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Credit market disequilibrium in Greece (2003-2011)

a Bayesian approach

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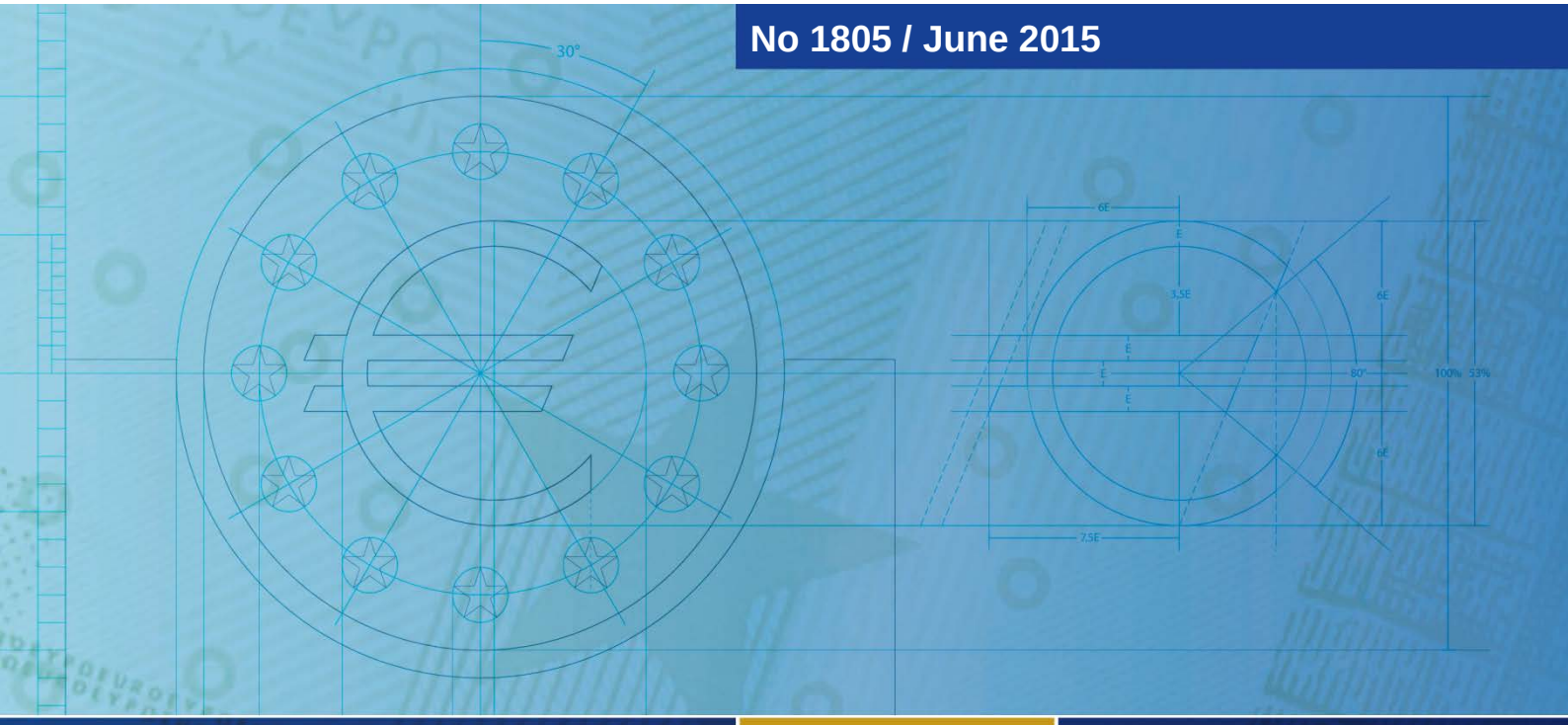


Abstract: Motivated by the linkage between credit and growth in the Greek economy, and the deceleration of credit since the financial crisis, this paper studies the evolution of credit demand and supply in Greece. A disequilibrium model of demand and supply is estimated spanning the period 2003M1-2011M3. The adopted specification allows for stochastic shocks on both supply and demand. A Bayesian estimation methodology with data augmentation for the latent variables is used. The analysis is carried out separately for each type of loan (short- and long-term business loans, consumer loans and mortgages) enabling the comparative study of the credit rationing and supply constraint effects among loan categories. The results indicate that, for all loan categories, excess demand characterized the boom period. After the intensification of the debt crisis, evidence is provided for the existence of excess demand due to binding constraints on supply. However, demand for short-term business loans has slowed down more than supply, reflecting businesses' need for stable funding.

Keywords: Credit disequilibrium; Greek credit market; Bayesian methods; Leading indicators; Stress test

JEL classification codes: D50, E44, E42, C32, G21, G28, P00

Non-technical summary: Disentangling supply and demand components for the credit market is a difficult exercise given that economic theory predicts that there are specific mechanisms related to informational asymmetries, which do not allow this market to reach a state of equilibrium. This paper undertakes such an exercise utilizing a Bayesian approach and applying it to four credit markets (short-and long-term business loans, consumer loans and mortgages) for the Greek economy spanning the period from 2003M1 to 2011M3. Specifically, a disequilibrium view of the credit market is adopted and credit demand and supply in the presence of credit rationing and adverse selection is estimated.

According to the disequilibrium approach, the observed quantity of credit is the minimum of demand and supply. An enhanced specification is assumed, which, in contrast to most of the existing literature, allows both supply and demand to be stochastic. It may be expected that, especially during periods of elevated uncertainty, stochastic elements will be present in both the demand and supply schedules.

The present paper estimates the disequilibrium model separately for various loan categories. In the majority of previous studies either only aggregate credit was considered or a panel data comprising a number of firms were analyzed. A comparative study of credit disequilibrium in different segments of the credit market has not been undertaken so far. Conducting such an analysis separately for each type of loan is especially interesting as the underlying dynamics for credit supply and demand may differ across segments.

The paper focuses on the Greek economy, whereby credit expansion was a pivotal factor behind the high growth rates experienced during the 2000s, lasting until the outbreak of the financial crisis in 2008. After the outbreak of the global financial crisis, credit decelerated, and even more so after the downward revision of the projections regarding Greek sovereign debt sustainability. This reversal of credit expansion is an amplifying factor for the recession that the Greek economy is undergoing during the last years. Both the ability of the banks to extend credit and the demand for credit on the part of firms and households seems to have been adversely affected during the latter period.

The paper finds that for all loan categories, excess demand characterizes the booming period that lasted until the global financial crisis, however, the crisis led to more diversified patterns of supply and demand across loan categories. Specifically, for short-term business loans, the fall in demand after the intensification of the sovereign debt crisis seems to be so severe so as to lead to high estimated probabilities of demand being less than supply, despite the supply constraints which are evident in this period. On the other hand, for the other types of loans (long-term business loans, consumer loans and mortgages), it is found that supply constraints are the dominant determinants of actually observed credit.

It is also found that mortgage loans exhibit the higher elasticity values for the primary determinants of supply (lending capacity) and demand (GDP) while the values for consumer loans are very close. This reflects both the steep credit expansion in these market segments during the boom and the swift deleveraging after expectations were revised downwards and a recessionary environment ensued. In addition, as regards business loans, estimated elasticities for long-term loans are found to be higher than for short-term loans. Short-term loans have the lowest elasticity values among all loan types. Therefore, historically, growth of mortgages and consumer loans has been most responsive to changes in economic activity.

Moreover, a recurring pattern for all types of loans is the negative shocks in demand which seems to have taken place around 2008Q3 and 2010Q2, therefore justifying the selection in this study of the time points defining the periodization of the crisis. During both transitions, uncertainty was elevated and this is reflected in the credit demand decisions of economic agents.

1. Introduction

The recent financial crisis has raised awareness among policymakers and academic economists on the pivotal role of credit booms for subsequent credit crunches.[1] The literature on the subject has been expanding substantially and the complacent view of the banking system as a medium that facilitates the smooth intermediation of savings from depositors to entrepreneurs and consumers is being replaced by a more complex one in which credit markets are characterized by irrational overshooting during both booms and crises[2], incentives for excessive risk-taking[3], and potential for inefficiency, from a social welfare perspective.[4] This view is also reinforced by the well-established strand of literature which posits an inherent disequilibrium view of the credit market[5] due to informational asymmetry (see e.g. Stiglitz and Weiss 1992[6]).

The view of credit markets, as being a prerequisite of economic growth but, at the same time, as being characterized by inherent instability was present in a number of theoretical works on business cycles (e.g. in Minsky 1986). However, this all-encompassing view of credit was assumed away in the macroeconomic models dominating policy analysis, which were based on the real business cycle theory, including their New-Keynesian extensions.[7] For a survey on the impact of the crisis on macroeconomics with an emphasis on the need to incorporate the financial cycle in order to understand business fluctuations see Borio (2012).

The present paper aims to contribute to the strand of literature investigating the tools to analyse credit developments encompassing a disequilibrium view of the credit

[1] Alessi and Detken (2011) find that the global private credit gap, defined as the detrended private credit to GDP ratio, is the best single indicator for costly crises. Boissay et al. (2013) develop a DSGE model whereby systemic banking crises break out in the midst of credit intensive booms.

[2] Gertler and Kiyotaki (2010) present a framework for thinking about credit frictions and explain how they can magnify a downturn, both as regards its intensity and length, mainly due to increased cost of capital and deleveraging by the banks. Haldane et al. (2010) offer another formulation regarding the amplification mechanisms originating in the credit market, focusing on the coordination failure among banks (for the latter mechanism, see also Rajan 1994).

[3] See e.g. Rajan 2006 for a discussion of banks' risk taking incentives. In a specific application, Houston et al. 2010 look at the effects of creditor rights on risk taking.

[4] Favara (2012) shows that agency problems give rise to inefficiencies also during boom periods. Specifically, due to the inherent conflict of interests between entrepreneurs and banks, the allocation of resources is not optimal. In this model, the inefficiency of credit allocation does not disappear when the firms' balance sheets are stronger because then the banks' control over investment projects is weaker and, consequently, the entrepreneurs will propose projects that optimize their own preferences, which include also private benefits. Heider and Inderst (2012) look at agency issues arising from loan officers' multi-task problem of generating loans and incorporating soft information into the credit approval process and how their incentives interact with the competition from other banks. Specifically, it is shown that competition induces inefficiency by affecting the process of evaluating the creditworthiness of borrowers.

[5] In the sense that even if one employs an equilibrium analysis, the equilibrium point will not equalize demand and supply.

[6] In this paper it is shown that even if banks can vary interest rates and collateral requirements towards individual lenders, credit rationing will still be the equilibrium outcome.

[7] However, for an enhanced DSGE model which includes a banking sector and can give rise to financial crises see Benes et al. (2014).

market by formulating an enhanced and flexible version of a disequilibrium model, which disentangles credit demand and supply and enables the monitoring of the evolution of financial imbalances. The paper illustrates how this model can be estimated following a Bayesian approach.

The flexibility and enhancement in the proposed disequilibrium model comes from the fact that, in contrast to the existing empirical literature on disequilibrium models, we adopt a *stochastic* formulation of both the demand and supply function rather than the simplifying assumption of deterministic demand and supply functions (e.g. as in Bauwens and Lubrano 2007). In the latter case uncertainty is present only with regard to the determination of the dominant force between supply and demand.[8] One would expect that, especially during periods of elevated uncertainty, stochastic elements will be important in the specification of both the demand and supply functions. The assumption of deterministic demand and supply adopted in previous empirical studies seems to have been made mainly in order to facilitate the econometric estimation rather than being grounded on solid economic reasoning. However, the Bayesian approach adopted here enables us to estimate the model while avoiding this restrictive assumption.

In addition, the present paper estimates the disequilibrium model separately for various loan categories (short-term business loans, long-term business loans, consumer loans and mortgages), which is a novel feature in the literature of disequilibrium models. In the previous studies either only aggregate credit was considered or a panel data comprising a number of firms were analyzed (see the review of the literature in Table 1). A comparative study of credit disequilibrium in different segments of the credit market has not been undertaken so far, according to the author's knowledge. Conducting such an analysis separately for each type of loan is especially interesting as the underlying causes for credit growth may differ among the segments of the credit market.[9] An investigation at the aggregate level would obscure such differences while the use of micro data is restricted usually to one particular segment (usually corporate loans).

The analysis of credit developments from the angle of separating demand and supply provides input in a number of research directions while it has implications for policy. First, a number of theoretical arguments regarding economic and financial cycles hinge on the relation between demand supply and they are *"not easy to validate […] empirically because it is extremely hard to separate demand side effects from supply side effects"* (Rajan 1994, p. 400)[10]. Second, there is ongoing research on developing early-warning indicator systems, and the monitoring of credit developments, with a focus on the building up of unsustainable imbalances, can provide useful input for

[8] In the latter case, shocks are allowed to be present only at the stage where the models selects whether demand or supply dominates.
[9] A similar research strategy was followed in Louzis et al. (2011) when examining the determinant factors of non-performing loans. In that work, the empirical analysis revealed significant differences among loan types as regards the determinants of non-performing loans and their impact.
[10] For a relevant discussion see Rajan (1994).

these systems and improve the accuracy of signals of imminent crises.[11] Third, credit developments can inform the calibration of the triggers for the activation of macro-prudential tools, such as the countercyclical capital buffer envisaged under Basel III, which aim to avoid coordination failures with regard to risk taking (Haldane et al. 2010) and incentivize the banks to create capital buffers during booms times that could be released when conditions deteriorate. Finally, the quantification of the relative impact of supply and demand in the actual credit observed is critical from a policy perspective, especially regarding policy responses aiming to revive the economic activity during recessions.[12]

Moreover, the present paper investigates credit development in Greece, a country which provides a "prototypical" case of an economy experiencing a boom period to be followed by a deep recession. Specifically, the Greek banking system represents a "clean" prototype case to examine the credit evolution in relation to demand and supply effects, as banks operate within a liberalized institutional environment[13], in the context of a relatively advanced and closed economy which was growing rapidly, until the outbreak of the crisis, and whereby banks followed a traditional business model involving mainly deposit-taking and loan-granting. Therefore, the results are not affected by additional factors which may be present in other jurisdictions, such as banks being highly involved in originate-to-distribute activities,[14] or swings in international trade or exchange rates affecting the macroeconomic environment and impacting on the evolution of credit volumes.

The central role that credit expansion had on the high growth rates which prevailed in the Greek economy during the 2000s and until the outbreak of the financial crisis in 2008 is well documented. Gibson et al. (2011) note that from 2001 to 2008, real GDP rose by an average of 3.9 per cent per year which is the second highest growth rate (after Ireland) in the euro area for that period. These authors also provide an account of the impingement of the global financial crisis on the Greek economy (see also Monastiriotis 2011). Mitsopoulos and Pelagidis (2011) note that from 1999 (when implementation into the Greek law of the EU banking directives was completed) to 2008, the total amount of loans issued by the main financial institutions was raised to

[11] See for example Alessi and Detken (2011). The importance of identifying the drivers behind credit expansions for the forecasting of crises is also reinforced by the theoretical model of Boissay et al. (2013) whereby a distinctive feature of the build-up period before the crisis is that at some point the credit boom turns from demand-driven to supply-driven.

[12] A clear policy focus can be found, for example, in Meisenzahl (2014) who investigates whether supporting banks' capital is the appropriate response to the credit crunch facing small firms in the U.S and whether additional demand side policies are needed. Similar focus can be found in Bernanke and Lown (1991). Carpenter et al. (2014) focus on evaluating the effectiveness of non-standard monetary policy measures by the Federal Reserve and the European Central Bank in stimulating bank loans. In their analysis, the supply and demand factors driving the observed bank loans are decomposed.

[13] The process of liberalizing the Greek banking system ended in 2003 i.e. the first year considered in the present study (Brissimis et al. 2013).

[14] A discussion of the effects of securitization in the context of an analysis which distinguishes credit demand from supply can be found in Bernanke and Lown (1991). Carpenter et al. (2014) restrict their analysis to business loans since the volume of outstanding loans to households could be significantly distorted by securitization.

over 80 percent of the GDP, from a mere 24 percent at the beginning of this period. Gagales and Roehler (2006, p. 17) estimate that credit expansion to households contributed to GDP growth on average 0.2 percentage point yearly in 1995-2004 and 0.4 percent in 2004. On the other hand, the credit deceleration that occurred after the global financial crisis, and especially since the downward revision of the expectations regarding Greek sovereign debt sustainability, is usually seen as an amplifying factor for the recession that the Greek economy is undergoing. Both the ability of the banks to extend credit and the demand for credit on the part of firms and households seems to have been adversely affected during the latter period. Although it is clear that both demand and supply effects were at work during these periods, their relative impact has not been investigated analytically. Instead in descriptive accounts of the macroeconomic developments in Greece one finds both supply and demand explanations used interchangeably (see also Section 3) but without attempting to quantify their relative importance.

Therefore, this paper aims to fill the gap in understanding the relative impact of demand and supply on the actually observed credit in the Greek economy, after the adoption of the euro and during the present crisis, as a means to enhance the understanding of the trajectory followed by the Greek economy during the aforementioned period. Clearly, information on whether credit is restricted (or is extended) because of binding constraints on demand or supply is critical for policy design.

The paper is structured as follows. Section 2 provides stylized facts of the Greek credit market during the examined period. Subsequently, Section 3 presents an overview of related studies for the Greek economy while Section 4 discusses the selection of variables used in the supply and demand functions. In Section 5 the disequilibrium model and the estimation procedure are presented. In Section 6 the results are discussed while in Section 7 a robustness analysis is performed to check the sensitivity of the results to alternative specifications. Section 8 looks at cyclical effects i.e. differences of behavior among booms and recessions. Finally, Section 9 concludes.

2. Stylized facts

Since 2001, when Greece joined the Eurozone, and until the outbreak of the financial crisis, a stable and growth-conducive macroeconomic environment, characterized by low interest rates, prevailed.[15] The liberalization of the financial system, which was gradually completed during the 1990s, led to the intensification of competition among

[15] For an account of the macroeconomic developments in Greece during that period, from different perspectives, see for example: Malliaropoulos and Anastasatos (2011); Mitsopoulos and Pelagidis (2011); Moutos and Tsitsikas (2010). For a long-run analysis of the business cycle in Greece see Michaelides et al. (2013).

banks to gain market share (Eichengreen and Gibson 2001, p. 563). On the demand side, the increase in debt ceilings, brought about by bank competition, induced households to attempt to smooth their consumption through borrowing. Economic activity was vigorous especially until the Olympic games of 2004. Therefore, firms were motivated to undertake investments, leading to increased credit demand for the business sector as well.

These factors affected positively both credit supply and demand leading to high rates of credit growth, although the contribution of each side of the demand-supply dipole is not altogether clear. One concern is that during the boom period the lending standards may have been low (Rajan, 1994), implying that credit demand was close to the observed quantity of credit i.e. that credit growth was primarily supply-driven.[16] Alternatively, one could view the rapid credit growth, experienced in the booming period, as a consequence of the expansion of economic activity or, in other words, as demand-driven.

The subprime mortgages crisis which broke out in 2007 and its subsequent transformation into a sovereign debt crisis (since the last quarter of 2009) had a negative impact on the Greek credit market. [17] It is clear that during this period both supply and demand were restrained although it is not obvious which component was mostly affected by the crisis. On the one hand, the closing of the interbank market to the Greek banks due to the sovereign debt crisis, the erosion of their deposit base[18], and their increasing reliance upon Central Bank funding, point to a decreased supply of credit. On the other hand, the fall of economic activity and the prevailing uncertainty about the prospects of the Greek economy are bound to have considerably weakened credit demand.

The Bank of Greece (BoG) Monetary Policy Report summarized this twofold impact of the economic environment on demand and supply as follows: "On the side of the loan supply, indications that lending criteria will become tighter persist, bolstered by the reasonable adjustment of banks to the current environment of heightened risk. At the same time, it is expected that the demand for credit will decrease, as implied by the deterioration of business expectations (as recorded in the continued decline in the economic sentiment indicator for Greece)" (BoG 2009, p. 97).

3. Literature review

[16] In this vein, the IMF noted in 2006 (IMF, 2006) that "…vulnerabilities have developed in the form of very high credit growth…" and that "…the very high rates of credit growth observed in recent years, while in part a desirable and natural consequence of financial market liberalization, are unsustainable in the medium term…".

[17] In turn, the news about Greece seems to have played a pivotal role in transforming the primary symptom of the crisis on the EU level to sovereign debt, see De Santis (2014).

[18] From September 2009 until June 2012, the Greek banks lost approximately €85 billion of deposits i.e. decreased by 36% from their peak value (BoG Monetary and Banking statistics).

There are a number of studies touching upon the subject of credit growth in Greece during the last decade. Karfakis (2013) investigates the credit-output link for the Greek economy and finds that the lagged value of credit has information content as regards predicting future output movements. Tagkalakis (2014) investigates this relationship from the angle of the transmission of fiscal policy shocks and finds that output contraction originating from fiscal policy shocks is more pronounced when credit is constrained. The analysis is conducted using an SVAR approach and imposing constraints on the model's coefficients. The discussion in Dellas and Tavlas (2012) places credit growth in the Greek economy, after joining the EMU, in the context of a monetary union in which there are no automatic adjustment mechanisms operating that would restrain credit growth in the absence of strong fundamentals. Provopoulos (2014) provides an account of the policy responses to the Greek crisis, also as regards the steps taken to stabilize the banking system, with the aim to restore the banks' capacity to supply credit to the real economy.

Katsimi and Moutos (2010) provide an interpretation of the pre-crisis developments in the Greek economy from a political-economy angle. They view the "unwarranted" credit expansion as accentuating external imbalances, in parallel with the internal fiscal imbalances produced by the domestic political–economic equilibrium, and as contributing to the inability of the Greek sovereign to access private financial markets in 2010.

The aforementioned studies place credit growth within a wider macroeconomic context and do not explicitly distinguish between the relative contributions of supply and demand in the process of credit expansion (and contraction, during the crisis period). In contrast, Brissimis et al. (2013) estimate demand and supply functions for the credit market in Greece employing a cointegration framework. The data set investigated spans the period 1990-2008 (i.e. does not cover the crisis period) and there is an emphasis on the changing institutional environment (primarily the liberalization) for the banking system during the 1990s and the early 2000s. This study focuses exclusively on consumer credit. In addition, the coefficients corresponding to GDP (for the demand side) and the lending capacity[19] (for the supply side) are set to 1, and, therefore, the results are not directly comparable with those of the present paper.

4. Disequilibrium model

The literature on asymmetrical information (Stiglitz and Weiss 1981) has pointed out the existence of mechanisms preventing the equalization of demand and supply, through price adjustment, in the credit market. In particular, banks may be reluctant to eliminate excess demand by increasing the interest rates as this will sort potential

[19] The lending capacity is proxied by the volume of deposits.

borrowers (adverse selection) and will create incentives for borrowers to undertake riskier projects (moral hazard). Consequently, interest rates will not adjust to equate demand and supply and the equilibrium will feature credit rationing and excess demand. On the other hand, there are mechanisms which could lead to excess supply of loans. De Meza and Webb (1987) present a model which due to asymmetrical information leads to overinvestment (i.e. excess supply of credit) instead of underinvestment.

Skipping the technical details, the difference between the two aforementioned models can be summarized by the following equation for the derivative of bank's profits with respect to the interest rate

$$\frac{dE\pi_B}{dr} = \underbrace{\frac{\partial E\pi_B}{\partial r}}_{\substack{\text{direct effect} \\ (+)}} + \underbrace{\frac{\partial E\pi_B}{\partial \hat{p}}}_{\substack{\text{safer borrowers} \Rightarrow \text{higher profits} \\ (+)}} \times \underbrace{\frac{d\hat{p}}{dr}}_{\substack{\text{change in average success probability} \\ (?)}} \tag{1}$$

where $\hat{p}$ is the mean success probability of financed projects, taking into account the change in the pool of the financed projects after the change in the interest rates.[20] This equation determines the type of equilibrium and, specifically, whether the bank will raise interest rates until demand equals supply or whether it may prefer to ration credit. The first term in the right hand side of (1) is the positive direct effect on the bank's profits after an increase in interest rates. The second term consists of the unambiguously positive effects on profits when $\hat{p}$ increases, and another term which represents the change in $\hat{p}$ brought about by a change in the interest rate. The sign of the latter term reflects the different assumptions of the two models. In the Stiglitz and Weiss model, the "marginal borrower", i.e. the borrower who is indifferent between requesting a loan from the bank and investing his wealth in a safe asset is "less risky" than the rest, who have been granted a loan, while in the De Meza and Webb model this borrower is "riskier".[21] As a consequence, in the Stiglitz and Weiss model an increase in interest rates drops out of the pool of those granted a loan "safe" borrowers (adverse selection), while the opposite is the case in the De Meza and Webb model. Therefore, $\frac{d\hat{p}}{dr}$ is negative in the former model and positive in the latter. Subsequently, credit rationing is possible in the first model because interest rates cannot always be used to equalize demand with supply, while the latter model may give rise to overinvestment compared to the first-best solution i.e. the equilibrium in an economy with full information. For a survey on models of the credit market with asymmetric information see Hillier and Ibrahimo (1993).

[20] Using the usual credit risk notation, the probability $\hat{p}$ could be written as $1-PD$, where PD is the (cumulative) probability of default.

[21] The reason is the assumed type of heterogeneity among the borrowers. In the Stiglitz and Weiss model, the expected project returns are the same, but the projects vary with respect to the dispersion of their returns (mean preserving spreads). In the De Meza and Webb model, the expected returns differ among the various projects.

However, over-investment or unsatisfied demand for credit can also occur through mechanisms originating in the oligopolistic structure of the banking sector[22] and on its heterogeneity (e.g. with respect to capital levels), rather than from asymmetric information. For example, oversupply could occur from banks' strategy to compete for market shares within an oligopolistic market structure. Romano (1988) proves that there may be oversupply in an oligopolistic market where firms produce a homogeneous good if the wedge between price and marginal cost is high enough. Baglioni (2007) examines the possibility of constraints in the credit supply, due to banks' undercapitalization, in the context of monopolistic and oligopolistic competition, with the result of reducing the impact of monetary policy expansionary intervention.

The empirical investigation of disequilibrium in the credit market has been based on the econometric model proposed by Laffont and Garcia (1977). This class of models posits credit demand and supply as latent variables and the observed quantity of credit as the minimum of the two. Different versions of disequilibrium models have been estimated, the main differences being the method of estimation and the specification of the stochastic terms. Table 1 presents an extensive overview of credit disequilibrium models that have been used in the literature. These studies span a number of jurisdictions and time periods, and they either examine the aggregate credit on a jurisdiction or the credit provided to firms i.e. there is no comparative study across loan types. The specifications of the demand and supply functions have been rather diverse, especially with regards to the supply function. Therefore, in the present paper a number of specifications are tested. The disequilibrium models have usually been estimated using maximum likelihood. However, the application of maximum likelihood for estimating such highly nonlinear models is tricky as the optimization algorithm can always get trapped in local minima. One pattern which is discernible (admittedly vaguely) among the variety of results obtained in these studies is that at the onset of a crisis credit is mostly supply-constrained, but at a later stage of a crisis, demand constraints may dominate.

The disequilibrium approach is based on estimating separate credit supply and demand functions. Credit supply and demand are understood as 'notional' supply and demand i.e. supply and demand corresponding to their fundamental determinants. Consequently, variables reflecting rationing are excluded. Therefore the guiding principle behind choosing the explanatory variables of supply and demand functions is to include only those determinants that do not reflect rationing.

The disequilibrium specification followed in this paper can be considered as an alternative to the econometric literature of identification, exemplified, for example by

[22] A strand in the literature studies the structural features of the banking sector which give rise to oligopolistic market structures. Such features are e.g. the regulation of the sector (Vives 2011), the presence of established relationships (Rajan 1992), the multilocational nature of banking activities and the importance of localized competition (Barros 1999) and the possibility of banks' using their branching decisions as a strategic non-price variable (Kim and Vale 2001).

Lewbel (2010) and Rigobon (2003). This literature suggests techniques to solve the identification in the presence of endogenous variables by formulating additional assumptions regarding the range of values of the estimated coefficients or the structure of the correlation matrix. The choice to adopt the disequilibrium approach for the analysis of the credit market can be justified given the strong theoretical basis for assuming a non-clearing credit market.

In addition, we choose to work with nominal variables (e.g. credit, GDP, interest rates), for four reasons. First, banks and borrowers may perceive different rates of inflation. Therefore, the "real" volume of credit may differ among the two types of agents and using the real credit as the dependent variable could well lead to bias in the results. Second, the unstable tax environment prevailing in Greece, especially since the onset of the sovereign debt crisis hinders the construction of reliable corresponding real variables. For example, the fiscal measures taken in 2010 and 2011 involved significant tax increases, intended to be temporary but remained largely in place, therefore obscuring the expectations and the perception of real values on the part of economic agents (see also Provopoulos 2014). Third, as Bernanke and Lown (1991) have argued, using the real value of outstanding loans can be misleading due to the long duration of the loan contract.[23] Finally, using the real credit imposes implicitly a unit elasticity of credit with respect to the price level, which may be violated in practice (for further discussion, see Buncic and Melecky 2013).

Finally, all variables are expressed in logarithms, with the exception of variables representing ratios and interest rates, in accordance with a long tradition in the money demand literature (Zarembka 1968; for an extensive survey see Sriram 2000).[24]

4.1. Credit Supply Determinants

The following variables are included as potential credit supply determinants:

Lending interest rate (LR). Banks have an incentive to extend credit supply the higher the interest rate they are able to charge. However, according to Stiglitz and Weiss (1981) the expected return by the bank increases less rapidly than the interest rate and decreases beyond a threshold as it affects the riskiness of the loans.[25] For this reason, the square of the interest rate is also included in the specification and it is expected to

[23] Carpenter et al. (2014) and Catao (1997) also work using nominal variables. The comparison of nominal credit to nominal GDP is also common in the regulatory literature e.g. see the instructions of the Basel Committee on Banking Supervision on the activation of the countercyclical capital buffer (BCBS 2010, p. 13).
[24] In addition, lagged instances of dependent variables are excluded for the reasons discussed in Section 5.1.
[25] Either by sorting potential borrowers (adverse selection) or creating incentives for excessive risk-taking (moral hazard).

have a negative sign, if the effects of informational asymmetries dominate, so that the credit supply is a concave function of the interest rate.

Lending capacity (LC). Lending capacity is defined as the total deposits adjusted for the required reserves in the ECB overnight facility. It is a scale variable that proxies the resources that are available to the banks when deciding their total credit supply. Consequently, a higher lending capacity enables banks to expand credit supply. [26]

Deposits were the main source of funding for the credit expansion of the Greek banks and, therefore, the lending capacity as defined here represents an economically meaningful proxy for the funding constraints (see also Brissimis et al. 2013 for a similar approach).

Nonperforming loans (NPL). Deterioration of asset quality in the form of increasing nonperforming loans hinders banks' ability to extend credit. Except from constraining resources to be used for credit expansion, NPLs also represent a proxy for credit risk. Therefore, it is expected that rising NPLs will increase the banks' risk aversion and discourage further lending. In addition, higher NPLs force bank to increase provisioning, increasing the cost of lending. As a result it is expected that an increase in NPLs should have a negative impact on credit supply.

Athens Stock Exchange Index (ASE). The stock exchange index is used as a forward-looking indicator of business expectations. Therefore, a positive relationship with credit supply is expected. On the other hand, a substitution effect cannot be dismissed beforehand, since investing in the stock exchange may be an alternative to credit expansion.[27]

Moreover, we include also variables aiming to capture strategic behavior on the part of the banks and substitution effects. Specifically for long-term loans, we also include the lending rate of short-term loans and the ratio of business nonperforming loans to consumer nonperforming loans. The former variable aims to capture the strategic decision by firms to strive for extending short-term or long-term business credit while the later variable is a proxy for the relative riskiness of the business sector compared to lending to households.

[26] Laffont and Garcia (1977) use, instead of the lending capacity, three distinct variables: term deposits, demand deposits and ratio of secondary reserves, and justify it invoking a "production function" argument. In this paper we do not distinguish between term and demand deposits. It is assumed that both represent equivalent funding sources i.e. we abstract from maturity considerations. Compared to Laffont and Garcia (1977) we also subtract from total deposits the amount of required reserves, in order to define the "lending capacity" variable. The decision to use the aggregate deposits seems to be in line with a common understanding of the banks' practices and it has been followed in most similar studies (see Table 1).

[27] Krainer (2014) examines specifically the link from the value of shares to loan supply and fails to reject this hypothesis. This linkage is interpreted to work through stronger profitability prospects for firms and higher net worth for households.

Finally, for consumer loans and mortgages, the level of business nonperforming loans is also included in the list of potential determinants as a proxy of the risk represented by alternative types of loans.

4.2. Credit Demand Determinants

Following Laffont and Garcia (1977), we do not want to introduce in the set of potential credit demand determinants those variables which would reflect an eventual rationing e.g. actual investment. In addition we do not want to include 'speculative' demand for credit, i.e. demand for negative present value projects. Therefore, we deliberately adopt a 'narrow' specification for demand which is considered as a function only of the current level of economic activity and the existing credit contract conditions i.e. the interest rate. Our approach is consistent with Brissimis et al. (2013) as regards the determinants of the credit demand in the Greek economy:

Lending rate (LR). The lending rate represents the cost of credit[28] and thus it is expected that there should be an inverse relationship between credit demand and the lending rate.

Nominal GDP (GDP). GDP provides a measure of economic activity which is a primary motivation for credit demand. Since credit facilitates transactions, a positive impact from GDP to credit demand is expected.

One could argue that the ASE index is also a demand determinant. We test this alternative specification in the robustness analysis (see Section 7).

5. Disequilibrium model – Bayesian inference

According to Stiglitz and Weiss (1981), due to asymmetric information, interest rates may not adjust to clear loan markets. Therefore, observed credit will not equal the value at the intersection of demand and supply curves. Under the "short side" assumption, the observed credit quantity is the smaller of the supply and demand values which are not observed. Adopting this approach complicates the econometric specification since there are two separate latent dependent variables (supply and demand) and the observed credit equals one of these two variables interchangeably in a stochastic way.

[28] In general, the cost of credit is multidimensional and it includes also collateral and other contract features, which are activated usually in the case of a default. However, given our definition of credit demand as a notional quantity, including only 'sound' projects (rather than 'speculative' ones), restricting ourselves to the interest rate seems to be a plausible approximation.

A Bayesian approach is well fitted to tackle this econometric specification as it avoids nonlinear optimization issues which are needed when a maximum likelihood estimation procedure is used. In addition, the data augmentation technique enables the estimation of the model using a modified Metropolis-Hastings simulation algorithm.

5.1. The model

Suppose that k observations of credit are available. Let x_{1t} and x_{2t} be the vectors of determinants of demand and supply and b_1 and b_2 be k_1x1 and k_2x1 parameter vectors for the demand and supply functions respectively. The expected values of demand (d_t) and supply (s_t) are therefore given by $x_{1t}^{'}b_1$ and $x_{2t}^{'}b_2$. Their actual values also include the shocks u_{1t} and u_{2t} which are uncorrelated. The observed quantity of credit is the minimum of demand and supply. Therefore, the model can be written as

$$d_t = x_{1t}^{'}b_1 + u_{1t} \tag{2}$$

$$s_t = x_{2t}^{'}b_2 + u_{2t} \tag{3}$$

$$q_t = \min(d_t, s_t) \tag{4}$$

where d_t is demand and s_t is supply.

In existing empirical literature (e.g. Bauwens and Lubrano 2007) an alternative specification has been adopted in which random shocks enter only through the min operator and determine the level of the observed quantity of credit i.e. $u_{1t} = u_{2t} = 0$ and $q_t = \min(d_t, s_t) + v_t$ with v_t a stochastic disturbance. In other words, this leads to a deterministic regime selection once the parameters are given. The advantage of this formulation is that it simplifies the estimation of a dynamic model in which lagged values of credit are included among the explanatory variables (for details, see the Working Paper version of Bauwens and Lubrano 2007).

The specification described by Eqs. (2) − (4) incorporates three critical features with regard to the demand and supply equations: First, to exclude lagged instances of the dependent variables and, second, to also exclude lagged instances of the right hand variables e.g. interest rate. Third, to include a stochastic term in both the supply and demand equations rather than on the selection equation. These choices were made based primarily on theoretical considerations. Elaboration on the rationale behind these choices follows.

Specifically, there are two main reasons for excluding lagged instances of the independent variables in the chosen specification. First, since demand and supply refer here to ‘notional quantities corresponding to their fundamental determinants’ we would like to exclude in their estimation the effect of ‘frictions’ or persistency

mechanisms related to the adjustment of credit. These phenomena would obscure the interpretation of the notional quantities, as defined here. Besides this "conceptual" reason, an alternative specification including lags (and based on an alternative understanding of what demand and supply of credit means) would have to deal with the issue of the lagged variable 'dominating the regression' and suppressing the explanatory power of the independent variables (Achen 2000).[29]

It is important to emphasize that for disequilibrium models the foremost reason behind the inclusion (or not) of the lagged independent variable is the preferred interpretation of the concept of 'notional' demand and supply. In this paper, the concept is defined with reference to its fundamental macroeconomic or other determinants. If the lagged independent variable was included then the notional demand/supply would have to be defined with respect also to frictions related to extending/contracting credit. We prefer the former 'pure' interpretation, based on the fundamental determinants.

Moreover, the formulation adopted here allows the stochastic components of demand and supply to affect the regime selection. The alternative would be to have deterministic demand and supply equations combined with a single stochastic term on the selection equation. The chosen formulation seems to be rather intuitive since random shocks to notional demand and supply should be able to exert influence over which regime prevails.

In extant literature an interest rate adjustment equation is sometimes included (see e.g. Sealey 1979). Interest rate adjustment, however, does not appear to be entirely consistent within the Stiglitz and Weiss (1981) theoretical framework in which disequilibrium is not a transient phenomenon due to sticky interest rates but is the outcome of rational behavior on the part of lenders and borrowers.

In the model defined by Eqs. (2) – (4), the probability of being in the demand regime (i.e. demand being lower than supply) is given by

$$\lambda_t = \Pr(d_t < s_t) = \Phi\left(\frac{x_{2t}^{'} b_2 - x_{1t}^{'} b_1}{\sqrt{\sigma_1^2 + \sigma_2^2}}\right) \tag{5}$$

where Φ is the standard normal cumulative distribution function. Given the regime, the unobservable quantity can be generated from a truncated normal distribution since there is a lower bound in its value. Specifically, in the case of a demand regime, s_t follows

[29] Also, given that the dependent variables are notional demand and supply, rather than the observed credit quantity, the assumption of exogenous right hand side variables (which provides an econometric justification for the inclusion of an autoregressive term) seems to be theoretically a plausible approximation.

$$s_t \sim TN_{d_t<s_t}\left(x'_{2t}b_2\ , \sigma_2^2\right). \quad (6)$$

Accordingly in the case of supply regime

$$d_t \sim TN_{d_t>s_t}\left(x'_{1t}b_1\ , \sigma_1^2\right). \quad (7)$$

Let us also denote by θ the column vector which contains the coefficients of both demand and supply

$$\theta = (b_1\, b_2)',$$

and by h the vector of precisions for the demand and supply equations

$$h = \left(\frac{1}{\sigma_1^2}\ \frac{1}{\sigma_2^2}\right)'$$

Let $d = \{d_t\}_{t=1}^T$ and $s = \{s_t\}_{t=1}^T$ represent realizations of the demand and supply series and let $\varphi = (s, d)$.

The estimation is carried out in a Bayesian framework using data augmentation (Tanner and Wong 1987). The idea of data augmentation is that when the supply regime is operating, d_t is drawn from the truncated normal distribution (since then only supply will be observable) and, accordingly, a simulated value for s_t is used when the demand regime is operating. For each iteration, the operating regime is determined stochastically, taking into account the current values of the coefficients. See also Section 5.4 below.

5.2. Prior elicitation

The data augmentation estimation procedure separates, at each iteration, the stage of simulating the operating regime from the simulation of the unknown parameters. Therefore, the discussion below regarding the prior elicitation and the posterior is presented assuming that one of the two regimes has been already selected and the demand and supply values have been drawn from their respective distributions for each point in time. Consequently, this step is akin to the Bayesian simulation for a normal regression and the formulations below are rather standard.

A Normal-Gamma natural conjugate prior is chosen i.e. a prior that yields a posterior which belongs to the same class of distributions while having also the same functional form as the likelihood function.[30] Our choice takes into account the dependence between the two vectors of parameters to be estimated, h and θ.The priors for both the supply and demand functions are defined using the parameters estimated from an

[30] For a general overview on the elicitation of priors see Bauwens and Korobilis (2010) and Koop (2003).

OLS regression. This choice was made based on two considerations. First, it uses the existing data in an economically intuitive way i.e. based on the results of a linear regression on observed credit. This method is also consistent with the bulk of previous literature, which does not distinguish between demand and supply but estimates their determinants on the observed amount of credit. Second, the proposed prior elicitation avoids biasing the results towards either the prevalence of a demand or a supply regime (as both OLS estimations use observed credit as the dependent variable).[31]

Specifically, we elicit a prior for the precision vector h of the following form

$$h_i \sim G\left(\underline{s}_i^{-2}, \underline{v}_i\right)$$

where $i = 1$ (demand) or 2 (supply), and a prior for the coefficient vector b, conditional on h, φ, of the form

$$b_i | h_i \propto N\left(\underline{b}_i, h^{-1}\underline{V}_i\right)$$

In this specification the prior hyper-parameters $\underline{v}_i$, $\underline{s}_i^2$, $\underline{b}_i$ are defined as follows

$$\underline{v}_i = T - k_i$$

$$\widehat{b_\iota} = \left(X_i' X_i\right)^{-1} X_i' y_i$$

$$\underline{s}_i^2 = \frac{\left(y_i - X_i \widehat{b_\iota}\right)'\left(y_i - X_i \widehat{b_\iota}\right)}{\underline{v}_i}$$

$$\underline{b}_i = \widehat{b_\iota}$$

where $\widehat{b_\iota}$ is the OLS estimator. On the other hand, $\underline{V}_i$, is defined as the variance-covariance matrix of the OLS estimation keeping only the diagonal elements. Consequently, the prior joint density takes the following form:

$$p(b_i, h_i) \propto f_{NG}\left(b_i, h_i | \underline{b}_i, \underline{V}_i, \underline{s}_i^{-2}, \underline{v}_i\right) \quad (10)$$

5.3. The posterior

Multiplying the prior and the likelihood yields a Normal-Gamma joint posterior (Koop 2003):

$$b_i, h_i | y, \varphi \propto NG\left(\overline{b}_\iota, \overline{V}_i, \overline{s}_i^{-2}, \overline{v}_\iota\right) \quad (11)$$

[31] This is equivalent in having a prior of an equilibrium in the credit market.

Note that the posteriors are defined conditional on the vector φ of supply and demand realizations. The posterior parameters are given by the following equations:

$$\bar{V}_i = \left(\underline{V_i}^{-1} + X_i' X_i\right)^{-1}$$

$$\bar{b_i} = \bar{V}_i \left(\underline{V_i}^{-1} \underline{b_i} + X_i' X_i \hat{b_i}\right)$$

$$\bar{v_i} = \underline{v_i} + T$$

$$\bar{v_i} \bar{s_i^2} = \underline{v_i} \underline{s_i^2} + v_i s_i^2 + \left(\hat{b_i} - \underline{b_i}\right)' \left[\underline{V_i} + \left(X_i' X_i\right)^{-1}\right]^{-1} \left(\hat{b_i} - \underline{b_i}\right)$$

The marginal posterior for *h* is

$$h_i | y, \varphi \sim G(\bar{s_i}^{-2}, \bar{v_i}) \tag{12}$$

and the conditional posterior for *b*

$$b_i | h_i, y, \varphi \sim N\left(\bar{b_i}, \bar{V_i}\right). \tag{13}$$

Given that b_i is conditional on h_i, the Gibbs sampler for the simulation of the posterior, iterates between the conditional posterior of b_i given h_i, and h_i given b_i.

5.4. Simulation

The simulation algorithm is based on the data augmentation technique, which is a scheme for augmenting observed data, in the presence of latent variables, so as to enable their analysis. In the model under examination, data augmentation is used to simulate the possible regimes i.e. the relation between supply and demand for all the time moments of the sample. At each iteration, after a regime 'profile' has been drawn from a distribution, which takes the coefficients of demand and supply functions as given, the standard steps of the Gibbs sampling algorithm can be applied to draw from the posterior.[32]

More formally, the idea is that the observed data $y = \left(q\ x_1\ x_2\right)$, is augmented by the vector $u = u(\lambda)$ i.e. a vector of values in the interval $[0,1]$ which determine whether a supply or a demand regime exists at each point in time, and the vector $\hat{q} = \{y_{s,t} : u_t < \lambda_t;\ y_{d,t} : u_t \geq \lambda_t\}$, which contains the latent quantities i.e. supply when a demand regime is operating and vice versa. The set of the latent data, therefore, can be represented by $z = (u\ \hat{q})$. When z is given, it is straightforward to estimate the

[32] The Gibbs sampling algorithm is especially suitable here, given our selection of the priors and the possibility to draw consecutively from the conditional posteriors for h_i and b_i. Alternatively, a Metropolis-within-Gibbs algorithm (Koop 2003) could also be used.

ensuing system of two independent equations for demand and supply since they both amount to normal linear regressions. We can generate multiple values of z, based on the equations (5), (6), (7) and, subsequently, $p(\theta|y)$ can be obtained by averaging over $p(\theta|y,z)$. Because of the mutual dependence of $p(z|y)$ and $p(\theta|y)$, an iterative algorithm to calculate $p(\theta|y)$ can be used, entailing successive draws of $p(z|y)$ and $p(\theta|y)$. For further details regarding the convergence properties of this procedure see Tanner and Wong (1987).

Analytically, the applied algorithm can be described by the pseudo-code presented in Appendix B.

5.5. Model selection

In order to avoid misspecification issues and address the issue of model uncertainty we estimate various models with different combinations of explanatory variables for the supply and demand functions, retaining each time the fundamental determinants, in order to check robustness of the estimations. In addition, we use a Bayesian model selection approach to choose between the various specifications.

Model selection is based on the comparison of posterior model probabilities. Given the narrow definition of demand that has been adopted (see Section 4.2), model uncertainty pertains mostly to the specification of the supply function. Therefore each model is characterized by a different supply function specification although the estimated posteriors differ for all coefficients, both of the demand and supply functions. We assume that the prior model probabilities are equal for all models and therefore we focus on the marginal likelihoods. If we denote by M_j one of the estimated models, the marginal likelihood

$$p(y|M_j) = \iint p(y|\theta,h)p(\theta,h)d\theta dh$$

can be approximated by Monte Carlo integration as follows:

$$p(y|M_j) \cong \frac{1}{S}\sum_{s=1}^{S} p(y|\theta^{(s)},h^{(s)})$$

Subsequently, the model with the highest calculated marginal likelihood is selected.

6. Results

The empirical analysis uses monthly data from the Bank of Greece and the Hellenic Statistical Authority for the period from 2003M12 to 2011M3. The period under

examination includes the largest part of the period after the adoption of the euro (which took place in 2002) and a significant part of the crisis phase. The data appendix A provides details on the sources and the definitions of the data used.

6.1. Results per loan category

A number of different specifications are estimated for the supply equation in order to check the sensitivity of the obtained results. In all specifications the lending capacity is included since after some initial experimentation it became clear that this is the primary determinant of credit supply. On the other hand, the specification for the demand equation is held constant since its determinants are considered to be more straightforward, given also our narrow definition of demand. Our chosen specification for the demand equation was followed also in Catao (1997) and Kim (1999). It should be noted that, in general, the salient features of the obtained results do not differ substantially, across different models, which is reassuring for their credibility (see also the robustness analysis presented in Section 7).

In Figures 1-20 the results of the Bayesian estimation are presented. Five figures correspond to each loan category: first, the posterior distribution for each parameter is shown along with the corresponding Markov chain produced from the simulation; second, the mean values of demand and supply are plotted against actual credit; third, mean excess demand and supply, defined by the difference between mean supply and demand and actual credit, is shown; finally, the time profile of the probability of being in demand regime (i.e. the probability of demand being less than supply) is depicted.

In Tables 2-8 the mean values of each coefficient's posterior are shown. Table 9 shows the marginal likelihoods for all estimated models. For the reader's convenience, the selected model, which attains the highest value for the marginal likelihood, is marked with an asterisk in all other figures and tables.

For each type of loan the results obtained with all 5 models are shown. Since, in general, there are no major qualitative differences among the results of the estimated models for each loan category, we will refer, henceforth, only to the results of the selected model, except where noted.

Estimates generate coefficients with the expected sign in the majority of cases. In addition, all selected models commonly predict the existence of excess demand most of the time. This is consistent with the theoretical predictions of the Stiglitz-Weiss model. In particular, the prediction of excess demand for the booming period 2003-2008, for all types of loans, also conforms to the perceived view. On the other hand, there are differences among loan categories regarding the time paths of supply and demand during the crisis period (see below).

For ease of exposition, henceforth, we will refer to the period from 2003 until the Lehman collapse as the Boom period, the period from the Lehman collapse (September 2008) until April 2010 when Greece applied for the Financial Support Mechanism (FSM) as the Global Crisis period and the remaining period until the end of our sample as the Debt Crisis period.

A common pattern is that demand effects dominate supply effects for all categories of loans during the Boom period. Therefore, excess demand is present in various degrees for the different types of loans and the observed amount of credit is determined by the banks deciding how much credit to extend. However, an obvious implication of this result is that the approach, which is frequently adopted in the literature, of modeling credit during normal times solely from the demand side[33] needs some re-thinking. The latter approach implies that demand places an upper bound on the issued credit, as banks are able to accommodate all demand of their customers (this point is explained further in Krainer 2014). In contrast, our results point to the existence of prevalent excess demand and of supply facing a binding constraint. Our results are consistent with the view that during the Boom period the credit in Greece expanded quickly due to the very low starting level of credit-to-GDP reflecting path-dependency and in particular the financial repression of the past and the need . The total household debt-to-GDP ratio was 34.7% at the end of 2005 and 47.5% at the end of 2008. These figures are significantly below the euro area average (2008: 59.5%) and the corresponding average for several OECD countries (2005: approximately 80%) (see e.g., Mitrakos and Simigiannis 2009, and Mitsopoulos and Pelagidis 2011).[34] Of course the picture becomes more complex during the crisis periods. In the following paragraphs we discuss the results for the different types of loans separately.

For short-term business loans, the signs of the coefficients are as expected, for all specifications, with the exception of those for interest rates in models 3 and 5 (Tables 1 and 2). Specifically, the signs of the estimated interest rate coefficients in these specifications predict a convex dependence of credit supply to interest rates (i.e. negative coefficient for IR_BUS_SHORT and positive coefficient for the square of IR_BUS_SHORT) rather than a concave dependence, as it is expected from the asymmetrical information literature. On the other hand, in model 4, where business NPLs are included, these coefficients have the signs compatible with the theoretical prediction. These results can be explained when one considers the tendency for a substitution of short-term for long-term loans as financial stress intensifies (see discussion below). This tendency was especially pronounced during the phase of the global crisis. Consequently, the concave dependence to the interest rate is conditional on the prevailing level of credit risk which determines whether a substitution of short-term for long-term loans takes place. Therefore, inclusion of the interest rate as a

[33] See e.g. Hofmann (2001) and Calza et al. (2003).
[34] On the other hand, our results provide an assessment with regard to the factors behind the volume of credit and not of the efficiency of the resulting credit allocation (e.g. its composition between consumption and investment).

credit supply determinant gives results consistent with theoretical predictions when conditioned on a variable representing credit risk such as business NPLs.

The elasticity of short-term business lending on lending capacity remains around 0.5 for all estimated models. Using the marginal likelihood criterion, Model 2, which includes the ASE index and the lending capacity, is selected.

Demand for short-term business loans is estimated to have been higher than supply during the Boom period. Growth of short-term business loans had started slowing down shortly before the Lehman collapse and turned negative since the March of 2009. The gap between demand and supply for short-term business loans seems to have narrowed significantly after the global financial crisis and until the end of our sample (Fig. 3-b). In the years 2006 and 2007, excess demand reached peak levels (Fig. 4-b). Up to the outbreak of the global financial crisis, the model predicts, for the most part, higher probability of being in a supply regime, reflecting strong credit demand, especially during 2006 and 2007 (Fig. 5-b). Afterwards, and especially since the start of the sovereign debt crisis, the probability of being in a supply regime has decreased.

The results for short-term business loans suggest that the effect of the recession, which hit the Greek economy after the outbreak of the sovereign debt crisis, on demand, may be even stronger than the corresponding effect of the supply constraints on bank lending. Specifically, the recession has led to a fall of the notional demand which is seemingly steeper than that of supply and therefore, the model predicts increasing probability of being in a demand regime.

The estimated coefficient for long-term loans, presented in Tables 4 and 5, are statistically significant while having the expected signs. The coefficient for lending capacity has lower values for specifications in which additional explanatory variables are included, reflecting the fact that these additional variables also contribute in explaining credit supply. Therefore, it seems sensible that Model 4 which includes also long-term interest rates and the ratio of business NPLs to consumer NPLs is selected according to the marginal likelihood value criterion.

In contrast to short-term business loans, the long-term business loans have not decreased in levels although there has been a decrease in observed growth rates which has intensified towards the end of the sample. Credit rationing characterized this market for the most part of the period under examination (Fig. 8-d). In the case of long term business loans, the sovereign debt crisis, rather than the global financial crisis, seems to constitute a structural break as regards the patterns of demand and supply. This seems to reflect a downward revision of expectations for domestic macroeconomic developments and the expected return of investment projects. Specifically, since the first months of 2010 both demand and supply have slowed down considerably with mean supply growth rates having turned slightly negative and mean demand following the observed credit level with marginally positive growth

rates (Fig. 8-d). Fig. 9-d also shows that supply of long-term business loans decreased sharply after the FSM was signed, reflecting the negative outlook of banks with respect to long term projects. Since entering into the sovereign debt crisis, the probability of being in a demand regime follows a downward path (see Fig. 10-d), reflecting an abrupt decrease in the supply of long-term loans on the part of banks. On the other hand, demand for this type of loans has not declined in levels, a result which is consistent with survey studies on the credit needs of Greek enterprises according to which long-term loans represent the most preferred means of financing for SMEs (GSEVEE 2009, p. 45).

Two factors lie behind the pattern observed during the crisis period, of a decline in the level of short-term loans and a deceleration, but not decline in levels, of long-term business loans. First, there exists empirical evidence that substitution of short-term with long-term loans has taken place, especially during the period from the Lehman collapse until the sovereign debt crisis (Hellenic Credit Risk Management Association 2011, p. 27). The motivation behind this response on the part of the banks is to alleviate the debt burden to firms in the context of a deteriorating economic environment. In this respect, it represents a rescheduling of existing short-term loans for working capital. Second, 'natural' deleveraging through maturing loans is slower on average for long-term loans.

The estimated coefficients for supply and demand functions for consumer loans are presented in Tables 6 and 7. All coefficients have the expected signs. The selected specification is the one with lending capacity as the only determinant of supply. The elasticity of credit supply to lending capacity is approximately 1.4 in most specifications. Given that consumer loans were priced consistently with the higher interest rate among the other types of loans it makes sense that banks would want to extend this type of loans and that only the lending capacity is a determinant factor. In addition, the market for consumer loans was still underdeveloped in the 1990s and therefore there was significant growth potential (see also Brissimis et al. 2013). It is also intuitive that the interest rate coefficient attains the highest range of values for this type of loans.

The absolute level of consumer loans showed a breakpoint at the Lehman collapse, which led to a downward path since the December of 2008. As in the case of long- and short-term business loans, a trough in the demand for consumer loans occurred during the first phase of the Global Crisis period (Fig. 13a). Demand recovered quickly and there is evidence of credit rationing during the rest of this period. However, the sovereign debt crisis affected demand adversely and its mean value as predicted by the model almost coincides with observed credit although supply declined even further (Fig. 14a). In addition, the probability of being in a demand regime was low during the Boom period, reflecting very strong demand for consumer loans, while it exhibited a sharp peak during the initial phase of the global financial crisis, due to weakened demand, but it has remained in low levels since then, due, mostly, to the constraints on the supply side (Fig. 15a).

Similar patterns of credit supply and demand are also observed for mortgages. Credit rationing seems to have been present for the stable growth period reaching a peak at the end of 2006, similarly to the other types of loans (Fig. 18a). The Lehman collapse represents a temporary shock to credit demand which recovered quickly although it entered a protracted downward path shortly before the intensification of the sovereign debt crisis. Supply, on the other hand, entered a phase of decline after the 2010M5. This pattern is shown more clearly in Fig. 19a which depicts mean excess supply and demand for mortgages. Fig. 20a shows that a supply regime was prevalent until the Lehman collapse and, except from the period around this event, for the rest of the period. During the sovereign debt crisis, due mostly to the collapse of supply for mortgages, the probability of being in a demand regime has remained in low levels.

It is also of interest to compare the elasticities of supply with respect to lending capacity and demand with respect to GDP across the different loan types since these variables are the primary determinants of supply and demand respectively. Mortgage loans exhibit the higher elasticity values for these major determinants of supply and demand while the values for consumer loans are very close. This reflects both the steep credit expansion in these market segments during the boom and the swift deleveraging after expectations were revised downwards and a recessionary environment ensued. In addition, as regards business loans, estimated elasticities for long-term loans are found to be higher than for short-term loans. Short-term loans have the lowest elasticity values among all loan types. Therefore, historically, growth of mortgages and consumer loans has been most responsive to changes in economic activity.

Overall, the bulk of the evidence suggests that, after the FSM agreement, supply constraints are binding and determine the actual level of observed credit. On the other hand, it is also clear that demand has weakened significantly. For most types of loans, the estimated mean value of demand during this period is not much higher than the actual credit, implying that even in the absence of supply constraints credit expansion would not be vigorous. Anecdotal evidence also supports the view of weakened demand.[35] For example, it has been reported that consumer loans and credit cards are used to pay special taxes while banks have granted loans for paying obligations, such as payments for settling housing illegalities.

Moreover, a recurring pattern for all types of loans is the negative shocks in demand which seems to have taken place around 2008Q3 and 2010Q2, therefore justifying the selection of the time points defining the periodization of the crisis phases. During both transitions, uncertainty was elevated and this is reflected in the credit demand decisions of economic agents.

[35] Demand, in the sense understood here i.e. notional demand which corresponds to the level of economic activity.

6.2. Credit elasticities

The comparison of the estimated elasticities with other studies is of great interest, even though a caveat as regards comparability should be kept in mind, due to the differences in the econometric methods applied and the structural characteristics of each jurisdiction under examination.[36] Sriram (2000) presents an extensive survey of estimated money demand functions and finds that the elasticity of "broad money" to GDP ranges from 0.25 to 3.50 (with a mean of 1.22). Our estimated GDP elasticities are towards the upper range of the spectrum (1.43, 3.87, 5.36, and 6.81 for short-term business, long-term business, consumer and mortgage loans, respectively). It should be taken into account that the studies surveyed by Sriram estimate *observed* money demand while in our case we estimate notional demand, for which observed demand is the lower bound. Therefore, it is plausible that the estimated values of elasticities tend to be somewhat higher in our case. Moreover, Buncic and Melecky (2013) estimate the elasticities of credit with respect to GDP for a number of countries and find a bi-modal distribution of elasticities with the first mode at a value around 2, the second mode at a value around 4, and the center of the distribution located around the value 3. Buncic and Melecky estimate these elasticities using an error correction framework, which allows for the existence of disequilibrium, while also using nominal quantities. Therefore, their study is closer to the present one compared with Sriram's. Consequently, it makes sense that the results of Buncic and Melecky are much closer to ours compared to those of Sriram.

A comparison with two other studies is also worth of mention. The estimations by Hofmann (2004) for a number of industrialized countries regarding the credit to GDP elasticity are somewhat lower compared to the values estimated here (ranging from close to 1 and up to 2.5). A clear difference, which may explain a large part of the discrepancy with our results, is that the countries under examination feature higher levels of financial intermediation compared to Greece (as reflected e.g. in their credit-to-GDP ratios). Catao (1997) investigates the credit elasticities for Argentina and uses expected nominal GDP (extrapolating from a regression of GDP with the stock market index) while the country under examination presents significant structural differences with Greece and, therefore, the results are not directly comparable. In that paper the elasticity of credit demand to GDP is significantly lower (0.12).[37]

In addition, other studies emphasize on the linkage between loan demand and the interest rate. For example, Gerali et al. (2010) calibrate the (average) elasticity of loan demand to reproduce the degree of market power[38] observed in the euro area and,

[36] When comparing our estimated elasticities with those that have been estimated using real variables, the divergence due to the conversion into real quantities should also be taken into account i.e. due to the fact that different price levels are used to convert e.g. nominal GDP and outstanding loans to their real counterparts.
[37] In addition, this study estimates the elasticity of supply with respect to lending capacity at a value which is at the low end of the values found here (0.37).
[38] Market power is proxied by the difference between the loan rate and the policy rate.

estimate it as −3.0. Carpenter et al. (2014) report an estimated elasticity around −2.0 for business loans. However, these studies used specifications whereby loan demand was not conditional on economic activity. In our case, GDP is the primary determinant of loan demand and therefore we find significantly lower values for the interest rate elasticity of loan demand (the maximum value is −0.3 for consumer loans). Catao (1997) finds elasticities of interest rates, both for the demand and supply functions, within a range similar to our results (−0.13 and 0.11, respectively).

7. Robustness analysis

Due to the uncertainty surrounding the determinants of credit demand and supply, we conduct a number of sensitivity analyses in order to check the robustness of the previous results. The sensitivity analyses were performed by modifying the models which were chosen above based on the maximum posterior probability criterion. In general, the patterns exhibited by the selected models still hold under the modified specifications.

First, we introduce *Central Bank dependence ratio* as a supply determinant. The Central Bank dependence is defined as the ratio of Central Bank funding to total deposits and it is expected to have a negative effect on supply as it reflects funding challenges. As can be seen in Fig. 21, during the period before the financial crisis Central Bank dependence was around levels below 5%. During the first phase of the global turbulence it escalated into levels around 15-20%. Since the outbreak of the sovereign debt crisis the Greek banks have been forced to borrow more even heavily from the ECB, since the capital-market access had been effectively shut down, and the ratio has reached levels almost as high as 40%.

For each category of loans we define Model 6 as the specification where the Central Bank dependence ratio is added in the set of supply determinants used in the corresponding selected model from Section 5 (i.e. Model 2 for short-term business loans, Model 4 for long-term business loans, Model 1 for consumer loans and Model 1 for mortgages).

Second, following Poghosyan (2010), we include the lagged ASE index as a demand determinant (Model 7). The sign of the ASE coefficient in credit demand is a priori unclear. On the one hand, it may reflect improved economic prospects and therefore increasing demand for credit. On the other hand, obtaining funds from the financial markets may be a substitute for bank lending. We label the specification with the lagged ASE index as Model 7.

Finally, inflation is included in both supply and demand functions (Model 8).[39] Given our choice to work with nominal variables, we would like to investigate whether including inflation, either current, perceived as a proxy for expected inflation, or lagged, on both supply and demand functions, enhances the model specification. The expected sign of the coefficient is not clear a priori.

The results are consistent with those of Section 6.[40] Specifically, regarding short-term loans, the estimation of Models 6 to 8 also show a peak in the gap between demand and supply in 2006 and a narrowing of this gap after the beginning of the Global crisis period. In addition, with the exception of Model 7, a strong negative effect on demand for short-term business loans is confirmed.

With regard to long-term business loans, Models 6 to 8 also point to the existence of excess demand during the Boom period. In addition, a negative shock in credit demand seems to have occurred during the Global Crisis period although the timing of this shock is not entirely consistent among the different specifications. A steep deterioration of both supply and demand (relatively more for supply), however, is commonly estimated for the Debt Crisis period.

The sensitivity test for consumer loans provides reassuring evidence that the whole Boom period demand exceeded supply. Furthermore, a sharp peak in the probability of demand being less than supply at the onset of the Global Crisis period is found in all specifications. This probability declines sharply during the rest of this period reflecting both adverse developments in supply and an increase in demand as in the selected Model 1. Finally, supply is estimated, on average, to be somewhat lower than demand during the Debt Crisis period, reflecting constraints of banks in granting consumer loans.

Regarding mortgages, the sensitivity checks confirmed the presence of excess demand during the Boom period. A sharp peak in the probability of being in a supply regime, reflecting negative shock on demand, is apparent at the initial phase of the Global Crisis period. Finally, a steep deterioration of both demand and supply is clear during the Debt Crisis period, albeit supply seems to be more severely distressed.

8. Cyclical effects

Section 6 presented a discussion of the results distinguishing between three subperiods. These results were obtained under the assumption that the coefficients of the demand and supply functions remain constant, independently of the state of the business cycle. In this section we focus on cyclical effects and, specifically, on the

[39] In the results presented here, current inflation (i.e. without lags) is assumed. Results obtained when using lagged inflation did not differ significantly and are available upon request by the author.
[40] The results of this section are available upon request.

effects of the cycle on the elasticities of demand and supply with respect to their primary determinants.

More specifically we distinguish between periods of positive and negative growth and assume that the elasticities of the primary determinants of both demand and supply (i.e. economic activity and lending capacity, respectively) differ among these two periods. Consequently we re-estimate the selected models for each loan category including a dummy variable which equals one when GDP growth is negative. In addition, the dummy variable is multiplied with GDP growth or the lending capacity (for the demand and supply functions, respectively) in order to investigate the effects of a recessionary period on the primary determinants of demand and supply, respectively.

The results of these estimations are presented in Tables 11-18. The coefficients of the corresponding model without the dummy variable are also repeated, for ease of comparison. The results point to a common pattern of lower elasticities (in absolute value) during periods of negative GDP growth, across the different loan categories.

Specifically, for all types of loans, except from the short-term business loans, both the elasticity of credit demand with respect to GDP and of credit supply with respect to the lending capacity decreases in times of negative GDP growth. One common factor behind the differential values of the elasticities among the two phases is the rapid expansion of credit during the Boom period and, the asymmetric and lower sensitivity of the credit demand during times of negative GDP growth.[41] In addition, this downward stickiness of credit in periods of negative GDP growth arises unavoidably due to the existence of credit which has been granted in the past and cannot be cancelled instantaneously. The latter effect is also compounded by the deposit outflows observed during the crisis which would also tend to lower the estimated elasticity (as households and firms withdraw cash from their deposit accounts substituting for bank loans).

Regarding the supply side, two other factors have contributed in lowering the absolute value of the elasticity during periods of negative GDP growth. First, the support provided to the banking system during the crisis (in the form e.g. of central-bank funding and also of indirect support through lending to the state by the official sector) seems to have played a role. In addition, the internal reallocation of credit among banks supported the aggregate volume of supplied credit as stronger banks were able to compensate for the limited capability of weaker banks to extend credit.

With respect to credit demand, an additional factor behind the downward asymmetry of the credit demand elasticity with respect to GDP is the demand component related

[41] Interestingly, Brissimis et al. (2013) find the same effect for the elasticity of consumer loan demand with respect to the interest rate for the crisis period. Our results are not directly comparable because in that paper a cointegration approach is used and the coefficient for the GDP has been fixed to 1. However, the common theme between our results and those of Brissimis et al. is the lower value of demand elasticities during the crisis.

to the need for covering crisis-related effects (unexpected losses e.g. of collateral value, lower cash flows etc.). This component of demand, which exists within a recessionary environment lead, supports to some extent credit demand, even though economic activity has weakened.

9. Conclusions

This paper estimates a disequilibrium model for the Greek credit market over the period 2003 – 2011. The analysis is carried out separately per type of loan, while a specification allowing for stochastic terms in the demand and supply equations is adopted. The latter feature seems to be intuitively well suited to model a situation which includes a period of deep recession such as that unfolding in the Greek economy. Estimation uses a Bayesian methodology with data augmentation to simulate the latent variables of supply and demand.

We find that lending capacity constitutes the main driver for credit supply, and economic activity, as proxied by the GDP, the main driver for credit demand. The estimation of different specifications for the supply function and the application of a marginal likelihood criterion leads to the conclusion that for consumer loans and mortgages the preferred specification includes only lending capacity as an explanatory variable for supply. On the other hand, for short-term business loans, the ASE index should also be included. Moreover, the selected specification for the supply of long-term business loans includes, except from the lending capacity, the interest rate and the ratio of business NPLs percentage to consumer NPLs percentage representing the relative riskiness of the business sector.

Furthermore, it is found that for all loan categories, excess demand characterizes the booming period that lasted until the global financial crisis. This finding is consistent with the theoretical prediction of the asymmetrical information literature since banks are reluctant to adjust interest rates in order to equate demand with supply as this will strengthen moral hazard and adverse selection incentives.

The crisis led to more diversified patterns of supply and demand across loan categories. The evolution was different for short-term compared to the other types of loans. Specifically, for short-term business loans, the fall in demand after the intensification of the sovereign debt crisis seems to be so severe so as to lead to high estimated probabilities of being in a demand regime (i.e. demand being less than supply), despite the supply constraints which are evident in this period. This is consistent with survey studies on the credit needs of Greek enterprises according to which, during the latter crisis period, long-term loans represent the most preferred means of financing. As regards the other types of loans (long-term business loans, consumer loans and mortgages), it is found that supply constraints are the dominant determinants of actually observed credit.

Therefore, the empirical analysis presented here reveals that the credit crunch (defined as a shortage of means of financing for the real economy) should not be attributed solely on the supply side. In particular, taking into account the analysis of short-term loans, it transpires that demand for certain types of loans seems to have been adversely affected by the recessionary state of the economy to an even greater extent than supply has been affected by constraints on lending capacity. Therefore, credit expansion in this segment of the credit market is conditional on stronger economic activity, which is the main determinant of demand. On the other hand, lending constraints seem to leave part of the notional demand unsatisfied, for the other types of loans.

Appendix A: Data definitions and sources

Loans (short-term business, long-term business, consumer and mortgages): Loans granted by Monetary Financial Institutions (MFIs), excluding the Bank of Greece, to domestic non-MFI residents. Short-term business loans are defined as those with maximum duration of 1 year. Long-term are those with a duration exceeding 1 year (source: Bank of Greece).

Lending rates (short-term business, long-term business, consumer and mortgages): euro-denominated loans from domestic credit institutions (source: Bank of Greece).

Deposits: deposits of non-MFIs at MFIs, excluding the Bank of Greece (source: Bank of Greece).

Nonperforming loans: nonperforming loans are defined as the loans overdue by more than ninety (90) days (source: Bank of Greece).

Central Bank funding: Debt to the Central Bank. Includes both debt to the European Central Bank and the debt incurred through the Emergency Lending Assistance mechanism, granted by the Bank of Greece (source: Bank of Greece).

Athens Stock Exchange Index (ASE): The Athens Stock Exchange General Index (source: Bloomberg)

GDP: Nominal GDP as reported by the Hellenic Statistical Authority.

Appendix B: Pseudo-code for the simulation

The simulation algorithm can be described by the following pseudo-code, which combines simulation steps for the selection of the (demand or supply) regime with the usual Gibbs sampler:

For $j = 1$ to $NumberOfIterations$

Set $\theta = \theta^{j-1}$, $h = h^{j-1}$

Compute $\lambda_t|\theta, h, data$ and draw from $u \sim U(0,1)$

If $< \lambda_t$, $y_d^j = q_t$ and draw s_t and allocate it to y_s^j

If $> \lambda_t$, $y_s^j = q_t$ and draw d_t and allocate it to y_d^j

Draw from $h^j|data$

Draw from $\theta^j|h^j, data$

End.

The initial values for all parameters were based on the OLS results. However, the results are not sensitive to the initial conditions as it was found by experimenting with the algorithm since a burn-in phase of 5,000 iterations precedes running the main loop (which includes 20,000 iterations). The computational time for each run of algorithm is below 10 minutes. Convergence is checked formally using the diagnostic proposed by Geweke (1992). Specifically the posterior estimates based on the first half of the draws are compared to those of the last half.

References

Achen, C. H., 2000. Why Lagged Dependent Variables Can Suppress the Explanatory Power of Other Independent Variables. Presented at the Annual Meeting of the Political Methodology Section of the American Political Science Association, UCLA, July 20-22.

Alessi, L., Detken C., 2011. Quasi real time early warning indicators for costly asset price boom/bust cycles: a role for global liquidity. *European Journal of Political Economy* 27, 520-533.

Atanasova, C. V., Wilson, N., 2004. Disequilibrium in the UK corporate loan market. *Journal of Banking & Finance* 28, 595-614

Baglioni, A., 2007. Monetary policy transmission under different banking structures: The role of capital and heterogeneity. *International Review of Economics and Finance* 16, 78-100.

Barajas, A., Steiner, R., 2002. Why Don't They Lend? Credit Stagnation in Latin America. *IMF Staff Papers* 49, 156-184.

Barros, P., 1999. Multimarket competition in banking, with an example from the Portuguese market. *International Journal of Industrial Organization* 17, 335-352.

Bauewens, L., Korobilis, D., 2010. Bayesian methods. ECORE Discussion Paper 2011/111.

Bauwens, L., Lubrano, M., 2007. Bayesian Inference in dynamic disequilibrium models: an application to the Polish credit market. *Econometric Reviews* 26, 469-486.

Bank of Greece, Monetary Policy Report 2009.

Bank of Greece, Annual Report 2008.

BCBS 2010. Guidance for national authorities operating the countercyclical capital buffer. *Bank for International Settlements*. Available from http://www.bis.org/publ/bcbs187.pdf.

Benes, J., Kumhof, M., Laxton, D., 2014. Financial crises in DSGE models: A prototype model. *IMF Working Paper Series 14/57*.

Bernanke, B., Lown, C., 1991. The credit crunch. *Brookings Papers on Economic Activity* 1991, 205-247.

Boissay, F., Collard, F., Smets, F., 2013. Booms and Systemic Banking Crises. *ECB Working Paper Series 1514*.

Borio, C., 2012. The financial cycle and macroeconomics: What have we learnt? *BIS Working Paper 395*.

Brissimis, S., Garganas, E., Hall, S., 2013. Consumer Credit in an Era of Financial Liberalisation: An Overreaction to Repressed Demand? *Bank of Greece Working Paper 148*.

Buncic, D., Melecky, M., 2013. Equilibrium credit: The reference point for macroprudential supervisors. *World Bank: Policy Research Working Paper 6358.*

Calza, A., Manrique, M., Sousa, J., 2003. Aggregate loans to the euro area private sector. *ECB Working Paper 202.*

Carpenter, S., Demirlap, S., Eisenschmidt, J., 2014. The effectiveness of non-standard monetary policy in addressing liquidity risk during the financial crisis: The experiences of the Federal Reserve and the European Central Bank. *Journal of Economic Dynamics and Control* 43, 107-129.

Catao, L., 1997. Bank Credit in Argentina in the Aftermath of the Mexican Crisis: Supply or Demand Constrained? *IMF Working Paper* 97/32.

De Meza D., Webb, C., 1987. Too much investment: A problem of asymmetric information. *Quarterly Journal of Economics* 102, 281-292.

De Santis, R., 2014. The euro-area sovereign debt crisis: Identifying flight-to-liquidity and the spillover mechanisms. *Journal of Empirical Finance* 26, 150-170.

Dellas, H., Tavlas, G., 2012. The road to Ithaca: the Gold Standard, the Euro and the origins of the Greek sovereign debt crisis. *Bank of Greece Working Paper 149*.

Eichengreen, B., Gibson, H., 2001. Greek Banking at the Dawn of the New Millenium in Bryant R. C., Garganas N. C. and Tavlas G. S. (eds.). *Greece's Economic Performance and Prospects*, Bank of Greece and the Brookings Institution.

Favara, G., 2012. Agency problems and endogenous investment fluctuations. *Review of Financial Studies* 25, 2301-2342.

GSEVEE (Hellenic Confederation of Professionals, Craftsmen and Merchants) (2009), *Financing of small and very small enterprises*.

Hakkio, C. S., Keeton, W. R., 2009. Financial Stress: What Is It, How Can It Be Measured, and Why Does It Matter? *Federal Reserve Bank of Kansas City Economic Review*. Second Quarter, 5-50.

Haldane, A., Aikman, D., Nelson, B. 2010), Curbing the credit cycle. Speech at the Columbia University Center on Capitalism and Society Annual Conference, New York 2010.

Heider, F., Inderst, R., 2012). "Loan prospecting", *Review of Financial Studies*, Vol. 25, pp. 2381-2415.

Hellenic Credit Risk Management Association 2011), *Banks and Credit*.

Hofmann, B., 2004),"The Determinants of Bank Credit in Industrialized countries: Do Property Prices Matter", *International Finance*, Vol. 7, pp. 203-234.

Houston, J., Lin C., Lin, P., Ma Y., 2010). "Creditor rights, information sharing, and bank risk taking", *Journal of Financial Economics*, Vol. 96, p. 485-512.

Gagales, A., Roehler, C., 2006), IMF Country Report No. 06/5

Gerali, A., Neri, S., Sessa, L., Signoretti, F., 2010), "Credit and Banking in a DSGE Model of the Euro Area", *Journal of Money, Credit and Banking*, Vol. 42, No. 6, 107-141.

Gertler, M., Kiyotaki, N., 2010), Financial intermediation and credit policy in business cycle analysis in Friedman, B., and Woodford M., (eds.), Handbook of Monetary Economics, Volume 3, Elsevier.

Geweke, J., 1992. Evaluating the accuracy of sampling-based approaches to the calculation of posterior moments. Bernando, J., Berger, J., Dawid, A., Smith, A., (eds.) *Bayesian Statistics 4*, 641-649. Oxford: Clarendon Press.

Gibson, H., Hall, S., Tavlas, G., 2011). The Greek financial crisis: growing imbalances and sovereign spreads, Bank of Greece *Working Paper 124*.

Hillier, B., Ibrahimo, M. V., 1993). Asymmetric information and models of credit rationing, *Bulletin of Economic Research*, Vol. 45, No. 4, 271-304.

Hofmann, B., 2001). "The determinants of private sector credit in industrialized countries: do property prices matter?", *BIS Working Paper 108*.

IMF Staff, 2006). IMF Staff Report for the 2006 Article IV Consultation, December 2006.

Karfakis, C., 2013). Credit and business cycles in Greece: Is there any relationship?, *Economic Modelling* , Vol. 32, pp. 23-29.Katsimi, M., and Moutos, T. 2010). "EMU and the Greek crisis: The political-economy perspective", Vol. 26, pp. 568-576.

Kim, M., Vale, B., 2001). Non-price strategic behavior: the case of bank branches, *International Journal of Industrial Organization*, Vol. 19, pp. 1583-1602.

Kosmidou, K., Kousenidis, D., and Negakis, C., 2014), "The impact of the EU/ECB/IMF bailout programs on the financial and real sectors of the ASE during the Greek sovereign crisis", (in press)

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

Krainer, R., 2014. "Monetary policy and bank lending in the Euro area: Is there a stock market channel or an interest rate channel? *Journal of International Money and Finance*, http://dx.doi.org/10.1016/j.jimonfin.2014.03.009.

Laffont, J., Garcia, R., 1977. Disequilibrium Econometrics for Business Loans. *Econometrica* 45 (5), 1187-1204.

Lewbel, A., 2010. Using Heteroscedasticity to Identify and Estimate Mismeasured and Endogenous Regressor Models. *Journal of Business and Economic Statistics* 30 (1), 67-80.

Louzis, D., Vouldis, A., Metaxas, V., 2011. Macroeconomic and bank-specific determinants of non-performing loans in Greece: a comparative study of mortgage, business and consumer loan portfolios. *Journal of Banking and Finance* 36, 1012-1027.

Malliaropoulos, D., 2011. Can Greece Jumpstart Growth Without Bank Credit Expansion? *Eurobank EFG: Economy and Markets* VI (8), 1-7.

Malliaropoulos, D., Anastasatos, T., 2011. Competitiveness, external deficit and external debt of the Greek economy. *Eurobank EFG: Economy and Markets*, VI (7), 1-13.

Meisenzahl, R., 2014. Verifying the state of financial constraints: Evidence from U.S. business contracts. *Journal of Economic Dynamics and Control* 43, 58-77.

Michaelides, P., Papageorgiou, T., Vouldis, A., 2013. Business cycles and economic crisis in Greece (1960-2011): A long run equilibrium analysis in the Eurozone. *Economic Modelling* 31, 804-816.

Minsky, H. M., 1986. *Stabilizing an Unstable Economy*. New Haven, CT: Yale University Press 1986.

Mitrakos, T., Simigiannis, G., 2009. The determinants of Greek household indebtedness and financial stress. *Economic Bulletin of the Bank of Greece* 32, 7-26.

Mitsopoulos, M., Pelagidis, T., 2011. *Understanding the Greek Crisis*. Palgrave Macmillan.

Monokrousos, P., Thomakos, D., 2011. A Technical Study on the Determinants and Outlook of Private Sector Deposits in the Greek Banking System. *Eurobank EFG: Economy and Markets* VI (8), 1-23.

Moutos, T., Tsitsikas, C., 2010. Whither public interest: The case of Greece's public finances. *FinanzArchiv* 66 (2), 170-206.

Mylonas, P., 2011. Bank Deposits: Liquidity Conditions are a Critical Component of Greece's Recovery, *National Bank of Greece Macroeconomic Analysis* (March 2011), 2-12

Perez, S. J., 1998. Testing for Credit Rationing: An Application of Disequilibrium Econometrics. *Journal of Macroeconomics* 20 (4), 721-739.

Poghosyan, T., 2010. Slowdown of credit flows in Jordan in the wake of the global financial crisis: supply or demand driven? IMF Working paper 10/256.

Provopoulos, G., 2014. The Greek Economy and Banking System: Recent Developments and the Way Forward. *Journal of Macroeconomics* 39, 240-249.

Rajan, R., 1992. Insiders and outsiders: The choice between informed and arms-length debt. *Journal of Finance* 47, 1367-1400.

Rajan, R., 1994. Why Bank Credit Policies Fluctuate: A Theory and Some Evidence. *The Quarterly Journal of Economics* 109, 399-441.

Rajan, R., 2006. Has Finance made the World Riskier? *European Financial Management* 12, 499-533.

Reinhart, C. M., Rogoff, K. S., 2010. From Financial Crash to Debt Crisis. *NBER Working Paper,* 15795.

Rigobon, R., 2003. Identification through Heteroscedasticity. *Review of Economics and Statistics* 85 (4), 777-792.

Romano, R. E., 1988. Oligopolistic competition for market share via voluntary excess supply. *International Journal of Industrial Organisation* 6, 447-468.

Sealey, Jr., C. W., 1979. Credit Rationing in the Commercial Loan Market: Estimates of a Structural Model Under Conditions of Disequilibrium. *Journal of* Finance 34 (3), 689-702.

Sriram, S., 2000. A survey of recent empirical money demand studies. *IMF Staff Papers* 47, 334-365.

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

Stiglitz, J. E., Weiss, A., 1992. Asymmetric Information in Credit Markets and its Implications for Macro-Economics. *Oxford Economic Papers* 44 (4), 694-724.

Tanner, M. A., Wong, W. H., 1987. The calculation of posterior distributions by data augmentation. *Journal of the American Statistical Association* 82, 528-550.

Tagkalakis, A., 2014. Credit and the transmission of fiscal policy shocks: Recent evidence from Greece. *Economic Letters* 122, 263-267.

Vives, X., 2011. Competition policy in banking. *Oxford Review of Economic Policy* 27, 479-497.

Zarembka, P., 1968. Functional forms in the demand for money. *Journal of the American Statistical Association* 63, 502-511.

Table 1: Literature review of credit disequilibrium models

	Country(ies) (time period) Credit type	**Supply function**	**Demand function**	**Methodology**	**Results**
Atanasova & Wilson (2004)	United Kingdom (1989-1999) Panel of firms	Collateral (borrower's total assets), risk (firm's coverage ratio), monetary conditions (innovations to the BoE base rate derived from a VAR model)	Activity (sales), size (total assets), substitutes (internal cash flows, net trade credit, access to financial markets), loan premium (time and sectoral dummies)	FIML with numerical maximization (EM algorithm) of the likelihood function	Evidence of a credit channel of monetary policy transmission (tight monetary policy affects the supply of credit to smaller firms)
Bauwens and Lubrano (2007)	Poland (1994-2002) Short-term (<1 yr) aggregate credit	Lending rate, Intervention rate of the central bank, ratio of long-term loans (>1 yr) to total loans, treasury bills to total assets	Industrial production, ratio of long-term loans (>1 yr) to total loans	Disequilibrium model – Bayesian estimation	Excess supply until 1999 and a period of excess demand after 2001
Barajas and Steiner (2002)	Colombia, Mexico, and Peru (1991-2001) Aggregate credit	Lending capacity, lending rate, interest rate on government bonds, non-performing loans, provisions	Lending rate, JP Morgan EMBI price, manufacturing output, real GDP	Disequilibrium model - Maximum likelihood estimation	Mixed results on the relative contributions of supply and demand in credit slowdowns
Catao (1997)	Argentina (1994-1996) Aggregate credit	**Long-run**: lending rate, lending capacity **Short-run** (additionally): NPL ratio	**Long-run**: nominal GDP, lending interest rate **Short-run** (additionally): unemployment	Simultaneous equations equilibrium model estimated with SURE	In the first part of the crisis, lending capacity constraints were important, however, demand factors were primary determinants at a later stage.

Kim (1999)	Korea (1987-1998) Aggregate credit	Lending rate, lending rate minus rate on CDs, bank deposits, industrial production	Lending rate minus yield on corporate bonds, industrial production	Disequilibrium model - Maximum likelihood estimation	During the 1997 crisis, credit contraction was mainly due to decreasing supply (credit crunch)
Laffont and Garcia (1977)	Canada (Until 1973) Business loans	Deposits, reserves ratio, industrial production, cost of funds, government bonds rate	Short- and long-term lending rates, Industrial production, retained profits	Disequilibrium model – Various estimation methods	Loans are demand determined (excess supply)
Perez (1998)	US (1981-1991) Panel of firms	Lending rate, sales, Beta, Federal Funds rate, reserves/monetary base	Lending rate, sales, liquid assets to short-term liabilities	Maximum likelihood	Firms experience credit rationing
Poghosyan (2010)	Jordan (1999-2010) Aggregate credit	Lending rate, Monetary policy stance (interest differential between policy rates in Jordan and the U.S.), industrial production, lending capacity, economic uncertainty	Lending rate, industrial production, stock exchange index	BHHH iterative procedure to maximize log-likelihood	Credit slowdown was mainly driven by reduced supply

Table 2: Estimations of supply equation (short-term business loans)

	Model 1	**Model 2 ***	**Model 3**	**Model 4**	**Model 5**
CONSTANT	7.581 (0.189)	7.991 (0.193)	7.953 (0.180)	7.199 (0.171)	10.406 (0.211)
ASE		-0.042 (0.017)			-0.082 (0.023)
LENDCAP	0.572 (0.051)	0.558 (0.049)	0.565 (0.050)	0.527 (0.048)	0.514 (0.048)
IR_BUS_SHORT			-0.101 (0.047)	0.245 (0.025)	-0.597 (0.063)
IR_BUS_SHORT^2			0.008 (0.009)	-0.020 (0.013)	0.048 (0.010)
NPL_RAT_BUS				-0.017 (0.011)	

Table 3: Estimations of demand equation (short-term business loans)

	Model 1	**Model 2 ***	**Model 3**	**Model 4**	**Model 5**
CONSTANT	-4.666 (0.170)	-4.666 (0.171)	-4.133 (0.160)	-4.133 (0.160)	-4.133 (0.160)
IR_BUS_SHORT	-0.006 (0.001)	-0.006 (0.001)	-0.002 (0.001)	-0.017 (0.013)	-0.017 (0.012)
GDP	1.426 (0.066)	1.426 (0.066)	1.384 (0.065)	1.384 (0.065)	1.384 (0.064)

Table 4: Estimations of supply equation (long-term business loans)

	Model 1	**Model 2**	**Model 3**	**Model 4 ***	**Model 5**
CONSTANT	2.549 (0.099)	4.630 (0.141)	5.173 (0.125)	5.886 (0.151)	3.702 (0.111)
ASE		-0.213 (0.035)			-0.223 (0.036)
LENDCAP	1.520 (0.078)	1.448 (0.077)	1.130 (0.065)	0.902 (0.059)	1.467 (0.079)
IR_BUS_LONG			0.544 (0.032)	0.238 (0.006)	0.360 (0.018)
IR_ BUS_LONG^2			-0.036 (0.018)	-0.023 (0.015)	-0.035 (0.017)
IR_BUS_SHORT			-0.335 (0.046)		
NPL_RAT_BUS/ NPL_RAT_CONS				-0.845 (0.070)	

Table 5: Estimations of demand equation (long-term business loans)

	Model 1	**Model 2**	**Model 3**	**Model 4 ***	**Model 5**
CONSTANT	-29.946 (0.391)	-29.945 (0.394)	-30.720 (0.405)	-30.720 (0.407)	-30.720 (0.404)
IR_BUS_LONG	-0.139 (0.029)	-0.139 (0.029)	-0.060 (0.022)	-0.060 (0.022)	-0.060 (0.022)
GDP	3.842 (0.093)	3.843 (0.093)	3.876 (0.094)	3.876 (0.095)	3.876 (0.093)

Table 6: Estimations of supply equation (consumer loans)

	Model 1 *	**Model 2**	**Model 3**	**Model 4**	**Model 5**
CONSTANT	2.226 (0.099)	2.155 (0.094)	-2.029 (0.145)	-4.117 (0.171)	-2.938 (0.165)
ASE		0.007 (0.011)			-0.024 (0.017)
LENDCAP	1.485 (0.078)	1.487 (0.078)	1.472 (0.081)	1.728 (0.086)	1.475 (0.082)
IR_CONS			1.380 (0.060)	1.436 (0.064)	1.709 (0.066)
IR_CONS^2			-0.109 (0.021)	-0.107 (0.021)	-0.134 (0.023)
NPL_RAT_CONS				-0.005 (0.008)	
NPL_RAT_BUS				0.050 (0.011)	

Table 7: Estimations of demand equation (consumer loans)

	Model 1 *	**Model 2**	**Model 3**	**Model 4**	**Model 5**
CONSTANT	-44.956 (0.493)	-44.956 (0.499)	-44.957 (0.500)	-26.906 (0.374)	-26.907 (0.371)
IR	-0.302 (0.043)	-0.302 (0.043)	-0.302 (0.043)	-0.078 (0.023)	-0.078 (0.023)
GDP	5.358 (0.105)	5.359 (0.104)	5.358 (0.105)	3.493 (0.089)	3.493 (0.090)

Table 8: Estimations of supply equation (mortgages)

	Model 1 *	**Model 2**	**Model 3**	**Model 4**	**Model 5**
CONSTANT	2.285 (0.098)	2.480 (0.099)	0.837 (0.025)	-1.347 (0.102)	0.890 (0.020)
ASE		-0.020 (0.017)			-0.015 (0.016)
LENDCAP	1.615 (0.081)	1.608 (0.081)	1.699 (0.083)	2.012 (0.091)	1.699 (0.083)
IR_MORT			0.505 (0.032)	0.473 (0.037)	0.533 (0.033)
IR_MORT^2			-0.06237 (0.020812	-0.050 (0.018)	-0.065 (0.021)
NPL_RAT_MORT				-0.017 (0.011)	
NPL_RAT_BUS				0.078 (0.017)	

Table 9: Estimations of demand equation (mortgages)

	Model 1 *	**Model 2**	**Model 3**	**Model 4**	**Model 5**
CONSTANT	-60.825 (0.571)	-60.825 (0.577)	-60.825 (0.576)	-31.318 (0.399)	-31.319 (0.395)
IR	-0.219 (0.038)	-0.219 (0.038)	-0.219 (0.038)	-0.066 (0.021)	-0.066 (0.021)
GDP	6.818 (0.116)	6.818 (0.114)	6.818 (0.116)	3.952 (0.095)	3.952 (0.096)

Table 10: Marginal likelihood values for all loan types and models.

Model / Type of loans	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Short-term business loans	76.37	81.28*	54.92	53.37	51.87
Long-term business loans	53.81	60.50	48.04	67.37*	48.81
Consumer loans	59.45*	58.36	37.82	39.25	37.26
Mortgages	56.25*	55.57	47.78	48.65	49.03

Table 11: Estimations of supply equation with dummy variable (short-term business loans)

	Model 2	**Model 2 with time dummy**
CONSTANT	7.991 (0.193)	8.0197 (0.0193)
Dummy		-0.3315 (0.0064)
ASE	-0.042 (0.017)	-0.0350 (0.0017)
LENDCAP	0.558 (0.049)	0.5420 (0.0048)
Dummy*LENDCAP		0.0616 (0.0012)

Table 12: Estimations of demand equation with dummy variable (short-term business loans)

	Model 2	**Model 2 with time dummy**
CONSTANT	-4.666 (0.171)	-1.3066 (0.0116)
Dummy		-4.8015 (0.0191)
IR_BUS_SHORT	-0.006 (0.001)	0.0234 (0.0006)
GDP	1.426 (0.066)	1.0948 (0.0058)
Dummy*GDP		0.4493 (0.0033)

Table 13: Estimations of supply equation with dummy variable (long-term business loans)

	Model 4	**Model 4 with dummy**
CONSTANT	5.886 (0.151)	5.4708 (0.0148)
Dummy		2.2512 (0.0083)
LENDCAP	0.902 (0.059)	0.9783 (0.0063)
Dummy* LENDCAP		-0.4153 (0.0053)
IR_BUS_LONG	0.238 (0.006)	0.2793 (0.0017)
IR_ BUS_LONG^2	-0.023 (0.015)	-0.0280 (0.0015)
NPL_RAT_BUS/ NPL_RAT_CONS	-0.845 (0.070)	-0.9169 (0.0073)

Table 14: Estimations of demand equation with dummy variable (long-term business loans)

	Model 4	**Model 4 with dummy**
CONSTANT	-30.720 (0.407)	-26.9530 (0.0385)
Dummy		0.6221 (0.0205)
IR_BUS_LONG	-0.060 (0.022)	-0.0291 (0.0019)
GDP	3.876 (0.095)	3.5084 (0.0090)
Dummy*GDP		-0.0458 (0.0064)

Table 15: Estimations of supply equation with dummy variable (consumer loans)

	Model 1	**Model 1 with dummy**
CONSTANT	2.226 (0.099)	1.9512 (0.0090)
Dummy		1.1158 (0.0042)
LENDCAP	1.485 (0.078)	1.5370 (0.0079)
Dummy*LENDCAP		-0.2054 (0.0041)

Table 16: Estimations of demand equation with dummy variable (consumer loans)

	Model 1	**Model 1 with dummy**
CONSTANT	-44.956 (0.493)	-27.1535 (0.0374)
Dummy		2.9274 (0.0070)
IR	-0.302 (0.043)	-0.0746 (0.0023)
GDP	5.358 (0.105)	3.5142 (0.0091)
Dummy*GDP		-0.2687 (0.0054)

Table 17: Estimations of supply equation with dummy variable (mortgages)

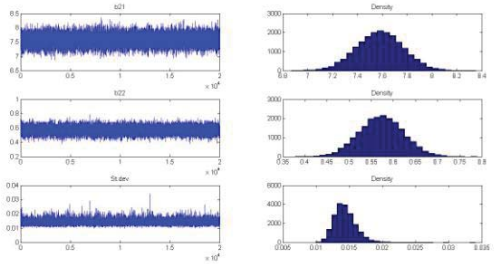
	Model 1	**Model 1 with dummy**
CONSTANT	2.285 (0.098)	2.0688 (0.0090)
Dummy		0.9710 (0.0005)
LENDCAP	1.615 (0.081)	1.6562 (0.0041)
Dummy*LENDCAP		-0.1780

Table 18: Estimations of demand equation with dummy variable (mortgages)

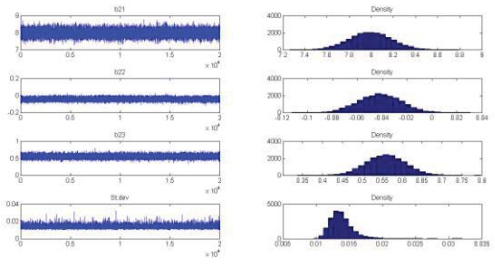
	Model 1	**Model 1 with dummy**
CONSTANT	-60.825 (0.571)	-31.9245 (0.0404)
Dummy		3.5008 (0.0087)
IR	-0.219 (0.038)	-0.0682 (0.0022)
GDP	6.818 (0.116)	4.0092 (0.0096)
Dummy*GDP		-0.3232 (0.0059)

Figure 1: Supply equation estimations for short-term business loans (Gibbs sampler chains and posterior distributions)

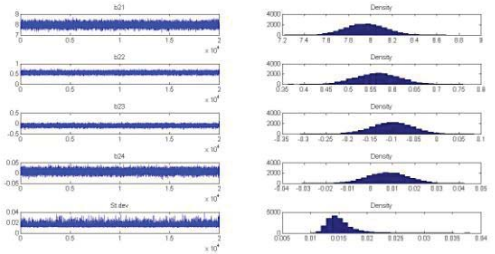
(a) Model l



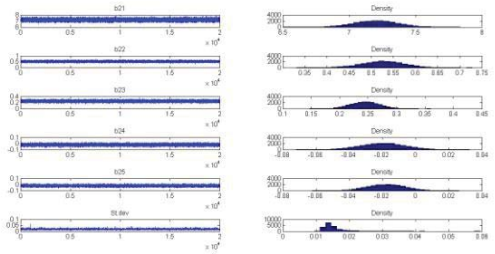
(b) Model 2 *



(c) Model 3



(d) Model 4



(d) Model 5

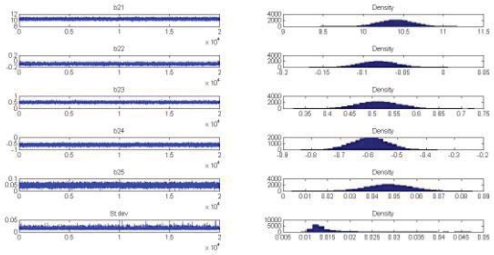
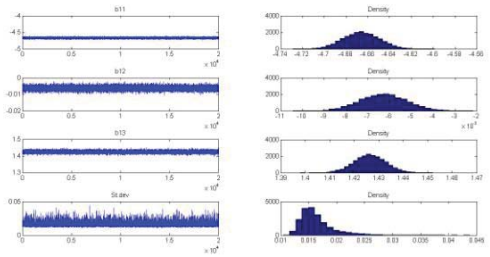
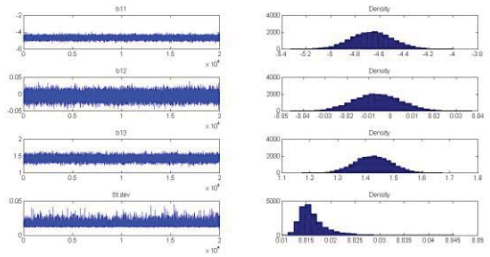


Figure 2: Demand equation estimations for short-term business loans (Gibbs sampler chains and posterior distributions)

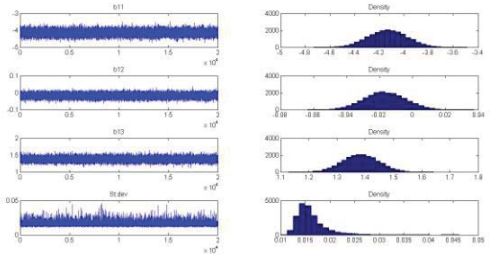
(a) Model 1



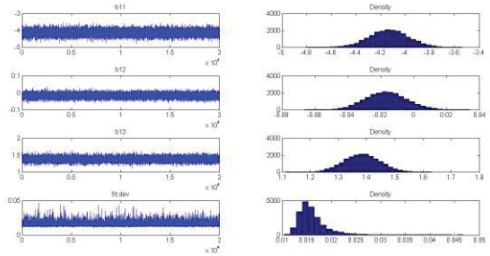
(b) Model 2 *



(c) Model 3



(d) Model 4



(e) Model 5

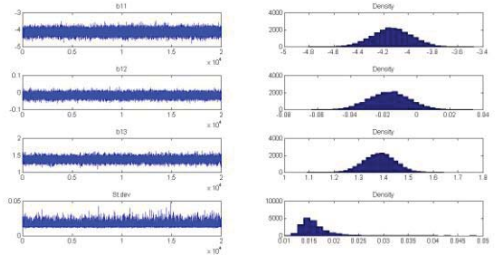
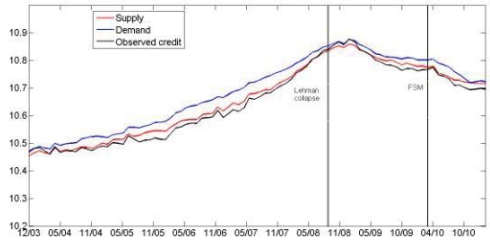
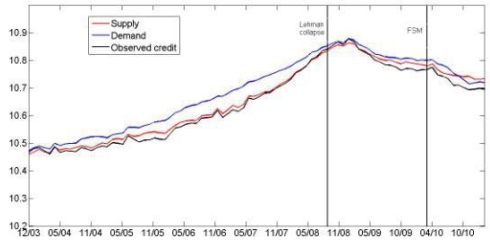


Figure 3: Mean supply and demand for short-term business loans

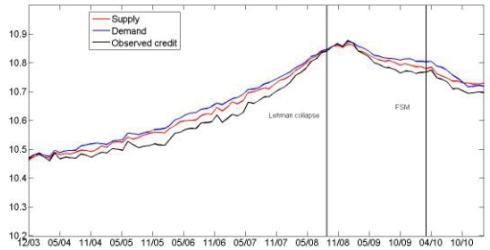
(a) Model 1



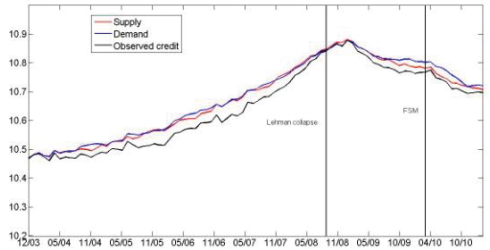
(b) Model 2 *



(c) Model 3



(d) Model 4



(e) Model 5

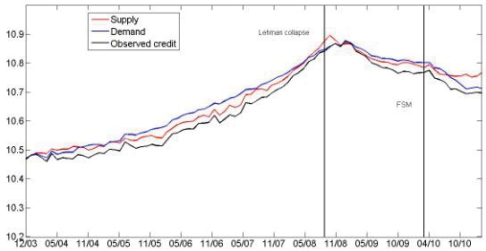
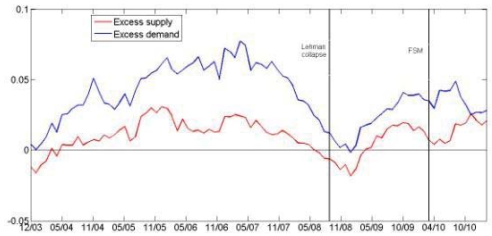
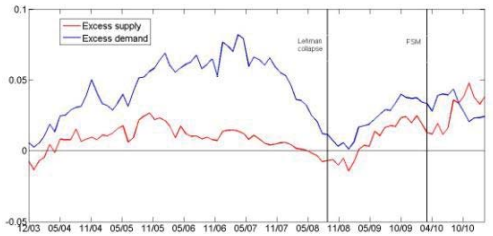


Figure 4: Mean excess supply and demand for short-term business loans

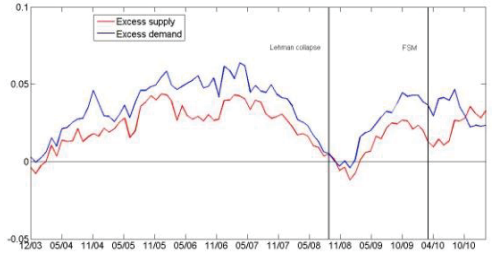
(a) Model 1



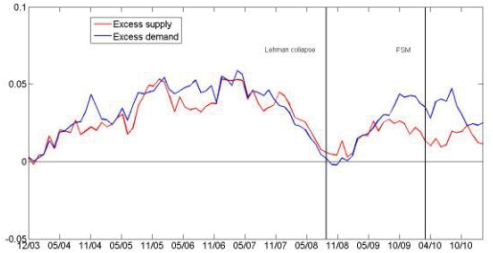
(b) Model 2 *



(c) Model 3



(d) Model 4



(e) Model 5

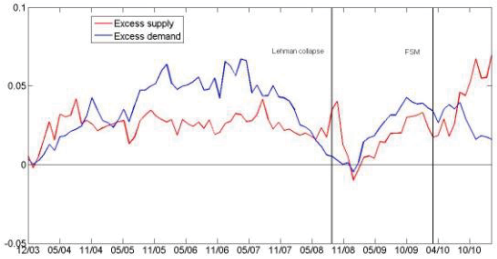
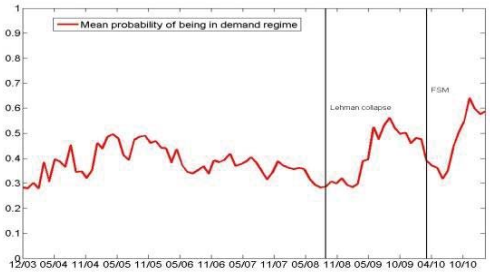
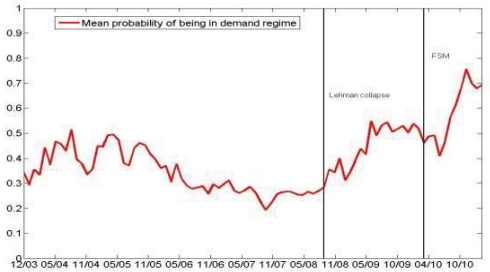


Figure 5: Probability of being in demand regime for short-term business loans

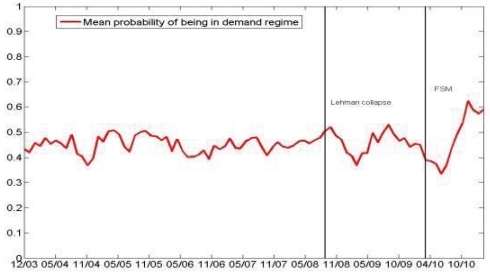
(a) Model 1



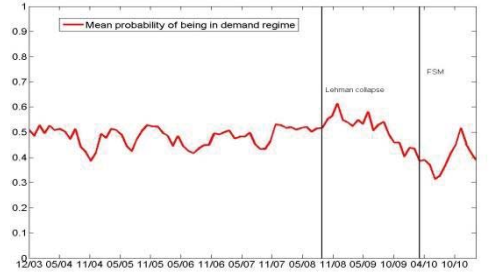
(b) Model 2 *



(c) Model 3



(d) Model 4



(e) Model 5

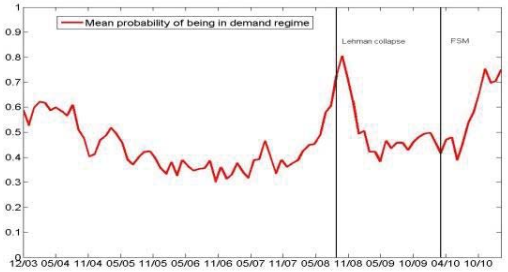
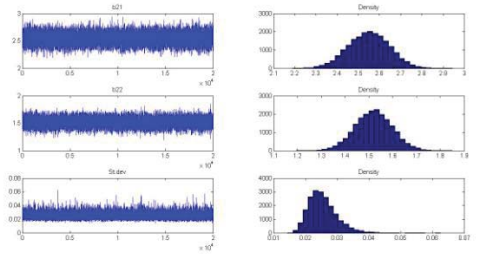
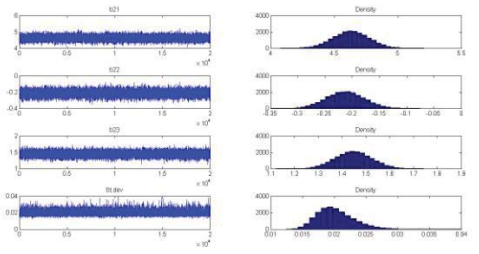


Figure 6: Supply equation estimations for long-term business loans (Gibbs sampler chains and posterior distributions)

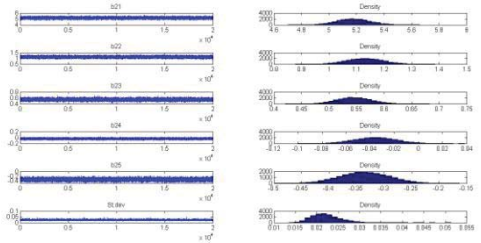
(a) Model 1



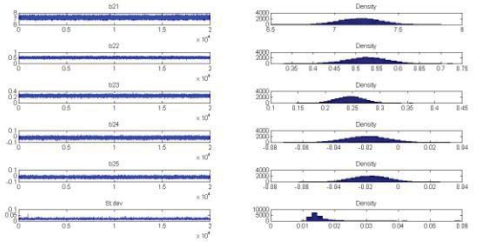
(b) Model 2



(c) Model 3



(d) Model 4 *



(e) Model 5

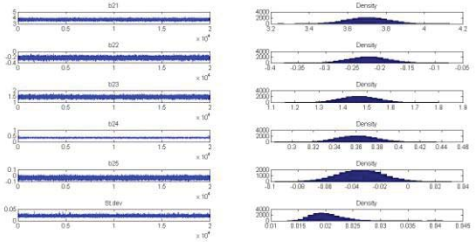
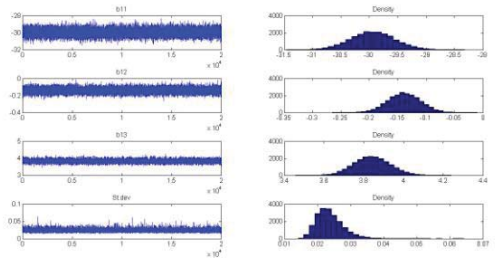
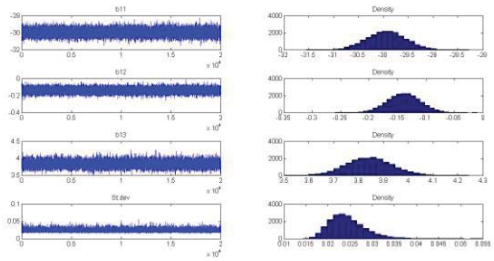


Figure 7: Demand equation estimations for long-term business loans (Gibbs sampler chains and posterior distributions)

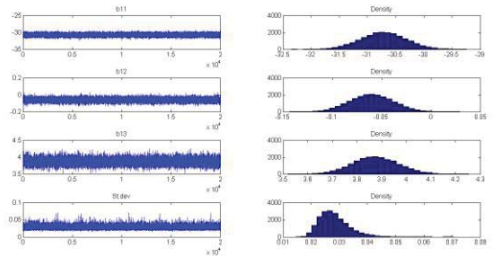
(a) Model 1



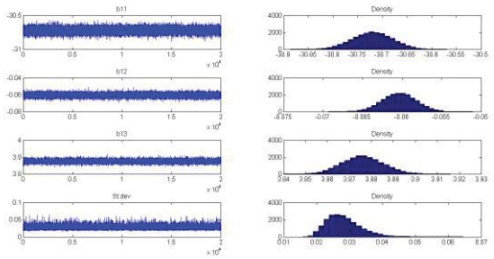
(b) Model 2



(c) Model 3



(d) Model 4 *



(e) Model 5

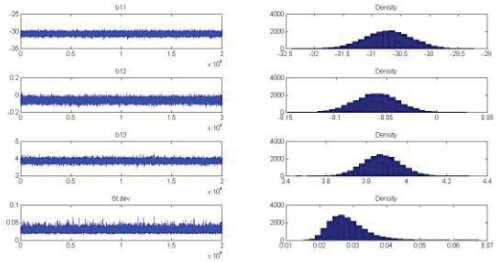
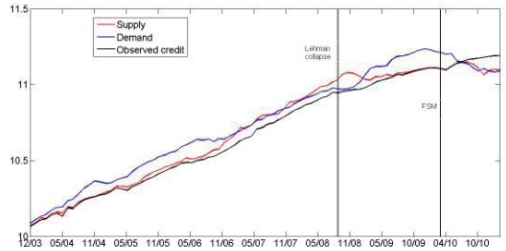
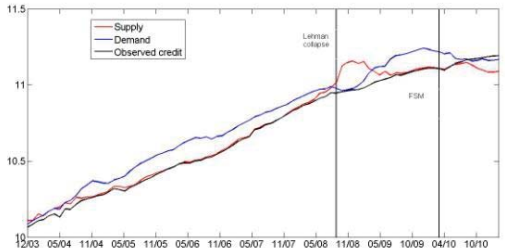


Figure 8: Mean supply and demand for long-term business loans

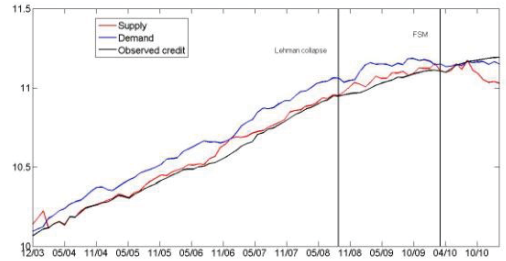
(a) Model 1



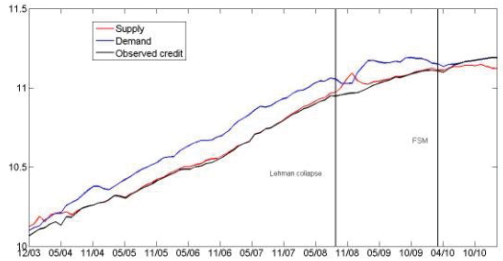
(b) Model 2



(c) Model 3



(c) Model 4 *



(d) Model 5

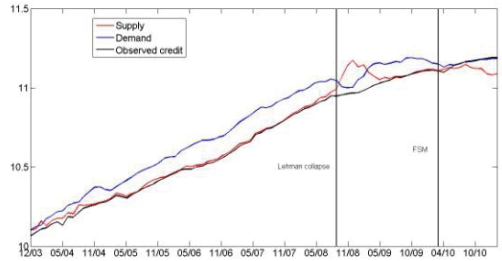
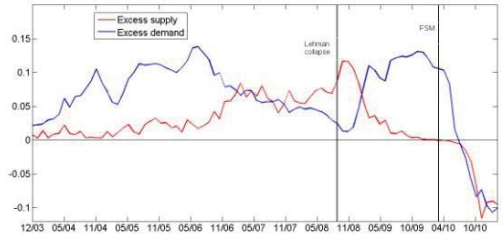
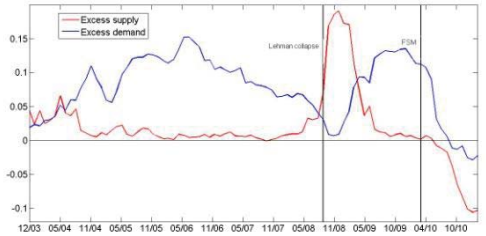


Figure 9: Mean excess supply and demand for long-term business loans

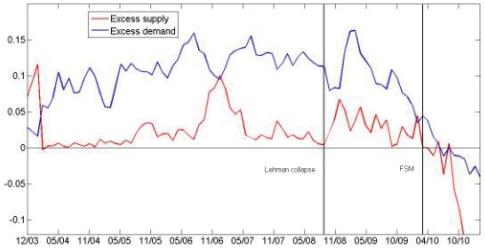
(a) Model 1



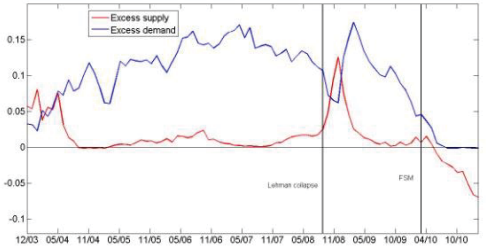
(b) Model 2



(c) Model 3



(d) Model 4 *



(e) Model 5

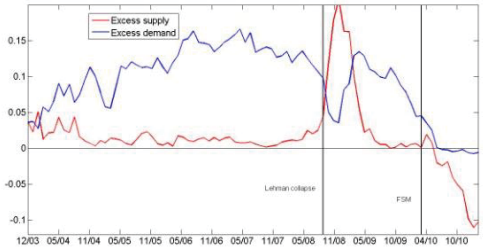
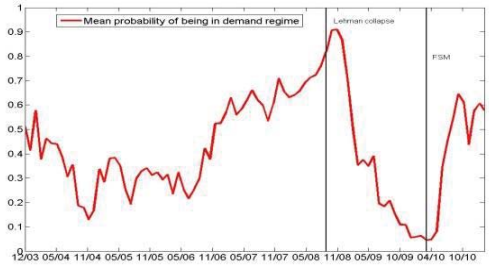
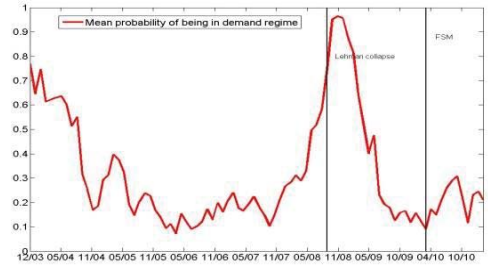


Figure 10: Probability of being in demand regime for long-term business loans

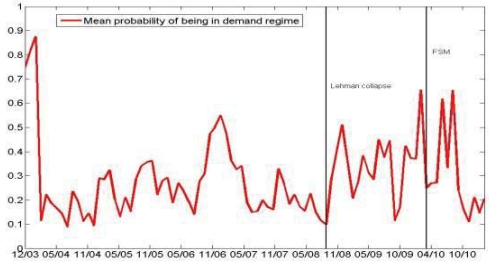
(a) Model 1



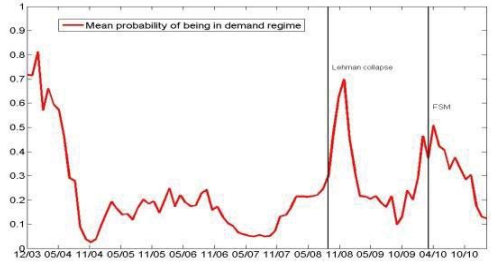
(b) Model 2



(c) Model 3



(d) Model 4 *



(e) Model 5

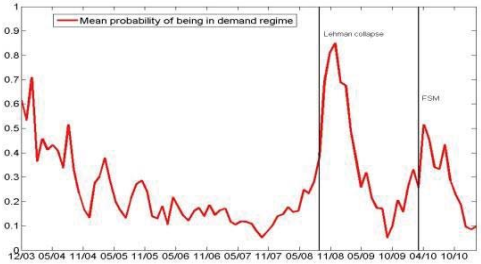
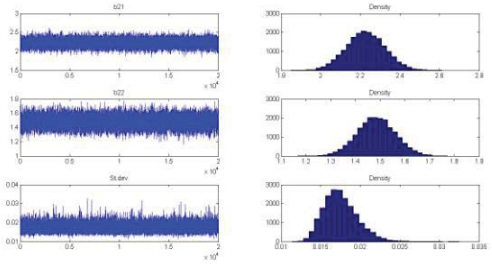
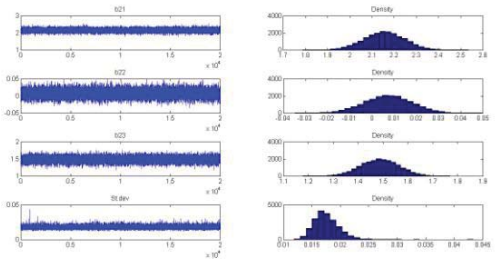


Figure 11: Supply equation estimations for consumer loans (Gibbs sampler chains and posterior distributions)

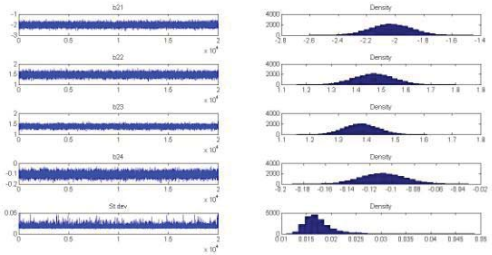
(a) Model 1 *



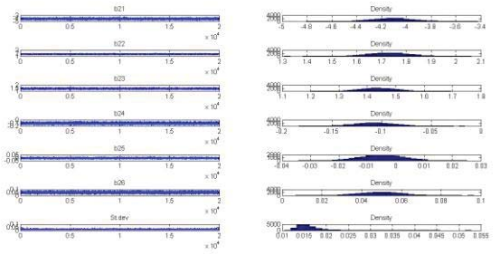
(b) Model 2



(c) Model 3



(d) Model 4



(e) Model 5

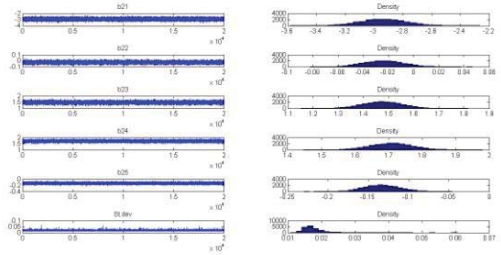


Figure 12: Demand equation estimations for consumer loans (Gibbs sampler chains and posterior distributions)

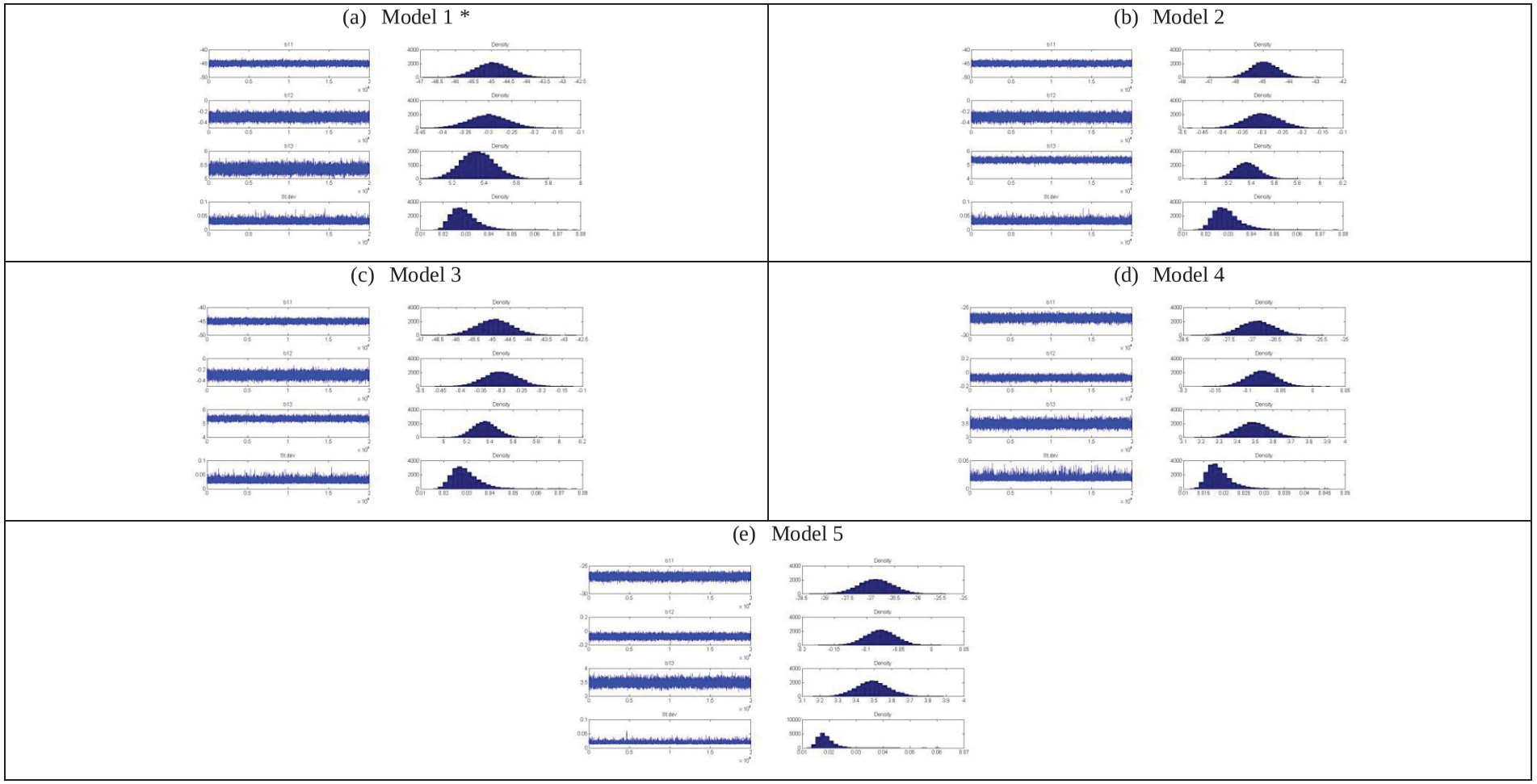
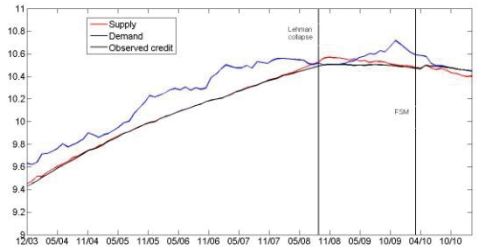
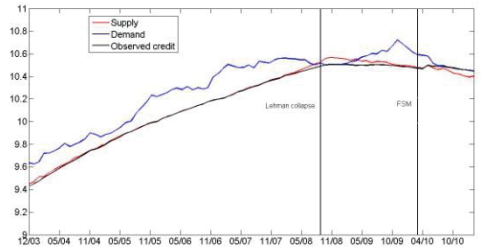


Figure 13: Mean supply and demand for consumer loans

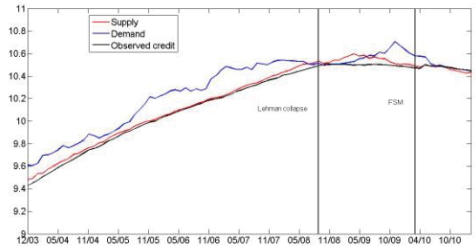
(a) Model 1 *



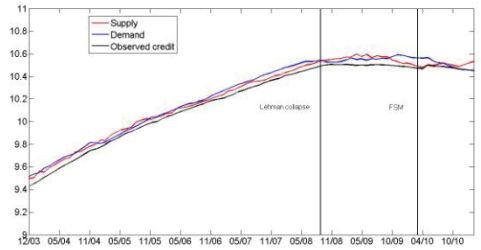
(b) Model 2



(c) Model 3



(d) Model 4



(e) Model 5

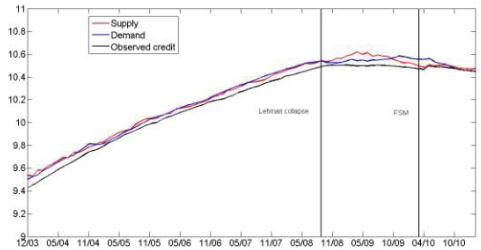
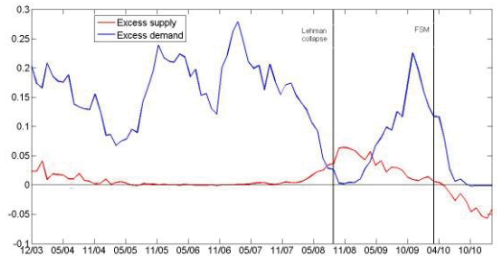
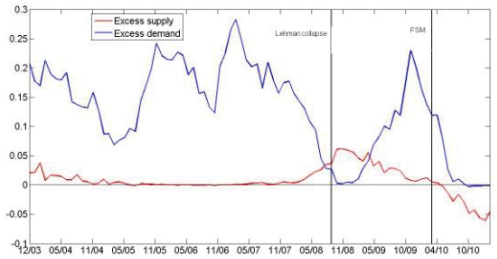


Figure 14: Mean excess supply and demand for consumer loans

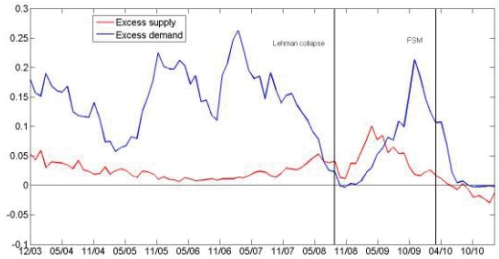
(a) Model 1 *



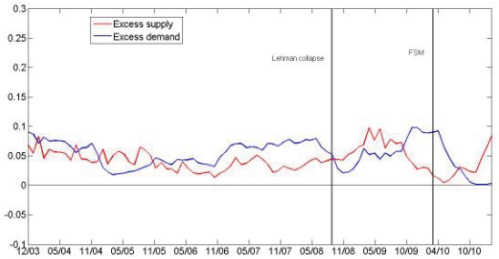
(b) Model 2



(c) Model 3



(d) Model 4



(e) Model 5

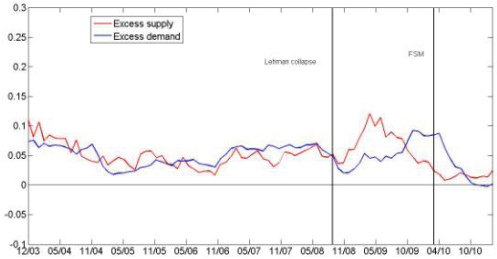
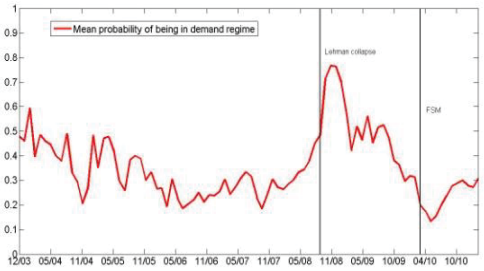
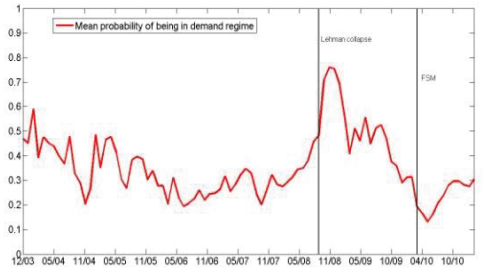


Figure 15: Probability of being in demand regime consumer loans

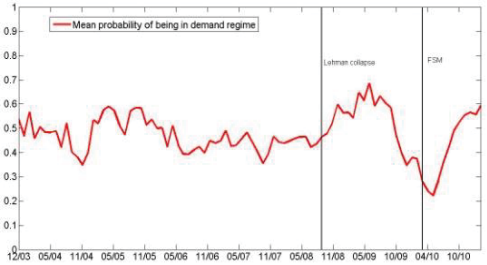
(a) Model 1 *



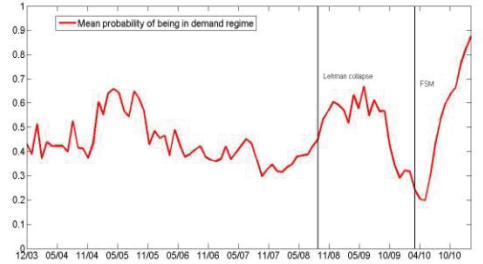
(b) Model 2



(c) Model 3



(d) Model 4



(e) Model 5

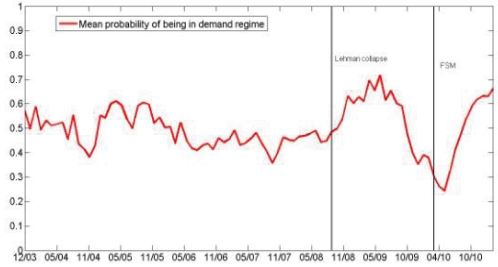
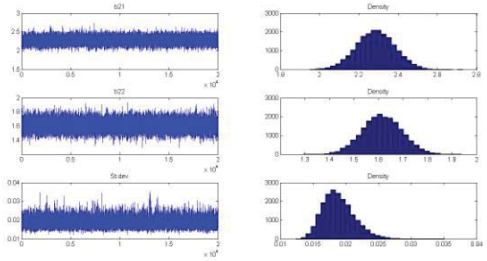
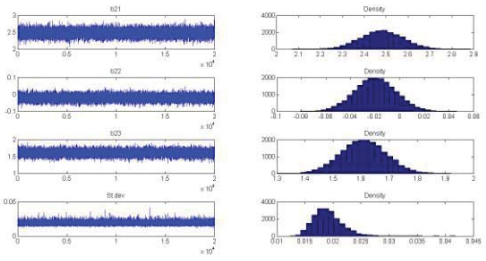


Figure 16: Supply equation estimations for mortgages (Gibbs sampler chains and posterior distributions)

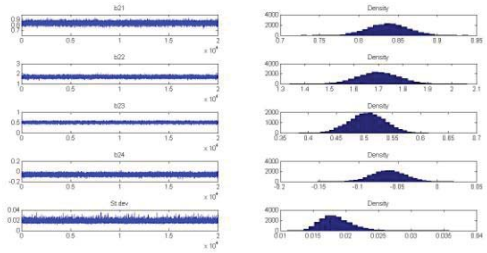
(a) Model 1 *



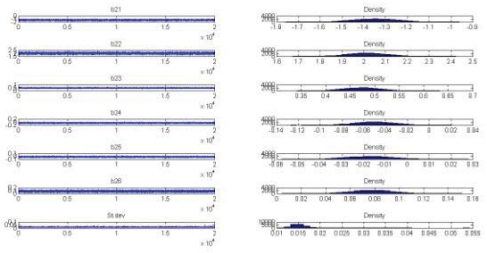
(b) Model 2



(c) Model 3



(d) Model 4



(e) Model 5

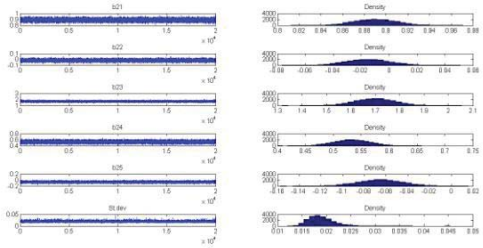
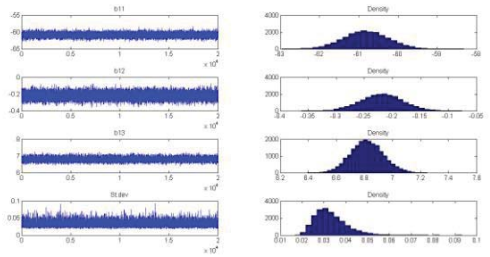
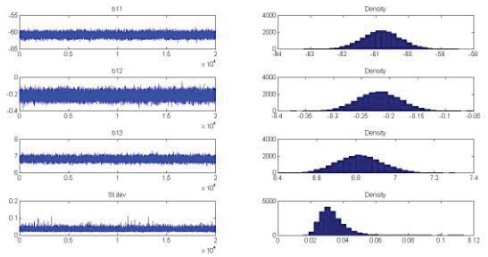


Figure 17: Demand equation estimations for mortgages (Gibbs sampler chains and posterior distributions)

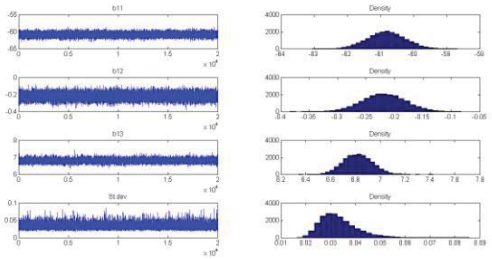
(a) Model 1 *



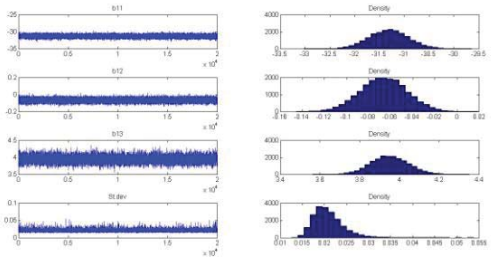
(b) Model 2



(c) Model 3



(d) Model 4



(e) Model 5

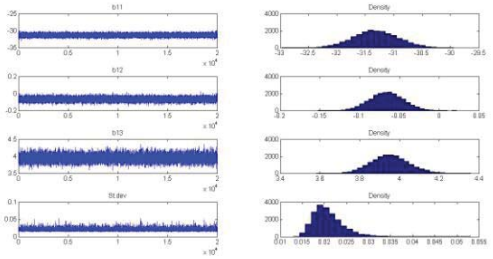
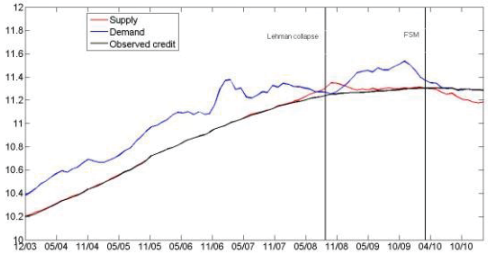
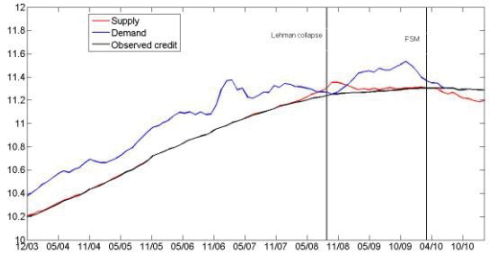


Figure 18: Mean supply and demand for mortgages

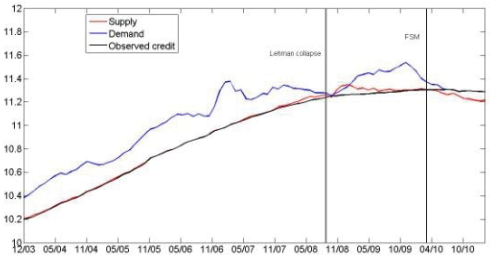
(a) Model 1 *



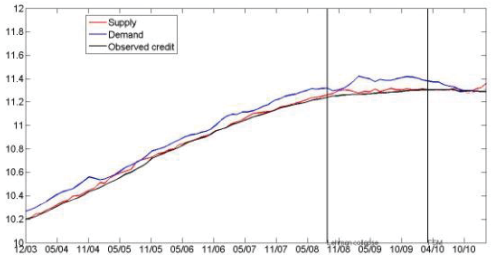
(b) Model 2



(c) Model 3



(d) Model 4



(e) Model 5

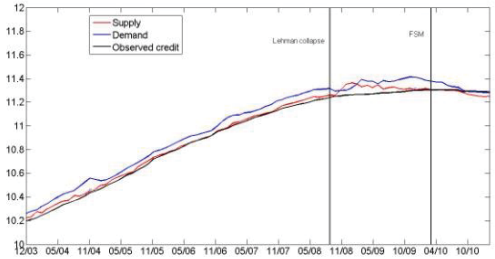
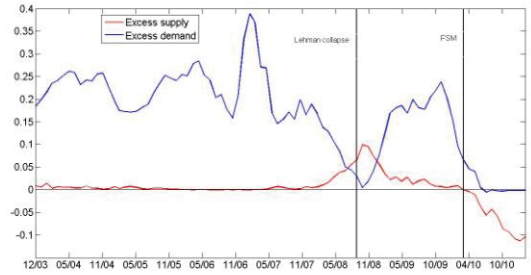
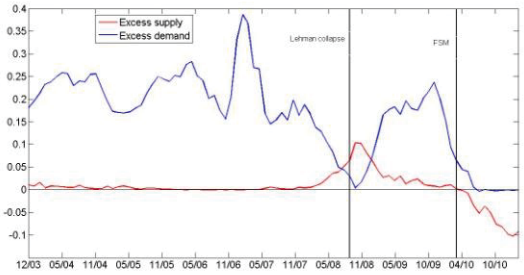


Figure 19: Mean excess supply and demand for mortgages

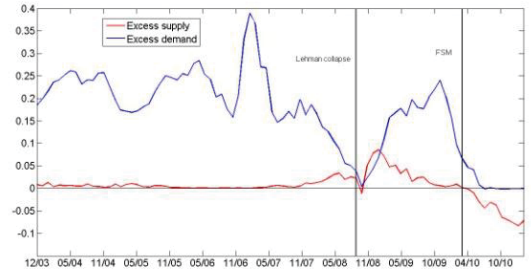
(a) Model 1 *



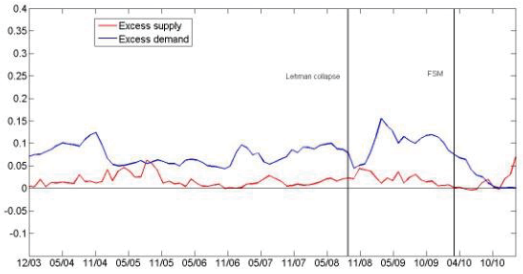
(b) Model 2



(c) Model 3



(d) Model 4



(e) Model 5

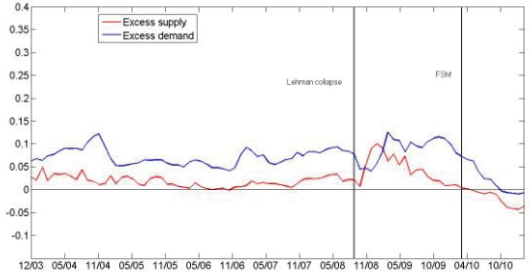
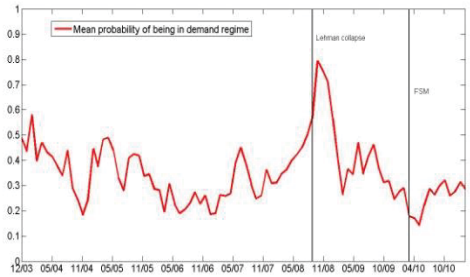
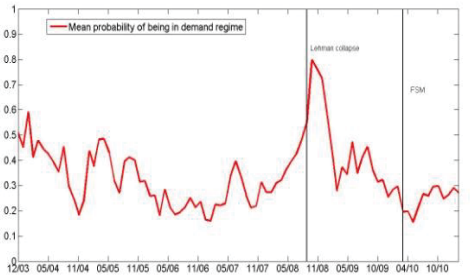


Figure 20: Probability of being in demand regime for mortgages

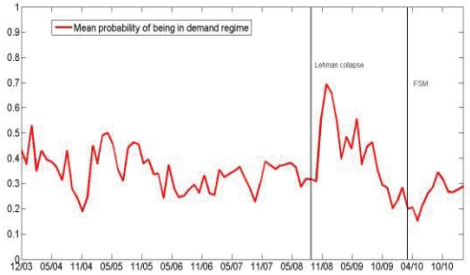
(a) Model 1 *



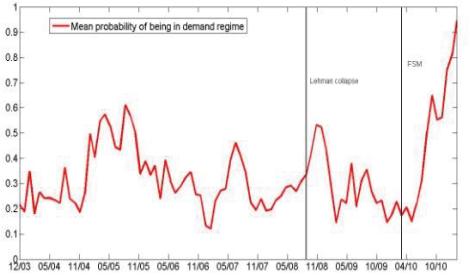
(b) Model 2



(c) Model 3



(d) Model 4



(e) Model 5

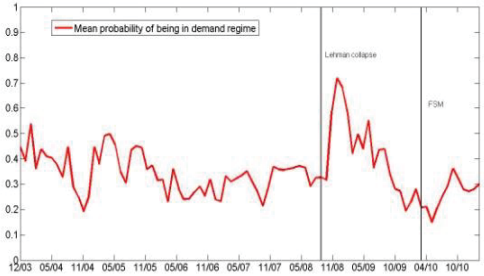
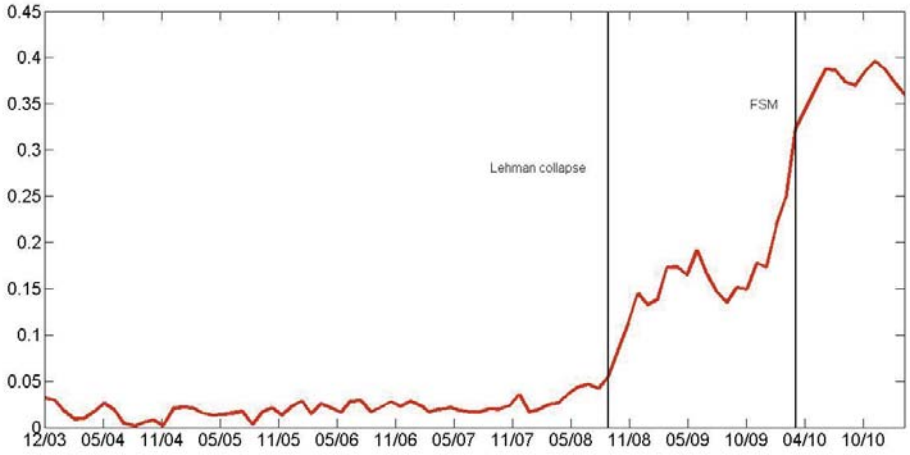


Figure 21: Central bank dependence ratio



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