Staff memo

Monetary policy with high household debt and low interest rates

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Summary

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We study how macroeconomic developments in Sweden are affected by the rapid increase in household debt levels that has happened over the last 30 years, while taking into account that interest rates have fallen over the same period. To do that, we use a dynamic stochastic general equilibrium model with housing and nominal debt calibrated to the level of households' debt and interest rates in the mid-1990s and the period 2006-2015.

We have three main results. First, we confirm earlier findings that unsystematic monetary policy has larger effects on key macroeconomic variables in the presence of higher household debt levels. Second, standard macroeconomic shocks give rise to a smaller variation in key macroeconomic variables in the economy with high debt and low interest rates. As the economy is more interest rate sensitive with high debt, the ability of monetary policy to stabilize the effects of standard macroeconomic shocks is larger, implying lower volatility. Third, shocks occurring in the financial system have larger effects on macroeconomic variables when debt is higher. Hence, higher interest rate sensitivity translates into higher vulnerability of the economy to financial shocks.

Finally, a Bayesian Vector Autoregressive (BVAR) model estimated on different sample periods provides some supporting evidence for our DSGE model-based results, since the effect of unsystematic monetary policy on GDP and house prices is larger with high debt.

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Introduction

Over the last 20 to 30 years two important changes to the economic environment have happened in Sweden and many other countries around the world. First, Sweden belongs to the group of countries with high and rising household debt over GDP (Zabai, 2017). Measured as a fraction of disposable income, household debt has increased from roughly 90 percent in 1995 to around 190 percent in the middle of 2019, corresponding to an annual growth rate often above 5 percent (see Figure 1). In terms of GDP, the share of household debt with houses as collateral increased from roughly 26 percent in mid-1990s to around 60 percent in the last decade. Second, interest rates have trended down as part of a global phenomenon. Figure 2 reports the downward trend in the Riksbank's policy rate, but the trend is also apparent in longer nominal interest rates and real rates both in Sweden and globally (see, for instance, Armelius et al. (2014), Rachel and Smith (2017), Holston et al. (2017)).

Figure 1. Household debt as percentage of annual disposable income.

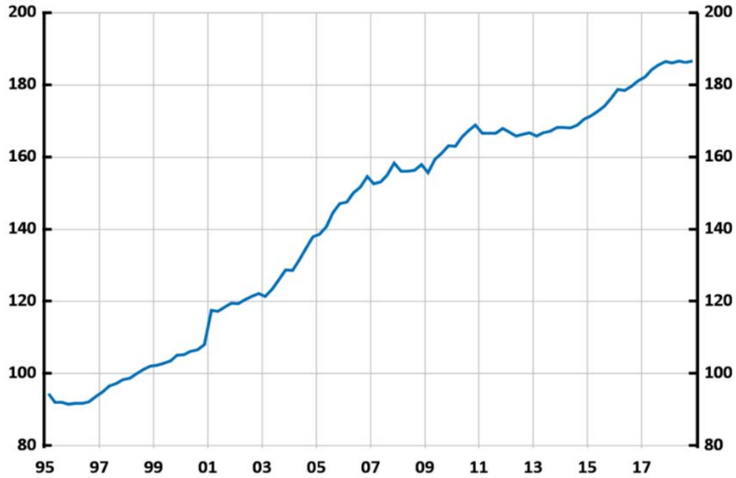
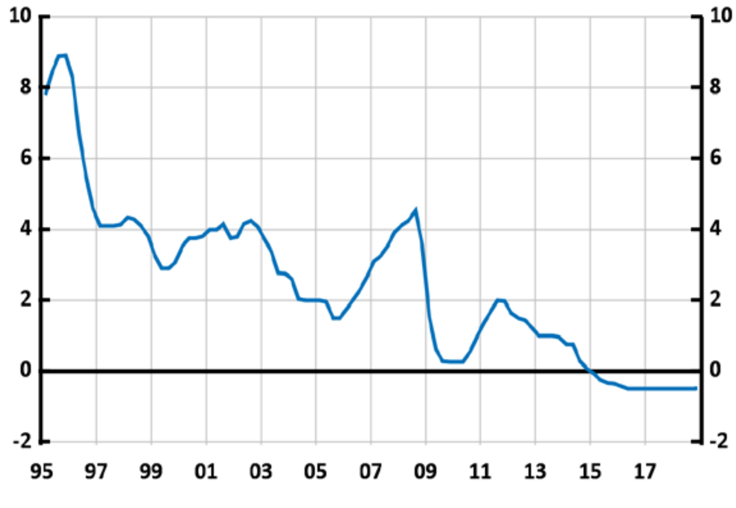


Figure 2. Repo rate, percent.



Previous papers have examined how the rise in debt levels affects financial stability and the monetary policy transmission mechanism. For the case of Sweden, Zabai (2017), Sveriges Riksbank

(2018), and Finansinspektionen (2018**)** have examined the financial stability consequences, while Sveriges Riksbank (2014) and Finocchiaro et al. (2016) have looked at the implications for the monetary policy transmission mechanism. What is less studied in the previous literature is whether the effects of other macroeconomic disturbances also change when debt is higher. Another strand of literature has examined the consequences for monetary policy of the fall in nominal and real interest rates (see, for example, Adam and Billi (2006, 2007), Söderström and Westermark (2009)). Most of the papers in this literature have focused on the constraint the effective lower bound represents for monetary policy, recognizing that situations where interest rates are at the lower bound will be more frequent if interest rates are lower on average. Few papers have examined the role of high household debt in connection with low interest rates, the exception being the contemporaneous work by Chen et al. (2019), who explicitly model the zero lower bound constraint on interest rates in a model with a housing sector.

In this paper we contribute to the existing literature by examining whether the stronger transmission of unsystematic monetary policy that previous studies have uncovered in the presence of higher household debt spills over into a strong effectiveness of systematic monetary policy and how that depends on the level of interest rates. In fact, we consider the case where high household debt is due not only to less stringent loan-to-value (LTV) ratio constraints, but also different interest rate levels. To shed light on these questions, we employ a macroeconomic model with a housing sector estimated on Swedish data that has previously been used by Finocchiaro et al. (2016).

The primary focus of our analysis is to compare monetary policy effectiveness under two calibrations of our model, one calibration with household debt and interest rate levels as in Sweden during the mid-1990s, and one with debt to GDP and interest rates as in Sweden during the period 2006-2015. We start by analysing the effects of exogenous unanticipated changes in interest rates, so-called monetary policy shocks. Subsequently, we broaden the analysis by also considering other shocks, namely standard demand and supply shocks, to study the systematic response of monetary policy. We also consider shocks that occur in the financial system.

First, we confirm earlier findings that the effects on key macroeconomic variables of exogenous unanticipated changes in the policy rate are larger when household debt levels are higher. In other words, the economy is more interest rate sensitive when household debt is higher – the monetary policy transmission mechanism is stronger. Second, we find that key macroeconomic variables vary less in response to standard macroeconomic shocks, when there is more debt and low interest rates in the economy, because monetary policy is more effective at stabilizing the economy after standard macroeconomic shocks. Hence, overall volatility is lower. This result holds in our model because we consider that not only the less stringent LTV ratio constraints, but also the level of interest rates has contributed to the high debt levels. Third, shocks occurring in the financial system have larger effects on macroeconomic variables when debt is higher. In particular, shocks to the spreads between lending rates to households and firms on the one hand, and the policy rate on the other, affect macroeconomic variables more when debt is higher. The intuition is the same as in the case of monetary policy shocks: with a more interest rate sensitive economy, shocks that directly move interest rates will have larger effects on macroeconomic variables. Hence, higher debt implies higher vulnerability of the economy to financial shocks.

Finally, we offer some evidence of the effect of monetary policy shocks on the economy from a Bayesian Vector Autoregressive model estimated on Swedish data for different sample periods. We find that exogenous unanticipated changes in monetary policy have indeed had stronger effects on GDP and house prices (and partly household debt) during the last years, but the same is not true for inflation and the exchange rate. Hence, the empirical analysis provides some support to the results of the DSGE model, but it also points out that some drivers that are missing in the model have probably counteracted the effects of high household debt on the transmission to inflation, leaving it unchanged with respect to earlier years.

The paper is structured as follows. First, we provide a literature review with a special focus on the case of Sweden. Then, we describe the macroeconomic model we use in the subsequent analysis and our calibration strategy. Our main points are made in the subsequent section. Afterwards, we provide a more in-depth analysis on the mechanism at work in our exercise and show empirical evidence from a BVAR model. Finally, we discuss some key conclusions.

Literature review

Our work is related to the ample literature on the role of the housing sector for the transmission of monetary policy, both at international level and with special focus on the Swedish economy. The most influential paper in the literature is Iacoviello (2005), that has been extended and adapted to different economies in subsequent work. Our main reference is Finocchiaro et al. (2016), providing a DSGE model with housing and a banking sector, built on Gerali et al. (2010). Finocchiaro et al. (2016) adds long-term debt to the original model. This model is estimated on Swedish data and is used to study the effect of various macroprudential policies to dampen household debt and how the transmission of monetary policy is affected by the level of household debt. The authors show that the effect of an unexpected rate hike on inflation is greater when household debt is higher, because of the higher sensitivity to interest rates. In the following analysis, we extend these findings by studying the case of high household debt and low interest rates, while also considering the systematic response of monetary policy and the financial side of the economy.

An additional study focused on monetary and macroprudential policy in Sweden is Chen et al. (2019). They extend the model in Iacoviello and Neri (2010) by including long-term debt, housing transaction costs and a zero lower bound constraint on policy rates. They find that unexpected changes to monetary policy are more effective when interest rates are low and household debt is higher, but this is problematic at the zero lower bound when macroprudential regulation requires an expansionary monetary policy. In fact, in this case the central bank is constrained from using a tool that has become more powerful, leading to worse macroeconomic outcomes. They furthermore find that the short-term macroeconomic costs are more substantial following a loan-to-value (LTV) tightening rather than a loan-to-income (LTI) tightening, especially in an environment where debt is high and monetary policy is close to the effective lower bound. The argument that changes in interest rates are more effective when household debt is higher is also discussed in Englund and Svensson (2017) and Svensson (2019). The authors point to the fact that the cash-flow channel of monetary policy is stronger with high household debt, so that smaller policy rate changes are needed to stabilize the economy than the case with lower household debt. We contribute to this discussion, by distinguishing the case of systematic and unsystematic components of monetary policy. Apart from Swedish studies, a recent paper that looks also at the systematic component of monetary policy is Greenwald (2018). The author explores the role of the mortgage credit channel in a model with loan-to-value ratio and payment-to-income constraints. These features deliver an amplified transmission from nominal interest rates into debt, house prices, and economic activity. Among other findings, the paper shows that the systematic response of monetary policy is more effective at stabilizing inflation in an economy with the mortgage credit channel, but it generates also larger swings in credit growth, that may not be desirable. This is in line with our results about the increased vulnerability of the economy to financial shocks.

In terms of empirical studies on Sweden, Gustafsson et al. (2017) calculate that a 1 percentage point rise in the repo rate would decrease households' disposable income by about 1 per cent, everything else equal and considering only direct effects. However, this is an aggregate estimate and varies a lot based on the level of indebtedness. Flodén et al. (2017) provide an estimate of the strength of the cash-flow channel of monetary policy using administrative data on Swedish households. Their results show that highly indebted households with adjustable rate mortgages reduce consumption growth more than households with little debt or fixed rate mortgages in response to an increase in the household interest rate. There is an even larger empirical literature on the role of housing for the transmission of monetary policy, concerning the rest of the world. Here we mention only the most relevant papers for our analysis. Calza et al. (2013) study the transmission of monetary policy to consumption, residential investment, and house prices in a sample of industrialized countries with different mortgage markets, including Sweden. Residential investment and house prices are found to be more responsive to monetary policy shocks when mortgage markets are more developed and flexible. Cloyne et al. (2018) use household survey data for the U.S. and the U.K. to document that the aggregate response of consumption to interest rate changes is driven by households with a mortgage, due to their higher marginal propensity to consume. Another paper using household-level data is Gelos et al. (2019). The authors study the response of households to monetary policy shocks before and after the financial crisis in the U.S. They find that the responsiveness of household consumption to monetary policy has diminished since the crisis, but this is not due to household indebtedness. Higher-indebted households have responded more to monetary policy shocks than lower-indebted households, both in pre-and post-crisis periods.

Consequences for monetary policy of the downward trend in nominal and real interest rates have been analysed in many previous papers. The starting point of many of these papers is that lower interest rates on average means that monetary policy will be more often in a situation where the effective/zero lower bound is binding. One of the first contributions to the topic is Adam and Billi (2006, 2007), while Söderström and Westermark (2009) discuss the issue for the case of Sweden. For a literature on the consequences of the lower bound for central banks and possible solutions to overcome it, see Rogoff (2017). The perspective in our analysis is somewhat different, since we show that if lower interest rates contribute to high household debt, there are implications for systematic monetary policy, even in the absence of a lower bound constraint.

A macroeconomic model with household debt

Structure and mechanisms

The model is identical to the one used by Finocchiaro et al. (2016), which in turn is based on the work by Gerali et al. (2010) and Iacoviello (2005). The model shares many features with standard New Keynesian DSGE models. To keep the exposition short we discuss only the distinctive features in detail.

Households obtain utility from consumption, leisure, and housing services and supply labour to entrepreneurs. There are two representative households in the model: a “patient” household (with a high discount factor) and an “impatient” household (with a low discount factor). In equilibrium, the patient household has sufficient funds to purchase a house without borrowing. Furthermore, she uses banks' deposit accounts to store resources. This household is called “the lender”, because her resources are channelled to the borrowers in the economy through the banking sector. The impatient household has insufficient funds to buy a house and consequently needs to borrow from the bank. She is called “the borrower”. Debt contracts are assumed to be long-term in the sense that the debt is not repaid fully after one period, but carries over to more periods. By assumption, the amount of new debt that the borrower can obtain in every period is limited to be at most a fraction of the current value of the housing investment, which represents collateral for the borrower. [2] This means that at the end of every period the total stock of debt equals debt at the beginning of the period less amortization plus new debt, where the amortization rate is a fixed parameter smaller than 100 percent.[3] The expressions below describe how debt in real terms at time t is accumulated over time and how the new amount of debt in real value is restricted by the borrowing constraint.

$$Debt_t = (1 - AmortizationRate) * \frac{Debt_{t-1}}{Inflation_t} + NewDebt_t \tag{1}$$

[2] This approach to introducing long-term debt is proposed by Kydland et al. (2016).
[3] One can go back to a model with one-period debt by fixing the amortization rate to 100 percent.

$$NewDebt_t \leq LTVratio * HousePrice_t * HousingInvestment_t \tag{2}$$

$$HousingInvestment_t = Housing_t - (1 - DepreciationRate) * Housing_{t-1} \tag{3}$$

The borrowing limit takes the form of a loan-to-value (LTV) ratio constraint.[4] The impatient household is assumed to borrow as much as possible, hence her borrowing constraint is always binding in equilibrium (that means that the equation holds with equality). Thanks to the introduction of long-term debt, the new debt issued in any period is related to the housing investment through the LTV ratio constraint. Hence, a change in house prices generated by a change in interest rates only has a direct effect on new debt, not the whole stock of debt.

Debt enters the budget constraint of the impatient household in the following way:

$$OtherExpenses_t + (AmortizationRate + InterestRate_t) * \frac{Debt_{t-1}}{Inflation_t} = NewDebt_t + OtherResources_t. \tag{4}$$

An additional important characteristic of the mortgage debt contract in the model is that it is specified in nominal terms, meaning that the interest rate to repay is fixed in nominal value.[5] Hence, an unexpected increase (decrease) in inflation will affect the housing sector by driving the ex post real cost of borrowing away from expected costs.

Entrepreneurs are responsible for the production of intermediate goods which they sell to retailers. Production requires labour services, capital services, and housing as input factors. Labour services are supplied by patient and impatient households. The labour market is split into two groups, hence the two types of households provide differentiated labour services and are paid different wages. Entrepreneurs are also "impatient" and need to borrow to finance the purchase of capital services. Their (one-period) debt is limited to a fraction of the value of their holdings of capital. The entrepreneurs' borrowing constraint is always binding in equilibrium.

A particular feature of the model is the existence of a banking sector characterised by monopolistic competition. Banks accept deposits from lenders and lend to borrowers and entrepreneurs. In addition to deposits, the lending activity is financed with bank capital. Banks also have access to a deposit and lending facility at the central bank. Assumptions are made to ensure that banks cannot use this facility to finance lending or deposit funds, but it does ensure that the central bank controls the interbank market rate. Banks' market power implies that there are spreads between deposit and lending rates for households and entrepreneurs, respectively, and the interbank rate. The markup for the lending rates and the markdown for the deposit rate are inversely related to the elasticities of substitution in each market.

Moreover, banks face adjustment costs for changing the rate on loans implying that there is incomplete pass-through from the policy rate to lending and borrowing rates. This feature of the banking sector slows down the response of the economy to changes in interest rates. The difference between lending and deposit spreads contribute to banks' profits that are used to accumulate bank capital. Banks have an optimal exogenous target for their capital-to-asset ratio and deviations from the target are costly.[6]

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[4] This borrowing constraint arises from the following micro-foundation, not present in the original model. Borrowers can repudiate their debt and in that case lenders can take over their assets by paying a cost that represents the losses incurred during the renegotiation process. Since this is known a priori, the maximum amount that lenders are willing to lend is the portion of the collateral value left, after subtracting the renegotiation cost that is attached to the LTV constraint. The way that the collateral constraint is introduced is similar to Kiyotaki and Moore (1997).

[5] The introduction of nominal debt in a model with financial frictions is one of the distinctive features of Iacoviello (2005) with respect to the previous literature.

[6] The assumption of a target for capital requirements helps to pin down the choice of equity versus deposits, that are otherwise perfect substitutes for the bank.

Assumptions are made to ensure that the stock of housing in the economy is fixed. In particular, patient households in the economy act as "buyers of last resort", in the sense that they make sufficient housing investments to ensure that the total stock of housing in the economy is the same in all periods. Although the fixed stock of housing seems a strong assumption, it can be motivated by the slow adjustment in the supply of housing and housing investment in Sweden. Hence, the model is equipped to analyse short-run questions, i.e. questions where it is reasonable to assume that the variation in the stock of housing is inconsequential for the results.

In the model, variations in the policy rate affect the economy through four alternative channels. *First*, they affect the consumption-savings decision of patient households through a standard consumption-Euler equation, hence we call it the "intertemporal substitution channel". *Second*, variations in the policy rate affect the debt repayment of borrowers and therefore their disposable income. As these households are always at the borrowing constraint in the equilibria we consider, they cannot smooth this variation in disposable income over time. Rather they have to adjust other spending, such as consumption, accordingly. This channel is often called the cash-flow channel and is at work because borrowers have flexible-rate debt.[7] It is typical of models with "financial accelerators", where endogenous developments in credit markets amplify and propagate shocks to the macroeconomy, in the spirit of Bernanke et al. (1999). *Third*, a collateral channel is at work. This channel entails that changes in the policy rate affect the value of houses and capital stock that represent collateral for borrowers (households and entrepreneurs). This means that their borrowing constraints can become more or less tight with respect to the previous period, hence affecting consumption and investment choices. This channel is a distinctive feature of Iacoviello (2005). *Fourth*, since debt is in nominal terms, any increase in inflation relaxes borrowers' constraints, while a decrease in inflation make them tighter. This is called the debt-deflation channel and is the second distinctive feature of Iacoviello (2005). As the author explains, the debt-deflation channel works to reinforce the financial accelerator in case of demand shocks and weaken it in case of supply shocks, since inflation and output move in opposite directions.

Calibration

In this section we discuss how we have calibrated the model to match some salient features of the Swedish economy during two different periods, 1995-1999 and 2006-2015.[8] Finocchiaro et al. (2016) estimated their model on Swedish data over the period 1995-2015. We assume that all but five parameters have remained constant over this period, while five parameters have changed. These parameters govern the levels of household debt and interest rates. Table 1 reports the targets of our calibration exercise. In order to match interest rates and debt levels in the two different periods, we calibrate five parameters of the model. These parameters are: the patient household's discount factor, the elasticities of substitution in the banking sector for deposits, loans to households and loans to entrepreneurs, and the LTV ratio for impatient households. The third column of Table 2 reports the values of these parameters calibrated to represent the economy during the period 2006-2015. The last column of Table 2 reports the values calibrated to represent the economy in the period 1995-1999. Table A1 and A2 in Appendix report values of the additional calibrated and estimated parameters from Finocchiaro et al. (2016) that we have not modified.

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[7] Mishkin (1996) describes this channel as a balance-sheet channel. Cloyne et al. (2018) refer to it with the name "cash-flow" channel.

[8] We choose 2015 as the ending point of our analysis in order to be close to the period of data used for the estimation of the model in Finocchiaro et al. (2016). This also implies that most of the period of negative repo rate and quantitative easing is outside our sample. Therefore, in the rest of our analysis we can disregard the issues of effective lower bound and shadow rate of interest.

Table 1. Comparison between the two steady states for the periods 2006-2015 and 1995-1999.

Target	2006-2015	1995-1999
Household mortgage debt / GDP	59	26
Lending rate to households	3.2	5.8
Lending rate to entrepreneurs	3.5	7.6
Deposit rate	1.2	2.6
Repo rate	1.7	5.2

Table 2. Key calibrated parameters for the model over the periods 2006-2015 and 1995-1999.

Parameters	Description	2006-2015	1995-1999
β_P	Patient households' discount factor	0.997	0.9935
β_I	Impatient households' discount factor	0.975	=
β_E	Entrepreneurs' discount factor	0.975	=
ν	Share of unconstrained households	0.6	=
μ	labor income share of unconstrained HHs	0.6	=
ρ_i	amortization rate	0.0069	=
ϵ^d	elasticity of subst. for deposits	-2.6	-1
ϵ^{bh}	elasticity of subst. for loans to HHs	2.1	9.5
ϵ^{be}	elasticity of subst. for loans to entr.	1.9	3.2
m_i	Households' LTV ratio	0.75	0.45
m_e	Entrepreneurs' LTV ratio	0.6	=

Using this calibration strategy, we can reproduce two different steady states for the Swedish economy. One steady state that captures the recent period, with average household debt equal to 59 percent, average repo rate at 1.7 percent and seemingly low lending and deposit rates. The second steady state is meant to resemble the mid-1990s, with average household debt equal to 26 percent, average repo rate at 5.2 percent and higher interest rates on deposits and loans (Table 1). It is important to notice that Finocchiaro et al. (2016) is solved with a zero steady-state inflation, and we keep this assumption across our two calibrations, where we targeted the spreads. [9] Hence, the following discussion relates to the nominal rates.

As shown in Equations (1) – (4), there are several parameters to vary in order to obtain different levels of household debt at the steady state: 1) the amortization rate, 2) the LTV ratio, 3) the depreciation rate of housing, or 4) the interest rate cost of debt.[10] Since the data on amortization time is limited, we do not use this option and leave the amortization rate equal to 0.69 percent for both steady states (Table 2), implying that debt is amortized over 50 years, as in Finocchiaro et al. (2016). Additionally, there is no evidence pointing to a change in the depreciation rate of housing. The options left are related to the LTV ratio and the interest rate cost of debt. Finocchiaro et al. (2016) have varied only the LTV ratio to study the case of an economy with high and low household debt. Chen et al. (2019) perform a similar exercise with two different calibrations, where not only the LTV ratio varies, but also the steady-state interest rates and the steady-state inflation. We cannot vary the steady-state inflation, hence we vary the first two, because there is ample evidence that the LTV ratio has increased in the last years and that interest rates have decreased. The data provided in Finansinspektionen (2009, 2017) start in 2002 and show that the LTV ratio for new mortgages was below 60 percent in 2002 and grew to around 70 percent in 2015. Considering that our model

[9] The reason for using zero steady-state inflation and targeting the spreads is related to the fact that average inflation in the period 1995-2015 was below the 2 percent target and also the nominal deposit rates were below 2 percent on average. Moreover, the authors argue that the average may be too influenced by the recent financial crisis.

[10] Moreover, one could vary the weight of housing in the utility function of impatient households, but we do not want to change preferences in our exercise.

features all mortgages, not only new mortgages and in order to match the data on mortgage debt over GDP, he loan-to-value (LTV) ratio is set equal to 60 percent for the recent period and 45 percent for the mid-1990s (Table 2). The LTV for entrepreneurs is the same for the two steady states, equal to 60 percent and delivers a steady-state value of corporate debt over GDP equal to 103 percent, in line with data.

In order to match the level of interest rates in the two economies, we start by varying the patient households' discount factor, that is directly related to the deposit rate offered by banks. We decrease the discount factor of patient households in the 1990s to achieve a higher deposit rate. This implies that in the low-debt economy patient households value the future less than in the high-debt economy, making the intertemporal substitution channel more tilted towards the present. The discount factor of impatient household is left unchanged, as in Finocchiaro et al. (2016). The elasticities of substitution in the banking sector are set to match the spreads of the deposit and lending rates with respect to the policy rate (Table 2). As can be seen from the numbers reported in Table 1 and Figure A1 in Appendix, lower interest rates in Sweden were associated also with higher mortgage spreads for households, that the model interprets as larger market power for banks in the household lending sector.[11]

Note that we have not modified the parameters pertaining to the share of constrained versus unconstrained households. In the model, 60 percent of the households are unconstrained and 60 percent of the labour share used in production is represented by unconstrained households. Other calibrated parameters are reported in Table A1 in Appendix and are mostly standard values from the literature.

Results

This section contains our main results. The analysis consists of comparing impulse response functions using the two versions of the calibration of the model.

Monetary policy shocks

We start by analysing the macroeconomic effects of unexpected exogenous changes in monetary policy. In particular, we consider the effects of a one percent increase in the repo rate. Figure 3 reports the results of this exercise where the red line represents the impulse response from the model calibrated to 2006-2015 and the black line represents the impulse response from the model calibrated to the mid-1990s (normalized to have a 1 percent impact on the repo rate to facilitate the comparison).

In both situations, the monetary policy shock causes the policy rate to increase, while consumption, GDP, investment, hours worked, and inflation drop. These are standard effects following a contractionary monetary policy shock. The aggregate consumption response is primarily driven by the drop in borrowers' consumption. In fact, the response of lenders´ consumption turns positive after five to eight quarters. The increase in the policy rate is transmitted to the economy through the banking sector, where lending rates increase, and loans to households and entrepreneurs decrease, while house prices drop (see Figure A2 in Appendix). Borrowers' consumption is reduced by the increased cost of loans (cash-flow channel) and by the drop in house prices (collateral channel). In addition, the drop in inflation makes the real value of debt increase *debt-deflation channel), which negatively affects borrowers' consumption. In contrast, lenders' consumption is boosted by the increase in lending rates and the drop in inflation through an income effect. Lenders' consumption

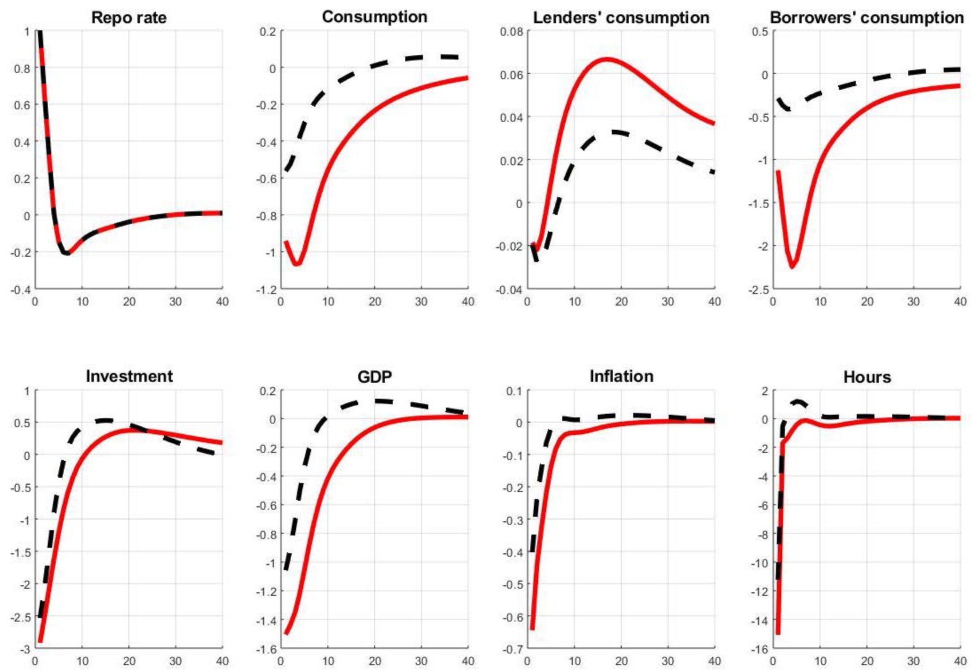
[11] See Sveriges Riksbank (2018) for a discussion on how stricter capital requirements and low interest rates in the post crisis period led banks to increase their mortgage margins.

drops initially, because higher lending rates give incentives to consume less and save more (intertemporal substitution channel). The income effect is obviously zero in the aggregate – any additional income earned by lenders has to be paid by borrowers. The reason why redistributing income across agents can have aggregate effects is that lenders and borrowers have different marginal propensities to consume (MPC). Since borrowers are at their borrowing limit all the time, their MPC equals unity. On the other hand, the MPC of lenders is less than unity because they are unconstrained.

Comparing the two economies, we notice that the responses of key macroeconomic variables are larger in the economy with more debt and lower interest rates. GDP drops 50 percent more and inflation 75 percent more when borrowers are more indebted. As the responses of hours and investment are quite similar across the two economies, the main reason for these difference is that aggregate consumption drops almost twice as much with high household debt. This, in turn, is caused by borrowers' consumption falling four times more on impact. The cash-flow (higher lending rates), collateral (lower house prices), and debt-deflation channels (lower inflation) work in the same direction and contribute to the larger drop in borrowers' consumption (see also Figure A2 in Appendix). In contrast, the income effect mentioned earlier contributes to lenders' consumption responding more positively in the economy with high debt.

A conclusion from this exercise is that unsystematic monetary policy, i.e. a monetary policy shock, has larger macroeconomic effects when debt is higher and interest rates are lower. Hence, we confirm the findings in Finocchiaro et al. (2016). The comparison with their work and more in-depth analysis in the section "Inspecting the transmission mechanism of monetary policy" suggest that key to the result is the level of household debt and not the level of interest rates. In the next subsection we explore whether the systematic part of monetary policy is more effective in a more interest rate sensitive economy.

Figure 3. Impulse responses to a monetary policy shock from DSGE model.

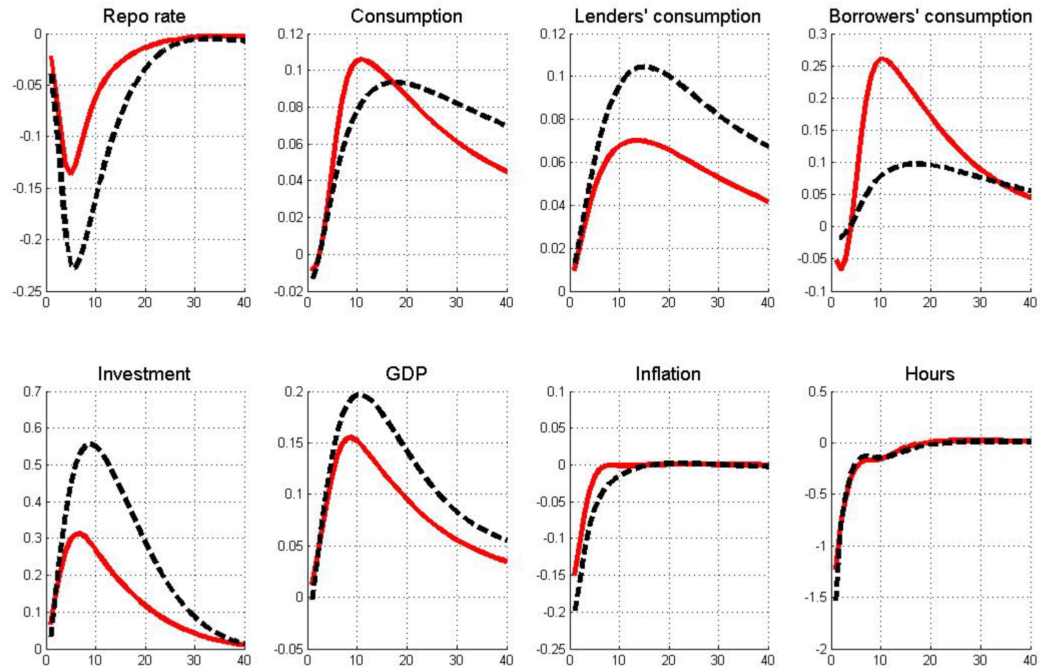


Note. Red line: model calibration with high debt and low interest rates in the steady state. Black line: model calibration with low debt and high interest rates in the steady state. The shocks are normalized to have the same impact on the repo rate. All variables are in levels and in deviation from steady state.

Demand and supply shocks

In this section we report impulse response functions following standard macroeconomic shocks. These shocks can be characterized as demand and supply shocks, depending on whether they generate positive co-movement (demand shock) or negative co-movement (supply) between output and inflation.[12] Monetary policy responds in a systematic manner to these shocks through the monetary policy rule. We aim to shed light on whether systematic monetary policy has become more effective since the mid-1990s. Notice that, unlike the case of the monetary policy shock, it is more difficult to compare the systematic response of monetary policy, due to the general equilibrium effects that move all variables at the same time. For this reason, we will describe the behaviour of the interest rate in relative terms with respect to the movements of inflation and GDP.

Figure 4. Impulse responses to a stationary productivity shock from DSGE model.



Note. Red line: model calibration with high debt and low interest rates in the steady state. Black line: model calibration with low debt and high interest rates in the steady state. The shock increases productivity by 1 percent on impact. All variables are in levels and in deviation from steady state.

Figure 4 reports the impulse responses after a temporary shock to productivity by one standard deviation. This is a shock that increases the amount of wholesale goods produced with given input factors. We label it a “supply shock” because it produces negative co-movement between GDP, driven up by the higher productivity, and inflation, driven down by the lower marginal costs. Under both calibrations, the shock causes GDP, consumption and investment to increase, while inflation and hours worked drop. The fall in inflation causes the central bank to lower the policy rate. As can be seen in Figure A3 in Appendix, the lower policy rate causes the household lending rate to fall and house prices

[12] Using the co-movement property between inflation and GDP to identify whether a shock is a demand or supply shock is often done when using VAR models, but not so often in the context of DSGE models. There are at least two reasons for this. First, shocks in DSGE models often affect both the demand and supply side of the economy. As an example, the supply shock we consider, a stationary productivity shock, will affect the demand side of the economy as it affects household income. Second, whether a given shock generates positive or negative co-movement (or any co-movement at all for that matter) depends on several model assumptions. For instance, the way the monetary policy reaction function is specified is crucial in this context.

to increase. The lower lending rate and higher house prices contribute positively to borrowers' consumption through the cash-flow and collateral channels. On the other hand, the drop in inflation increases the value of their debt in real terms, thereby contributing negatively to their consumption through the debt-deflation channel.

Comparing the two economies, we notice that the responses of investment, GDP, inflation are more muted in the economy with high debt and low interest rates, even though the policy rate response is much smaller in this economy. The fact that the economy with high debt and low interest rates is more interest rate sensitive implies that the systematic part of monetary policy is more effective in this situation. In other words, the central bank can achieve better stabilization of the economy with a smaller movement in the policy rate.

The variable that moves substantially more in the economy with high debt is borrowers' consumption: it drops more on impact but subsequently it increases much more. First of all, the debt-deflation channel, which contributes negatively to borrowers' consumption, is more muted in the economy with high debt and low interest rate: as inflation drops less in this situation the real value of debt increases less. Second, as shown in Figure A3 in Appendix, the lending spreads decrease more after the shock, especially the one for households. This makes the demand for loans increase much more (due to the cash-flow channel).

Figure 5 reports the impulse responses after a shock to government spending. This shock is labelled "demand shock", because it induces positive co-movement between GDP, driven up by increased demand for goods, and inflation, driven up by increased marginal costs. The initial response of consumption, GDP, investment, and inflation to the shock is positive. This causes the repo rate to increase as the central bank aims to stabilize inflation and the real economy. However, after about 5-8 quarters the response of consumption, investment and GDP becomes negative. Whereas the lenders can intertemporally smooth the negative impact on their consumption, borrowers are constrained, so their consumption has to fall by the drop in income. As Figure 5 shows, the impact on borrowers' consumption is limited. The contemporaneous increase in house prices, through the collateral channel, and inflation, through the debt-deflation channel, loosens the borrowing constraint for borrowers and contributes to stabilizing the response of their consumption.

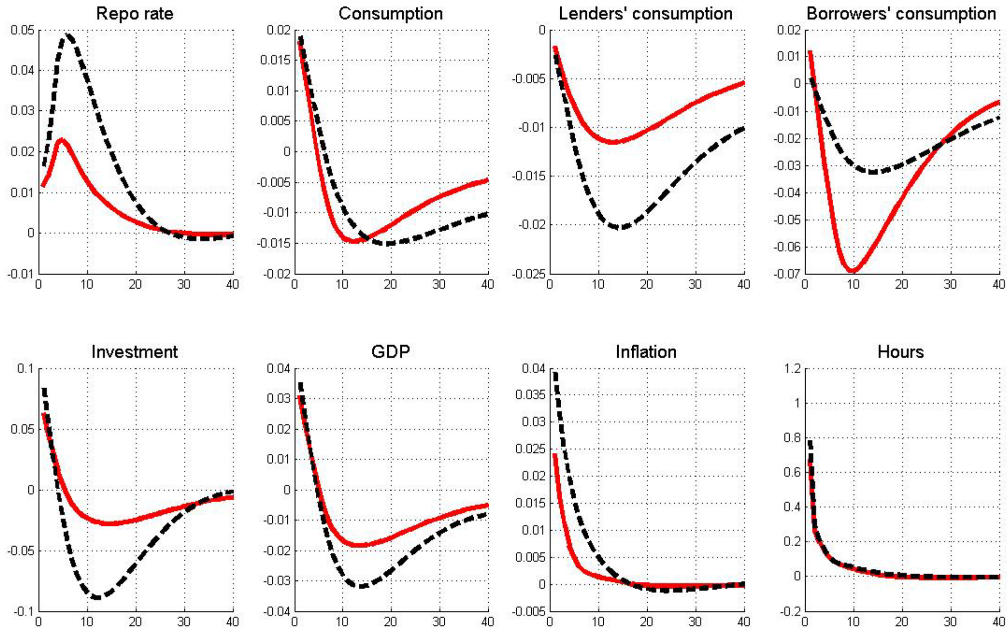
Comparing the two economies, GDP, consumption and investment increase in a similar way but return to their steady state more quickly in the economy with high debt. In the high-debt economy inflation increases less and goes back to steady state more quickly. Overall, the high-debt economy responds less to the government spending shock, while spreads move more (see Figure A4 in Appendix) and the repo rate increases much less than in the low-debt economy, confirming the fact that systematic monetary policy is more effective.

As mentioned above, the debt-deflation channel reinforces the financial accelerator of the model in the case of the government spending shock, while it weakens it in the case of the productivity shock. Most importantly, though, the debt-deflation channel operates in different ways for the transmission of systematic and unsystematic monetary policy to the economy. After a contractionary monetary policy shock, the interest rate increases and inflation decreases, making the borrowing constraint of the households tighter. The debt-deflation channel goes in the same direction as the collateral and cash-flow channels, bringing borrowers' consumption down and contributing to the stronger effect of monetary policy in the economy with high household debt. However, this is not the case after a systematic response of the interest rate. After a productivity shock or a government spending shock that lowers inflation, the repo rate responds in the same direction. While the cash-flow and collateral channels contribute positively to borrowers' consumption, the debt-deflation channel goes in the opposite way. In the section "Inspecting the transmission mechanism of monetary policy" we will argue that this is crucial to make systematic monetary policy more or less effective with high household debt.

Financial shocks

The analysis conducted so far suggests the following interpretation. The economy with high debt and low interest rates in the steady state is more interest rate sensitive compared to the economy with low debt and high interest rates. The implications are: 1) the macroeconomic effects of monetary policy shocks are larger in the more interest rate sensitive economy, 2) monetary policy is more effective in stabilizing the economy and inflation following other shocks. However, this increased interest rate sensitivity is likely to have also implications for macroeconomic volatility, if the economy is hit by a financial shock. To shed light on this question, we conduct an exercise that aims to mimic a situation where the price of credit increases for exogenous unanticipated reasons. We use the two lending spread shocks that are present in the model. The first is a shock to the spread between the lending rate to households and the marginal bank fund rate, while the second is a shock to the spread between the lending rate to entrepreneurs and the marginal funding rate. In the model, the marginal bank funding rate corresponds to the policy rate, so in effect the two shocks affect the spreads between the policy rate and the lending rates. We normalize the shocks such that the changes in both spreads are the same across the two model calibrations on impact.

Figure 5. Impulse responses to a government spending shock from DSGE model.

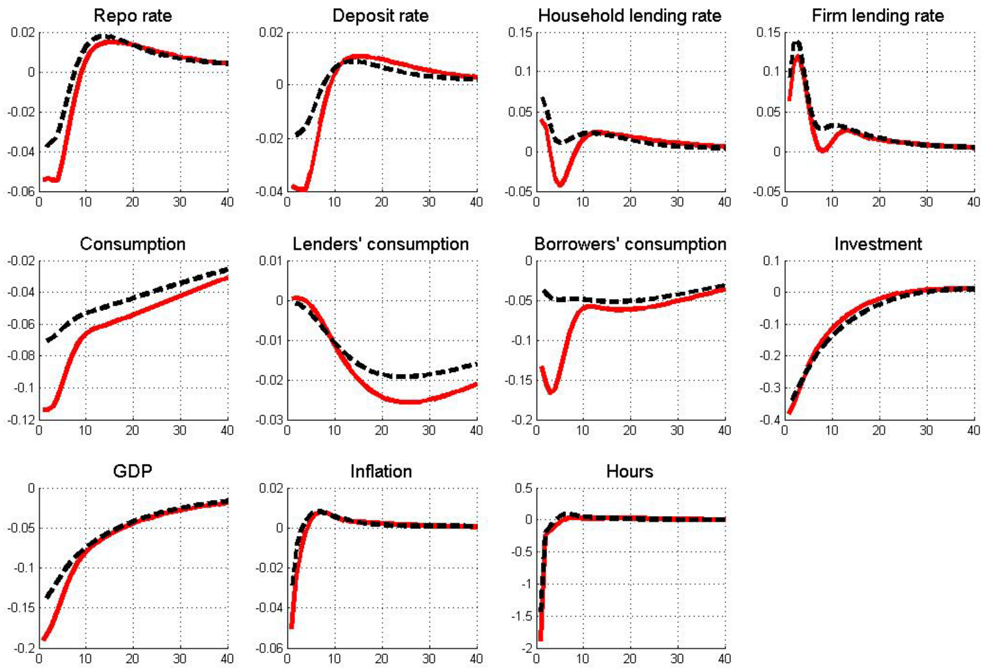


Note. Red line: model calibration with high debt and low interest rates in the steady state. Black line: model calibration with low debt and high interest rates in the steady state. The shock increases government spending by 1 percent on impact. All variables are in levels and in deviation from steady state.

Figure 6 shows the impulse responses of key macroeconomic variables to the spread shocks. The shock causes consumption, GDP, investment, hours worked, and inflation to drop. Furthermore, house prices fall and lending rates to borrowers and firms increase. Hence, from the perspective of borrowers and firms the shock, in qualitative terms, works very much like a contractionary monetary policy shock. As inflation falls, the central bank lowers the repo rate, which causes the deposit rate to fall.

Comparing the two economies, we notice that the impact of the shock on the economy is larger in the case with higher debt and low interest rates. The reason is the same as with the contractionary monetary policy shock: borrowers' consumption falls more when debt is high due to the stronger cash-flow, collateral and debt-deflation channels in this situation. Unlike the cases with supply and demand shocks, the economy is more volatile after the financial spread shock when household debt is higher. A repo rate that targets GDP and inflation cannot stabilize the economy as quickly. In other words, the economy with high debt is more vulnerable to financial shocks.

Figure 6. Impulse response to a financial spread shock from DSGE model.



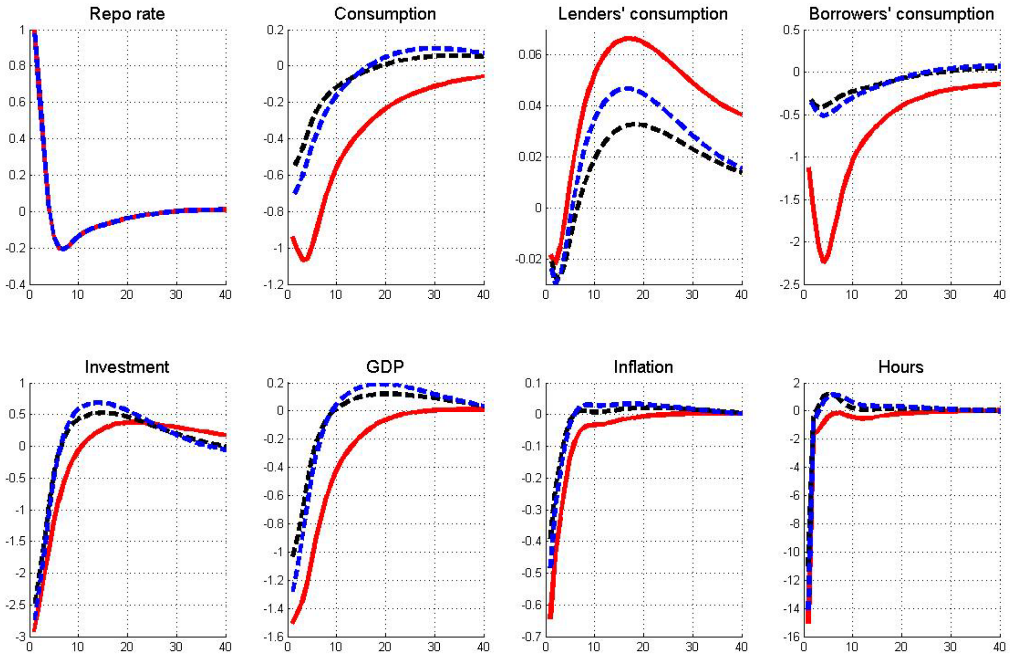
Note. Impulse response to a household lending rate markup shock and contemporaneously to a firm lending rate markup shock, normalized to the same response of each lending spread. Red line: model calibration with high debt and low interest rates in the steady state. Black line: model calibration with low debt and high interest rates in the steady state. All variables are in levels and in deviation from steady state.

Inspecting the transmission mechanism of monetary policy

The results discussed in the previous section are motivated by the increase in household debt that has happened since the mid-1990s, in connection with a fall in interest rates. In this section, we analyse the importance of each of these structural changes for our results. We do so by comparing the impulse responses shown previously with those derived from an intermediate calibration, where household debt is at the lower levels of the mid-1990s but interest rates (and so spreads) are at the levels of the more recent period. More specifically, we calibrate the model with the same parameters used to represent the Swedish economy of the last years and we change only the LTV ratio, as done previously in Finocchiaro et al. (2016). We set the value of LTV ratio equal to 0.45 to represent the period 1996-1999 (see Table 2).

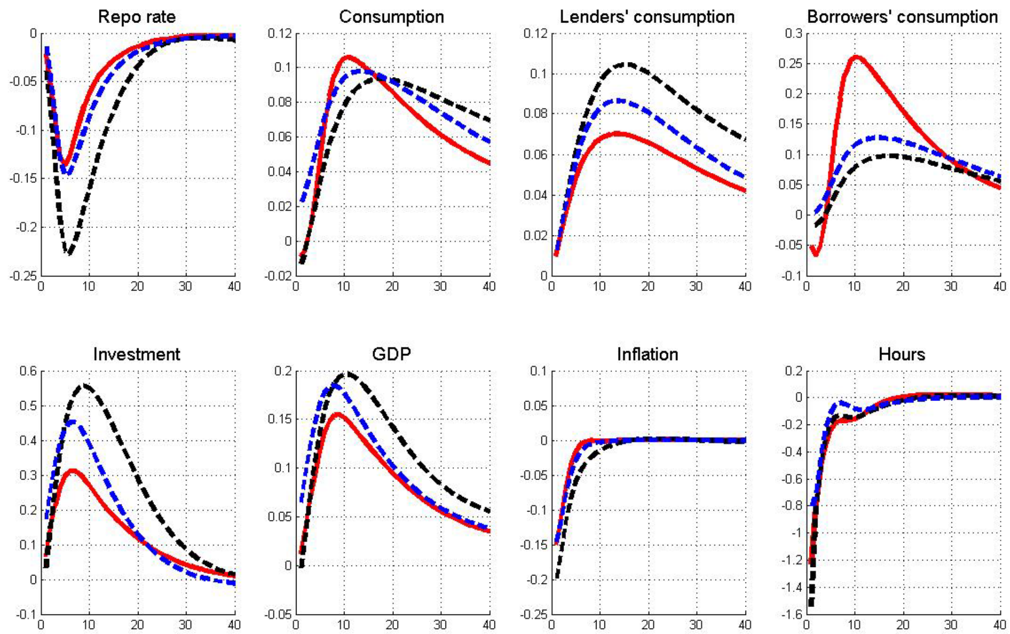
Now we compare the impulse responses discussed above with those from the intermediate-case economy. The response of the economy with low debt but low interest rates after a monetary policy shock is similar to the one of the economy with low debt and high interest rates, as shown in Figure 8. Hence, it is primarily because of the higher household debt that monetary policy shocks have a larger effect on the economy, confirming the results in Finocchiaro et al. (2016).

Figure 8. Impulse responses to a monetary policy shock from DSGE model.



Note. Red line: model calibration with high debt and low interest rates in the steady state. Blue line: model calibration with low debt and low interest rates in the steady state. Black line: model calibration with low debt and high interest rates in the steady state. The shocks are normalized to have the same impact on the repo rate. All variables are in levels and in deviation from steady state.

Figure 9. Impulse responses to a stationary productivity shock from DSGE model.

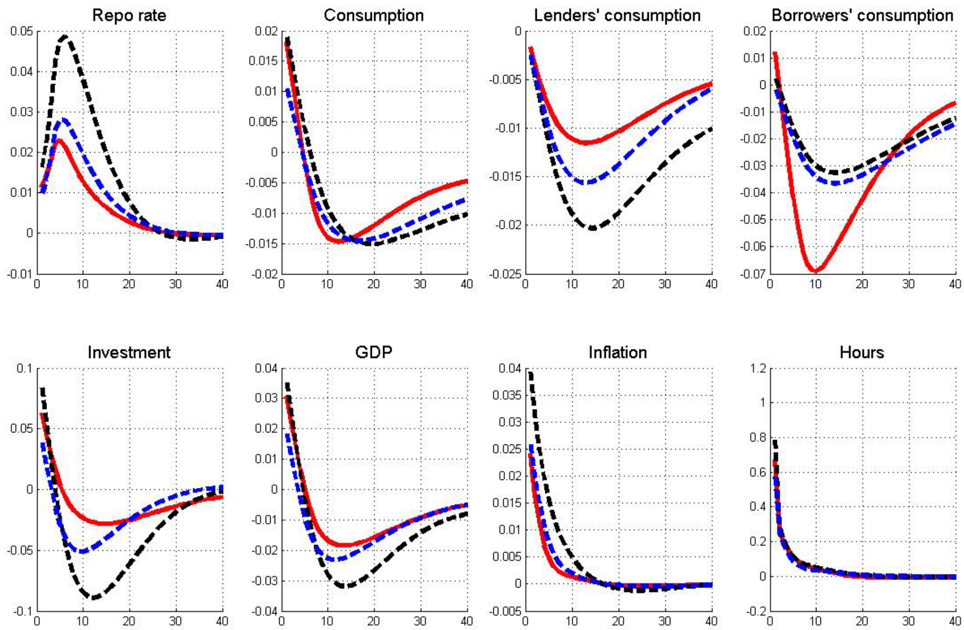


Note. Red line: model calibration with high debt and low interest rates in the steady state. Blue line: model calibration with low debt and low interest rates in the steady state. Black line: model calibration with low debt and high interest rates in the steady state. The shock increases productivity by 1 percent on impact. All variables are in levels and in deviation from steady state.

Figure 9 reports the impulse responses after a technology shock and we notice that the response of GDP and inflation in the economy with low debt and low interest rates, for a given change in the repo rate, is very similar to the case of high debt and low interest rates. Similar conclusions can be drawn from the responses to the government spending shock, reported in Figure 10. Hence, the fact that the systematic component of monetary policy is more effective in the model calibrated to the recent period relies on the level of interest rates and spreads. If the high debt levels are also due to the low level of interest rates and different spreads, then monetary policy is more effective at stabilizing the economy. This implies that the different transmission mechanism of the systematic versus the unsystematic component of monetary policy is crucial for our results to hold. As mentioned before, the debt-deflation channel is the element that differentiates the two transmission mechanisms: it operates in the opposite way than the other channels under the systematic response of monetary policy.

Comparing the impulse responses in this and the previous sections, one can infer that if we vary the LTV ratio but not the interest rates, the cash-flow and collateral channels of monetary policy are weaker, and are counteracted by the debt-deflation channel in the case of systematic monetary policy, making the net effect null. Instead, the debt-deflation channel strengthens the effect coming from the other channels in the case of unsystematic monetary policy, making the net effect larger. These results point to the fact that the model assumption that debt contracts are written in nominal terms, which gives rise to the debt-deflation channel, is key to determine if monetary policy is more effective at stabilizing the economy with high household debt in this type of exercises.

Figure 10. Impulse responses to a government spending shock from DSGE model.



Note. Red line: model calibration with high debt and low interest rates in the steady state. Blue line: model calibration with low debt and low interest rates in the steady state. Black line: model calibration with low debt and high interest rates in the steady state. The shock increases government spending by 1 percent on impact. All variables are in levels and in deviation from steady state.

Supporting evidence

We have discussed the effectiveness of monetary policy changes with high household debt and low interest rates from the perspective of a DSGE model with a housing sector. In line with previous studies based on DSGE models, we found that the macroeconomic impact of a monetary policy shock should be larger with higher household debt levels. In this section we take a more empirical perspective, by asking whether there is evidence of a larger effects on macroeconomic variables of monetary policy shocks with high household debt in a BVAR model estimated on Swedish data. We find some tentative evidence that this is the case.

We use a slightly modified version of the BVAR model proposed in Laséen and Strid (2013). The model contains ten variables: trade-weighted measures of foreign GDP, inflation and policy rate, and domestic GDP, CPIF, household debt, real house prices, repo rate and real effective exchange rate.[13]

All the variables are at quarterly frequency and in logarithmic form, except the interest rates that are in percentage levels. Foreign and Swedish GDP, house prices and household debt are detrended (by removing a linear trend), in order to account for their behaviour in the last years and to make the comparison across time more consistent. The model is estimated with 4 lags and the full sample of data available goes from 1995 to 2018. As Sweden is a small open economy, the foreign block is assumed to be exogenous to the domestic economy. The identification of the monetary policy shock is done with recursive (Cholesky) contemporaneous restrictions and the order of the variables is the one specified above. Hence, monetary policy is allowed to react instantaneously to changes in all the variables, except the exchange rate. But the monetary policy shock affects only the exchange rate on impact, while the rest of the domestic variables are affected with a lag. [14] Since the GDP series, house prices and household debt enter the model in levels, the monetary policy shock does not affect their levels in the long run. We run the model on different sample periods, in order to examine whether the impact of the monetary policy shock has changed across time. The main period is 1995-2007, that means excluding the financial crisis. We extend the sample to 2015, which covers the estimation period of Finocchiaro et al. (2016). We further extend the sample to 2018, to include the years when the Riksbank set the policy rate below zero and started its Quantitative Easing (QE) program, as a robustness check.

Figure 11 reports the impulse responses of the repo rate, the GDP, inflation, house prices, household debt and exchange rate to a monetary policy shock during the abovementioned subsample periods. The responses are normalized to the same impact of 25 basis points on the repo rate. First of all, in the subsamples that extend to more recent years we notice a more negative effect of a monetary policy shock on GDP and house prices. For these variables, the responses are close to or are outside the 95 percent confidence bands of the period 1995-2007. The response of household debt is also more negative for the later subsample periods, but it is always within the confidence bands of 1995-2007 for the first 12 quarters. Secondly, the responses of inflation and the exchange rate are basically unchanged across the periods. Third, given that the results for the period ending in 2018 go in the same direction as for the shorter sample, we conclude that the QE program and the negative rates do not seem to drive the results.

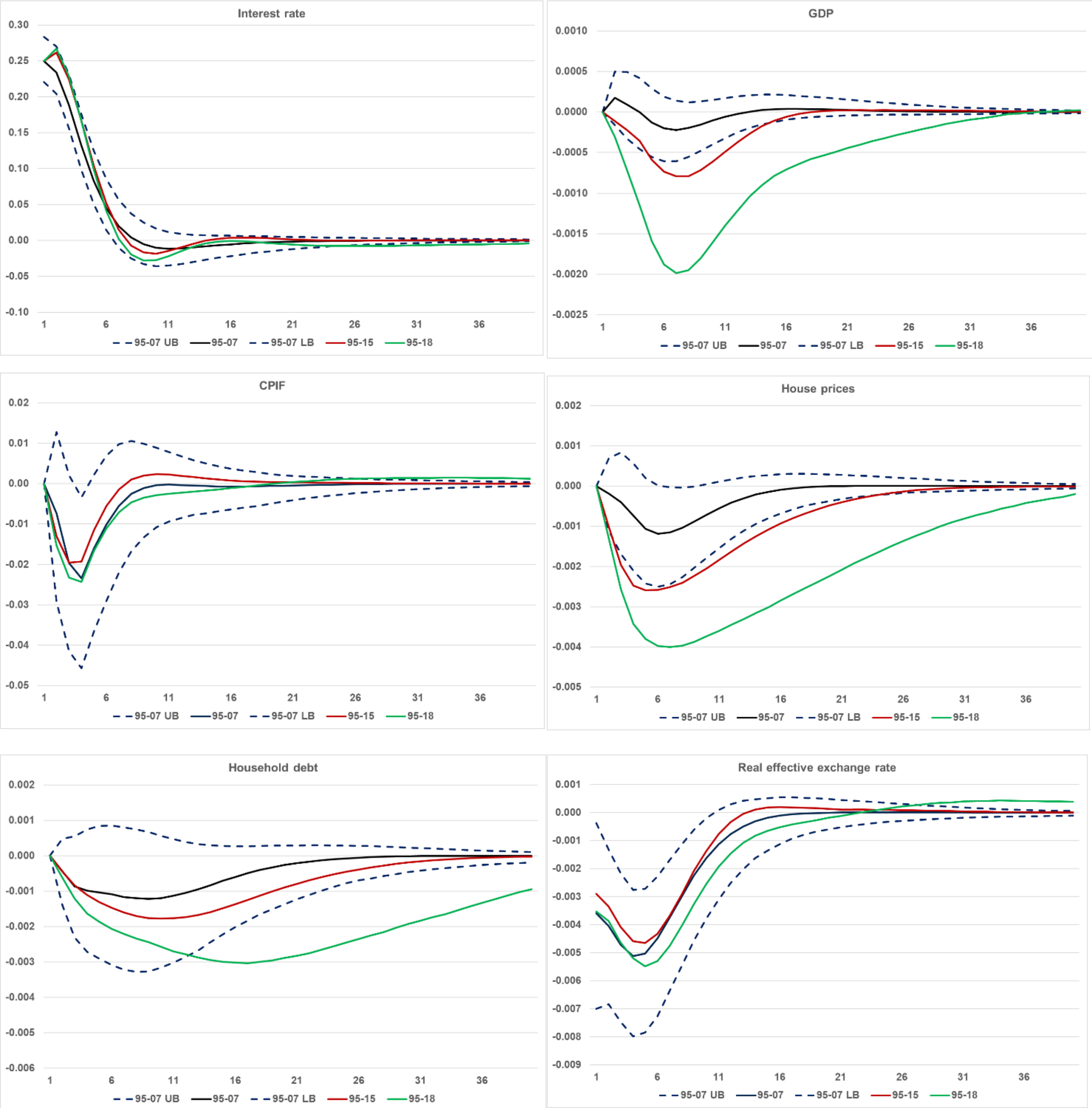
As monetary policy shocks have larger impact on some key macroeconomic variables such as GDP and house prices, there is some tentative evidence for the presence of stronger effects of monetary policy shocks in a situation with more household debt. The same, though, is not true for inflation. More analysis is required to arrive at a more definitive answer.[15]

[13] The original model in Laséen and Strid (2013) does not contain the real effective exchange rate. For details about the data series and the choices about priors, refer to their appendix.

[14] Placing the interest rate before the exchange rate is a standard choice for the identification of monetary policy shocks for small open economies. A similar identification strategy with Swedish data is used in Lindé, Nessén and Söderström (2009). Moreover, evidence of the contemporaneous effect of the monetary policy shock on the exchange rate is provided in Iversen and Tysklind (2017) with a different methodology, relying on high-frequency data.

[15] Our DSGE model is a closed economy model, hence it lacks the transmission of foreign shocks and the role of the exchange rate. The comparison with the results from the BVAR model may suggest that these are key factors that neutralized the domestic drivers of an increased effectiveness of monetary policy. In addition to that, there is a recent literature arguing that monetary policy is less effective when rates are low for long (Borio, Hofmann, 2017) and when there is high uncertainty (Aastveit et al, 2017; Castelnuovo and Pellegrino, 2018, Pellegrino, 2018). While these factors can be captured by the BVAR model, they are not accounted for in our DSGE model.

Figure 11. Impulse responses to a monetary policy shock from BVAR.



Note. We present responses for the subsamples 1995-2007 (black), 1995-2015 (red) and 1995-2018 (green), with 95 percent confidence bands (dotted lines) for 1995-2007.

Conclusion

In this paper, a DSGE model with housing and nominal debt contracts is used to examine the impact on the economy from having a larger stock of household debt and lower interest rates. In particular, a version of the model calibrated to the economic situation in Sweden in the mid-1990s is compared to a model version calibrated to the economy of the last decade. We consider the case where high household debt is due not only to less stringent loan-to-value (LTV) ratio constraints, but also different interest rate levels. The focus of the analysis is whether and how the effectiveness of monetary policy is affected by increased debt levels in connection with lower interest rates.

We find that the high interest rate sensitivity due to high debt levels makes the effects of unsystematic monetary policy on key macroeconomic variables stronger, confirming previous results in the literature. The systematic component of monetary policy is also found to be more effective at stabilizing the economy, implying lower volatility after demand and supply shocks. This result holds in our model because we consider that not only the less stringent LTV ratio constraints, but also the level of interest rates (and spreads) have contributed to the high debt levels. Moreover, we find that shocks occurring in the financial system have larger effects on macroeconomic variables when debt is higher. Hence, higher interest rate sensitivity translates into higher vulnerability of the economy to financial shocks. This can motivate a financial stability concern coming from high levels of household debt in Sweden.

Finally, a Bayesian Vector Autoregressive model estimated on different sample periods provides some supporting evidence for our DSGE model-based results, since the effect of unsystematic monetary policy on GDP and house prices is larger with high debt. However, the same is not true for inflation. Hence, the empirical analysis provides some support to the results of the DSGE model, but it also points out that some drivers that are missing in the model have probably counteracted the effects of high household debt on the transmission to inflation, leaving it unchanged with respect to earlier years.

Our results on the effectiveness of monetary policy are particularly interesting, as central banks around the world have been facing the problem of the zero/effective lower bound on interest rates since the latest financial crisis. Unconventional monetary policy measures, such as quantitative easing and forward guidance, have been in place in many countries, including Sweden, in order to provide additional monetary stimulus in the presence of interest rate close to the lower bound. Our analysis has abstracted from the presence of the effective lower bound. In a contemporaneous study, Chen et al. (2019) show that, since unsystematic monetary policy is more effective when interest rates are low and household debt is higher, this is problematic for an economy at the lower bound if more expansionary monetary policy is required. In this case, the central bank is constrained from using a tool that has become more powerful, leading to worse macroeconomic outcomes.

Appendix

Additional tables

Table A1. Other calibrated parameters.

Parameters	Description	Value
ϕ	inverse of Frisch elasticity	1
j^P	Weight of housing for patient households	0.2
j^I	Weight of housing for impatient households	0.6
α	Capital share in production function	0.35
δ_k	depreciation rate of capital	0.025
δ_h	depreciation rate of housing	0.006
ϵ^y	elasticity of subst. for goods	6
ϵ^l	elasticity of subst. for labor	5
π	SS gross inflation rate	1
v^b	Target capital-to-loans ratio	0.16

Table A2. List of estimated parameters.

Parameters	Description	Value
κ_p	price stickyness	28.4666
κ_w	wage stickyness	79.0514
κ_i	investment adj. cost	10.2065
κ_d	deposit rate adj. cost	0.0508
κ_{be}	firms' rate adj. cost	2.4668
κ_{bh}	households' rate adj. cost	0.3068
κ_{kb}	cost for leverage dev.	1.8488
ϕ_π	Taylor rule coeff. inflation	0.8584
ϕ_y	Taylor rule coeff. output	0.3092
ρ_{ib}	Taylor rule inertia	0.8065
ι_p	price indexation	0.10
ι_w	wage indexation	0.10
a^i	consumption habit coefficient	0.95

Note. The weight assigned to inflation is equal to 0.86, that may seem low but the inflation measure contained in the rule is the annual rate. Hence, four quarters after a shock has hit the economy, the repo rate responds to the current quarterly change in inflation and the previous three quarterly changes. In fact, annual inflation can be decomposed in the product of quarterly inflation in the following way:

$$\pi_t^4 = \pi_t * \pi_{t-1} * \pi_{t-2} * \pi_{t-3}.$$

We do not report the values of the shock processes because they are not the focus of our exercise, but they are the ones estimated in Finocchiaro et al. (2016).

Additional figures

Figure A1. Interest rates used for the estimation of the model by Finocchiaro et al. (2016).

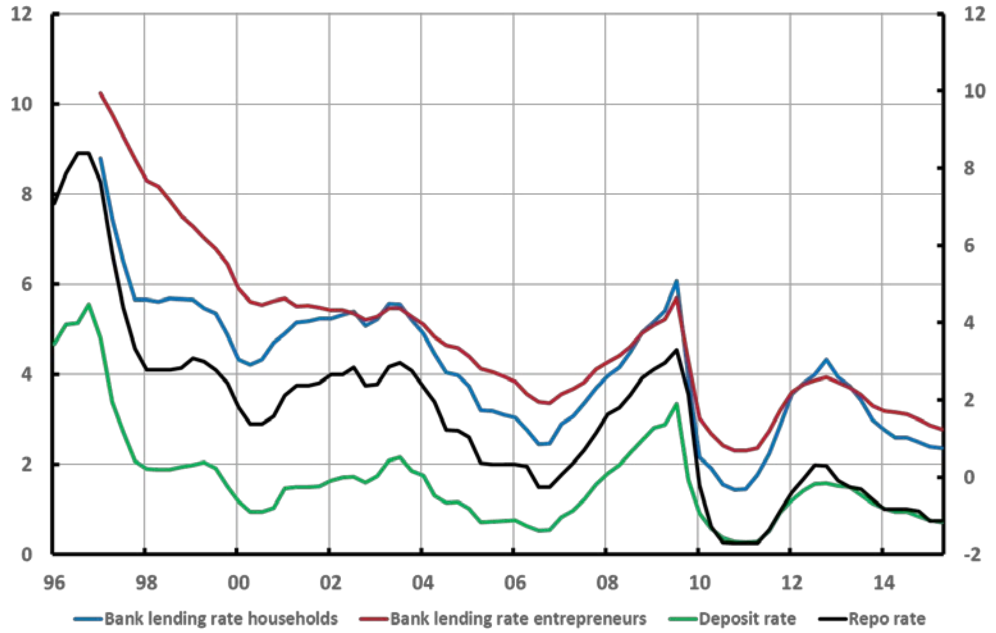
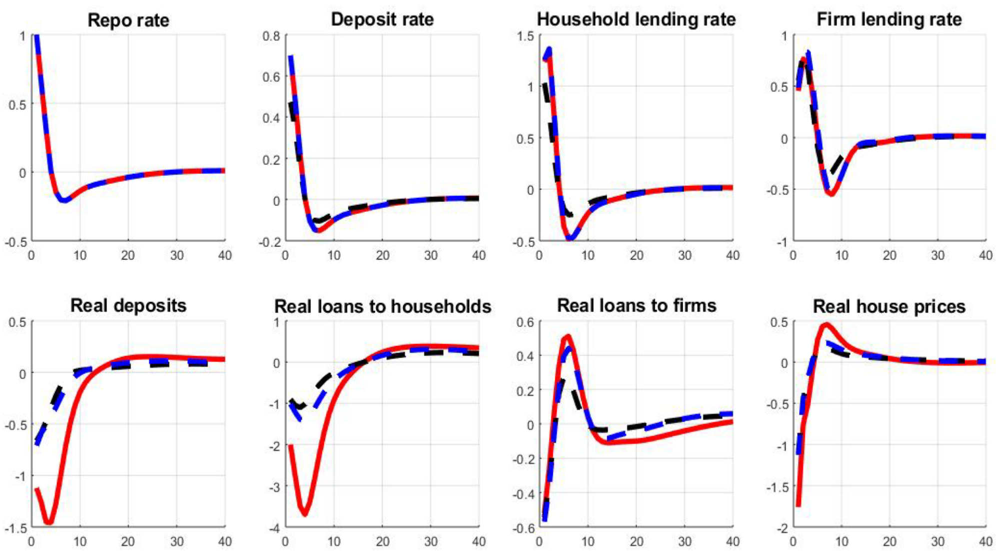
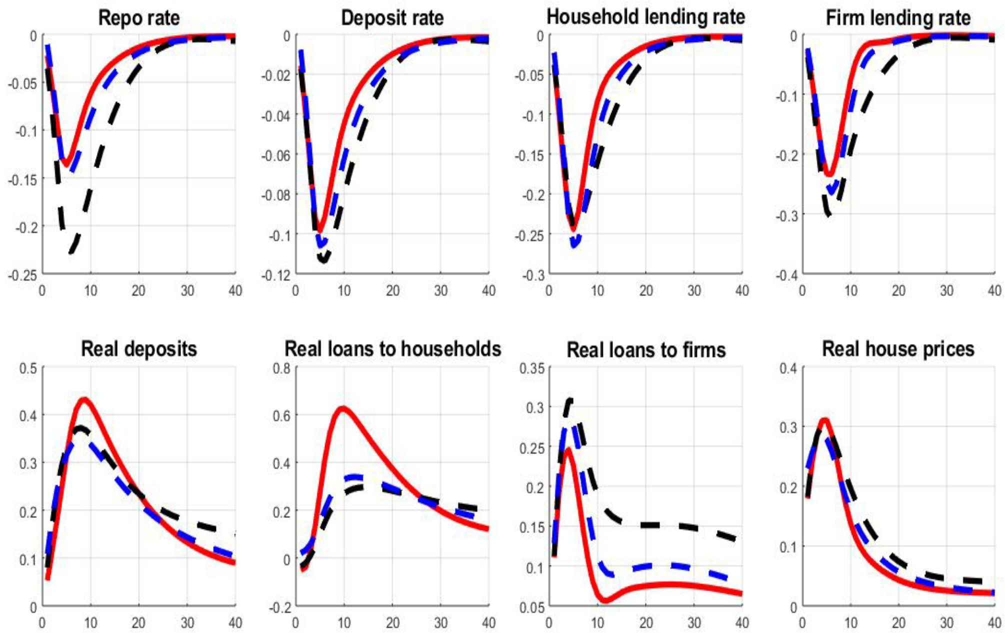


Figure A2. Additional impulse responses to a monetary policy shock from DSGE model.



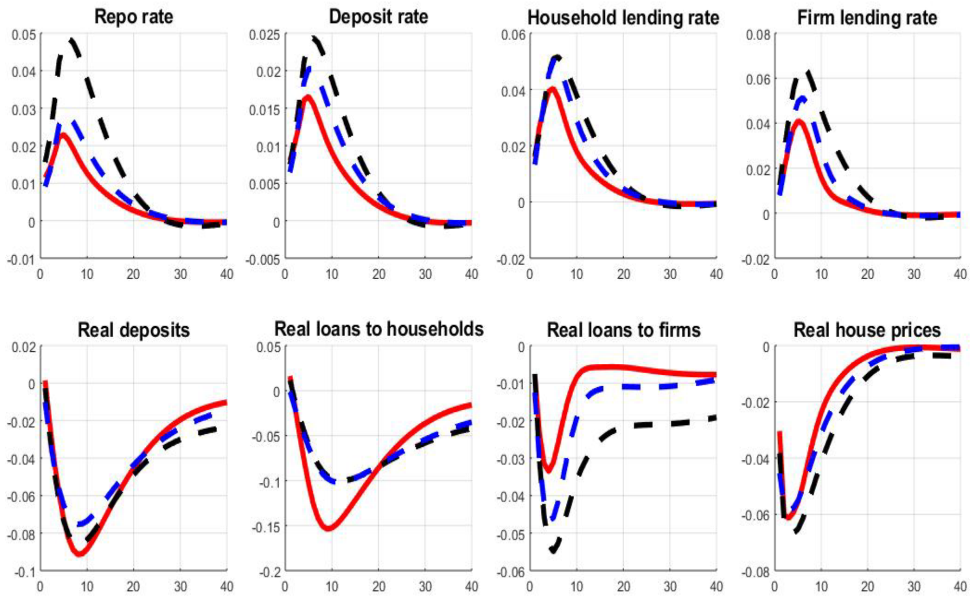
Note. This Figure complements Figures 3 and 8 in the main text. Red line: model calibration with high debt and low interest rates in the steady state. Blue line: model calibration with low debt and low interest rates in the steady state. Black line: model calibration with low debt and high interest rates in the steady state. The shocks are normalized to have the same impact on the repo rate. All variables are in levels and in deviation from steady state.

Figure A3. Additional impulse responses to a stationary productivity shock from DSGE model.



Note. This Figure complements Figures 4 and 9 in the main text. Red line: model calibration with high debt and low interest rates in the steady state. Blue line: model calibration with low debt and low interest rates in the steady state. Black line: model calibration with low debt and high interest rates in the steady state. The shock increases productivity by 1 percent on impact. All variables are in levels and in deviation from steady state.

Figure A4. Additional impulse responses to a government spending shock from DSGE model.



Note. This Figure complements Figures 5 and 10 in the main text. Red line: model calibration with high debt and low interest rates in the steady state. Blue line: model calibration with low debt and low interest rates in the steady state. Black line: model calibration with low debt and high interest rates in the steady state. The shock increases government spending by 1 percent on impact. All variables are in levels and in deviation from steady state.

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