiplier equation, we get:

$$m_B = \frac{Cr_{B/NB}}{H} = \underbrace{\left(\frac{1 + h}{h + r}\right)}_{\text{(A)}}\underbrace{\left(\frac{1}{1 - \eta^E - \eta^B}\right)}_{\text{(B)}}.$$

The first ratio, (A), is the standard money multiplier, which is larger than one. The second ratio, (B), is also larger than one, because $\eta^E + \eta^B < 1$, resulting in a bank credit multiplier larger than one. If the banking system increases the ratio of leverage from the non-banking system, η^B, or the equity financing, η^E, the bank credit multiplier increases. Hence, for the same amount of bank credit less high-powered money is required.

Given the bank credit multiplier, m_B, and the equilibrium amount of credit, $Cr^*_{B/NB}$, we derive the optimum amount of high-powered money demanded by banks as:

$$H^* = \frac{Cr^*_{B/NB}}{m_B}. \tag{4}$$

At this point, we would like to emphasize an important distinction. The interpretation of our multiplier is diametrically opposed to the interpretation of the multiplier in standard economic textbooks. Therein, the money supply process starts with the central bank injecting a specific amount of high-powered money into the banking system which then, by the multiplier process, generates a quantity of money that surpasses the initial base money injection by a factor larger than one. However, this modeling approach does not capture adequately the mechanism of endogenous money creation by the banking sector (Werner, 2014; McLeay et al., 2014). Consistent with the endogenous money theory, our model incorporates this feature where causality runs from money to high-powered money. That means, it is the banking sector that acts first by extending credit and, in a second step, the central bank provides the high-powered money, determined by the multiplier relation, that the banking sector demands. This order of causation is expressed in equation (4), where the equilibrium amount of high-powered money is a function of credit and the multiplier.

3.3 Market for high-powered money

The role of the central bank is two-fold in this model. On the one hand it sets the refinancing rate, and on the other hand it provides high-powered money as a monopolistic supplier. The central bank provides as much high-powered money as the banking sector demands for a fixed price (refinancing interest rate, i_R), that it sets.

The demand for high-powered money can be considered as a function of bank credit. If there is no equilibrium amount of credit at the market for bank credit, banks have no incentive to demand high-powered money. Hence, the prohibitive price for bank credit less the spread for equity and bond refinancing, e in equation (5), is equal to the prohibitive price for high-powered money.

Assuming a linear demand function for high-powered money, H^D, we derive its slope by connecting two points on the demand schedule (saturation quantity and quantity at reservation price). Thus, we obtain the following demand function for high-powered money:

$$H^D = \frac{Cr^*_{B/NB}}{m_B} - \frac{Cr^*_{B/NB}}{m_B \times e} i_R, \tag{5}$$

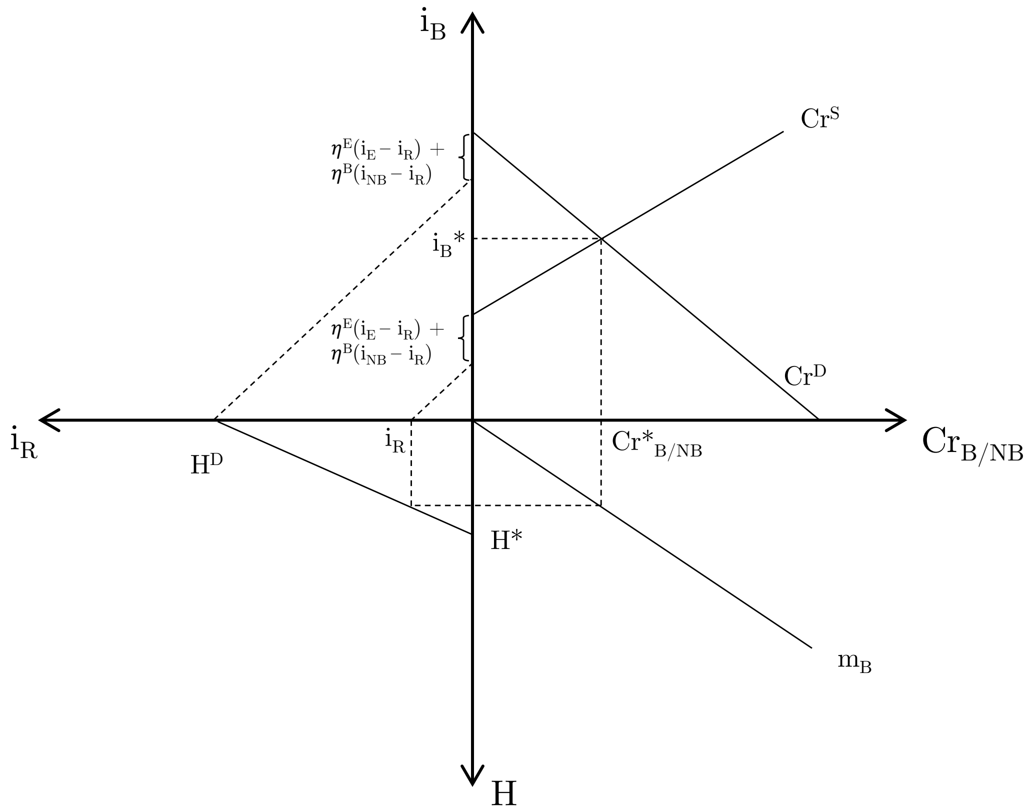
$$\text{with } e = \left(\frac{a + di_{NB}}{b + d}\right) - \eta^E(i_E - i_R) - \eta^B(i_{NB} - i_R). \tag{6}$$

Banks' demand for high-powered money is determined by the optimal credit volume, the multiplier relation, the prohibitive price as well as the refinancing rate set by the central bank. This determination is in line with causality running from credit to high-powered money.

3.4 Graphical illustration

Figure 2 shows a graphical representation of the model, which also highlights the connection between the two markets. By choosing the refinancing rate, the central bank sets the intercept of the credit supply curve. The refinancing costs at the equity market as well as at the bond market shift the supply curve upwards by increasing the intercept. The intersection between credit demand and supply determines the interest rate and amount of bank credit in equilibrium. Via the bank credit multiplier, we obtain the amount of high-powered money at a fixed refinancing rate.

Figure 2: Complete model of the credit market with all sectors: banks, non-banks and central bank



4 Empirics

We estimate a credit market with explanatory variables chosen on the basis of our theoretic model. To take into account the specifics of a credit market, like the information structure (Stiglitz and Weiss, 1981), we estimate a disequilibrium model. Stiglitz and Weiss (1981) motivated the case for disequilibria on the credit market where non-clearing lending rates are based on information-theoretic arguments. Financial contracts are especially subject to information asymmetries such that banks might set interest rates below the clearing market rate. The reason for this is that increasing the market rate has two effects. First, good borrowers drop out of the market (adverse selection) and, second, borrowers are likely to undertake riskier projects (moral hazard), thereby increasing default costs. As a consequence, market rates are not consistent with the market-clearing rate which leaves one market side constrained.

The empirical model for estimating a disequilibrium model takes the following form:

$$d_t = x'_{1t}\beta_1 + u_{1t}, \tag{7a}$$

$$s_t = x'_{2t}\beta_2 + u_{2t}, \tag{7b}$$

$$q_t = \min(x'_{1t}\beta_1 + u_{1t}, x'_{2t}\beta_2 + u_{2t}). \tag{7c}$$

d_t and s_t represent the notional demand and supply for credit. β_1 and β_2 are the slope parameters for demand and supply, respectively. x_{1t} is a $(k_1 \times 1)$ vector and x_{2t} is a $(k_2 \times 1)$ vector of explanatory variables for d_t and s_t, respectively. Obviously, identification is only possible if the two explanatory vectors differ in at least one co-variate.

$u_{1t} \sim N(0, \sigma_1)$ and $u_{2t} \sim N(0, \sigma_2)$ are error terms and independent of each other which allows for different supply and demand variances. The observed credit volume, q_t, is set equal to the minimum of the two market sides, where the other side of the market remains unobserved.

The model consists of the demand equation, (7a), supply equation, (7b), and one minimum condition, (7c), which allocates observed credit, q_t, to the demand or the supply side. The specification in equation (7c) includes demand and supply disturbances *inside* the min condition and, therefore, introduces a stochastic regime selection. Alternatively, it is possible to leave out the error terms and obtain a deterministic regime selection, where an error term is added outside the min condition to capture observational errors. We retain the model with stochastic regime selection because from an economic perspective it is more reasonable that demand and supply shocks determine, by including them into the min condition, which market side is operational. Ultimately, the min equation implements the crucial disequilibrium assumption. Due to sticky interest rates, quantities have to adjust and the observed outcome is set equal to the shorter market side. Which market side we truly observe is unknown. Given the parameter estimates and data, we can only assign a probability to each observation of belonging to the demand or the supply side and set the market side that is likely to be smaller equal to the observed market volume. The other market side is unobserved and treated as a *latent* variable.

4.1 Estimation

Historically, disequilibrium models have been estimated by means of classical methods, i.e., maximum likelihood estimation. In this context, Maddala and Nelson (1974) made a significant contribution by deriving general likelihood functions for this class of models. However, in this scenario, maximum likelihood estimation runs quickly into problems. The complexity of disequilibrium models leads to non-monotonic and non-smooth likelihood functions where numerical optimization techniques prove to be indispensable. Nevertheless, it is likely that optimization algorithms get stuck in local optima and do not converge to the global optimum.

An alternative approach, which avoids numerical optimization, is to resort to bayesian estimation techniques. In particular, Bauwens and Lubrano (2007) paved the way by proposing an elegant way to estimate dynamic disequilibrium models with bayesian methods. They use a dynamic version of the disequilibrium model, apply the data augmentation principle by Tanner and Wong (1987) for treating the unobserved data problem and use Gibbs sampling to obtain posterior distributions of the model parameters. Tanner and Wong propose to apply a Gibbs sampler to draw the latent variable and model parameters iteratively. More specifically, the latent variable is sampled conditionally on the model parameters and the observed variables, and then the model paramaters are in turn updated conditionally on the simulated latent variable and the observed variables. This poses no problem since the conditional distributions are known (cf. Section 4.2). We follow closely their estimation procedure and apply it to our static disequilibrium model.

The estimation procedure can be separated into two stages. First, we determine for each point in time which regime, demand or supply, conditional on the data and parameter estimates, is observed. Second, given the sample separation, we draw parameters from conditional probabilities and by averaging them we obtain their posterior means and distributions. These steps are iterated until parameter estimates have converged.

4.2 Bayesian inference

We apply a normal linear regression model and estimate it with bayesian methods to derive posterior estimates. We use a natural conjugate prior that has the same distributional form as the likelihood.[10] We elicit priors of the following form:

$$\pi(h_i) \sim \mathcal{G}(\underline{s_i}^{-2}, \underline{\nu_i}) \quad \text{and} \quad \pi(\beta_i|h_i) \sim \mathcal{N}(\underline{\beta_i}, h_i^{-1}\underline{V_i}).$$

h_i is the error precision, i.e., $h_i = \sigma_i^{-2}$. Their joint prior distribution is called a normal-gamma distribution:

$$\pi(\beta_i, h_i) = \pi(\beta_i|h_i) \times \pi(h_i) \sim \mathcal{NG}(\beta_i, h_i|\underline{\nu_i}, \underline{s_i}^{-2}, \underline{\beta_i}, \underline{V_i})$$

for $i = 1$ (demand) and 2 (supply). $\mathcal{G}(\cdot, \cdot)$ represents a gamma distribution, $\mathcal{N}(\cdot, \cdot)$ a normal distribution and $\mathcal{NG}(\cdot, \cdot, \cdot, \cdot)$ a normal-gamma distribution. In general, the hyperparameters are defined as follows:

$$\begin{aligned}
\underline{\nu_i} &= T - k_i, \\
\underline{\beta_i} &= \beta_{i,OLS}, \\
\underline{s_i}^2 &= \frac{(y_i - x_i\underline{\beta_i})'(y_i - x_i\underline{\beta_i})}{\underline{\nu_i}}, \\
\underline{V_i} &= diag(Var(\beta_{i,OLS})),
\end{aligned}$$

where $\underline{\nu_i}$ is the degree of freedom with T equal to the number of observations and k_i equal to the number of co-variates. $\underline{\beta_i}$ is the OLS estimator, and $\underline{s_i}^2$ is defined as the error variance. Finally, $\underline{V_i}$ represents the covariance matrix of the OLS estimator where all off-diagonal entries are zero. The prior hyperparameters allow the econometrician to introduce prior information that he has about the economic problem. We take a neutral standpoint and do not impose any external information. This means that we choose non-informative priors, which amounts to setting $\underline{\nu_i}$ and $\underline{V_i}^{-1}$ equal to zero. Since we use a natural conjugate prior, it follows that the posterior belongs to the same family of distributions, i.e.:

$$p(\beta_i, h_i|y_i) \sim \mathcal{NG}(\bar{\nu_i}, \bar{s_i}^{-2}, \bar{\beta_i}, \bar{V_i}),$$

[10] Notation draws on the book by Koop (2003). Variables with underscores are normally prior values and variables with bars posterior values.

Note that posterior quantities depend on sampled values, y_i, of the dependent variable. The posterior parameters read as follows:

$$\begin{aligned}
\bar{\nu}_i &= \underline{\nu}_i + T, \\
\bar{V}_i &= (\underline{V_i}^{-1} + x_i'x_i)^{-1}, \\
\bar{\beta}_i &= \bar{V}_i(\underline{V_i}^{-1}\underline{\beta}_i + x_i'x_i\beta_{i,OLS}), \\
\bar{\nu}_i\bar{s}_i^2 &= \underline{\nu}_i\underline{s}_i^2 + \nu_i s_i^2 + (\beta_{i,OLS} - \underline{\beta}_i)'[\underline{V_i} + (x_i'x_i)^{-1}]^{-1}(\beta_{i,OLS} - \underline{\beta}_i).
\end{aligned}$$

Finally, the marginal posterior for the error precision and the conditional posterior for the parameter vector of explanatory variables are:

$$p(h_i|y_i) \sim G(\bar{s}_i^{-2}, \bar{\nu}_i) \quad \text{and} \quad p(\beta_i|h_i, y_i) \sim N(\bar{\beta}_i, \bar{V}_i).$$

Now, the following two equations represent the demand and supply equation for credit:

$$d_t^{(j)} = x_{1t}'\beta_1^{(j)} + u_{1t}^{(j)} \text{ and} \tag{8a}$$

$$s_t^{(j)} = x_{2t}'\beta_2^{(j)} + u_{2t}^{(j)}, \tag{8b}$$

where the superscript j indicates the j-th draw in our bayesian estimation cycle. The first iteration, $j = 1$, is initialized with OLS estimates, assuming that the market is in equilibrium, i.e., $q_t = d_t = s_t$.[11] These values are used in turn to determine which regime is operative. We now draw a value $U_t^{(j)}$ for each observation from a uniform distribution. Given the estimates, we can calculate the probability, $\lambda_t^{(j)}$, of the notional demand being shorter than notional supply:

$$\lambda_t^{(j)} := \mathbb{P}(d_t^{(j)} < s_t^{(j)}) = \Phi\left(\frac{x_{2t}'\beta_2^{(j)} - x_{1t}'\beta_1^{(j)}}{\sqrt{\sigma_2^{2(j)} + \sigma_1^{2(j)}}}\right). \tag{9}$$

Φ designates the standard normal distribution function and $\sigma_1^{2(j)}$ and $\sigma_2^{2(j)}$ are the variances of the notional demand and supply equations, respectively. We now assign the observed

[11] Taking OLS estimates to initialize the procedure is unproblematic because the influence of starting values on the results diminishes along the iteration process.

credit variable in the following way:

$$\text{If } U_t^{(j)} < \lambda_t^{(j)} \text{ then } y_{1t}^{(j+1)} := q_t \text{ and draw } y_{2t}^{(j+1)} \sim \mathcal{TN}_{d_t^{(j)} < s_t^{(j)}}(x'_{2t}\beta_2^{(j)}, \sigma_2^{2(j)}), \quad (10)$$

$$\text{If } U_t^{(j)} > \lambda_t^{(j)} \text{ then } y_{2t}^{(j+1)} := q_t \text{ and draw } y_{1t}^{(j+1)} \sim \mathcal{TN}_{s_t^{(j)} < d_t^{(j)}}(x'_{1t}\beta_1^{(j)}, \sigma_1^{2(j)}), \quad (11)$$

where $y_1^{(j)}$ and $y_2^{(j)}$ represent vectors of demand and supply, respectively, that are stacked with observed or sampled values of the dependent variable. $\mathcal{TN}$ denotes a truncated normal probability distribution. At this stage, the market side which is more likely to be shorter is set equal to the observed credit variable and the other market side, which is likely to be larger and not observable, is sampled from a truncated normal probability distribution.

The estimation procedure can be summarized by the following pseudo-code:

1. $(\beta_1^{(j)}, \beta_2^{(j)}, \sigma_1^{2(j)}, \sigma_2^{2(j)}) = (\beta_1^{(j-1)}, \beta_2^{(j-1)}, \sigma_1^{2(j-1)}, \sigma_2^{2(j-1)})$, where $j = 1$ corresponds to OLS estimates.

2. For $t = 1, ..., T$:

   Calculate $\lambda_t^{(j)}$ as in (9) and draw $U_t^{(j)}$ from a uniform distribution.

   If $U_t^{(j)} < \lambda_t^{(j)}$, set $y_{dt}^{(j+1)}$ equal to q_t and sample $y_{st}^{(j+1)}$ as in (10).

   If $U_t^{(j)} > \lambda_t^{(j)}$, set $y_{st}^{(j+1)}$ equal to q_t and sample $y_{dt}^{(j+1)}$ as in (11).

3. Draw $(\beta_1^{(j+1)}, \beta_2^{(j+1)}, \sigma_1^{2(j+1)}, \sigma_2^{2(j+1)})$ from conditional posterior distributions.

4.3 Model specification

In our analysis, we focus on the German credit market for firms. We use monthly data from January 1999 up to December 2014. We draw our data mainly from the Deutsche Bundesbank. Our explained variable represents an aggregate credit variable to enterprises and self-employed working people comprising different maturities.[12] The selection of the variables we include in our model is largely based on the theoretic model in section 3. We map every variable from our model to an empirical counterpart, except for equity costs due to data constraints. In the credit demand equation we include industrial production (Y), the lending rate (i_B) and the corporate bond rate (i_{NB2}). On the supply side equation we introduce, again, industrial production and the lending rate and, in addition to that,

[12]for more details see the data appendix (section 7.2).

a spread between the bank lending rate and the refinancing rate (Spread 1, $i_B - i_R$), a spread between the bank bond rate and the refinancing rate (Spread 2, $i_{NB1} - i_R$) and the percentage of non-performing loans (npl) in Germany.[13] Accordingly, our baseline reads as follows:

$$\begin{aligned}
\log(Cr_t^D) &= c_1 + \beta_{12}\log(\mathrm{Y}_{t-12})\beta_{13}i_{B,t} + \beta_{13}i_{NB2,t} + u_{2,t}, \\
\log(Cr_t^S) &= c_2 + \beta_{22}\log(\mathrm{Y}_{t-12}) + \beta_{23}i_{B,t} + \beta_{24}(i_B - i_R)_t + \beta_{25}[\eta_B(i_{NB1} - i_R)]_t ... \\
&\quad + \beta_{26}\mathrm{npl}_t + u_{1,t}.
\end{aligned}$$

We estimate the model in levels. All variables, except interest rates and spreads, are expressed in logs. We take 100.000 bayesian draws and discard the first 25.000 draws as burn-in. To ensure convergence of the parameters, we apply Geweke-statistics (Geweke et al., 1991) and inspect the convergence of the model parameters visually.

[13] In contrast to the theoretic model, we apply the actual bond rates for banks and non-financial corporations.

5 Results

The estimation results of the German market for firm credit are illustrated in Table 2. Since disequilibrium models are possibly prone to instability, we test for their robustness by applying different estimation methods. The first column depicts bayesian estimates, the second column ML estimates and the third column OLS estimates. For inference, we adjust for autocorrelated residuals. Closer inspection reveals that the estimates are of similar magnitude, quantitatively and qualitatively, independent from the estimation method.

Table 2: Baseline estimation results of the German market for firm credit

	Model 1 Bayesian	Model 2 Maximum Likelihood	Model 3 OLS
Credit Demand			
Constant, c_1	5.945***	5.936***	6.254***
	(0.347)	(0.151)	(0.302)
Industrial production[1], Y	0.157**	0.159***	0.087
	(0.073)	(0.031)	(0.063)
Lending rate, i_B	-0.021**	-0.006*	-0.024***
	(0.01)	(0.004)	(0.009)
Corporate bond rate, i_{NB2}	0.027**	0.01***	0.028***
	(0.011)	(0.003)	(0.007)
Credit Supply			
Constant, c_2	5.839***	5.64***	5.486***
	(0.466)	(0.664)	(0.592)
Industrial production[1], Y	0.13	0.146	0.232*
	(0.095)	(0.138)	(0.121)
Lending rate, i_B	0.047***	0.078***	0.019**
	(0.016)	(0.013)	(0.008)
Spread 1, $(i_B - i_R)$	0.097***	0.143***	0.042***
	(0.023)	(0.024)	(0.012)
Spread 2, $\eta_B(i_{NB1} - i_R)$	-0.039	-0.03	-0.017
	(0.05)	(0.047)	(0.034)
Non-performing loans, npl	-0.057***	-0.099***	-0.021
	(0.018)	(0.021)	(0.015)

Dependent variable: Credit to non-financial firms and self-employed persons.

[1] Industrial production enters with its 12^{th} lag.

Standard errors in parenthesis. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Two-tailed test.

Starting with the credit demand equation, we find significant effects at the 5 percent level for industrial production, the lending rate and the corporate bond rate. Industrial production and the corporate bond rate affect credit demand positively. A one percent increase in industrial production leads to a 0.16 percent increase in credit demanded, and a rise in the corporate bond rate by one percentage point increases credit demand by 0.03 percent. The lending rate, however, factors in negatively with a coefficient of around 0.02. Qualitatively, the estimates are consistent with theory. Increases in industrial production need credit for financing labor and capital services that flow into the production of goods. A higher lending rate, which represents the cost of credit, has the tendency to reduce credit demand. Finally, higher corporate bond rates imply that funding via the non-banking market becomes more expensive for firms. Consequently, firms are more willing to finance their expenses with bank credit.

Turning to the credit supply equation, we do not detect a significant effect of industrial production on credit supply. Apart from that, the remaining estimates prove to be significant at the 1 percent level. We find a positive estimate for the lending rate, which represents higher bank revenues for a given volume of credit, and for spread 1 (the spread between lending rate and refinancing rate), which expresses a profit margin that incentivizes banks to supply more credit. Compared to the lending rate estimate it is even more important quantitatively. The only variable that factors in negatively is spread 2 (the spread between the bank bond rate and the refinancing rate). Spread 2 can be given the interpretation of a cost, representing maturity transformation. Therefore, it is reasonable to find a negative coefficient. In summary, the regression results indicate that prices play a significant role in the determination of credit. On the supply side, we find a significant and positive role for price variables on credit that influence the banks' revenue. In contrast to other studies, we do not include quantity variables like deposits into the credit supply equation because this would be in conflict with our earlier discussion of the banks' ability to create credit by pure will. It would be problematic to explain credit causally with deposits when the act of extending credit creates simultaneously deposits. On the demand side, we introduce subsitutability for firms between bank and non-bank financing where the possibility of arbitrage between the two forms of finance seems to play a significant role. Altogether, our findings support our price-theoretic modeling approach of bank credit.

Figure 3: Observed bank credit to firms and self-employed people and notional credit demand and supply

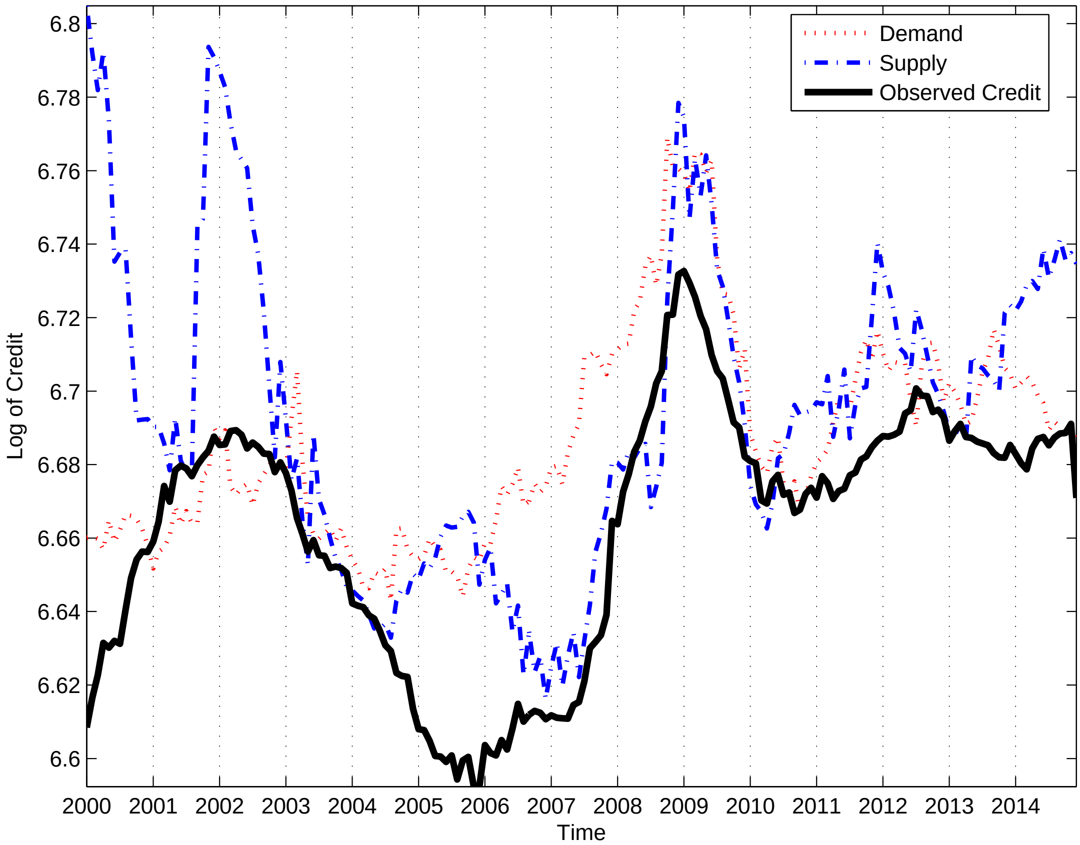
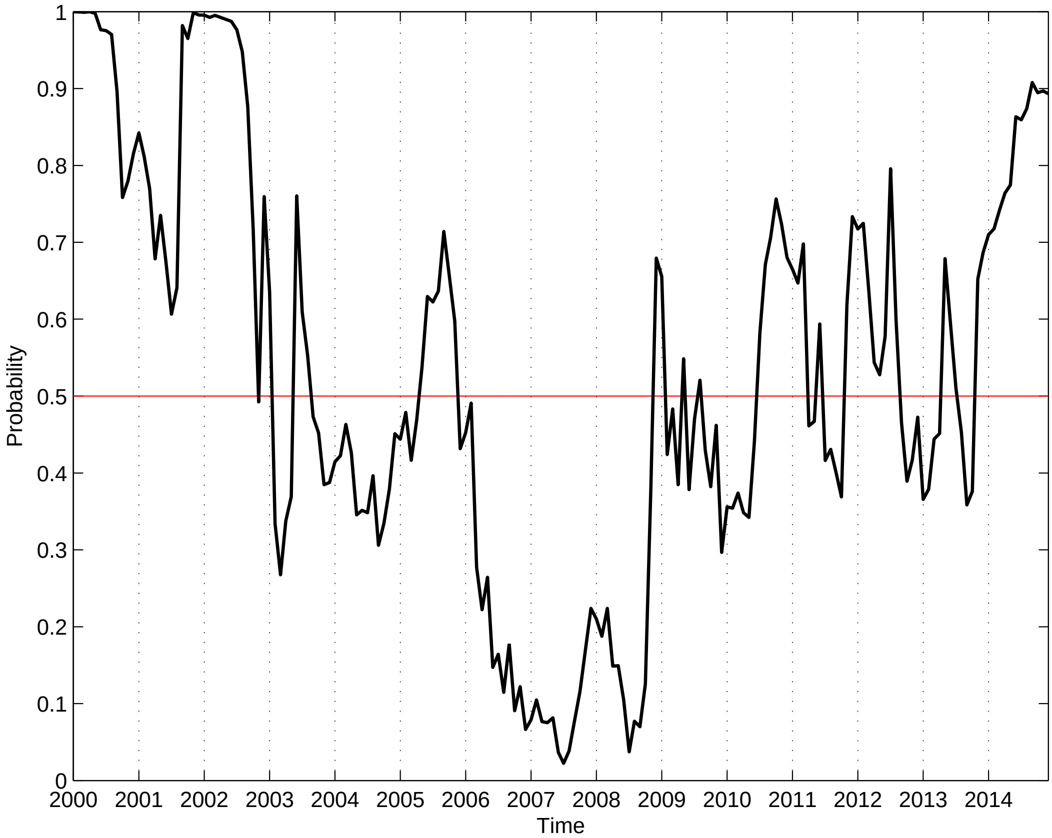


Figure 3 illustrates observed bank credit to firms and self-employed people (black line), notional credit demand (dashed red line) and notional credit supply (dashed-dotted blue line). This representation indicates which market side was likely to be the restricting market side for every point in our sample. In the period before the financial crisis in 2007, we identify two sub-periods with excess supply. The first period occurs around 1999 to 2003 and reflects the economic malaise in Germany at that time. During this period, Germany was characterized by low economic growth, low inflation and high unemployment rates. On account of the large weight of Germany in the Eurozone, its low inflation rates forced the ECB to keep interest rates at a relatively low level in order to meet its mandate of price stability for the Eurozone. As a consequence, the loose monetary policy was one factor for the boom in southern European countries, especially in Greece and Spain, where low nominal rates and high inflation rates translated into low real rates, provoking economic expansions. In Germany, the low growth rates eventually led the German government to undertake far-reaching reform measures (Agenda 2010).

The second sub-period, in 2005, was characterized by a more stable economic environment with constant inflation and moderate growth. This time, bank-related factors could have been the source for weak credit demand. The announcement of the Basel II regulations in 2004, which were finally adopted in 2007, translated into tighter credit standards which eventually led firms to find alternative means of finance. Consistent with this explanation, firms increased their share of internal financing that made up almost the entire volume of finance during the years 2004 and 2005 (Deutsche Bundesbank, 2012), which resulted into a credit supply overhang. Following this excess supply period, the most distinct period extends from 2006 until 2010. Until 2009 we observe a sharp increase in bank credit. Then, with the outbreak of the financial crisis, the credit expansion came to a halt and we observed a decline in the volume of credit until 2010. During the increase, our model suggests an excess demand regime. Hence, the uptrend in credit before 2008 could have been stronger if the banks had been willing to lend more. In the aftermath of the financial crisis, no clear demand or supply regime can be identified. The safety programs for banks from the ECB and the German Bund (Soffin) as well as the stimulus package of the German Bund contributed to a fast recovery ans stabilization of the German credit market after the crisis. Then, after the publication of the positive results for German banks in November 2014, notional credit supply started to exceed notional credit demand. In contrast, the demand for bank credit by firms started to decrease. The decline in credit demand can be a sign of the slow growth environment in the Eurozone and the dim economic outlook in general.

Figure 5 provides an alternative presentation of our results. The graph shows the estimated probability of observing a demand regime for every observation in the sample. The sequence of probabilities represents a probabilistic counterpart to figure 3. Plotting notional demand and supply, as in figure 3, illustrates which market side might be the constraining force. Computing the probability of a demand or supply regime, complements our analysis in terms of providing the likelihood of a specific regime. The regime probabilities support our previous observations. At the beginning of the millennium, i.e., up to 2003, and in 2005 we observe an elevated likelihood of a demand regime with a probability greater than 0.7. In between, we have changing patterns with equally likely regimes. Following this, we identify the most characteristic period of our sample. From 2006 to 2010, our model suggests a supply restricting regime with a probability of approximately 0.9. This is consistent with an acceleration of the German economy before the crisis. After 2010, we have, again, alternating regime probabilities with occasional spikes.

Figure 4: Probability of a demand regime (demand is restricting force)



An important caveat of this type of analysis is that it is not possible to pin down structurally the exact reasons for an eventual shortage in demand or supply. The model design only allows to analyze whether a demand or supply schedule is more likely. Nevertheless, we check the plausibility of our estimation results by contrasting them with developments in the national and international environment.

6 Conclusion

We present a model of an aggregate credit market. Banks operate as profit-maximizing firms and serve credit demand by non-banks. The model integrates the central bank, banks, and non-banks into the determination of credit supply. The central bank sets the refinancing rate for base money which influences the supply of bank credit. Bank supply and firm demand for bank loans determine the equilibrium market rate and credit volume. Banks then demand a fraction of their credit business, determined by the bank credit multiplier, in form of base money on the market for central bank credit. In our model, credit business precedes the banks' refinancing operations, which is a better description of how banks operate in reality. Besides base money from the central bank and deposits as a source of refinancing, the banks in our model also have the opportunity to back their credit business via equity and bond markets. At last, we put our model to a test and estimate a market for German firm credit and show that the determinants of credit supply and demand, that have been selected on account of our theoretic model, play a significant role. In addition to that, our empirical framework of a disequilibrium model allows to identify periods of credit supply or credit demand overhang between 1999 and the end of 2014.

7 Appendix

7.1 Sectoral balance sheets

Table 3: Central Bank's balance sheet

Assets	Liabilites
Credit from Central Bank to Banks $Cr_{CB/B}$	Reserves R Cash C

Table 4: Bank's balance sheet

Assets	Liabilites
Credit from Banks to Non-banks $Cr_{B/NB}$	Equity E
	Bonds B
Reserves R	Deposits D
	Credit from Central Bank to Banks $Cr_{CB/B}$

Table 5: Non-bank's balance sheet

Assets	Liabilites
Deposits D	Credit from Banks to Non-banks $Cr_{B/NB}$
Cash C	
Bonds B	
Equity E	

7.2 Data

Table 6: Description of variables

Variable	**Transformation**	**Source**
Credit to non-financial firms	SA, log-level	Bundesbank
Industrial production	SA, log-level	Destatis
Bank lending rate	Level, %	Bundesbank
Corporate bond rate	Level, %	Bundesbank
Bank bond rate	Level, %	Bundesbank
Refinancing rate	Level, %	Bundesbank
Non-performing loans	Level, %, interpolated (cubic)	Worldbank

Figure 5: Credit to non-financial corporations and self-employed people (in logs)

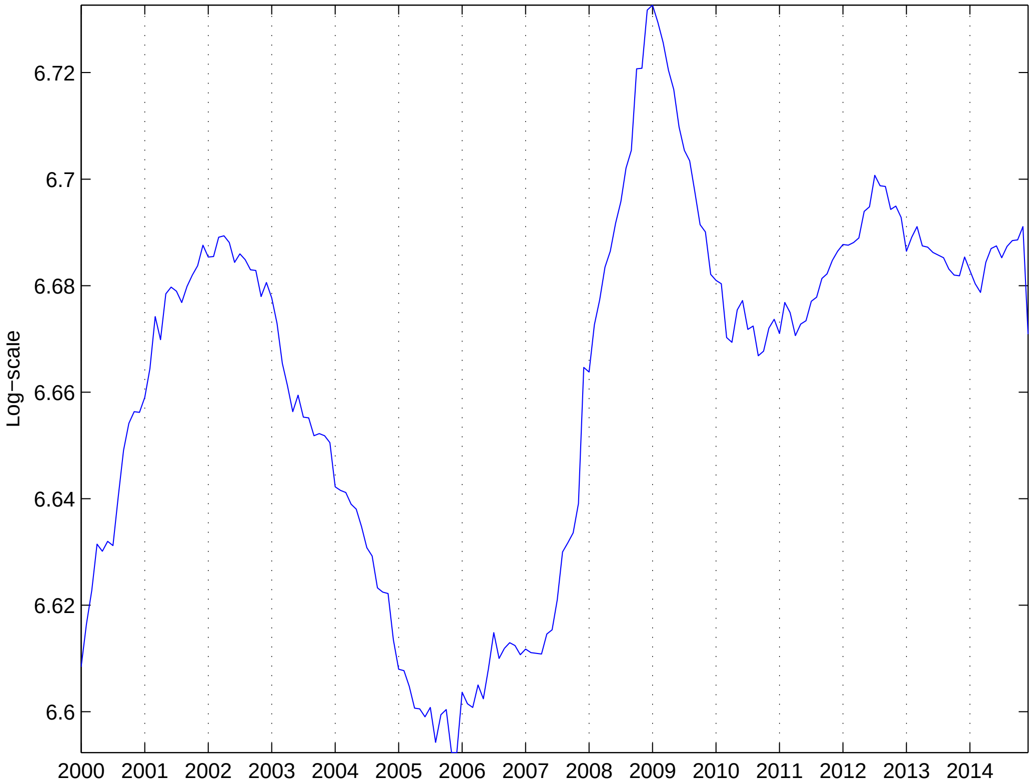


Figure 6: Supply side variables

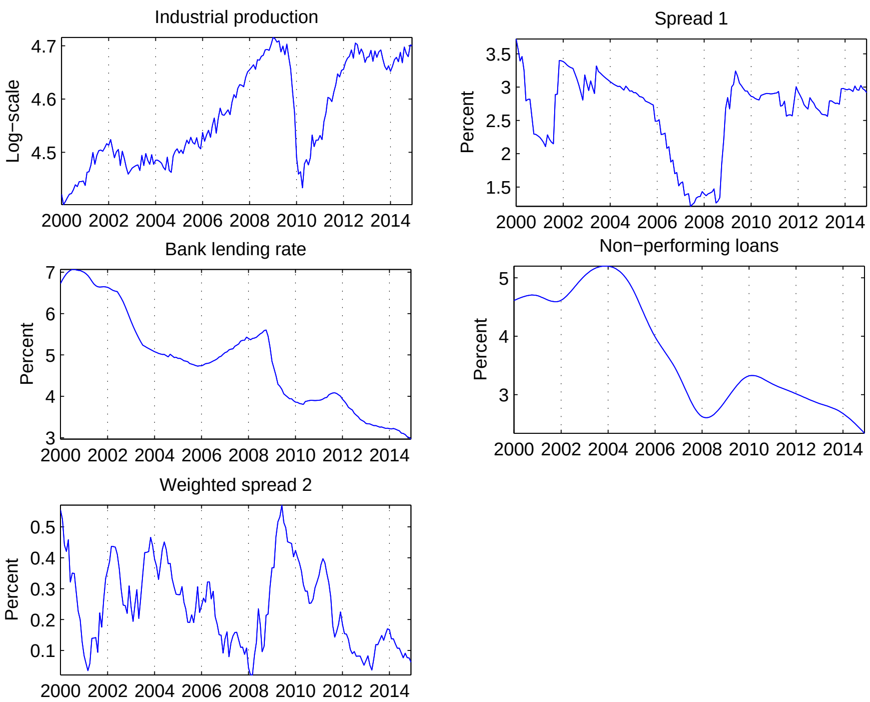
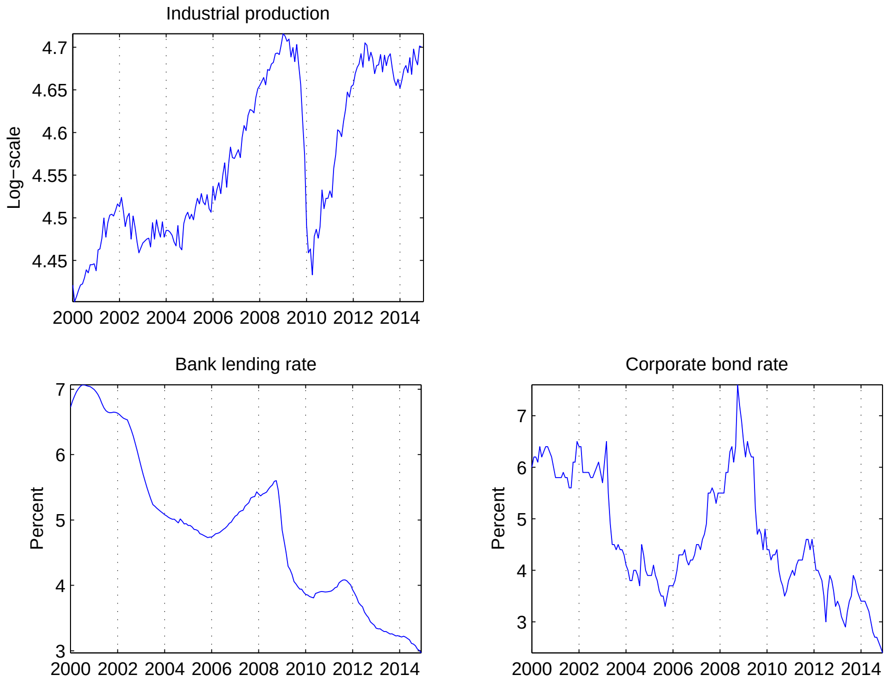


Figure 7: Demand side variables



7.3 Unit root tests

Table 7: Unit root tests for model variables

Variable	Test	P-val.		Test-stat.	Crit.-val.: 5%	Decision
log(loans)	ADF (w Trend)	0,3162				not stat.
	ADF (wo Trend)	0,1515				not stat.
	Phillips-Perron (w Trend)	0,0042				stat.
	Phillips-Perron (wo Trend)	0,0002				stat.
	KPSS (w Trend)			0,0951	0,146	not stat.
	KPSS (wo Trend)			0,7230	0,463	stat.
log(ip)	ADF (w Trend)	0,0654				not stat.
	ADF (wo Trend)	0,2789				not stat.
	Phillips-Perron (w Trend)	0,2297				not stat.
	Phillips-Perron (wo Trend)	0,4480				not stat.
	KPSS (w Trend)			0,0636	0,146	not stat.
	KPSS (wo Trend)			1,3846	0,463	stat.
loan rate	ADF (w Trend)	0,0330				stat.
	ADF (wo Trend)	0,9259				not stat.
	Phillips-Perron (w Trend)	0,1046				not stat.
	Phillips-Perron (wo Trend)	0,9435				not stat.
	KPSS (w Trend)			0,0673	0,146	not stat.
	KPSS (wo Trend)			1,5672	0,463	stat.
corporate bond rate	ADF (w Trend)	0,4380				not stat.
	ADF (wo Trend)	0,7352				not stat.
	Phillips-Perron (w Trend)	0,3706				not stat.
	Phillips-Perron (wo Trend)	0,6771				not stat.
	KPSS (w Trend)			0,1331	0,146	not stat.
	KPSS (wo Trend)			0,8615	0,463	stat.
spread 1	ADF (w Trend)	0,6843				not stat.
	ADF (wo Trend)	0,3799				not stat.
	Phillips-Perron (w Trend)	0,3465				not stat.
	Phillips-Perron (wo Trend)	0,1364				not stat.
	KPSS (w Trend)			0,1840	0,146	stat.
	KPSS (wo Trend)			0,2193	0,463	not stat.
Spread 2× bond ratio	ADF (w Trend)	0,1885				not stat.
	ADF (wo Trend)	0,2114				not stat.
	Phillips-Perron (w Trend)	0,0435				stat.
	Phillips-Perron (wo Trend)	0,0513				not stat.
	KPSS (w Trend)			0,0789	0,146	not stat.
	KPSS (wo Trend)			0,537	0,463	stat.
npl	ADF (w Trend)	0,0323				stat.
	ADF (wo Trend)	0,7272				not stat.
	Phillips-Perron (w Trend)	0,6824				not stat.
	Phillips-Perron (wo Trend)	0,9335				not stat.
	KPSS (w Trend)			0,1480	0,146	stat.
	KPSS (wo Trend)			1,3741	0,463	stat.

References

Asimakopulos, A., 1986. Finance, Liquidity, Saving, and Investment. Journal of Post Keynesian Economics 9 (1), 79–90.

Bauwens, L., Lubrano, M., 2007. Bayesian Inference in Dynamic Disequilibrium Models: An Application to the Polish Credit Market. Econometric Reviews 26 (2-4), 469–486.

Bofinger, P., Schächter, A., 1995. Alternative Operating Procedures for Monetary Policy - A New Look at the Money Supply Process. CEPR Discussion Papers 1257, C.E.P.R. Discussion Papers.

Borio, C., Disyatat, P., 2011. Global Imbalances and the Financial Crisis: Link or no Link? BIS Working Papers 346, Bank for International Settlements.

Borio, C. E., Disyatat, P., 2015. Capital Flows and the Current Account: Taking Financing (more) Seriously. BIS Working Papers, Bank for International Settlements.

Boysen-Hogrefe, J., Dovern, J., Groll, D., van Roye, B., Scheide, J., 2010. Droht in Deutschland eine Kreditklemme? Kiel Discussion Papers 472/473, Kiel Institute for the World Economy (IfW).

Cosimano, T. F., 1988. The Banking Industry under Uncertain Monetary Policy. Journal of Banking & Finance 12 (1), 117–139.

Davidson, P., 1986. Finance, Funding, Saving, and Investment. Journal of Post Keynesian Economics 9 (1), 101–110.

Deutsche Bundesbank, 2012. Long-Term Developments in Corportate Financing in Germany? Evidence Based on the Financial Accounts. Monthly Report January 2012, 13–27.

Disyatat, P., Dec. 2008. Monetary Policy Implementation: Misconceptions and their Consequences. BIS Working Papers 269, Bank for International Settlements.

Disyatat, P., 2011. The Bank Lending Channel Revisited. Journal of Money, Credit and Banking 43 (4), 711–734.

Erdogan, B., 2010. Kreditklemme in Deutschland: Mythos oder Realität? Vierteljahrshefte zur Wirtschaftsforschung 79 (4), 27–37.

Everaert, G., Che, N. X., Geng, N., Gruss, B., Impavido, G., Lu, Y., Saborowski, C., Vandenbussche, J., Zeng, L., Jan. 2015. Does Supply or Demand Drive the Credit Cycle? Evidence from Central, Eastern, and Southeastern Europe. IMF Working Papers 15/15, International Monetary Fund.

Freixas, X., Rochet, J.-C., 2008. Microeconomics of Banking, 2nd Edition. Vol. 1 of MIT Press Books. The MIT Press.

Fuhrmann, W., 1987. Geld und Kredit : Prinzipien monetärer Makroökonomik.

Geweke, J., et al., 1991. Evaluating the Accuracy of Sampling-Based Approaches to the Calculation of Posterior Moments. Vol. 196. Federal Reserve Bank of Minneapolis, Research Department Minneapolis, MN, USA.

Ito, T., Ueda, K., October 1981. Tests of the Equilibrium Hypothesis in Disequilibrium Econometrics: An international comparison of credit rationing. International Economic Review 22 (3), 691–708.

Jakab, Z., Kumhof, M., 2015. Banks are not Intermediaries of Loanable Funds–And Why This Matters. Tech. rep.

King, S. R., 1986. Monetary Transmission: Through Bank Loans or Bank Liabilities? Journal of Money, Credit and Banking 18 (3), 290–303.

Koop, G., 2003. Bayesian Econometrics. Wiley.

Kugler, P., 1987. Credit Rationing and the Adjustment of the Loan Rate: An Empirical Investigation. Journal of Macroeconomics 9 (4), 505–525.

Laffont, J.-J., Garcia, R., 1977. Disequilibrium Econometrics for Business Loans. Econometrica: Journal of the Econometric Society, 1187–1204.

Lavoie, M., 1984. The Endogenous Flow of Credit and the Post Keynesian Theory of Money. Journal of Economic Issues 18 (3), 771–797.

Ledvina, A., Sircar, R., 2011. Dynamic Bertrand Oligopoly. Applied Mathematics & Optimization 63 (1), 11–44.

Lindner, F., 2012. Saving Does not Finance Investment: Accounting as an Indispensable Guide to Economic Theory. IMK Working Paper 100-2012, IMK at the Hans Böckler Foundation, Macroeconomic Policy Institute.

Maddala, G. S., Nelson, F. D., 1974. Maximum Likelihood Methods for Models of Markets in Disequilibrium. Econometrica 42 (6), 1013–1030.

Martin, C., 1990. Corporate Borrowing and Credit Constraints: Structural Disequilibrium Estimates for the U.K. The Review of Economics and Statistics 72 (1), 78–86.

McLeay, M., Radia, A., Thomas, R., 2014. Money Creation in the Modern Economy. Bank of England Quarterly Bulletin, Q1.

Nehls, H., Schmidt, T., 2003. Credit Crunch in Germany? RWI Discussion Papers 6, Rheinisch - Westfälisches Institut für Wirtschaftsforschung (RWI).

Palley, T., 1996. Accommodationism versus Structuralism: Time for an Accommodation. Journal of Post Keynesian Economics 18 (4), 585–594.

Pazarbasioglu, C., 1997. A Credit Crunch? Finland in the Aftermath of the Banking Crisis. International Monetary Fund Staff Papers 44 (3), 315–327.

Reznakova, L., Kapounek, S., Oct. 2014. Is There a Credit Crunch in the Czech Republic? MENDELU Working Papers in Business and Economics 2014-50, Mendel University in Brno, Faculty of Business and Economics.

Rottmann, H., Wollmershäuser, T., June 2013. A Micro Data Approach to the Identification of Credit Crunches. Applied Economics 45 (17), 2423–2441.

Schmidt, T., Zwick, L., 2012. In Search for a Credit Crunch in Germany. Ruhr Economic Paper (361).

Singh, N., Vives, X., 1984. Price and Quantity Competition in a Differentiated Duopoly. The RAND Journal of Economics 15 (4).

Stiglitz, J. E., Weiss, A., June 1981. Credit Rationing in Markets with Imperfect Information. American Economic Review 71 (3), 393–410.

Tanner, M. A., Wong, W. H., 1987. The Calculation of Posterior Distributions by Data Augmentation. Journal of the American Statistical Association 82 (398), 528–540.

Vouldis, A., Jun. 2015. Credit Market Disequilibrium in Greece (2003-2011) - a Bayesian Approach. Working Paper Series 1805, European Central Bank.

Werner, R. A., 2014. Can Banks Individually Create Money out of Nothing? The Theories and the Empirical Evidence. International Review of Financial Analysis 36 (C), 1–19.

Wied-Nebbeling, S., 1997. Markt- und Preistheorie. Springer-Lehrbuch. Springer.

Winker, P., 1996. A Macroeconomic Disequilibrium Model of the German Credit Market. Discussion papers, series ii, University of Konstanz, Collaborative Research Centre (SFB) 178 "Internationalization of the Economy".