THE REAL ECONOMIC EFFECTS OF MONETARY POLICY: CONSIDERING ASSET PRICES AND HOUSEHOLD DEBT

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Abstract

Cycles in economic activity and assets pricing are a recurrent theme in economics. Throughout the twentieth century there has been a debate regarding the role of monetary policy in the creation and prevention of real economic shocks. The purpose of this thesis is to model the response in Swedish real economic activity to changes in monetary policy, accounting for asset pricing and debt growth. Such a model is useful for policymakers to assess the impact of policy changes on real economic stability. To answer this question both a traditional structural vector autoregressive, SVAR, and the more recent local projection, LP, estimation technique is used. The results indicate that when using LP, repo rate increases tend to yield negative real economic growth approximately two years after a policy shock when taking asset prices and debt into account The estimates from SVAR corroborate the results of the LP technique, but yield overall statistically insignificant results.

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1 Introduction

Economic shocks are a recurrent theme in economics. Throughout centuries there have been crises and shocks stemming from shocks in asset pricing values, some famous examples include tulip mania in 1637, the great depression in 1929 and the 2008 financial crisis. The interest of modelling economic shocks lies in making markets efficient and reduce the destabilizing effects of shocks on the economy and business cycles. Crises in the form of recessions are costly in terms of aggregate economic efficiency resulting in welfare costs (Galí, Gertler, & López-Salido, 2007). The unemployment associated with recessions also tend to reduce earnings among workers and tend to increase anxiety in regard to future employment opportunities generating social costs (Davis & von Wachter, 2011). Del Negro and Otrok (2007), amongst others, theorize that central banking authorities partake in the creation of shocks by inflating asset prices, defined in this thesis as share and housing prices, resulting from monetary policy. By decomposing housing prices into a local and national level, where the local housing prices are explained by local factors while national prices is driven by monetary policy, (Del Negro & Otrok, 2007) find that in the decades preceding 2005 monetary policy seems to have gained an increasing role in explaining housing prices. This is supported by Friedman and Schwartz (1963) and Mian and Sufi (2018) who find that monetary policy can explain substantial variations in business cycles. This is however disputed by C. A. Sims and Zha (2006) who find no evidence of monetary policy to be associated with historical recessions.

Modern monetary policy aim at controlling inflation at a two percent target. This is accomplished by setting the interest rates, which expands and contracts the money supply and affects the level of inflation (Riksbanken, 2018). Changes in money supply result in either higher or lower interest rates, which affect individual's consumption and saving behaviour, Ludvigson (2002) refer to this phenomenon as the wealth consumption channel. Floden (2016) findings support the theory that interest rates have an effect on household consumption behaviour via mortgage debt. Floden (2016) who find a negative effect between households with variable interest rate mortages and household consumption, as the general interest rate rises. As the central bank sets the repo rate which affects the general level of interest rates

in the economy this would imply that there is both an empirical and theoretical association between the actions taken by policymakers and variations in business cycles. While the issue of monetary policy transmissions in regard to house prices been studied in the United States and EU, see e.g. Ludvigson (2002), Del Negro and Otrok (2007), Goodhart and Hofmann (2008) etc, literature is scarcer regarding Sweden, particularly when considering both debt and asset prices jointly. Sweden differs substantially compared to the United States in terms of system of governance and the fact that Sweden is a welfare state. Therefore, it would not be unreasonable to expect different individual consumption behaviour regarding income and wealth. It should also be noted that most studies focus on either the real economic effects of monetary policy transmission via either the debt channel or the wealth channel. While (Floden, 2016) studies the debt channel of monetary policy transmissions in Sweden, he does not take asset pricing into account. Ludvigson (2002), who studied the consumption wealth channel in the United States, account for household net wealth and fail to find evidence of a monetary policy transmission via the consumption wealth channel, however this might not be representative for Sweden due to differences in economic structure. Swedish households tend to hold a large fraction, compared to other countries, of their financial wealth in shares and other equity, while at the same time being comparatively highly indebted.
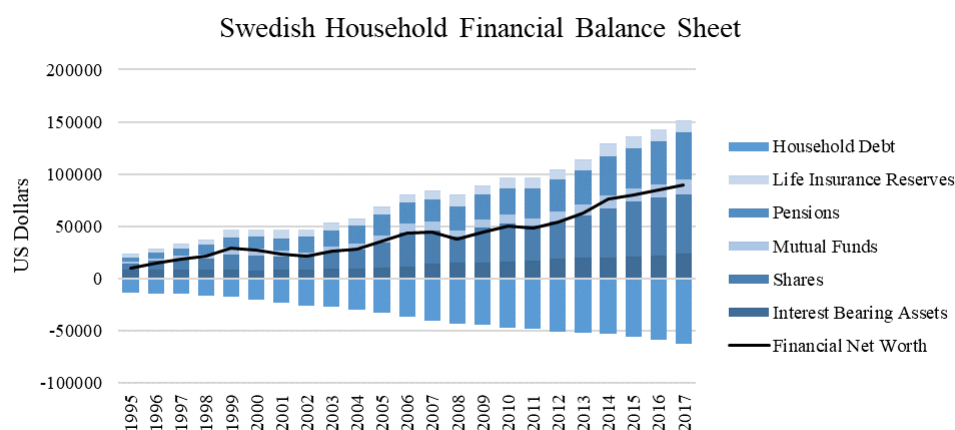

Figure 1: Swedish Household Financial Balance Sheet, note that no housing assets are included. Data source: OECD (2019a).

Therefore, it is possible that the real economic effects are underestimated if not both assets and debt is taken into account. The effects might therefore also differ compared to other countries such as the United States, where households tend to both be less indebted and hold a smaller fraction of their financial assets in shares. The purpose of this thesis is to fill the gap in the literature by modelling monetary policy transmission to Swedish real economic activity via asset prices and debt jointly.

The main area of interest is thus the response of real economic activity to monetary policy when accounting for debt and asset prices. As such the two following questions are posed: What is the response of Swedish asset prices to changes in Swedish monetary policy? What is the response of Swedish real economic activity, business cycles, to changes in Swedish monetary policy when accounting for asset prices and household debt? The latter should already be incorporated into the central banks tools for setting monetary policy, unlike the former which according to Christiano, Eichenbaum, and Trabandt (2018) is difficult to model, a topic which will be discussed in the next section. Thus, this paper suggests the use of monetary policy as an explanatory variable for business cycle and asset price variations. By asset prices I refer to the Swedish stock market and housing prices indices. The primary shocks of interest are changes in monetary policy and their subsequent ripples throughout financial markets and household finances. Being able to model the responses to policy changes could yield valuable insight regarding how the real economy reacts to changes in monetary policy and the joint role played by asset prices and debt. To answer the research question two econometric methodologies in macroeconomics are employed, the traditional structural vectorautoregressive model, SVAR, and a new approach called local projection, LP, which is generally more robust compared to SVAR (Stock & Watson, 2001) (Jordà, 2005). The vector autoregressive approach to macroeconomic modelling was introduced by (C. Sims, 1980), which provided a relatively easy approach to model the responses of different events in macroeconomics. The SVAR approach is however full of problems such as unrobustness and misspecification. LP was introduced by Jordà (2005) to counter these issues, which is considerably more robust and can be used in non-linear modelling.

The SVAR model is estimated from an ordinary VAR model, where constraints are introduced to mitigate

potential problems with contemporaneous effects. The SVAR model indicates that higher asset prices tend to have a positive association with real economic activity, while a repo rate shock tend to yield lower asset prices and reduced economic activity. The estimates are however generally statistically insignificant at a 95% level.

The LP method also indicates that an asset pricin shock tend to increase real economic activity, while a repo rate shock tend to yield lower asset prices and reduced economic activity. However, unlike SVAR, the LP estimates are statistically significant at a 95% level. This implies a negative association between restrictive monetary policy and real economic activity, when accounting for household debt and asset prices jointly.

This paper is structured as follows, i) Section two reviews literature regarding the wealth and debt channels of monetary policy transmission mechanisms. ii) Section three and four presents the theoretical model and methodology for the analysis. iii) Section five discuss the data used for the analysis and summarizes some core characteristics and developments observed over time. iv) Section six presents the analysis of the estimated model. v) Finally, section seven presents the conclusion of the analysis.

2 Literature Review

The notion that monetary policy has an effect on business cycles and asset prices is not a new one. Friedman and Schwartz (1963) argue that changes in monetary supply contributes to a substantial portion of variations in the business cycle. Generally central banks apply dynamic stochastic generalized equilibrium models, or DSGE, as the primary analysis method when setting monetary policy (B. Bernanke, 1999). These DGSE models have evolved over time to take a large number of micro- and macroeconomic variables into account including financial frictions. Christiano et al. (2018) point out that given the infancy of introducing financial frictions into the DGSE framework and the rarity of full blown financial crises their effects are not captured accurately by the financial frictions introduced in the DSGE models. As Galí et al. (2007) points out, crises and recessions are costly in terms of aggregate economic efficiency resulting in welfare costs. Recessions tend cause frictions in labour markets and output, which creates a gap between potential output and actual output resulting in an economic welfare cost.

According to Mian and Sufi (2018) changes in monetary policy results in an expansion of credit supply, the expansion of credit results in a boom and bust cycle in economic activity. The expansion of credit mainly boosts demand in the real economy rather than increasing firms productivity. The reversion is subsequently driven by a decrease in the aggregate demand which is amplified for nominal rigidities, banking sector disruptions, constraints on monetary policy and legacy distortions from the boom. Mian and Sufi (2018) findings are corroborated by Floden (2016), who find a statistically significant negative effect between household debt, with variable interest rates, and consumption in Swedish households as interest rates rises. Jordà, Schularick, and Taylor (2015) find that debt has a positive effect on housing prices. B. S. Bernanke and Gertler (1986) also find that debt tend to amplify the swings in real economic activity. Similarly Sousa (2010) finds that changes in monetary policy results in substantial changes in household wealth.

The effect of monetary policy on real economic activity via household wealth is referred to as the consumption wealth channel. The consumption wealth channel is based on the notion that asset market values react to economic news and policy changes, while consumers react to changes in asset market

values. Thus, the purpose of the consumption wealth channel in monetary policy is to describe the underlying mechanism of how changes in monetary policy affect asset values, which in turn affect consumer spending on goods and services. According to Gowland and Gilbert (1985), Kennedy (1966) and Modigliani (1944) this implies that the changes in asset values, via household wealth, can act as a natural stabilizer for business cycles. However, it would also imply that monetary policy can potentially have a destabilizing effect on real economic activity.

This implies that monetary policy will have a stronger effect on real economic activity when households are highly indebted and have variable interest rates (Floden, 2016). Bordo and Olivier (2002) show that boom-busts in asset prices are costly in terms of reduced output. They also argue that monetary policy can be used to deter asset pricing booms by restricting private credit. There are significant differences in terms of consumption and wealth behaviour between individuals in Sweden and the United States. Sweden have a larger welfare system which arguably makes individuals more inclined to consume their income. Swedes also tend to hold a relatively large fraction of their financial wealth in shares, while at the same time being highly indebted (OECD, 2019a). This could imply that any potential effects in Sweden might differ from that of the United States.

There are however studies disputing the monetary policy transmission mechanism via the wealth channel. Del Negro and Otrok (2007) use a vector autoregressive model to evaluate the effect of monetary policy on local housing prices in the United States, who find monetary policy to has a comparatively low impact on the housing prices. Ludvigson (2002) attempt to quantify the consumption wealth channel of monetary policy using a small structural vector autoregressive model. Ludvigson (2002) find the wealth consumption channel to play a minor role in the monetary transmission to consumption. Similarly, Maki (2001) find that increasing asset prices tend to directly increase household consumption. The effect however is comparatively small, a one dollar increase in wealth results in a five cent increase in consumption, which contrary to Ludvigson (2002) findings is highly statistically significant. Furthermore argues Mishkin (2001) that if central banks target asset prices it will likely erode their independence as controlling asset prices is beyond the capabilities of the central banks.

3 The Consumption Wealth Channel

This section use general economic theory in the framework of a multivariate time series model, which should capture the effect of monetary policy on business cycles and asset pricing. Figure 2 illustrates the underlying theoretical framework of the channels through which the repo rates might affect economic activity.
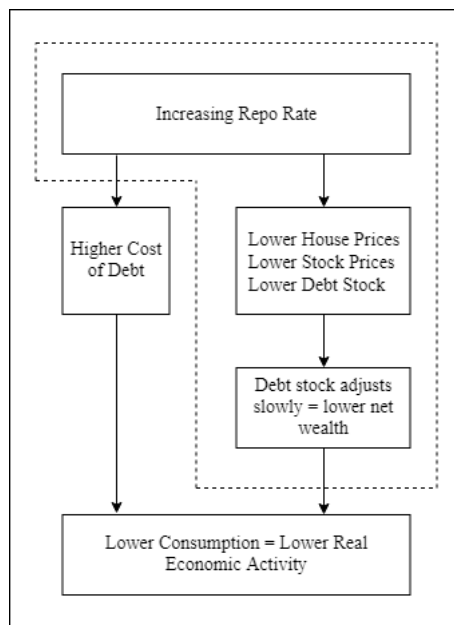
Figure 2: The direct and indirect effects of monetary policy on economic activity.

The reasoning in figure 2 can be expressed in the following manner. Under the assumption that the goal of individuals and firms are to maximize an intertemporal utility function, where the final measure of utility in a point in time t is a function of the consumption, savings and investments in all remaining time periods, and they can to borrow money at a level of interest r. Given the intertemporal nature of the maximization problem, should future consumption and savings be discounted with an interest rate determined by time preference, similar to the interest on borrowed funds. This implies that it is possible to shift future income to the present t using lending, resulting in an increase or decrease in the money supply depending on the change in interest rates. This reasoning is associated with the consumption

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wealth channel described by Ludvigson (2002). This is illustrated in figure 2 within the dashed area, which represents the indirect effects of monetary policy on economic activity.

The underlying idea is that expansionary monetary policy should result in a greater money supply and lower interest rates, R, when the level of interest rates decreases so does the cost of borrowing. When the cost of borrowing is reduced the level of debt, D, increases simultaneously with the amount of assets, A, and consumption, a phenomenon which Mian and Sufi (2018) and Jordà et al. (2015) find in the United States and Floden (2016) in Sweden.

This results in both an increase in the GDP, Y and in the underlying leverage, a correlation which Friedman and Schwartz (1963) as well as Bordo and Olivier (2002) points out. Based on Mian and Sufi (2018), B. S. Bernanke and Gertler (1986) and Floden (2016), there should be a greater negative real economic outcome when household leverage is high, which should translate to asset prices.

As discussed earlier in the context of the consumption wealth channel described by Ludvigson (2002). An increase in consumption and assets should result in greater firm profits, in turn causing an expansionary shift in the demand to hold shares of equity. As such, the demand of holding shares in firms should firms, resulting in higher valuations of equity. Therefore, should the value of firm equity and business cycles be correlated with each other. As in the case of equity values the housing prices should also increase. Increasing the monetary base should per definition increase the money available today for individuals to utilize. As such there should be an expansionary shift in the demand curve resulting in a higher housing valuations, as in the case of Del Negro and Otrok (2007), given a lagged reaction in the supply curve. Assuming that housing prices have a lagged reaction, there should also be a price increase in housing for no other reason than the expansionary monetary policy. This implies that asset prices are correlated with each other as well as with variations in the business cycle. The model for asset prices is incorporated in the VAR model presented in equation 1.

When a shock occurs, for example a natural disaster or in this case higher interest rates, the shock in the business cycle is multiplied by the amount of leverage. As Mian and Sufi (2018) pointed out, should an increased leverage result in a greater shock to the variation in the business cycle, compared

to lower leverage. As such it is not unreasonable to theorize that a shock in the form of a change in the monetary policy should have a lagged effect on the variation in business cycles. Given the implied correlation between asset prices, business cycles and monetary policy should such a shock result in simultaneous responses for all variables at one point in time. If individuals have erroneously maximized their intertemporal utility maximization function, by for example exhibiting complacent behaviour as Brooks (2000) describes, could a repo rate shock result in business cycle and asset pricing variations.

4 Local Projection & SVAR

Similar to Ludvigson (2002) and Stock and Watson (2001) it should be possible to model the response in business cycles and asset prices, defined as share and housing prices, variations to changes in monetary policy, while considering household debt, using a structural vector autoregressive and local projections approach. As Stock and Watson (2001) describes, VAR can be thought of as a combination of traditional OLS models and autoregressive models. It is suitable for capturing dynamic changes in multivariate time series expressed as impulse response functions, which model the response of a shock over time until it converges to the equilibrium. Both a structural vector autoregression, SVAR, and local projection, LP, model is used. The reason for this is that SVAR is the standard methodology in macroeconomic modelling Stock and Watson (2001), while LP is a new improved modelling method which provides more robust estimates compared to SVAR (Jordà, 2005). Furthermore, if both models provide similar estimates it could imply that the results are consistent. Both techniques can be estimated empirically using OLS.

4.1 Vector Autoregressive and Structural Vector Autoregressive Models

VAR models, short for Vector Autoregressive models, is a method to estimate models for multivariate time series. It was introduced as method for macroeconomic analysis by C. Sims (1980). The underlying principle of a VAR model is to express each variable, for example y_t and x_t in time t, as a function of lagged values of the variables, for example y_{t-1} and x_{t-1}. VAR follows the same assumptions as univariate time series, AR, meaning that the relevant time series should be stationary in nature. The VAR model can formally be expressed as:

$$z_t = k + B_1 z_{t-1} + ... + B_p z_{t-p} + u_t \tag{1}$$

Where z_t, in equation 1 is a vector of the variables real GDP growth, housing returns, share returns, debt and policy rates. Thus $z_t = (R_t, H_t, S_t, D_t, Y_t)$. B_t is a five times five matrix of beta coefficients for each

time period t. k in equation 1 is a vector of constants, p denotes the number of time lags used, t denotes the current time period. u_t denotes a vector of error terms, which, in expectation, is equal to zero and has a constant variance.

The notation Y_t is used for GDP in time t, which yields the VAR equation presented in equation 1. The value of p, the number of lags used is determined using the Akaike Information Criterion, AIC, as is the custom in VAR modelling. AIC measures the relative quality of a model compared to other models, in this case it implies that several models using different lags are estimated and the number of lags in the model with the lowest AIC value is then selected.

Using time lags allows for changes further back in time to affect what happens today is convenient as the outcome of period t may be determined by events earlier than the previous time period. Y_t is likely going to be a function of earlier Y_{t-p} as well as the accumulation of debt, interest rates and asset prices. Thus, should the coefficient estimate of each variable change over time. For example, would our theory stipulate that a recent increase in interest rates along with an accumulation of debt result in a decrease in Y_t.

As such, the coefficient for R_{t-p} should be negative with a greater significant impact when p is closer to t, implying changes in the short term. Similarly should the coefficient for H_{t-p} and S_{t-p} be positive with a greater significant effect when p is closer to t, as asset prices tend to respond fairly quickly to changes in fundamental values. While changes in debt should accumulate over time implying a more distributed effect over time. It should also be noted that the coefficients incorporate the effect of leverage, accumulation of debt, on GDP over time.

Asset prices should respond quickly to changes in interest rates, R_{t-p}, and GDP, Y_{t-p}, due to the efficiency of financial markets. This could potentially imply a contemporaneous relationship between the variables. For the case of Y_{t-p} this would imply positive values of greater significance when p is closer to t than p, while the coefficients for R_{t-k} are expected to be negative and of greater significance when p is closer to t than p. As in equation 1 should the value of the coefficients for debt, D_{t-p}, and monetary policy, R_{t-p}, be significantly dispersed over time rather than be concentrated at time t.

It should be noted that if the lagged coefficients are close to zero or statistically insignificant it would imply that the variable at p point in time does not affect the current observed value in the dependent variable. In the case of the interest rates, it would thus be expected that as p increases, the coefficient approach zero and becomes statistically insignificant.

A problem with the ordinary VAR model is that each vectors error term is not necessarily uncorrelated, which will result in biased impulse response estimates by endogenous error terms. To account for this the VAR is structured by imposing restrictions on certain variables to account for contemporaneous effects, which brings us to the subject of Structural Autoregressive models, SVAR.

The problem of endogeneity or reverse causality is solved by introducing restrictions on the estimates in the VAR model. The restrictions are constructed in accordance with structural assumptions to thus obtain a multivariate time series model without any endogeneity issues. The SVAR can be formally expressed as:

$$B_0 z_t = k + B_1 z_{t-1} + ... + B_p z_{t-p} + Ce_t, \quad u_t = Ce_t \quad and \quad E(e_t \, e_t') = I \tag{2}$$

The SVAR model in equation 2 is identical to the VAR model in 1 with the exception of B_0. B_0 is a five times five matrix of coefficients detailing the restrictions for the structural VAR. e_t is the error term in time t, while C is a five times five matrix which is calculated such that $E(e_t \, e_t') = I$. Meaning that the error term is an identity matrix, implying a standard normal distribution. By introducing restrictions in the underlying VAR model, it is possible to force coefficients in certain time periods to be zero and assigning certain values to certain coefficients in other time periods. This causes the model to, theoretically, bypass the endogeneity problems of the original VAR. The estimated impulse responses is then given by:

$$IR(t, d_i, \Omega_{t-1}) = E(z_{t+x} | u_t = d_i; \Omega_{t-1}) - E(z_{t+x} | \Omega_{t-1}) \tag{3}$$

Where Ω_{t-1} is the variance for u_t and d is the vector of shocks.

4.2 Local Projection

Some major disadvantages with VAR and SVAR models are that they estimate the data globally, as one step ahead forecasts, where the impulse responses are a function of multi-step forecasts. Jordà (2005) presented a methodology called Local Projections, LP, which aim to address this problem by local approximations for each forecast. Thus, the forecasted response is, unlike the VAR, not a function of previous forecasts.

According to Jordà (2005) this tends to make LP more robust and accurate compared to other multivariate time series models such as VAR and SVAR which extrapolates the results into increasingly distant horizons. Furthermore, they can easily be estimated using simple regression techniques and allow for experimentation with non-linear or alternative specification which may otherwise be impractical in a multivariate context. As such it is possible to express the projection of z_{t+s}, where $s \in \{0,1,...T\}$ is the forecast horizon, as an ordinary linear regression equation.

$$z_{t+s} = k^s + B_1^{s+1} z_{t-1} + ... + B_p^{s+1} z_{t-p} + u_t^s \tag{4}$$

The impulse response function can then be estimated as:

$$IR(t,s,d_i) = E(z_{t+x}|v_t = d_i; X) - E(z_{t+x}|v_t = 0; X) \tag{5}$$

Where d is the vector with shocks and $X_t = (z_{t-1}, z_{t-2}, ...)$, v_t is the shock conditional on X_t. It is possible to express equation 5 as:

$$\hat{IR}(t,s,d_i) = \hat{B}_i^s d_i \tag{6}$$

5   The Macroeconomic Data

Data for the macroeconomic variables are gathered from the OECD (2018), BIS (2018) and St.Louis (2019) databases. The following sections will focus on the data characteristics of the macroeconomic variables.

The macroeconomic variable real GDP growth represents changes in the business cycles in Sweden. Real GDP growth data, adjusted for seasonality, on a quarterly basis is downloaded from the OECD (2018a) database. Real GDP growth is defined as the aggregate expenditures on final goods, minus imports, on a quarterly basis. It should be noted that real GDP growth is used rather than nominal GDP growth. The reason being that unlike nominal GDP, real GDP growth is adjusted for inflation. By using real GDP growth potential endogeneity issues are avoided as the Swedish central banks sets its repo rate based on inflation (Riksbanken, 2018). The real GDP growth over time is presented in figure 3, as the figure indicates the GDP growth has been somewhat varied on a quarterly basis, however both visual and formal tests in table I appear to indicate stationarity.
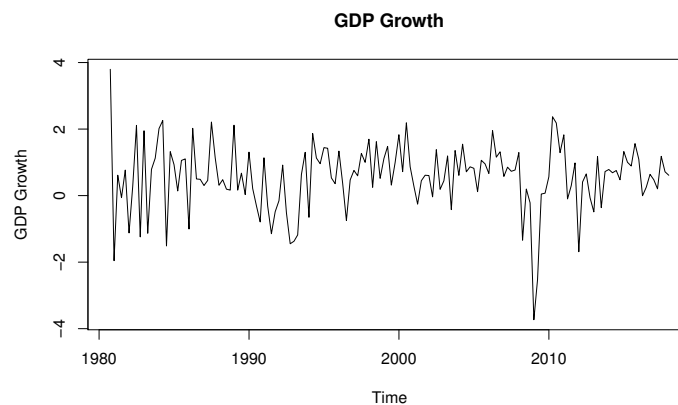

Figure 3: Quarterly real GDP Growth since end of Q3 1980 to Q4 2017.

Data on asset pricing indices with quarterly observations are also obtained from the OECD (2018) database. The asset prices are partitioned into two variables, shares and housing prices. The OECD (2018c) share price indicator is defined as common shares of companies traded on national or foreign

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stock exchanges. The index is calculated as the market capitalization weight price of the stocks and does therefore not take dividends into account. Similarly the OECD (2018b) house prices indicator shows the prices of Swedish residential property prices over time. The share and housing prices are illustrated in figure 4. It should be noted that neither of the two-time series appear to be stationary in their original index form, as the test in table I confirms, which would indicate a need for transformation.
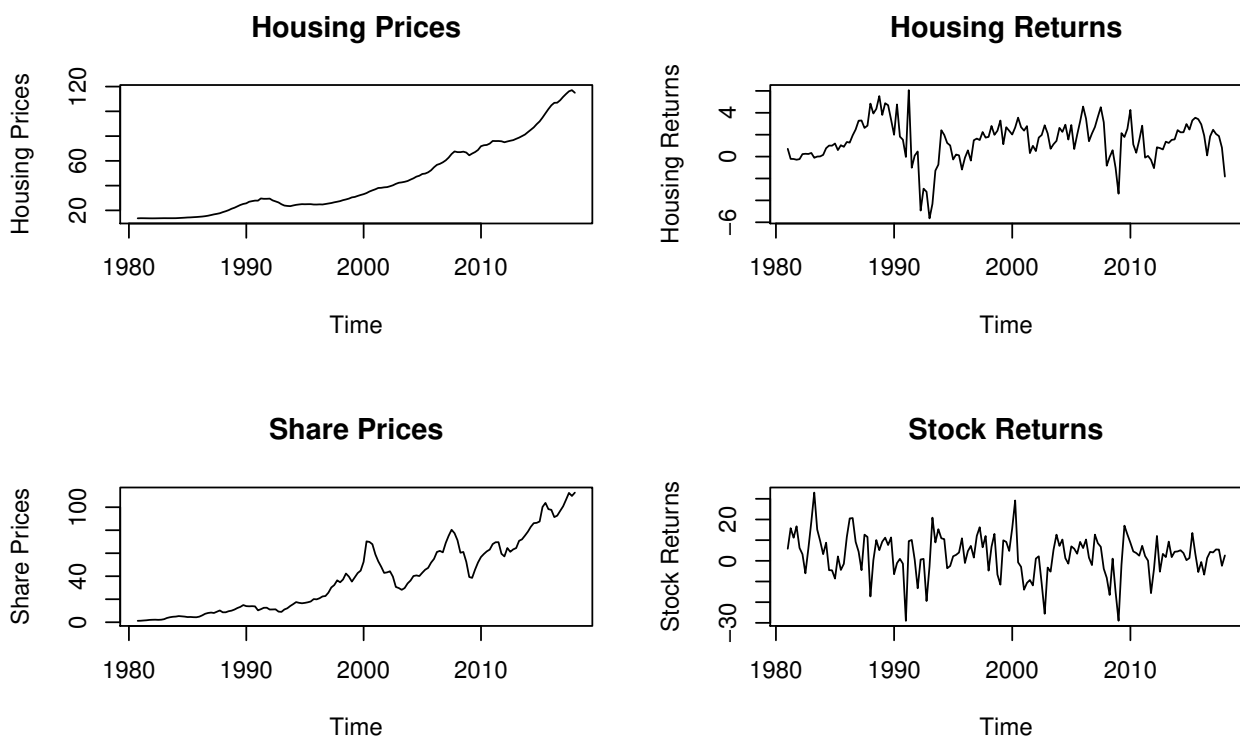
Figure 4: Asset prices and asset returns since the end of Q3 1980 to Q4 2017

The data on quarterly interest rates are downloaded from BIS (2018), while quarterly household debt is downloaded from St.Louis (2019). St.Louis (2019) defines the household debt variable as the amount of credit provided by domestic banks to households and non-profit institutions serving households as specified by the System of National Accounts 2008. The household debt and repo rate are illustrated over time in figure 5. The debt time series does not appear to be stationary, verified by the ADF test in table I, which implies a need for variable transformation. As indicated by figure 5 and table I the time

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series for repo rates does appear to fulfill the stationarity assumption either. Based on figure 5 it appears as though the main problems in the time series are derived from the 1990 to 1994 Swedish financial crisis, during which the central bank quickly raised the repo rate to unprecedented levels.
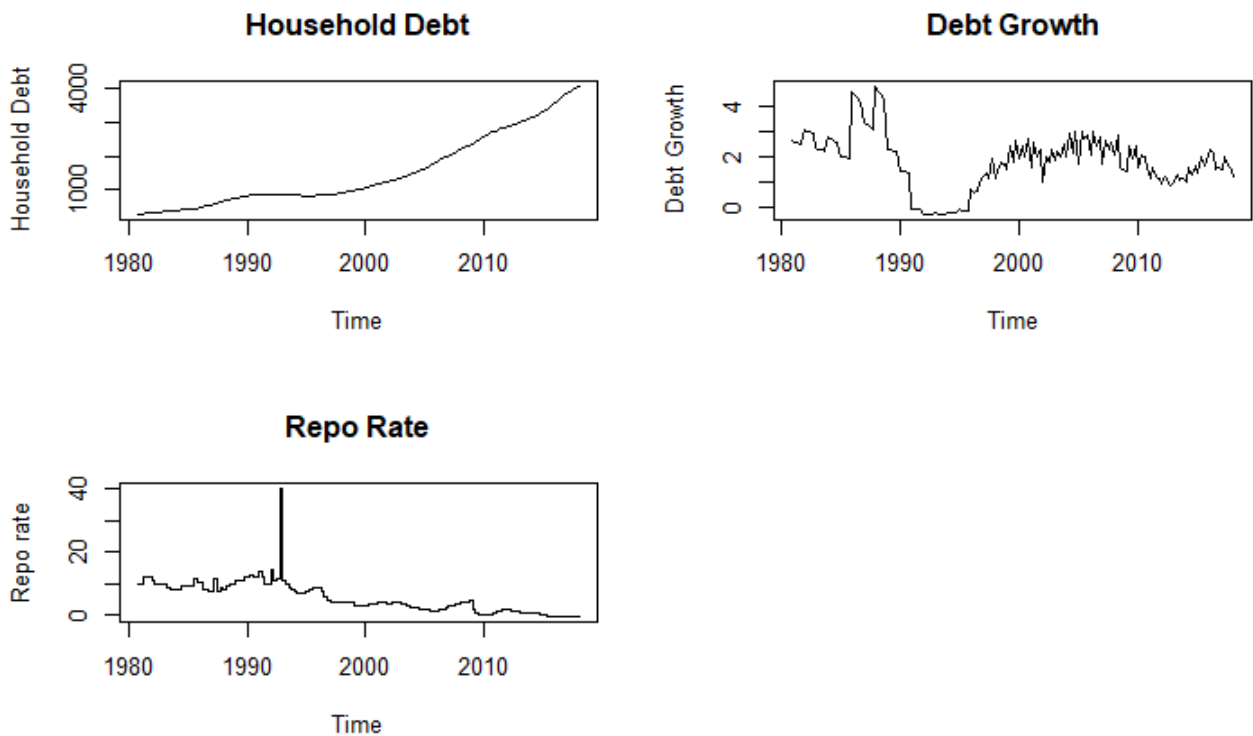
Figure 5: Quarterly household debt, household debt growth and repo rates since Q3 1980 to Q4 2017.

As discussed in the previous section, time series analysis requires the variable observations to be stationary. Stationarity implies that the probability distribution of the random variables does not change over time. This also translates into a constant mean and variance over time. Stationarity is formally tested using an augmented Dickey-Fuller and Zivot Andrews test, the ADF test for the macroeconomic variables are displayed in table I below.

Table I: Augmented Dickey-Fuller test, the null hypothesis is for non-stationarity while the alternative hypothesis is staionarity.

	Augmented Dicky-Fuller Test for Stationarity	
	p-value of Original time series	p-value of Transformed time series
Real GDP Growth	0.01	NA
Share Prices	0.6002	0.01
Housing Prices	0.9873	0.0831
Household Debt	0.9198	0.0248
Repo Rate	0.3731	NA

As the augmented Dickey-Fuller tests in table I indicates, all the variables except for real GDP growth fail the test for stationarity. This implies a need for variable transformation. To get around possible non-stationarity issues and obtain the variations, the variables are logged and the difference between t and $t-1$ is taken. By taking the first difference of the logged time series a new time series of the approximate percentage changes for each time period is obtained. This changes the interpretation of the variables to stock returns, rather than a stock index, housing returns rather than a housing index and household debt growth, rather than a household debt index.

Rerunning the augmented Dickey-Fuller test after the transformations yields stationary time series for all variables except housing returns and repo rate, which is also somewhat implied by figure 4. Before any additional transformations I conduct a Zivot Andrews test for stationarity. The alternative hypothesis in the Zivot Andrews test is that the time series is stationary when accounting for potential structural breaks in the underlying time series (Zivot & Andrews, 1992). The results are presented in table II below.

Zivot Andrews Test	
	Test Statistic
Real GDP Growth	-12.2451***
Stock Returns	-8.4853***
Housing Returns	-6.5997***
Debt Growth	-5.3275**
Repo Rates	-10.6692***

Table II: Zivot Andrews test for stationarity. The null hypothesis is that the time series has a unit root, ***,**,*, indicate that the null hypothesis can be rejected at a 1%,5% and 10% level respectively.

From table II we find the time series for repo rate and housing returns to be stationary when taking structural breaks into account, contrary to the conclusions of the ADF test where they were close to being stationary. The structural break that cause problem pointed out by the Zivot Andrews test, and evident by figure 5, is the financial crisis in Sweden during 1990 to 1994. To account for this structural break in the time series a dummy variable is constructed which takes the value one for Q1 1990 to Q4 1994. By accounting for the structural break, the time series should become stationary and result in reduced bias in the estimates in the analysis. It should also be mentioned that stock returns, housing returns and debt growth is multiplied with one hundred to convert the series into percentage numbers from decimal form, so that all variables are measured on the same scale.

It should be noted that the number of observations, after the variable transformations are 149, meaning that the analysis will be based on 149 observed quarters per variable, including the dummy variable for the 1990 crises. This implies that the total number of observations used in the analysis is 894. While this might be considered few from an econometric point of view it is a substantial in macroeconomic modelling. However, there is likely going to be some endogenous issues in the analysis as it is difficult to account for all potentially endogenous variables without suffering from overparameterization.

6 Estimating the Model

The analysis is partitioned into two parts. In the first part an LP model is estimated, which is then followed by a SVAR. Each subsection includes a short robustness check for each corresponding method. Each estimated impulse response is expressed as the effect of a one standard deviation shock in each variable. This is convenient as it allows for easier comparison for the effects when the variables are expressed in different units of measurements.

6.1 Local Projection

I now estimate the local projection model presented in equation 4. In the following section select impulse response functions will be presented based on the theoretical reasoning from section 3 and the hypothesis. The full figure matrix of impulse response functions is presented in figure 22 in the appendix.

I begin by estimating the impulse response functions of asset prices on real GDP growth. The impulse response functions of stock returns and housing returns on real GDP growth are presented in figure 6 and 7 respectively. Note that the outer, middle and inner confidence bands represent a 95%, 90% and 68% confidence level respectively.
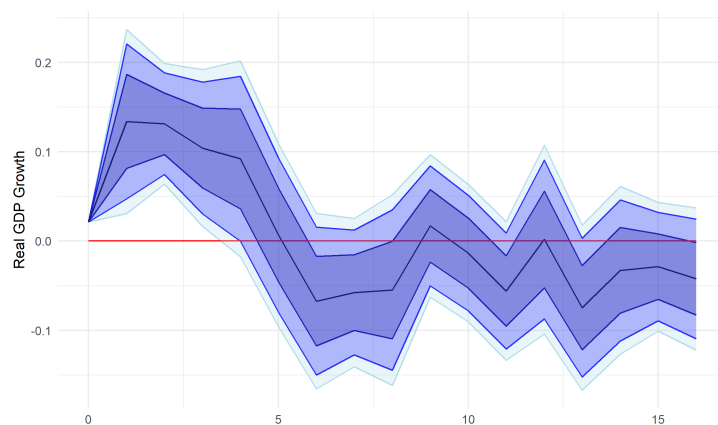

Figure 6: IRF of a one standard deviation increase in stock returns on real GDP growth.

Figure 6 indicate that increasing stock returns appear to be associated with an increase in real GDP

growth for a year before converging towards zero. The estimated impulse response function is statistically significant at a 95% level. This is consistent with the expected response discussed in section 3, where increased stock returns should increase individuals wealth, by holding stock, thus increasing aggregate demand, as theorized by Ludvigson (2002), Gowland and Gilbert (1985), Kennedy (1966) and Modigliani (1944).
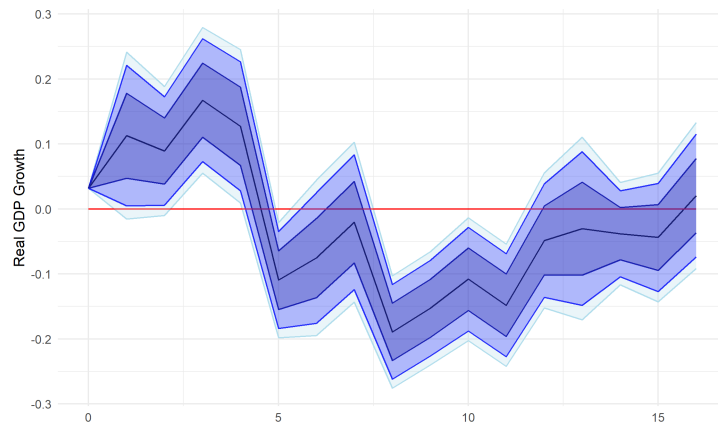

Figure 7: IRF of a one standard deviation increase in housing returns on real GDP growth.

Similar to stock returns housing returns also tend to be associated with increased real GDP growth for one year. However, after two years this association turns into a negative real GDP growth rate before converging towards zero. The estimates are statistically significant at a 95% level. The estimated impulse response of housing prices on real GDP growth is also consistent with the theoretical model in section 3. A boost in housing returns tend to result in a boom in real economic activity within the first year which then turns into a bust after two years. It should be noted that the positive impulse responses of asset prices presented in figure 6 and 7 are consistent with Maki (2001) who find that increasing asset prices tend to be associated with increased household consumption. It is interesting that housing returns are initially associated with an increase in real economic activity and then a decrease, it is possible that there is some form of housing pricing cycle which is not considered in the model.

According to theory there should also be a positive short-term association between debt growth and real GDP growth, the estimated impulse response function of an increase in debt growth is presented in figure
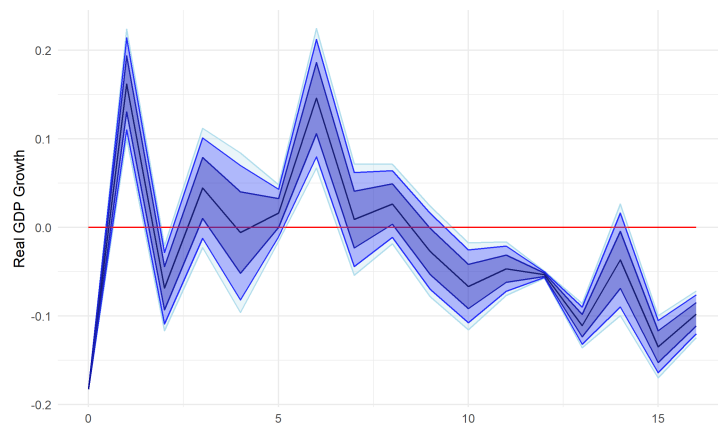
8.

Figure 8: IRF of a one standard deviation increase in debt growth on real GDP growth.

Figure 8 show a clear short-term association, six months, between debt growth and real GDP growth before converging towards zero. It should also be noted that after four years the increased debt growth seems to have a negative effect on real GDP growth. This is consistent with the theory that debt increases short-term aggregate demand at a cost of long-term aggregate demand. The estimated impulse response function is statistically significant at a 95% level. It is also consistent with Mian and Sufi (2018) who found that debt mainly boost demand in the real economy and tend to lead to boom and bust cycles and Floden (2016) who found that the level of household debt affects the amount of disposable income.

The underlying hypothesis of this thesis is that changes in repo rates will reduce real economic activity, measured as real GDP growth, when taking asset prices and debt growth into account. The impulse responses in figures 6, 7 and 8 have focused on the effects in real GDP growth from shocks in asset prices and debt. The following impulse responses in figures 9, 6 and 11 will focus on the effect of repo rate changes on asset prices and debt.
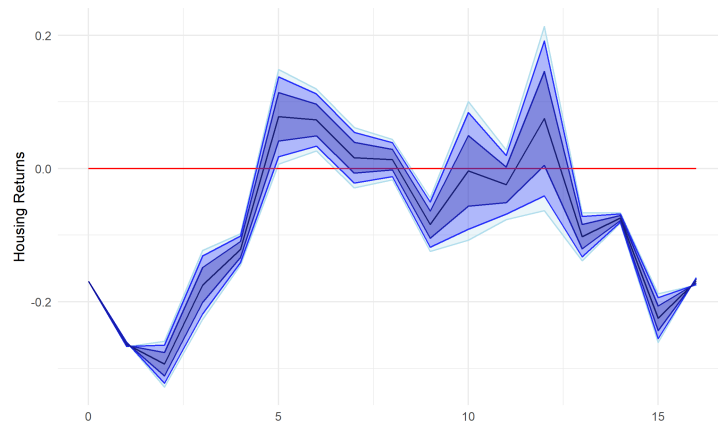
Figure 9: IRF of a one standard deviation increase in repo rate on housing returns.

Figure 9 indicate that an increase in the repo rate tend to have a clear negative association with housing returns. Within the first year of a policy interest rate hike there is a decrease in housing returns, which briefly turns positive after seven quarters before once again turning negative about three years after the increase in repo rate. As the previous IRFS, the estimated impulse response is statistically significant at a 95% level. The estimated impulse response is mostly consistent with the expectation that increasing repo rate should tend to decrease housing prices due to the higher cost of borrowing. It is somewhat surprising that there is a statistically significant increase in quarter five before the housing returns once again turn negative. A possible explanation for this could be that there is some bias in the estimates as not all variables which affect housing prices are considered. Given the scarcity of observations it is difficult to fully account for all potential endogenous variables in a model without suffering from overparameterization.
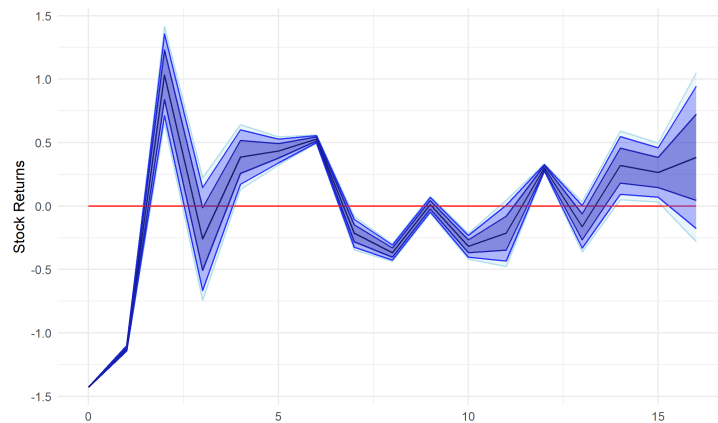
Figure 10: IRF of a one standard deviation increase in repo rate on stock returns.

Increasing repo rates tend to be associated with an immediate negative response in stock returns, which turns into a positive effect after three quarters before converging towards zero. It makes sense that stock returns would be contemporaneously affected by repo rates as financial markets tend to react quickly to changing conditions. As in the case of housing returns the estimated impulse responses are statistically significant at the 95% level. The statistically significant effect of repo rate changes on asset prices are consistent with the findings of Del Negro and Otrok (2007) and Sousa (2010).

Before we move on to the final question of how repo rates affect real GDP growth we must first answer the question of how debt growth is affected if the policy interest were to increase.
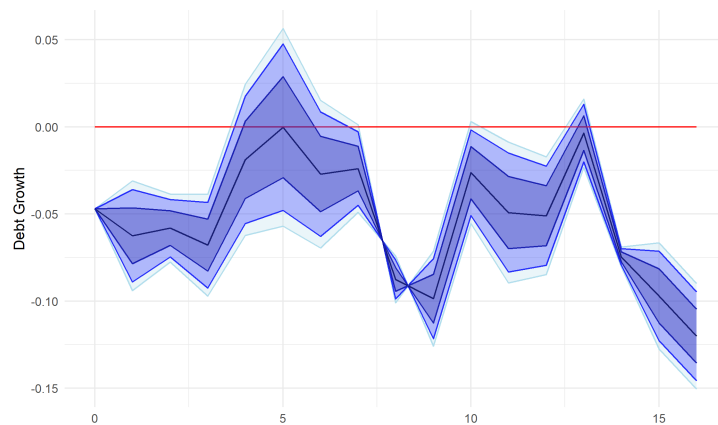
Figure 11: IRF of a one standard deviation increase in repo rate on debt growth.

Debt growth tends to respond negatively to increasing repo rates, as illustrated by figure 11. This is once again intuitive. As repo rates determines the money supply, and thus the level of interest rates in the economy, should a repo rate shock also increase the cost of borrowing. When the cost of borrowing rises it would seem reasonable that individuals borrow less. Once again, the impulse response function is statistically significant at a 95% level. This result is consistent with Mian and Sufi (2018) and Floden (2016) who find expansionary monetary policy to be associated with increasing credit supply. Note that an expansionary monetary policy is equivalent to lowering the repo rate, which would imply the inverse of the estimated response in figure 11.

Knowing how real GDP growth responds to shocks in asset prices and debt growth and how asset prices and debt growth respond to changes in repo rates. It is possible to estimate how repo rates affect real GDP growth when taking asset prices and debt growth into account, the estimated results are presented in figure 12.
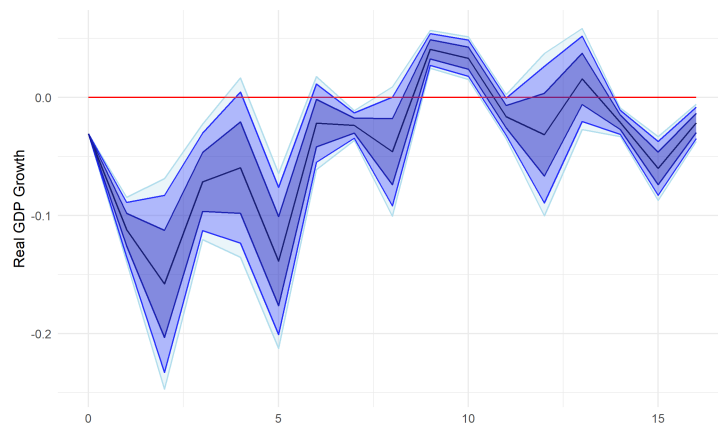
Figure 12: IRF of a one standard deviation increase in repo rate on real GDP growth.

The impulse response function in figure 12 indicate that increasing the repo rate tends to yield negative real GDP growth up to one and a half to two years after the increase before converging towards zero after about two years. This is consistent with the general macroeconomic principle that it takes approximately two years for repo rate changes to have any affect in the economy. The impulse response function also hints at the repo rate increase results in a small increase in real GDP growth after three and a half years, however as the estimated effect is once again negative after four years it is possible that this is noise while the time series converges towards zero. The impulse response is statistically significant at a 95% level. Overall the LP model confirms that increases in the repo rate does tend to result in negative real economic growth two years after the policy change. In the next section a robustness check of the estimated impulse response of real GDP growth from changes in the repo rate will be conducted.

6.1.1 LP Robustness Checks

We check the robustness of the previous results by increasing the degrees of freedom in the analysis. In practice this means that we exclude one of the less important variables and rerun the analysis. We start off by estimating the LP impulse responses excluding both asset prices and debt, only using repo rates and real GDP growth, the full impulse response matrix can be found in figure 21 in the appendix. While there is still a statistically significant negative effect after two years of a policy interest rate increase, the

25

effect is reduced and less statistically significant. This implies that the inclusion of asset prices and debt improves on the model, and that the results in figure 12 are robust. When estimating the model without stock returns the results are highly similar to that of the impulse response function reported in figure 12. This further confirms the robustness of the results reported in figure 12, and indicate that stock returns contribute little to the overall model.

I also control for inflation, CPI, the results of which can be found in figure 23 in the appendix. The inflation data is collected from (OECD, 2019b). Inflation is excluded in the main analysis as it is not the focus of this thesis and introducing more variables would decrease the degrees of freedom in the estimation. As the figure illustrates, the inclusion of inflation tend to have little effect on the estimates, there is some additional negative effect on debt and asset prices, but the effect on real economic growth is marginal. This provides further evidence of the LP models estimates robustness.

6.2   Vector Autoregression

I start the analysis by estimating the ordinary VAR model, presented in equation 1, using the variables real GDP growth, housing returns, stock returns and policy interest rates. The results are first presented as forecast error variance decomposition, FEVD, in table III, IV, V and VI. Forecast variance error decomposition show the amount of information each variable contributes to the other variables in the regression.

Table III: Forecast Error Variance Decomposition of real GDP growth.

	R	H	S	D	Y	EC
1	0.00	0.00	0.00	0.07	0.93	0.00
2	0.02	0.02	0.03	0.12	0.80	0.00
3	0.03	0.03	0.04	0.12	0.77	0.01
4	0.03	0.07	0.05	0.12	0.69	0.04
5	0.03	0.11	0.05	0.11	0.64	0.07
6	0.04	0.11	0.05	0.11	0.62	0.07
7	0.04	0.10	0.05	0.16	0.58	0.07
8	0.04	0.11	0.06	0.16	0.58	0.07
9	0.04	0.12	0.06	0.16	0.56	0.07
10	0.04	0.14	0.06	0.15	0.54	0.07
11	0.04	0.14	0.06	0.16	0.54	0.07
12	0.04	0.17	0.06	0.15	0.52	0.06

As the forecast variance decomposition for real GDP growth in table III indicates GDP appear to be largely determined by lagged values of GDP within a four period horizon. As the forecast horizon increases lagged housing returns and debt growth appear to compose a larger fraction of the forecasted variance. This would indicate that while real GDP growth is largely determined by lagged values of real GDP growth, household wealth in the form of housing returns and debt growth appear to explain some of the variance. We now move on to the forecast error variance decomposition for stock returns, which is presented in table IV.

Table IV: Forecast Error Variance Decomposition of Stock Returns.

	R	H	S	D	Y	EC
1	0.05	0.01	0.95	0.00	0.00	0.00
2	0.06	0.01	0.91	0.00	0.01	0.00
3	0.07	0.01	0.86	0.02	0.01	0.02
4	0.06	0.02	0.77	0.04	0.01	0.10
5	0.07	0.02	0.73	0.08	0.01	0.09
6	0.07	0.04	0.71	0.07	0.02	0.09
7	0.08	0.06	0.68	0.07	0.02	0.09
8	0.08	0.07	0.65	0.08	0.02	0.10
9	0.08	0.07	0.65	0.08	0.02	0.10
10	0.08	0.08	0.62	0.10	0.03	0.10
11	0.08	0.08	0.61	0.10	0.03	0.10
12	0.08	0.08	0.60	0.11	0.03	0.09

Table IV stock returns are largely determined by lagged stock returns. As the forecast horizon increases debt appear to explain a greater fraction of the stock return forecast error variance. We also estimate the forecast error variance decomposition for housing returns, which is presented in table V.

Table V: Forecast Error Variance Decomposition of Housing Returns.

	R	H	S	D	Y	EC
1	0.04	0.96	0.00	0.00	0.00	0.00
2	0.13	0.87	0.00	0.00	0.00	0.00
3	0.16	0.78	0.01	0.03	0.01	0.01
4	0.16	0.74	0.01	0.04	0.01	0.05
5	0.15	0.70	0.01	0.06	0.02	0.06
6	0.15	0.69	0.01	0.07	0.02	0.06
7	0.15	0.68	0.02	0.08	0.02	0.06
8	0.14	0.66	0.03	0.09	0.02	0.06
9	0.14	0.64	0.03	0.10	0.02	0.08
10	0.14	0.63	0.03	0.10	0.03	0.09
11	0.13	0.62	0.03	0.10	0.04	0.09
12	0.13	0.62	0.03	0.09	0.04	0.09

As table V illustrates housing returns are largely determined by lagged housing returns. As the forecast

horizon increases a larger fraction of the variance is explained by debt and the repo rate. This is expected as housing returns should largely be driven by increasing housing prices, which according to expectation is correlated with debt growth. This brings us to the forecast error variance decomposition of debt.

Table VI: Forecast Error Variance Decomposition of Debt Growth.

	R	H	S	D	Y	EC
1	0.01	0.00	0.00	0.99	0.00	0.00
2	0.02	0.00	0.00	0.97	0.00	0.00
3	0.02	0.01	0.00	0.93	0.03	0.00
4	0.02	0.01	0.00	0.90	0.05	0.03
5	0.02	0.01	0.00	0.87	0.07	0.03
6	0.02	0.01	0.00	0.86	0.08	0.04
7	0.01	0.02	0.02	0.83	0.07	0.04
8	0.01	0.03	0.04	0.77	0.10	0.05
9	0.01	0.04	0.04	0.74	0.12	0.05
10	0.01	0.05	0.04	0.72	0.14	0.05
11	0.01	0.07	0.03	0.68	0.16	0.05
12	0.01	0.09	0.03	0.66	0.17	0.05

Table VI indicates that the forecast error variance decomposition is largely explained by lagged values of debt growth. As the forecast horizon increases real GDP growth and housing returns seems to play an increasingly important role in explaining the forecast error variance. This would seem intuitive as housing returns and debt growth should be correlated, while real economic activity should be correlated with debt growth. As explained in section 3, when individuals borrow to consume in the current time period there should be an increased consumption in the current time period and lesser consumption in future time periods. To test the statistical significance of the variables I run Granger-causality test using the VAR model.

Granger-Causality tests are used to formally test whether lagged values of a regressor have any predictive power on the outcome variable. Table VII presents the results of a series of pairwise Granger-Causality tests.

Table VII indicates that housing and stock returns as well as debt growth Granger-cause GDP. Table VII also indicate that housing returns Granger-cause repo rates and stock returns. Debt growth Granger-cause real GDP growth and housing returns, which seems intuitive as household debt should increase real economic activity and result in increasing housing prices. Due to the potential simultaneity problems

Table VII: p-values for the Granger-Causality Tests

Regressor	Dependent Variable in Regression				
	Real GDP Growth	Stock Returns	Housing Returns	Debt Growth	Repo Rate
Real GDP Growth	0.00	0.49	0.38	0.33	0.11
Stock Returns	0.00	0.00	0.11	0.49	0.29
Housing Returns	0.00	0.03	0.00	0.54	0.00
Debt Growth	0.00	0.13	0.032	0.00	0.056
Repo Rate	0.08	0.25	0.07	0.99	0.00

associated with the macroeconomic variables, for example would one expect there to be instantaneous changes in some variables simultaneously a test for simultaneous effects is also run.

Table VIII: p-values for Test of contemporaneous effects.

Regressor	Dependent Variable in Regression				
	Real GDP Growth	Stock Returns	Housing Returns	Debt Growth	Repo Rate
Real GDP Growth	0.00	0.13	0.27	0.02	0.41
Stock Returns	0.13	0.00	0.01	0.08	0.00
Housing Returns	0.27	0.01	0.00	0.96	0.06
Debt Growth	0.02	0.08	0.96	0.00	0.40
Repo Rate	0.40	0.00	0.06	0.40	0.00

From table VIII we see that debt growth and real GDP growth appear to have a contemporaneous effect, meaning that both variables are correlated at the same point in time. Stock returns exhibit a contemporaneous effect with housing returns and repo rates. This is to be expected as financial markets tend to quickly adapt to changing conditions, meaning that one would expect stock to react instantaneously rather than over time. Thus, we can conclude that the ordinary VAR model requires structural constraints to be imposed to take care of the problem of contemporaneous effects. This is corrected for in the structural VAR model, SVAR, in the next section.

6.3 Structural Vector Autoreggression

To account for potential theoretical contemporaneous issues we estimate a structural vectorautoregressive model by imposing constraints on equation 1, which yields equation 2. As in the case of Ludvigson

(2002), the repo rate is assumed to not be contemporaneously affected by anything. Housing returns are assumed to be contemporaneously affected by debt growth and stock returns, as indicated by VIII. Note that if there is a contemporaneous correlation between housing returns, stock returns and debt, then it is likely that the correlation in table VIII is spurious. Thus, constraints are imposed such that debt can only affect housing returns in the current period as the majority of Swedish debt borrowed from banks is likely mortgages (Floden, 2016) (OECD, 2019a). Stock returns are in turn allowed to be contemporaneously affected by housing returns (Ludvigson, 2002). Debt growth is assumed to not be contemporaneously affected by anything, while real GDP growth is assumed to be contemporaneously affected by debt growth, see table VIII. In summary this results in the constraint matrix B_0.

$$
B_0 = \begin{bmatrix}
1 & 0 & 0 & 0 & 0 \\
0 & 1 & \beta_{23} & \beta_{24} & 0 \\
\beta_{31} & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & \beta_{54} & 1
\end{bmatrix}
$$

I begin by estimating the response in real GDP growth from a change in stock and housing returns, note that the outer, middle and inner confidence intervals represent a 95%, 90% and 68% confidence level respectively. The confidence intervals are estimated using bootstrapping, which makes them sensitive to unrobustness. It should also be noted that the dashed line in the following figures is the corresponding LP estimate, it is included for the purpose of comparing the estimates between SVAR and LP.
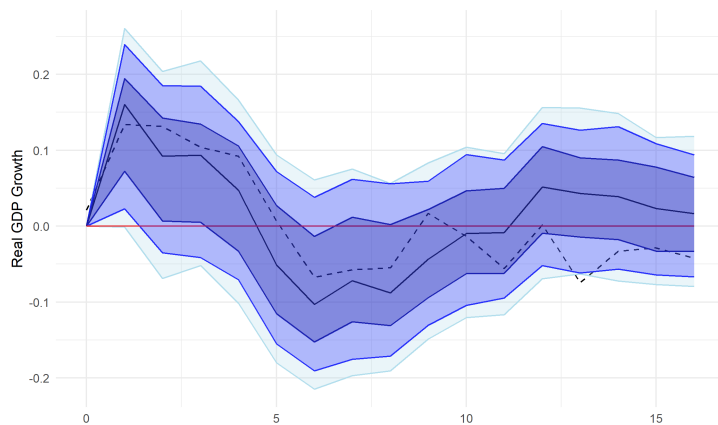
Figure 13: IRF of a one standard deviation increase in stock returns on real GDP Growth. The dashed line represent the corresponding LP estimate.

Figure 13 indicates that increasing stock returns tend to be associated with a short-term increase in real GDP growth, which is to be expected. The estimated impulse response is however statistically insignificant at a 95%, but significant at a 90% level. The positive estimates are consistent with Maki (2001) findings who find that increasing household wealth tend to be associated with increased household consumption. The estimates are also highly reminiscent to the LP estimates, the major difference being the major reduction in variance for the LP estimates.
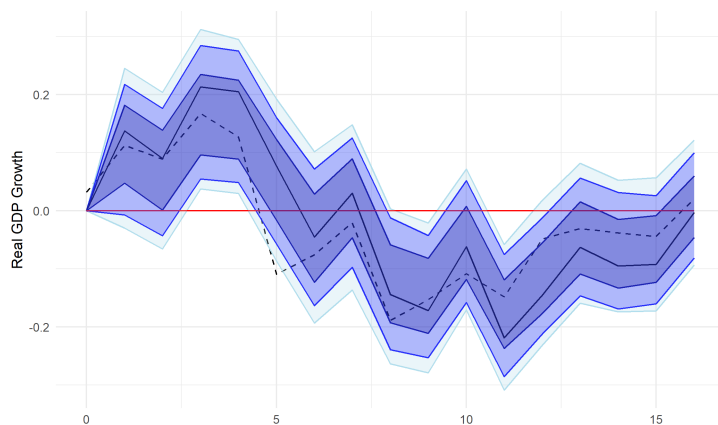

Figure 14: IRF of a one standard deviation increase in housing returns on real GDP Growth. The dashed line represent the corresponding LP estimate.

The estimated impulse response of an increase in housing returns on real GDP growth is positive in the short and medium term. This seems intuitive as real aggregate demand should increase if individuals wealth increases, which is consistent with Maki (2001) , but not Ludvigson (2002) findings. The impulse response function is statistically significant at a 95% level. Interestingly, as in the case of LP, there seems to be a positive short term association between housing returns and real economic activity, which decreases five to 15 forecast horizons later. It is possible that this is caused by a natural cycle in housing prices. Once again the SVAR estimates in figure 14 is highly reminiscent of figure 7, which shows consistency across estimation methods. We now move on to examine the response on real GDP growth from an increase in debt.
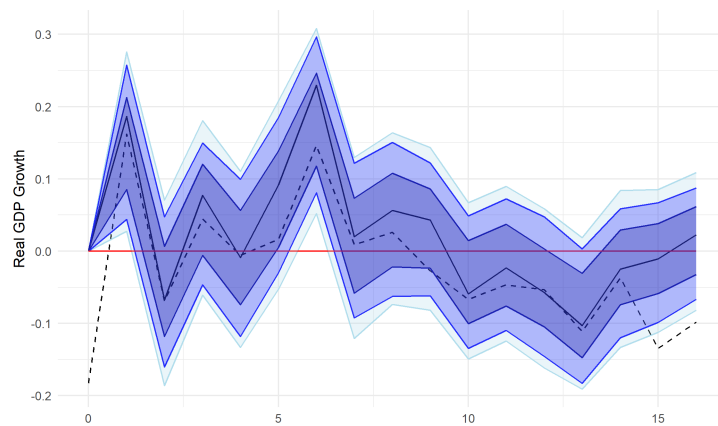

Figure 15: IRF of a one standard deviation increase in debt growth on real GDP Growth. The dashed line represent the corresponding LP estimate.

An increase in debt growth tends to be associated with a short-term increase in real GDP growth and a medium-term decrease in economic activity, which is statistically significant at a 95% level. A short-term boost in real economic activity and a medium-term decrease seems intuitive as debt implies that future income is used for current consumption. This is consistent with Mian and Sufi (2018) who find debt to boost real economic activity and tend to result in boom and bust cycles. The SVAR estimates are highly reminiscent of the LP estimates, further supporting consistency across estimation methods. Before answering the question of how repo rates affect real economic activity accounting for asset prices

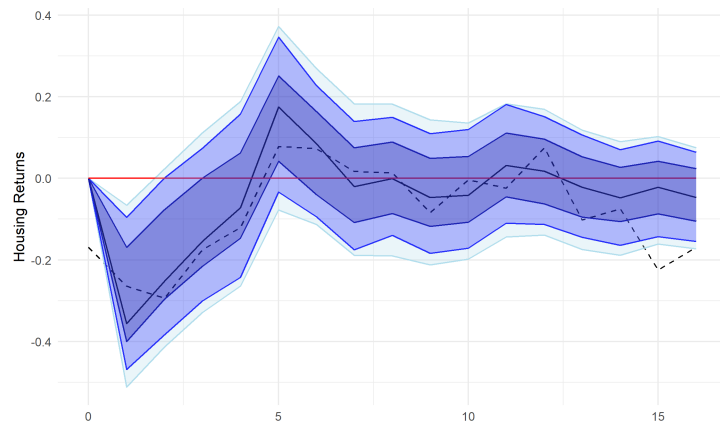and debt we must first estimate the effect of changes in repo rates on asset prices and debt.

Figure 16: IRF of a one standard deviation increase in repo rate on housing returns. The dashed line represent the corresponding LP estimate.

Increasing repo rate tend to yield decreasing housing returns within a one-year time horizon. These estimates are statistically significant at a 95% level. This is expected as the underlying theory suggests that a reduction in the money supply should lower housing prices. It should also be noted that once again the SVAR estimates in figure 17 are very similar to the LP estimates in figure 7.
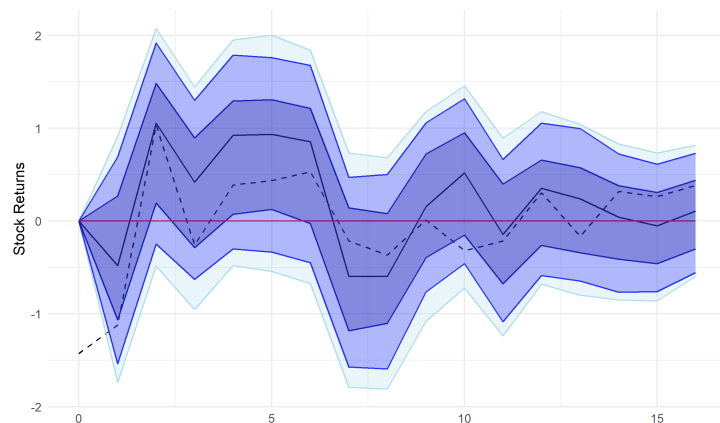

Figure 17: IRF of a one standard deviation increase in repo rate on stock returns. The dashed line represent the corresponding LP estimate.

As in the case of housing returns, stock returns tend to be associated with a short-term increase followed by both medium-term decreases and increases. This is to be expected as financial markets tend to quickly adapt to changing conditions, thus it might be that the changes are too quick to model accurately, and the ensuing estimates are simply noise converging towards zero. Repo rates should have a negative effect on asset prices as in the case of Del Negro and Otrok (2007) and Sousa (2010). The SVAR estimates are, as in the previous cases, very similar to the corresponding LP estimates, the LP estimates are however statistically significant.
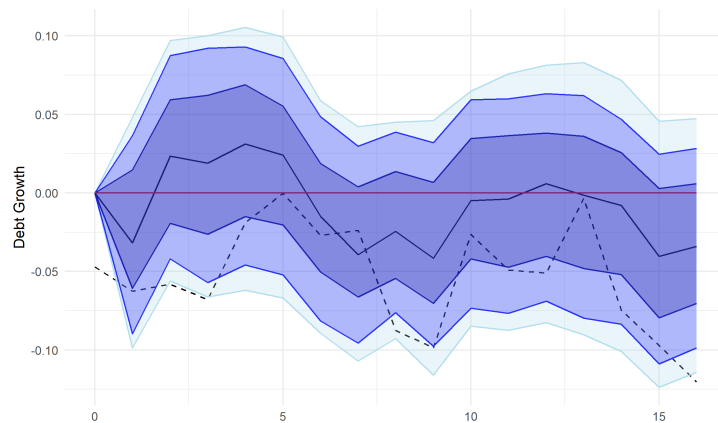

Figure 18: IRF of a one standard deviation increase in repo rate on debt growth. The dashed line represent the corresponding LP estimate.

Debt growth tend to have a negative response to repo rate increases within the first two years, this is however statistically insignificant. It seems intuitive that an increase in the repo rates would reduce debt growth given the higher cost of borrowing associated with higher interest rates. This result is consistent with Mian and Sufi (2018) who find expansionary monetary policy to be associated with increasing credit supply. Note that an expansionary monetary policy is equivalent to lowering the repo rate, which would imply the inverse of the estimated response in figure 11. The SVAR estimates differ slightly from that of the LP. While the sign and general curve of the estimates are similar, the SVAR model is overall statistically insignificant and converge toward zero sooner. The LP estimate also indicate that the the effect of a repo rate is more negative compared to SVAR.
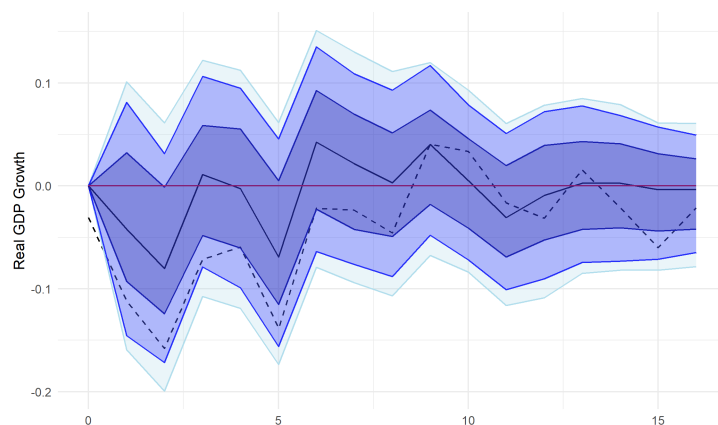
Figure 19: IRF of a one standard deviation increase in repo rate on real GDP growth. The dashed line represent the corresponding LP estimate.

As indicated by the impulse response function in figure 19 there appear to be a two-year time lag before any potential effects of a repo rate is visible. The estimated effect is as expected negative, however statistically insignificant at the 90%, 95% and 68% levels. In summary the SVAR model is not able to find any strong statistically significant effects from repo rate changes on real GDP growth when taking asset prices and debt growth into account. The estimates are however similar to the highly statistically significant effects in LP. Given that LP appear to be a superior estimation method with lower variance, it would thus seem as though there is an empirical effect between repo rates and real economic activity when taking debt growth and asset prices into account.

6.3.1 SVAR Robustness Checks

We perform a robustness check by rerunning the SVAR model while excluding stock returns, which increases the degrees of freedom used in the analysis. The results do not change substantially compared to the original model, however it should be noted that some of the variation is reduced while the impulse response estimates are the same. It is possible that the large model variance is derived from the underlying parametric assumptions not being satisfied. Only stock returns and housing returns follow a normal distribution, while real GDP growth, debt growth and repo rate tend to be skewed, see figure 20 in

the appendix. This could potentially imply that LP is a more suitable approach which will yield better estimates, as it does not rely on the same assumptions. The results of the LP are highly reminiscent of the SVAR estimates, however the model variance is largely reduced. It is possible that the reduction in variance in the LP model is caused by LP being a more robust modelling approach. Overall the similarity in the estimates indicate that the estimated effects are consistent and fairly robust.

It should also be mentioned that I also control for inflation in the SVAR model. Inflation is allowed to have a contemporaneous association with housing prices. However, as in the case of LP, the inclusion of inflation does not appear to have any major effects in the model. In fact, the inclusion of inflation tend to actually increase the variance in the SVAR estimates. This can potentially be explained by either model misspecification, or overparameterization due to the number of observations. As such, the exclusion of inflation does not appear to affect the model significantly.

7 Conclusions

The purpose of this thesis is to explain real economic activity as a function of repo rates, while accounting for asset prices and household debt. To answer this hypothesis data for GDP, share prices, housing prices, household debt and repo rates were collected from St.Louis (2019), BIS (2018) and OECD (2018). The variables were transformed to fulfil the stationarity assumption imposed by time series modelling.

To answer the research question a vector autoregressive analysis, structural vector autoregressive analysis and local projections is used. An ordinary vector autoregressive analysis proved to be somewhat non-informative. The vector autoregressive analysis did however prove to be useful for causality tests, particularly to identify Granger-causality and contemporaneous correlation. The SVAR improved the results, albeit they were statistically insignificant. LP resulted in very similar estimates to those of the SVAR model, with the distinct difference of a substantially lower variance. The reduction in variance is likely due to LP being a more robust method as the estimates from LP and SVAR are highly similar.It does however also indicate that more studies are needed to verify a potential causal relationship.

While the SVAR model was unable to show any effect of repo rate changes on real GDP growth, accounting for asset prices and debt growth, the LP model provided evidence for rising repo rates resulting in negative real GDP growth rates two years after the policy change. The negative effect of expansionary monetary policy on real economic activity was enhanced when accounting for changes in asset prices and debt growth. Future research can account for inflation or international dynamics. As Sweden is a small open economy, international interest rate dynamics and trade flows are likely to affect asset prices and real economic activity.

Other possibly important aspects, which this study does not take into account, are savings in financial instruments other than stocks. Bonds and bond mutual funds are also popular forms of investments, which could also have an important effect on real economic activity. By negating this it is possible that I underestimate the negative real economic effects of interest rate increases, due to that fact that bonds have an inverse relationship with interest rate levels.

Overall this implies that there is a significant real economic cost to monetary policy when accounting for the asset pricing, and especially the debt channel. It might therefore be prudent for the Swedish central bank, and policymakers, to consider additional real economic consequences when implementing monetary policy. Further studies could focus on the implementation of asset pricing and debt growth into a DSGE framework, which can be used by the central bank when setting monetary policy.

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Appendices

A   Variables

Histogram of the distribution of the transformed variables. Stock returns and housing returns appear to be approximatly normally distributed, while real GDP growth is normally distributed with a skew. Debt growth is not particularly normally distributed and contain some fat tails indicating a higher probability of extreme events. The repo rate appear to be a highly skewed normal distribution.
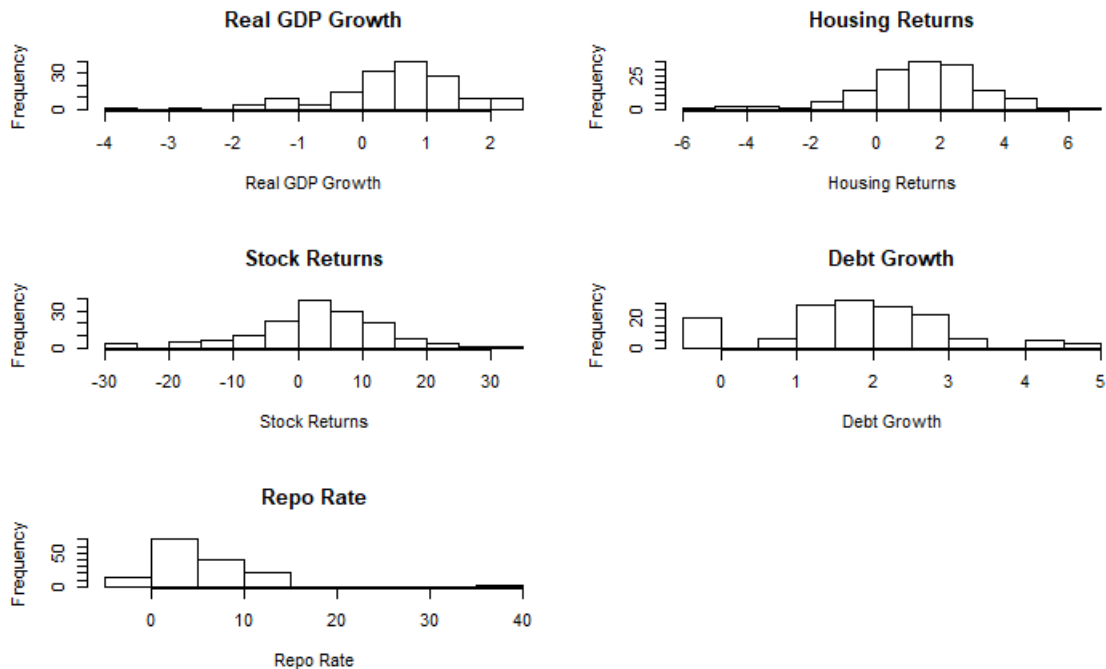

Figure 20: Macroeconomic Variable Distributions

B   Local Projection

In the following section all of the estimates of the LP model are presented. The figure below presents the model when asset prices are excluded.
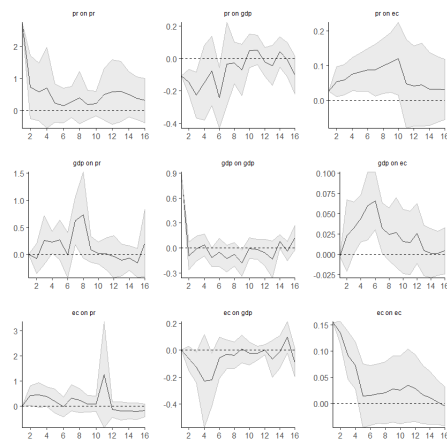
Figure 21: LP model with only real GDP growth and policy rates, taking structural breaks into account.

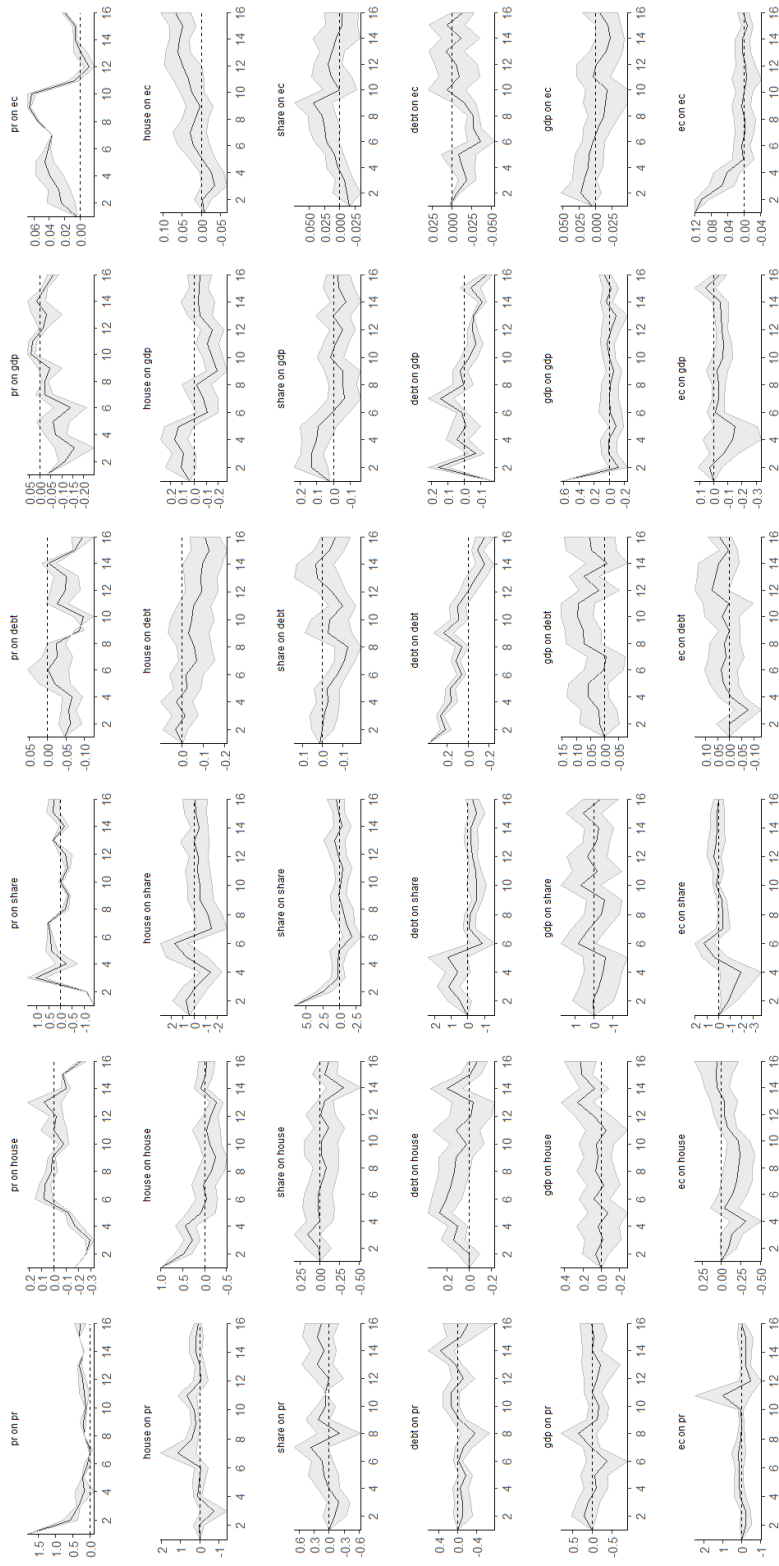The following figure presents all the estimates of the LP model.
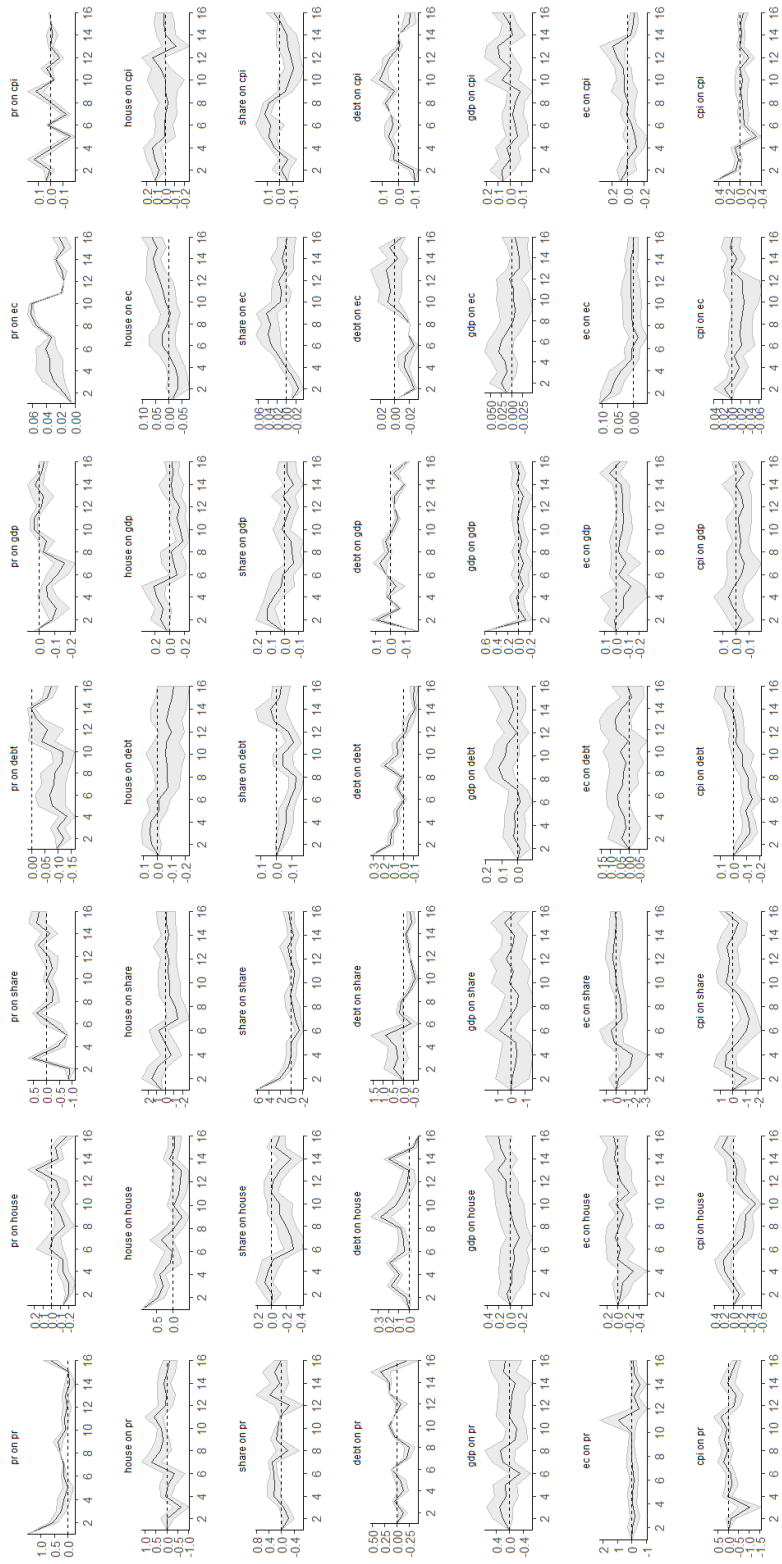
Figure 22: Full LP model

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Figure 23: Full LP model, controlling for CPI

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