# Zero Rates and Zero Benefits?

A SVAR model approach investigating the effectiveness of modern monetary policy conditional on household debt

Sanjin Alagic & Samuel Hederén

Supervisor: Anna Grodecka-Messi

May 26, 2021

Lund University

**Abstract**

Ever since the Great Recession in 2008, the effectiveness of monetary policy has been increasingly debated. Central banks in modern economies were forced to find new ways of conducting expansionary monetary policy beyond conventional methods, most notably through quantitative easing and forward guidance, as they were at, or very close to, the zero lower bound of nominal interest rates. However, even with these new ways to stimulate the economy, the inflation has not been responding proportionally and has almost persistently remained stuck below the target. Today, subsequent to more than a decade of almost constant expansionary monetary policy to an under-shooting of the inflation target, household debt has been steadily increasing in many countries. This has raised questions about the role that household debt plays in determining the effectiveness of monetary policy. Using a Structural Vector Autoregression model with data from Sweden and the US, this paper aims to explore the effectiveness of (unconventional) monetary policy conditional on household debt. By using alternative measures of policy rates to reflect the new realities of modern monetary policy, we show that high debt can have a detrimental effect on the effectiveness of monetary policy.

**Keywords**: Shadow rates – Monetary base – Inflation – Household debt – Quantitative easing – Forward guidance

# Contents

# 1 Introduction

The repo rate and federal funds rate were long the primary tools used by the Swedish Riksbank and the US Federal Reserve respectively, to keep inflation in check. In an effort to stimulate the economy following the Great Recession in 2008, policy rates were lowered to, or very close to, zero, without fully succeeding in restoring the economy to its full potential. Thus, to avoid prolonging the recession, central bankers were forced to start using more creative and unconventional tools to conduct expansionary monetary policy, as lowering the policy rate substantially was no longer an option. The tools in question are large scale asset purchasing (commonly referred to as quantitative easing) and transparent communication of the central banks future intentions (forward guidance).

Today, more than a decade later, we know that these stimuli remained in place beyond the recession and are now arguably key elements of monetary policy rather than unconventional interventions. Such policy tools continue to be used precisely because the inflation target has not been reached. As the central banks have a clear mandate to meeting the target, there has been no reason to withdraw from these policies. Consequently, monetary policy has spent a decade in unexplored macroeconomic territory, the result of which has sparked a debate among economists (see e.g. Leigh et al., 2012; Mian and Sufi, 2014; Alpanda and Zubairy, 2019). The main issue for debate has been what do to do if a new crisis arises when we are already conducting expansionary monetary policy, yet struggle to meet inflation targets.

Another consequence of the more than a decade long low-rate environment is an increasing level of debt. Increasing household debt in Sweden and growing public debt in the US has sparked yet another related debate about the effectiveness of monetary policy in times of high debt. No clear consensus exists in the literature regarding its role in the monetary policy transmission mechanism, although it predominantly points towards having a positive effect. However, the results found are primarily based on policy rates as the sole monetary policy tool, which has been stuck around zero since the recession.

Recently, some economists have found ways to measure the outlook of monetary policy beyond looking at policy rates only, using instead an alternative measure called shadow rates, which incorporates information about the extent of unconventional monetary policies (see e.g. De Rezende and Ristiniemi, 2020; Wu and Xia, 2016). This paper seeks to add information regarding the effectiveness of monetary policy in situations of high household debt by first comparing the mirroring development of household debt in Sweden and the US and then comparing relative debt levels within each country, by using alternative measures to policy rates.

Our findings from the country comparisons show somewhat contradictory results, indicating the need for a modest interpretation due to possible omitted variables between the countries. Expanding the analysis to include comparisons between relatively high and low debt periods within each country, we find evidence for a less effective monetary policy in times of high debt.

The disposition of the paper is as follows. First, in Section (2), we give a brief overview of how and why monetary policy has been changing during the past few decades. Then we provide an overview of the construction of the alternative policy rate measure, shadow rates, in Section (3). In Section (4), we illustrate the evolution of debt over time, and its consequences on monetary policy. Section (5) explains the methodology and specification choices of our empirical model in detail. Section (6) presents and discusses the results of the model. Limitations and suggestions for further research is discussed in Section (7) and Section (8) concludes.

# 2 The Evolution of Monetary Policy

Since the early 1090s most western central banks have resorted to inflation targeting (at the somewhat arbitrary rate of 2%) through interest rates as the primary tool of monetary policy. The Swedish Riksbank switched to an inflation targeting system in 1993 whereas the US Federal Reserve has followed an unofficial inflation targeting system (made official in 2012) since 1996 (Heikensten and Vredin, 2002; FED, 2020). The move to an inflation targeting monetary policy regime within many developed economies roughly coincides with the advent of what macroeconomist have dubbed "The Great Moderation" in these same economies. This refers to a period from the mid-1980s to 2006 characterized by systematically lower variations in the output gap and inflation (Bernanke, 2004). Although no clear consensus exists on the exact start and end points of the period or its causes, good luck, prudent policy decisions and changing economic structures have been pointed out as likely causes (Galí and Gambetti, 2009). In this relatively stable environment monetary policy performed well; throughout the 1990s and early 2000s price levels were effectively maintained and economic growth was steady.

The policy tool of choice for the central bank to control the price level during this time was the policy rate. Understanding the manner in which the policy rate affects the economy, i.e. the transmission channels of monetary policy, thus became of central importance.

The textbook way in which the policy rate was thought to control inflation was through it's effect on the long-term interest rate. It was assumed that a change in the nominal short-term rate would translate to a change of the nominal long-term rate as well, due to the expectation that the short-term rate would persist. Then, because prices are sticky, the real long-term interest rate would be affected as well, shifting the demand of firms and households due to changes in costs of capital over the entire horizon and directly affecting inflation (Beyer et al., 2017; Friedman, 1970). This theory proved insufficient to explain the effect that the policy rate has on inflation however, and has been appended to include several other channels as well. Of these, the credit channel gained prominence in the literature and is of considerable interest as it relates to household debt, a topic covered in section (4.1) (Bernanke and Blinder, 1988; Bernanke and Gertler, 1995).

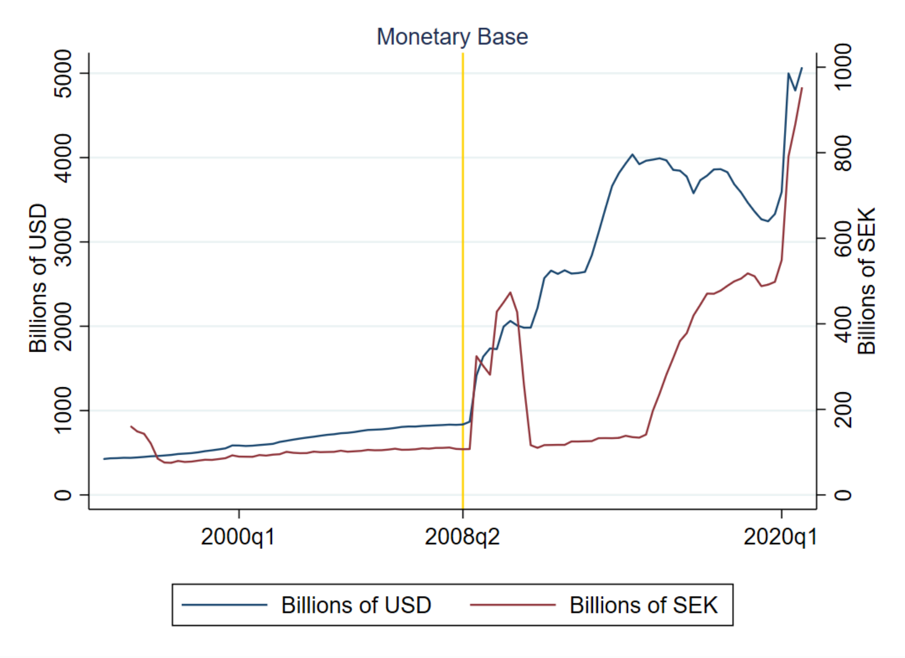
The credit channel is made up of two components: the balance sheet channel and the bank lending channel. The balance sheet channel refers to the fact that a change in the interest rate will affect both the demand and supply of loans in the economy, thereby altering consumption and investment (see e.g. Bernanke and Blinder, 1988; Bernanke and Gertler, 1995; Beyer et al., 2017). Lowering the interest rate will increase borrower net worth as their debt burden is reduced and their demand for more loans increase. On the supply side, the increased net worth of the potential borrower makes the borrower less risky in the eyes of a commercial bank, thereby increasing the supply of loans at the lower interest rate (ibid.). In the bank lending channel the central bank controls the amount of loans issued by commercial banks by controlling the amount of loanable funds available to the commercial bank through the policy rate. Lowering the policy rate will make it cheaper for the commercial banks to borrow money from the central bank, thereby increasing their available reserves. This new money is then lent, consumed, deposited and lent out again in several rounds. This process is dubbed the ”money multiplier” because the eventual money supply available in the economy will be considerably larger than the initial influx of base money from the lowering of the policy rate. The increased money supply in the economy and the increased economic activity will lead to higher prices (if output is not similarly scaled up) (Disyatat, 2011; Carpenter and Demiralp, 2012). The opposite policy measure similarly leads to lower prices, concluding the inflation control of central banks.

## 2.1 The Zero Lower Bound and ”New Normal”

The zero lower bound (ZLB) is characterized by having short-term nominal interest rates at or close to zero, which is a situation that could lead to precarious macroeconomic outcomes. If the lower bound of policy rates is met, the traditional tool of adjusting the rates to stabilize business cycles can only be used in one direction, namely *increasing* interest rates to *decrease* aggregate demand. In theory, a zero nominal interest rate promotes economic growth, primarily because lending money will either be free or have a negative cost, given a non-negative inflation, thus stimulating demand. However, what if that economy is at the ZLB but still below its inflation target?

After the Great Recession of 2008, most modern central banks found themselves in this peculiar situation. Policy rates were very close to or even precisely at zero, whereas the economies were still experiencing a negative GDP gap. That is when central banks started introducing unconventional monetary policy tools such as large-scale asset purchases, now known as quantitative easing (QE). This meant that the central banks shifted focus from the 'price' of money (i.e. interest rates) to the quantity of money, and thus started drastically expanding their balance sheets, as seen in Figure (1) below.

**Figure 1:** Expansion of the Monetary Base Before and After the Great Recession

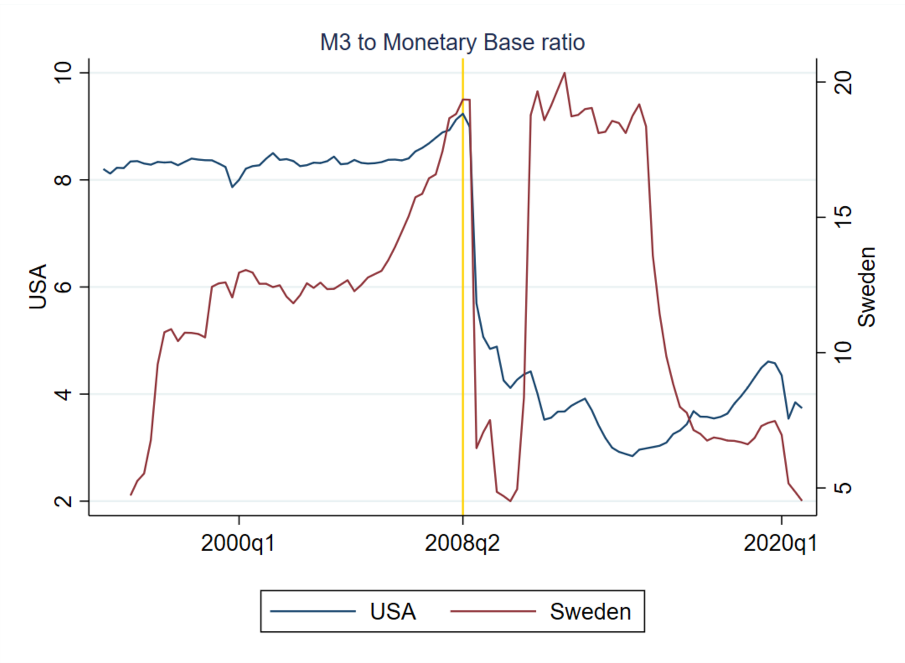



Sources: FED (2021c) and SCB (2021a) respectively.

The motivation behind the QE method was simply to find other ways of injecting more money into the economy to increase economic activity, as the option of lowering interest rates further to induce said influx of money was no longer an option. Thankfully, most empirical studies show that QE can effectively reduce bond yields and market interest rates of different maturities analogous to conventional rate cuts (Gilchrist et al., 2015). However, some uncertainties exist regarding through which precise channels QE works (Joyce et al., 2012). The intuitive mechanism is that central bank asset purchasing raises its prices, which in turn lowers the long-term real rate due to the nature of their inverse relationship. As QE became increasingly used by the central banks, another speculation regarding its mechanism was suggested. Namely, that QE mostly works through its signaling effects (Fawley et al., 2013; Mishkin, 1996), now known as forward guidance. If a central bank suggests it will not be raising the policy rate for some time, there is still always room for investors to be skeptical and cautious concerning such an announcement. However, if that same announcement is complementary to a large-scale asset purchase, it is much easier for investors to believe the it, as there is so much money on the table.

Dating all the way back to Keynes (1936) and Von Hayek (1937), increasing money supply in an environment of low interest rates has been a concern. They both argued that a liquidity preference may arise in such situations because the alternative cost of holding cash is erased, which would lead to a minimum effect on aggregated demand despite an increased availability to lend money, known as the ”liquidity trap”. Plotting the ratio between the central bank monetary base (M0) and the entire money supply in the economy (M3), i.e., the money-multiplier, this problem becomes evident.

**Figure 2:** The Money Multiplier




Sources: FED (2021c) and SCB (2021a) respectively.

Comparing Figures (1) and (2), it becomes clear that further monetary expansion does not necessarily lead to a greater money supply in the economy as a whole. In fact, we even see an inverse relationship between the money multiplier and the expansion of balance sheets. In Sweden, for example, during the one period after the financial crisis where the

Riksbank seemed not to be expanding its balance sheets, the multiplier temporarily recovered. The mechanism through which the bank lending channel operates appears no longer to be in effect. Instead, this liquidity trap has lead us to new and unexplored macroeconomic territory with peculiar outcomes, known as the ”New Normal” (see e.g. Bayoumi et al., 2014; Brainard et al., 2016; Bartocci et al., 2019). The New Normal has come to be characterized by persistently low interest rates while the inflation target is simultaneously undershot and the Phillips curve is flattened (i.e., unaffected inflation despite decreasing unemployment) (Brainard et al., 2016). To reduce the dampening effects of the liquidity trap, QE methods with their signaling effects, have become more widely adopted over time. Thus, in this New Normal era, central bank asset purchasing and communication, or forward guidance, have become key elements of monetary policy, to calm investor speculation about future rate increases (Filardo and Hofmann, 2014).

In summary, there are a number of ways in which monetary policy can be conducted, and with many conventional tools lacking effectiveness, unconventional methods are being more widely adopted. The past decade has been characterized by a continuous expansion of central bank balance sheets and attempts to transparently communicate monetary policy, with little luck in hitting the inflation target. The appropriate path for monetary policy has therefore been debated ever since the Great Recession, as the macroeconomic implications of not being able to stimulate the economy in a subsequent crisis can be quite severe. Today, amid the Covid-19 pandemic, this debate has perhaps reached its peak, dividing economists into two camps depending on whether they believe that the QE stimuli will lead to a catch-up effect in inflation, hence forcing central banks to raise rates; or that we have hit a new equilibrium of low interest rates and therefore cannot use history to infer upcoming effects of the stimuli on the inflation. The fact that the federal reserve recently officially changed its inflation target to an *average* inflation target might speak for the importance of ’forward guidance’.

# 3 Shadow Rates

It can be challenging to measure the effects of monetary policy as the toolbox available to the policy makers has to change and expand. To exclusively track policy rates, for example, might give rise to misleading conclusions if central banks exclusively use QE methods. Therefore, as monetary policy is becoming more creative and unconventional policies more widely adopted, new ways of capturing the entirety of these effects is needed.

One approach to capture the broad effect of unconventional policy actions with one single measure, called shadow rates, was put forth by Black (1995). This concept builds on the idea of viewing currency (and thus also the nominal interest rate) as options, as people always can choose (i.e. exercise their option) to hold their currency instead of holding financial instruments. This means that the nominal short-term interest rates, $r_t$, is always $r_t \geq 0$ (because if $r_t < 0$, rational individuals would choose to hold currency), which in turn means that the long-term interest rates must be strictly positive because the future short-term rate may be positive even when the current short-term rate is zero.

Black (1995) proposes the short-term interest rate to be thought of as

$$r_t = max(s_t, \underline{r}) \tag{1}$$

where the shadow rate, $s_t$, is affine in $s_t = \delta_0 + \delta_1^{'} X_t$ and $X_t$ is a $p \times 1$ vector of $p$ chosen pricing factors (for full derivation please see Wu and Xia (2016)). The key takeaway is that $r_t = s_t$ $\forall \mathrm{r}_t \geq 0$, by construction, but $s_t$ itself may take negative values and thus may diverge from $r_t$ below the ZLB, $\underline{\mathrm{r}}$. With sufficient constraint on the long-term rates ($> 0$), the shadow rate captures movements in the entire yield curve, while still allowing it to deviate from the short-term rates which becomes crucial at the ZLB, thus illustrating the comprehensive stance of monetary policy at the ZLB (Wu and Xia, 2016, 2020). The intuition behind the shadow rate is simply that it suggests how the policy rate would have looked - had it not already been at the ZLB.

However, since Black's (1995) concept was introduced we have witnessed negative nominal interest rates, for example in Sweden during 2015-2020 (Holmberg et al., 2015). De Rezende and Ristiniemi (2020) estimate a shadow rate when the ZLB is not completely binding. In this new specification $r_t = s_t$ during conventional monetary policy periods but is derived from the government bond yield curve and its short rate expectations component when unconventional monetary policies are present or announced.

$$\Delta s_t = \begin{cases} \Delta r_t & \text{if } t < t_0 \\ \phi_1 \Delta X_t^{SR} & \text{if } t \geq t_0 \text{ s.t. } t \neq t^* \\ \phi_2 \Delta X_t & \text{if } t \geq t_0 \text{ s.t. } t = t^* \end{cases} \tag{2}$$

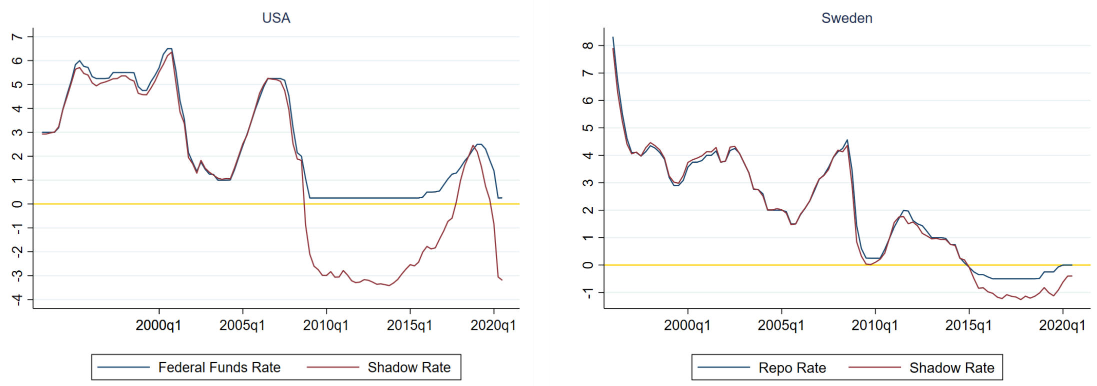
where $t_0$ is the *first* day of announcement regarding upcoming unconventional monetary policy measures and $t^*$ is any other day of unconventional policy announcement subsequent to $t_0$. $X_t$ again is a $p \times 1$ vector of $p$ chosen pricing factors and $X_t^{SR}$ a $p \times 1$ vector of factors that outline the short rate expectations.[1] More specifically, in this particular specification, the authors choose pricing factors from the finance literature and estimate yield-only models, meaning that $X_t$ strictly includes information available in the yield curve (De Rezende and Ristiniemi, 2020). Namely, X is the product of a $p \times N$ matrix of portfolio weights multiplied by a $N \times T$ matrix of observable yields, where the authors use $p$ principal components of yield as pricing factors and assume correctly priced bonds.

It can be seen in (2) that this revised model has some similarities with (1), namely that the interest rate and the shadow rate follow each other during conventional times and that both models are driven by yield curve information (even though $X_t$ in equation (1) allows for additional information depending on which pricing factors are chosen). However, there are some important distinctions as well. In Black's (1995) equation (1), $s_r = r_t$ by construction, following the theoretical constraint that the nominal interest rate can never become negative. With the absence of that assumption, De Rezende and Ristiniemi (2020) allow for $s_t \neq r_t$ even when the rates are positive. Instead, they define them as equal up to the point of the first announcement regarding unconventional methods of monetary policy. In addition, they let the changes in the shadow rate be decided by changes in the short rate expectations when $t \neq t^*$, meaning that days subsequent to the first announcement regarding unconventional measures are only driven by short rate expectations, given that no announcement is made on that day. On days on which announcements do occur, the changes in the shadow rate is driven by both the short rate expectations as well as the yield-component embedded in $X_t$.

By not imposing a lower bound constraint on the nominal interest rate, De Rezende and Ristiniemi's (2020) alternative shadow rate estimate becomes more suitable to use, as it is able to measure the overall stance of monetary policy at any time. This includes the New Normal policy environment which has been witnessed during the past decade with large central bank balance sheets and exceptionally low interest rates. The shadow rates are plotted together with the actual policy rates for both countries in the figures below.

[1] Which should adjust to events that may affect investors' expectations of future monetary policy in any day, such as domestic and foreign macroeconomic news, monetary policy announcements, speeches, etc. (De Rezende and Ristiniemi, 2020).

**Figure 3:** Policy and Shadow rates



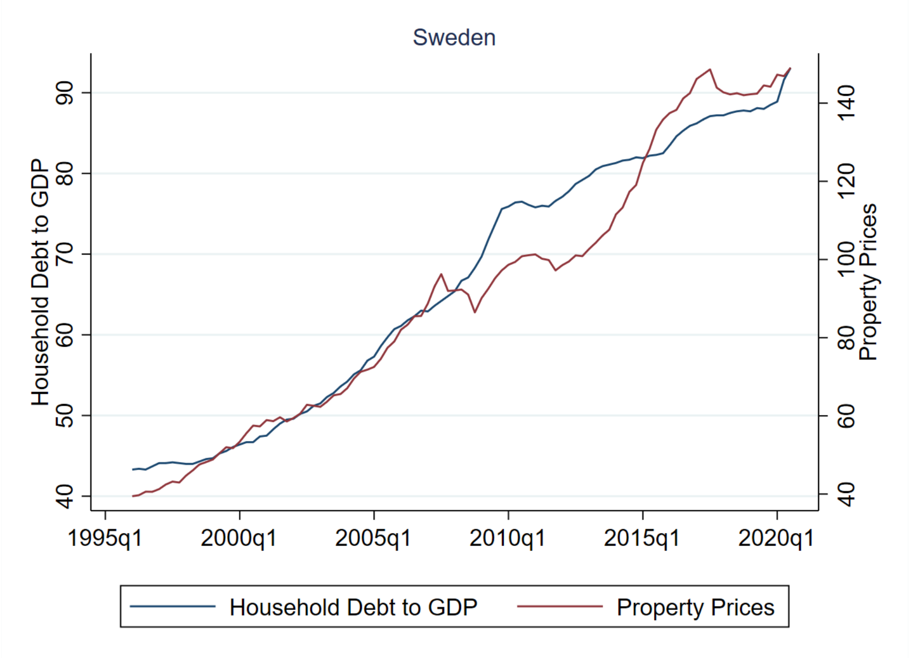

Source: De Rezende (2021).

# 4 Inflation and Debt

Ever since the Great Recession in 2008, most western central banks have almost constantly been conducting expansionary monetary policy, while undershooting the inflation target. Looking at the data (as we will do in this section) one can quickly note that even though the general price level (i.e. inflation) has been responding poorly to expansionary monetary policy, price levels in the housing market have not. Nor have the levels of debt.

In Sweden, household debt has been increasing steadily since the late 1990's, which has been correlated with the price level of the property market, shown in Figure (4) below.

**Figure 4:** Household Debt and Property Prices



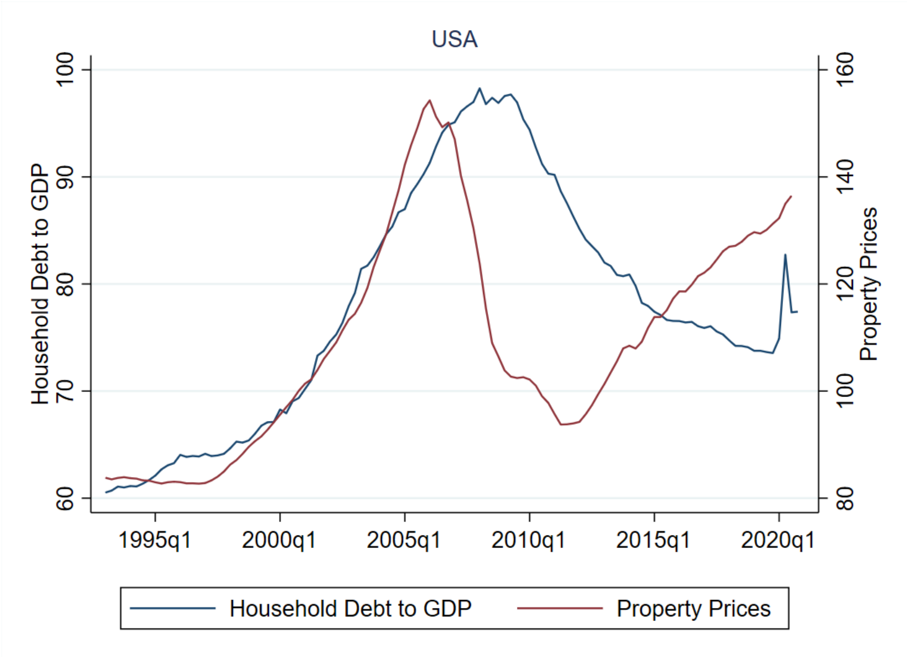

The property price level is indexed at 2010=100. Sources: BIS (2021c) for the property prices and BIS (2021a) for household debt.

The continuously low interest rates have made lending money and property investments an increasingly attractive option, as seen by developments over time in Sweden. Looking at this graph, it could be argued that monetary policy has not lost its ability to affect price levels per se, but rather that it impacts the ”wrong” sections of the economy. The low rates have made investing in housing relatively more attractive relative to consuming basic goods, i.e. increased the alternative costs of consumption, perhaps resulting in a persistently low rate of inflation adjacent to swelling housing prices (since the CPI does not include housing prices). Furthermore, a report from Holmberg et al. (2015) shows variable rate mortgages have become increasingly common over time, in line with the low-rate environment.[2]

The development of household debt in the USA paints another picture. Figure (5) shows a similar trend of positively correlated household debt ratio and property prices, but only leading up to the financial crisis.

[2]defined herein as a mortgage with a fixation period of 3 months or less.

**Figure 5:** Household Debt and Property Prices




The property price level is indexed at 2010=100. Source: BIS (2021c).

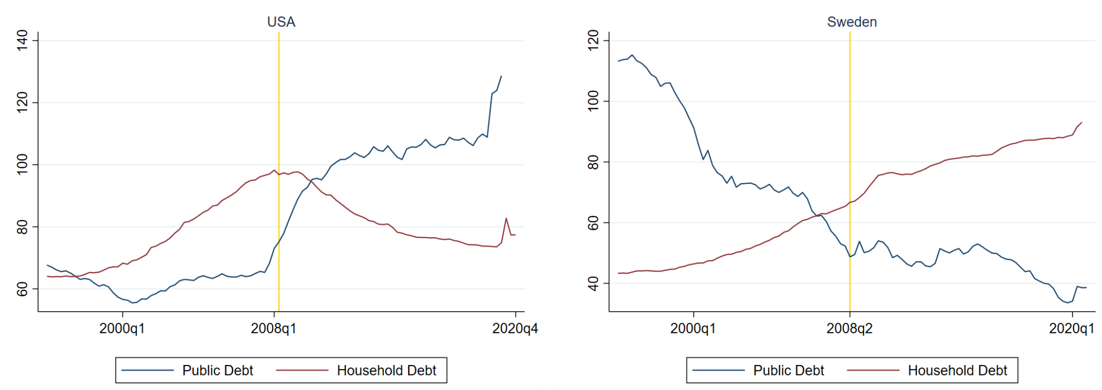
After 2008, the trends started diverging as property prices tumbled, as a result of the crash in the mortgage market (inducing the Great Recession), subsequently picking up again after 2012. The more relevant change (for this paper) that occurred was the reversal of household debt after the crisis. Following the mortgage crisis, which left many indebted consumers and businesses in bankruptcies, household debt steadily decreased (except for the small upward-spike in 2021, likely due to the Covid-19 crisis).

So why has debt been decreasing in the US during such a low-rate environment? It has not, really, at least not the total debt.[3] The abrupt mortgage crisis prompted economists and politicians in the US to advocate a reduction in household debt, seeing it as essential for the recovery of the US economy (Leigh et al., 2012; Mian and Sufi, 2014). With this, several reforms of the banking system were proposed and adopted and new legislation introduced, such as the 'Dodd-Frank Wall Street Reform and Consumer Protection Act' (Library of Congress, 2010), which placed new constraints on commercial banks, making it harder to issue loans. The reaction might not be a big surprise, as the crisis was built upon overly indebted consumers investing in properties. However, due to the substantial majority of fixed rate mortgages (Holmberg et al., 2015), a reduction in household debt indirectly also meant a reduction in aggregate private consumption to finance such debts. So as not to have a completely stagnating economy when households started reducing

[3]Except for the period during the Covid-19 crisis. However those last 2 data points are later excluded in the model, since it seemed to cause some skewed results.

their debt, the US government increased its spending to stimulate the economy and public indebtedness took over (Figure 6). Hence, the reduction in household debt since 2008 is not to be confused with a generally declining debt in the US, but rather it shows the fundamental difference in policies between Sweden and the US. Both countries have steadily been increasing debt in one way or another during the ZLB era, but in opposite directions between public and private indebtedness. In the US, public debt has been continuously increasing whereas household debt started decreasing after 2008. Sweden's public debt, however, has been decreasing and the burden of indebtedness has fallen on households. This almost mirroring indebtedness during the ZLB environment is plotted in Figure (6) below.

**Figure 6:** Debt as a Percentage of GDP




The US data is gathered from FED (2021a) and the Swedish data from BIS (2021b). All data is computed to an annual ratio of debt to GDP.

## 4.1 Household Debt and Monetary Policy

The effects of monetary policy actions on inflation are heavily dependent on the reactions of the households in the economy. A decrease in the policy rate will lead to lower market interest rates and subsequently spur consumption by changing the inter-temporal consumption/saving decisions of households (Hughson et al., 2016). Such a reduction might also, in theory, increase the price of assets held by the households, such as housing, and thereby increase disposable income and consumption. It is therefore of great interest to the central banker to understand how and whether the reactions to monetary policy actions are dependent on the financial situation of the household.

The financial crisis and subsequent experience with the ZLB largely discredited the bank lending channel, discussed in Section (2), as a still viable theory of the transmission channel for monetary policies. The related balance sheet channel and how it relates to the households and their level of indebtedness is however of central importance to the contemporary literature (Bernanke and Blinder, 1988; Hughson et al., 2016; Flodén et al., 2021). The balance sheet channel posits that, for indebted agents, a lower interest rate will reduce the amount the agent needs to dedicate to debt servicing, thereby increasing, not only net worth and credit, but also available cash to consume (ibid.). This would suggest that the more indebted the households are, the more responsive they would be to a shift in policy rate, as the change in debt service would be that much greater the larger the debt (see e.g. Cloyne et al. (2020); Flodén et al. (2021); Gelos et al. (2019)).

On the other hand, lowering the policy rate will reduce interest earnings for lending households so the ultimate effect would be dependent on whether or not the representative household were net borrowers or net lenders. Hughson et al. (2016) find evidence of the balance sheet channel of both borrowing and lending households but note that the effects on borrowing households outweighs those of the lending households. These findings are corroborated by Kim and Lim (2020) who, using panel data on 23 countries, find that policy rate shock has a larger effects in countries where indebtedness is relatively high and interest payments not fixed, meaning that loan payments could be adjusted and the balance sheet channel will work to full effect. Looking at Sweden specifically, Flodén et al. (2021) find evidence for the same balance sheet channel when households hold large amounts of adjustable rate loans. Cloyne et al. (2020) also observe that heterogeneity in the response of households to policy rate shocks supports the balance sheet channel. Households with mortgages are the primary drivers of aggregate consumption increases following policy rate cuts, whereas renters respond by less than the mortgage households and mortgage-free home owners are unresponsive. This, again, suggests that the effects are driven by the variable rate loans many households with mortgages hold (Flodén et al., 2021).

The effect of monetary policy on households balance sheets seems to have substantial empirical support but it is not the sole transmission channel that household debt might affect. Whereas the balance sheet channel will get stronger as household debt increases, the demand for new loans will simultaneously decrease with debt (Alpanda and Zubairy, 2019).[4] This reduction in demand for loans is closely linked to the phenomenon of debt overhang. Debt overhang relates to the fact that when an economic agent, be it a household, corporation or state, holds a large amount of debt, it become more risk averse and devotes most earnings to servicing its debt. This then causes the agent to miss out on potentially productive investments, thereby lowering its overall income (Krugman, 1988; Melzer, 2017). Alpanda and Zubairy (2019) show that if the reduction in demand for

[4] As is true for Sweden in Appendix A, when comparing Figures 19, 22 and 23. The shadow rate shows a positive correlation with the share of consumption to GDP but it shows a negative correlation with the share of investments to GDP

loans from the debt overhang is larger than the balance sheet channel effect, the net effect of the monetary policy measure in time of high household debt will be weakened.

During times of recession, evidence suggests that more indebted households internalize the threat of lost revenue and employment, and thus become less responsive to expansionary monetary policy as a result (Mian and Sufi, 2015). In one of their previous studies, Mian and Sufi (2014) also show that households that leveraged home equity loans to spend in the period before the Great Recession experienced significantly reduced levels of income and spending growth following the crisis. This would support the evidence of a cash-in-hand effect of the balance sheet channel in the short-term, while questioning whether it is a desirable effect in the long-term.

An important theme that is conspicuously missing from most contemporary literature on the effectiveness of monetary policy in high debt scenarios is the ability to conduct policy rate changes. Even though monetary policy appears to become more effective with the indebtedness of households, the fact remains that modern monetary policy has arguably become hamstrung during the New Normal. Expansionary monetary policy has continuously demonstrated its ineffectiveness to the extent that it has become the very thing which characterizes the New Normal. Thus, given the continuous increase in debt during this low-interest environment in both countries, the central banks cannot really conduct contractionary policy either, because a flexible market interest rate might create a devastating debt overhang effect on either the state or its citizens. Therefore, we argue, that it perhaps matters little that the policy rate becomes more powerful with household debt if the very low-rate environment creating debt also traps the policy rate at the ZLB, as increasing it would risk ruining overly exposed households.

## 4.2 Our Aim and Contribution

The previous literature in this area of research seems to lean towards the view of a more effective monetary policy in situations of high household debt. However, the realities of the New Normal keeps contradicting these empirical results, since the tools of monetary policy seemingly are continuously weakened even in economies where household debt continuously rises, for example in Sweden. Our view is that one perhaps does not capture the full effect of monetary policy in this New Normal environment where forward guidance and quantitative easing is prominent, by only looking at the policy rates. Instead, we suggest making use of alternative estimates of modern monetary policy, namely, shadow rates and the expansion of central banks monetary bases.

First, we compare the effects of shocks to the shadow rates *between* Sweden and the US.

The comparison stems from the fact that their household debts have been developing in opposite directions ever since the policy rates became a mute tool following the Great Recession. Then, we examine the effects of said shocks *within* each country, by testing periods below and above the household debt sample mean. Additionally, we also provide corresponding results by looking at the monetary base as a direct proxy for the QE measures, precisely since it has become such a prominent tool to monetary policy in the New Normal.

In summary, our aim with this paper is to examine the effectiveness of monetary policy conditional on household debt, by using alternative measures to policy rates, better reflecting modern monetary policy, in Sweden and the US respectively.

# 5 Data and Empirical Strategy

## 5.1 Data

We make use of roughly 30 years of time series data on different macroeconomic variables related to monetary policy. Data from the US covers the sample from 1993 Q1 to 2020 Q4 whereas the Swedish data spans from 1996 Q1 to 2020 Q4. The difference in the sample periods is due to availability of data.[5] In accordance with the literature and the availability of data, a quarterly frequency was chosen. Swedish household debt as well as policy and shadow rates were reported in monthly and semi-daily frequency, respectively. By summing up all the observations by quarters and dividing them by the number of observations in each quarter, an average over the time period was created. Consequently, this results in some variation in the original data being lost, but monetary transmission channels tend to require some time to propagate in the macro variables of interest for this paper. Hence, the higher frequency data would help little in the analysis (Friedman, 1961).

Sources of the data and the descriptive statistics of the final variables used in our model are as follows:[6]

[5]As a robustness check, the period 1993 Q1 to 1995 Q4 in the US data was excluded to ensure differences in the models were not driven by the different sample periods. As no discernible difference could be observed, the full US sample was used.

[6]All variables are plotted for visual representation in Appendix A. The ordering is identical to that in the tables.

**Table 1:** Descriptive Statistics - Sweden

| Label | Mean | SD | Min | Max | Source |
|---|---|---|---|---|---|
| Shadow Rates | 1.777 | 2.040 | -1.260 | 7.239 | De Rezende (2021) |
| Log(Monetary Base) | 5.094 | 0.697 | 4.318 | 6.860 | SCB (2021a) |
| Log(Consumer Price Index) | 4.537 | 0.084 | 4.408 | 4.664 | OECD (2021) |
| Log(Consumption to GDP) | 3.839 | 0.021 | 3.783 | 3.887 | OECD (2021) |
| Log(Investments to GDP) | 1.963 | 0.276 | 1.143 | 2.464 | SCB (2021b) |
| Log(Property Price Index) | 4.446 | 0.397 | 3.681 | 5.004 | BIS (2021c) |
| Log(Commodity Prices Index) | 12.762 | 0.608 | 12.111 | 13.999 | IMF (2021) |
| Real Exchange Rate | 7.912 | 1.134 | 5.987 | 10.584 | FED (2021d) |
| Household Debt to GDP | 66.508 | 16.297 | 43.314 | 93.105 | BIS (2021a) |
| Observations | 99 | | | | |

Note: The Riksbank's monetary base and the CPI was manually adjusted for seasonality using a moving average filter with a fixed window size, while the rest of the variables were already seasonally adjusted when collected. The real exchange rate is denoted in SEK/USD. The CPI is an index at 2015=100, property prices at 2010=100 and and commodity prices at 2012=100 respectively.

**Table 2:** Descriptive Statistics - USA

| Label | Mean | SD | Min | Max | Source |
|---|---|---|---|---|---|
| Shadow Rates | 1.288 | 3.426 | -3.849 | 6.256 | De Rezende (2021) |
| Log(Monetary Base) | 14.096 | 0.791 | 13.013 | 15.167 | FED (2021c) |
| Log(Consumer Price Index) | 4.430 | 0.179 | 4.100 | 4.701 | OECD (2021) |
| Log(Consumption to GDP) | 4.203 | 0.019 | 4.162 | 4.229 | BEA (2021) |
| Log(Investments to GDP) | 2.859 | 0.093 | 2.549 | 3.010 | FED (2021b) |
| Log(Property Price Index) | 4.678 | 0.183 | 4.415 | 5.039 | BIS (2021c) |
| Log(Commodity Prices Index) | 4.593 | 0.009 | 4.579 | 4.612 | IMF (2021) |
| Household Debt to GDP | 77.863 | 11.243 | 60.522 | 98.270 | FED (2021a) |
| Observations | 112 | | | | |

Note: The FED's monetary base was manually adjusted for seasonality using a moving average filter with a fixed window size, while the rest of the variables were already seasonally adjusted when collected. The consumer prices are indexed at 2015=100, property prices at 2010=100 and commodity prices at 2012=100 respectively.

## 5.2 The SVAR Model

Ever since the seminal work by Sims (1980) on the topic of vector autoregressive (VAR) models and their applications in macroeconomics, they have become a mainstay of the literature on the topic. VAR models are capable of capturing dynamic co-movements of multiple time series and are therefore very useful when analyzing variables that are inherently linked and dependent on each other, as macro variables typically are. As the name implies, the VAR model constructs a vector of $k$ equations with an equal amount of $k$

variables. Each variable is dependent on its own lagged values as well as simultaneous and lagged values of the other variables in the model. Perhaps the most prominent use of VAR models in the monetary policy literature is to compute a corresponding impulse response function (IRF). The IRF traces-out the dynamic response of the variables in the model to a one-period positive, exogenous, shock to the model. This will be used to simulate a monetary policy shock and observe the effects on household behavior dependent on the different levels of debt they are facing (Canova and Ferroni, 2020).

The standard reduced-form VAR model is defined as follows:

$$Y_t = A_1 Y_{t-1} + ... + A_p Y_{t-p} + e_t \tag{3}$$

$$E(e_t e_t') = \Sigma \tag{4}$$

where $Y_i$ is a vector containing the $k$ endogenous variables of the model, $A_i$ the $n \times n$ coefficient matrices, $e_t$ are the error terms, and $\Sigma$ is the error terms covariance matrix. The reduced form VAR model is unable to capture contemporaneous effects between the variables as only lagged values are included in the model. Monetary policy makers often react in real time to changing economic situations, however, so not allowing for that in the model would result in misspecification issues (Sims, 2011). Additionally, the error terms of the model will often be correlated, which becomes an issue when estimating the IRFs. To solve this, the model is rewritten into a Structural VAR (SVAR):

$$BY_t = C_1 Y_{t-1} + ... + C_p Y_{t-p} + Du_t \tag{5}$$

$$e_t = Du_t \tag{6}$$

where matrix $B$ now capture the contemporaneous relationship between the variables in the model. The addition of $B$ must mean that $C_i \neq A_i$ because, in all likelihood $B \neq I$. As mentioned, the error terms of the VAR model will generally be correlated. This correlation becomes an issue when the goal is to examine the effect of a shock to one variable in the remaining variables as the other shocks are assumed to be constant, as in the IRF. When the errors are correlated this assumption is violated. To solve this, the error term from (4) is deconstructed into a combination of structural shocks shown in (7) with:

$$E(u_t u_t') = I \tag{7}$$

Assuming that $B$ is non-singular, (5) can be rewritten solving for $Y_t$:

$$Y_t = B^{-1}C_1Y_{t-1} + ... + B^{-1}C_pY_{t-p} + B^{-1}Du_t \quad (8)$$

Comparing (8) to (3) it becomes clear that:

$$B^{-1}C_i = A_i \quad (9)$$

and

$$E(B^{-1}DD'B^{-1'}) = \Sigma \quad (10)$$

Equation (10) shows the essential identification problem the SVAR model is subject to. By definition, econometric identification refers to the model parameters being uniquely determined from the observable data-generating population (Lewbel, 2019). Both $B^{-1}$ and $D$ are square $n \times n$ matrices containing $n^2$ elements whereas the covariance matrix $\Sigma$, being symmetric, only contains $n(n+1)/2$ elements. The Structural VAR model is thus overidentified and the imposition of $n^2 + n(n+1)/2$ restrictions on $B^{-1}$ and $D$ are required for identification to be reached (Sims, 2011).

## 5.3 Identification Strategy

Economists reach identification in the SVAR model by imposing restrictions on $B^{-1}$ and $D$ based on economic theory (Enders, 2015). However, identification in the SVAR model can be reached and justified in any number of ways. Indeed, current literature on the topic is a thesis in itself, and there is no unique best way of achieving identification (Sims, 1980). With that in mind, this paper follows the example set by Sims and uses the so-called Cholesky decomposition to achieve identification.

With the Cholesky decomposition, a positive definite matrix is transformed into a lower triangular matrix. In the context of equation (10), the matrix $A$ is assumed to be lower triangular and $B = I$. In this way $n(n+1)/2$ and $n^2$ restrictions are placed on $B$ and $D$ respectively, resulting in:

$$B^{-1}B^{-1'} = \Sigma \quad (11)$$

Correct inference can now be drawn from the IRFs of the SVAR model. As with any identification strategy, the Cholesky decomposition makes assumptions about the economic relationship between the variables. In this case the direction of causality in the contemporaneous relations among the variables is assumed to be one-way and goes from left to right. Therefore, the ordering of the variables in the vector $Y$ becomes important as the variable ordered first will be allowed to affect all variables contemporaneously, whereas the variable ordered last will only affect it's own contemporaneous value. Altering the ordering will affect the economic interpretation of the impulse responses. With the order of causality going from left to right in the Cholesky decomposition, it makes economic sense to order the variable one believes to be the slowest-moving first and the most responsive last (Sims, 1980). The ordering used in this paper is:

*CPI*, *Property Prices*, *Real Investment*, *Real Consumption*, *Commodity Prices*, *(Exchange Rate)*, *Monetary Policy*

The economic interpretation of this ordering is that a shock to CPI will affect all other variables contemporaneously, whereas a shock in monetary policy will only affect the other variables with a one-period lag.

This choice of variables and their subsequent ordering draws from previous research on the topic of monetary policy transmissions. Ordering CPI first and the monetary policy tool last is ubiquitous in the literature, as shown in Sims (1980), Sims et al. (1990) and Bernanke and Gertler (1995). Considering that property prices is a different, more specific, measure of price levels, it is also assumed to be slow moving and ordered after CPI (Rahal, 2016). Output is often included in related literature, where it is placed between price level and monetary policy. We have instead partitioned output into household consumption and investment, and placed them in the order that output would have entered the model (Giordani, 2004). Finally, commodity prices are included, and the exchange rate for Sweden is placed before the monetary policy variable. Both are fast moving financial variables that will react more nimbly than price level and output data and thus belong further back in the ordering (Uhlig, 2017; Sims, 1992).

## 5.4 Model Specification

As stationary data is typically desired for unbiased results in any VAR model, the initial procedure was to deploy Dickey-Fuller tests for each variable (Enders, 2015). The null-hypothesis of a unit root was rejected for the shadow rates only. Having determined that the majority of the data is not stationary, the subsequent procedure was to test for cointegration between the variables.

Considering that the Engle-Granger test lacks power in some circumstances where the data is not trending but the residuals are still not well behaved, and suffers from inconsistencies if the cointegrating vectors are of certain forms, Johansens trace test, which uses a Maximum Likelihood Estimation procedure, was used instead (Enders, 2015). The test showed a cointegrated vector of rank 2, indicating a cointegrated relationship between the variables of interest, as $0 < r = 2 < k = 6(7)$, where k is the total amount of variables in $Y^{US}$ ($Y^{SWE}$). This is an important result because it eliminates the validity of simply first-differencing or de-trending the variables to make them stationary (Sims et al., 1990; Sims, 2011). The argument is that first-differencing leads to misspecifications if the variables are cointegrated, whereas keeping them in levels retains consistent (even super-consistent) estimates, asymptotically. An alternative approach, usually suggested in most classic econometric literature (see e.g. Enders, 2015), is to make use of a vector error correction model (VECM) if the variables are cointegrated. Yet, Sims (2011) argues that the use of a VECM for macroeconomic variables typically becomes an imprecise process, with only very small efficiency gains. Therefore, his resulting argument is to (almost) always keep cointegrated macro variables in levels when using any VAR approach, and not to impose neither first-differences or cointegration results (ibid.). The ultimate shortcoming of this, according to Sims (2011), long run results need to be interpreted with care, which is why we constrain the IRFs to a maximum of 15 quarters in order to not extend a typical business cycle. Thus, in line with the theoretical foundation of Sims et al. (1990); Sims (2011) and adjacent literature (see e.g. Kim and Lim, 2020; Bernanke and Gertler, 1995; Carpenter and Demiralp, 2012), the variables were chosen not to be differenced but rather used in their logarithmic level-form, as seen in Tables (1) and (2).

The lag specification of the SVAR models is based on the Schwarz-Bayesian information criteria (SBIC), due to the relatively large sample size. The lowest estimated value of the SBIC was found at two lags, hence suggesting the use of a SVAR(2) model. This was true for both respective country models, making our baseline SVAR(2) models look as follows:

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + B^{-1} D u_t \tag{12}$$

with $Y_t^{US}$ consisting of CPI, property price index, real investment (investment to GDP), real consumption (consumption to GDP) and the monetary policy tool (shadow rate and monetary base) and $Y_t^{SWE}$ of the same variables but with the added real exchange rate before the monetary policy tool. The inclusion of price level data when modeling transmission channels of monetary policy is self-explanatory, as both the Federal Reserve and the Riksbank are inflation-targeting central banks. Household debt is closely linked to property prices, with most Swedish and American household debt being tied up in mortgages that are affected by changes to the interest rate (Flodén et al., 2021; Cloyne et al., 2020). Real investment and real consumption were included for the reason listed above and hereinafter referred to as simply investment and consumption respectively. The exchange rate only appears in the Swedish model and refers to the SEK/USD exchange rate.[7] The variable reflects the fact that, for a small open economy, the exchange rate will play a larger role in the decision making of the policy maker than it does for a large country (Fleming, 1962; Mundell, 1963). Commodity prices are included in the model to adjust for a well-known feature of the Cholesky decomposition called the price puzzle. The prize puzzle refers to a tendency of the price level to increase in response to a contractionary shock in the monetary policy (Uhlig, 2017). Sims (1992) posits that this counter-intuitive result stems from the fact that policy makers might include variables that forecast future inflation in their information set when setting the policy rate. If the SVAR model does not take this into account, endogenous movements in the monetary policy in response to future inflation will appear as exogenous policy shocks. The solution is then to include variables useful in forecasting future inflation, with Sims (1992) advocating for the use of commodity price indices. The monetary policy tool refers to either shadow rates or the monetary base. The shadow rates are constructed to capture the entirety of monetary policy, including forward guidance, changes in the monetary base, etc., while the monetary base captures the act of quantitative easing more isolated (De Rezende and Ristiniemi, 2020). The two different measures of monetary policy are never used in the same model, but rather are alternated between two identical setups to induce additional confidence for our results.

It is worth mentioning that the IRF, by construction, produces a positive exogenous shock of one standard error in a given variable. Due to the opposing nature of the variables shadow rates and monetary base, i.e. a positive shock in shadow rates represents a contractionary policy measure whereas a positive shock in the monetary base represents an expansionary shock. They will be named accordingly in the result section.

Having identified the baseline model, we proceed to add a dummy variable, K, to distinguish between relatively low and high household debt to GDP for each country. We define the dummy simply as

$$K = \begin{cases} 1 & \text{if } [\frac{HHD_i}{GDP_i}] > \overline{\frac{HHD}{GDP}} \\ 0 & \text{if } [\frac{HHD_i}{GDP_i}] < \overline{\frac{HHD}{GDP}} \end{cases}$$

with $i \in 1, ..., n$, and alternate between 1 and 0. $HHD$ denotes household debt and $\overline{\frac{HHD}{GDP}}$ is our sample mean of the household debt to GDP ratio, estimated through $\frac{1}{n}\sum_i^n \frac{HHD_i}{GDP_i}$. Thus,

[7] Both models were tested with the exchange rate included (with data gathered from BIS, (2021b) for the US). As theory would suggest, only the Swedish model was notably affected by the inclusion (Mundell, 1963; Fleming, 1962). In the interest of preserving degrees of freedom, the exchange rate was thus excluded for the US model.

adding this to equation (12), the final model becomes

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + B^{-1} D u_t \mid K_i$$

allowing us to not only compare the effectiveness of monetary policy between Sweden and the US, as their household debts develop in opposite directions over time, but also to compare effectiveness within each country conditioned on whether the household debt to GDP ratio is above or below the sample mean.

# 6 Results

## 6.1 Some Initial Remarks

Most of previous literature has reached its results on the effectiveness of monetary policy by examining the policy rate. That measure has long been an obvious choice, as it is the very thing monetary policy revolves around. However, our belief is that the entirety of monetary policy is not well captured with this measure, given the ZLB and the unconventional methods it has brought. Therefore, this section will provide an analysis of the effectiveness of monetary policy with two alternative measures, namely shadow rates and the monetary bases.

Because of the way an IRF is constructed, the shock to the monetary policy variable is by definition a one-period (i.e. one quarter) *positive* shock, with the magnitude of one standard deviation. Both shadow rates and monetary base will thus increase. For the shadow rate, this will correspond to a contractionary shock whereas, for the monetary base, it will be an expansionary shock. Both are labeled accordingly. This difference does not carry any economic implications, due to the symmetric nature of the linear SVAR model, but should be kept in mind when reading the results.

The X-axis reports the number of quarters that have elapsed since the shock. This number has been set to fifteen, meaning that the horizon of the forecast stretches three years and three quarters in total. The Y-axis reports the scale of the response and the shaded area surrounding the response curves are the confidence intervals (CI), calculated at the 95% level. Thus, whenever the CI surrounds zero on the Y-axis, the effect is insignificant and cannot be interpreted meaningfully.

One final note is that, although included in the model, commodity prices (and exchange rates for Sweden) will not be interpreted analytically - since they are only necessary covariates for the model[8] but do not provide relevant economic information to our analysis. The IRF for the Swedish exchange rate was excluded from the plotted graphs. This was done solely for aesthetic reasons in order to present the results symmetrically. The full graphs, with exchange rates included, are shown in Appendix B. Similarly, the monetary policy variable will not be interpreted to a large extent, since it is only included to show which variable was shocked and to which magnitude.

The chronological order of this section will be as follows: We start by doing a cross country comparison of a shock in monetary policy between Sweden and the US. Then, the same shock is compared between the ”high debt” and ”low debt” state within each economy. The full order is first examined only for shocks in the shadow rates, followed by shocks in the monetary base.

## 6.2 Country Comparison Using Shadow Rates

Figures (7) and (8), present the first results. Initially, inflation seem unresponsive to a shadow rate shock for Sweden and the US. However, after a year and a half, inflation turns negative in Sweden. As a time lag in inflation is not completely unexpected[9], the IRF results for Sweden still show a relatively effective monetary policy, seeing as inflation does decline with a contractionary policy measure. In the US, inflation cannot be observed to respond in any economically meaningful way, despite a clear drop in consumption during, roughly, the first ten periods following the shock. Comparing the two countries, given that Sweden is steadily increasing its household debt while it is decreasing in the US, it could already be argued that higher household debt leads to more effective monetary policy, *ceteris paribus*. This would be in line with Kim and Lim (2020) and Flodén et al. (2021), who find that higher indebtedness tends to lead to more effective monetary policy, due to the balance sheet channel.

[8] See section (5.4) for further explanation of the exact specification of the model.

[9] As is stated in section (5.4) it is the slowest macroeconomic variable to react - hence the chosen ordering of the Cholesky decomposition.

**Figure 7:** Contractionary Shock Sweden

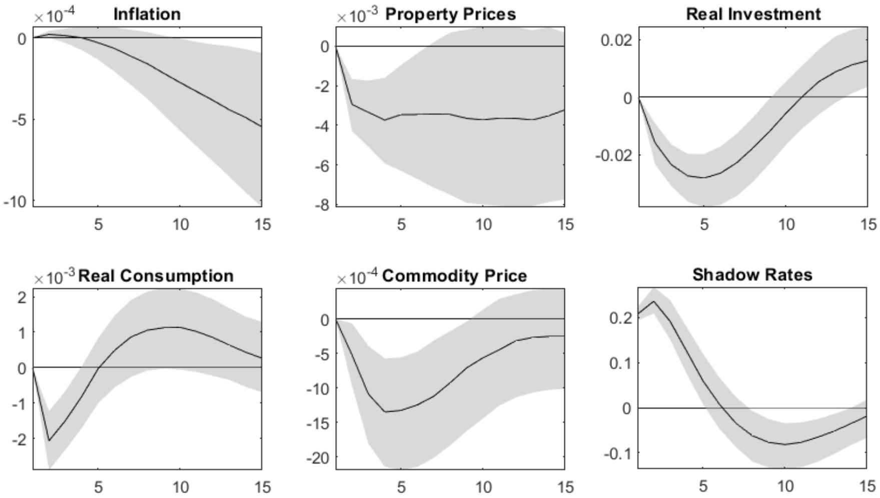
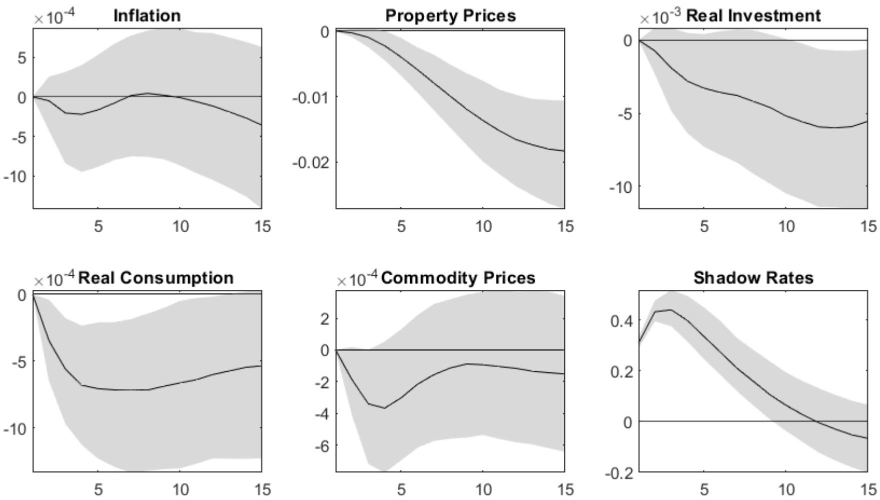



**Figure 8:** Contractionary Shock USA




Comparing property prices for both countries, we see a decrease following the shock for both, but in different time periods. In Sweden the decrease is more rapid, with most of the decrease happening in the first few periods before leveling off, or at least becoming inconclusive. In the US, the response is more delayed but then stays negative for the entire subsequent horizon. Keeping in mind that investments are positively correlated with property prices, the results show coherence. In Sweden, investments first react with a fast decrease followed by insignificance (and even a small period of it turning positive before adjusting to the mean) in later time periods. In contrast, in the US, investments first stay statistically unaffected, and then decrease in later periods. Worth considering when looking at these results, is that the standard deviation (the size of the shock by construction) is larger in the US, and that the reversions to the means are slower. This could be a possible explanation for the deviating results in property prices and investments.

Again, ceteris paribus, it could be argued in line with Kim and Lim (2020) and Flodén et al. (2021) that monetary policy in situations of high debt (i.e. Sweden in this case) is more effective, given that the smaller contractionary shocks decrease inflation (the desired effect) more. Conversely, the difference in the reforms conducted and macroprudential policy between the two countries after the recession, might suggest that this result perhaps not only captures differences in levels of household debt, but rather also capturing differences such as, for example, Sweden having flexible mortgage rates to a larger extent than the US (Holmberg et al., 2015). In that case, the level of indebtedness itself is conditioned on the types of mortgage rates, making it hard to isolate the effect. Either way, the results seem to concur with the existence of a balance sheet channel of monetary policy, but cannot fully distinguish whether it is larger than the effect of a debt overhang, which would have the opposite effect(Alpanda and Zubairy, 2019). Thus, we interpret the country comparison by itself modestly, and continue by comparing high and low debt within each country in the section below.

## 6.3 Comparing High and Low Debt Using Shadow Rates

### 6.3.1 Sweden

In Figures (9) and (10), the IRFs from a shock to the shadow rate in Sweden are shown, corresponding to the high and low debt periods respectively. Inflation, when debt is high, increases in response to an increase in shadow rate. This increase is admittedly small and disappears within the year but goes against standard economic theory, which dictates that contractionary monetary policy should lower the price level (Friedman, 1970). For the low debt period, inflation decrease immediately, to later turn insignificant around the ninth quarter. Contrasting the results from the previous section, these results do not support the findings of authors like Bernanke and Blinder (1988), Kim and Lim (2020) and Flodén et al. (2021), who concluded that monetary policy should be more effective if household debt is higher. An increase in the shadow rate should, according to the balance sheet transmission channel, not lead to price levels and consumption increasing as more of the households available funds will need to be diverted to interest servicing. Instead, these results would be more in line with the likes of Alpanda and Zubairy (2019) and Melzer (2017), who argue that a debt overhang could suppress the effects of the balance sheet channel, explaining the reduced effectiveness of monetary policy in times of high debt. Although consumption responds inconclusively, the property prices and investments act according to what would be expected from a contraction monetary policy and decrease.

**Figure 9:** High Debt Contractionary Shock Sweden

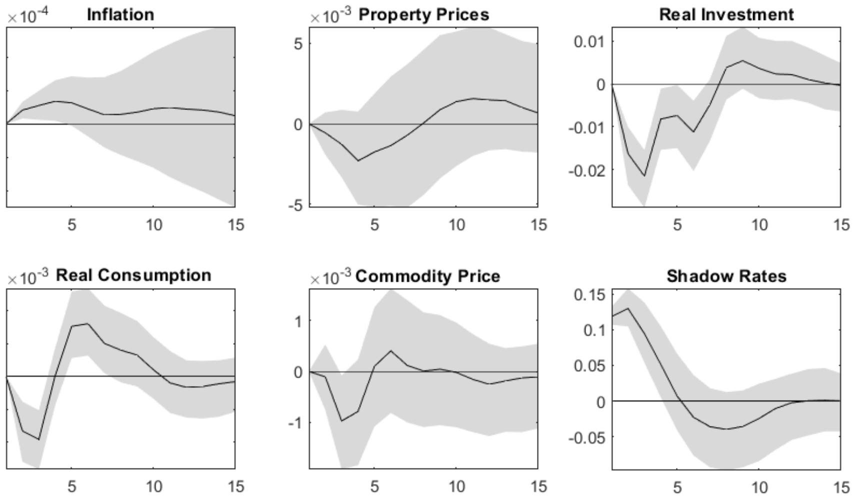
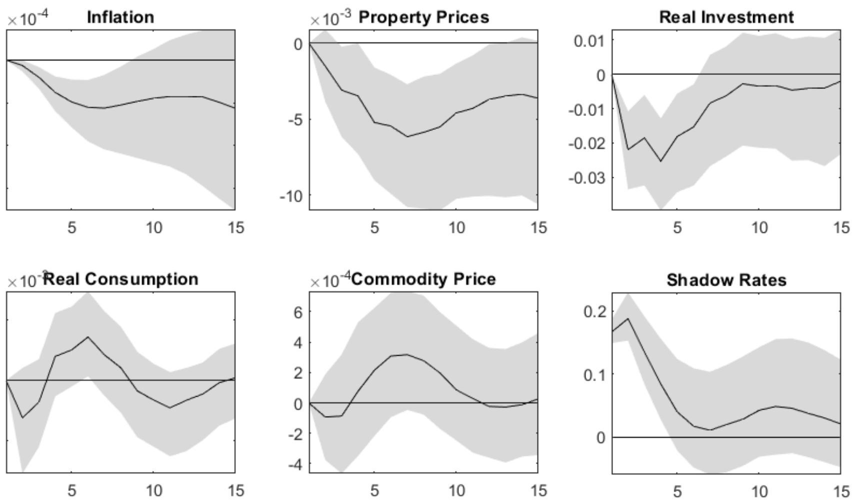



**Figure 10:** Low Debt Contractionary Shock Sweden




These results challenge our previous results from the country comparison, where the effects of a shock to the shadow rate were more impactful in Sweden, the relatively high debt country with more variable mortgage rates. The increase in inflation seen in Figure (9), coupled with the positive values for consumption around period five, would even suggest that monetary policy is highly ineffective when households have higher levels of debt. As discussed during the country comparison the difference in these results (Figures 7 and 8) might not be fully attributable to the different levels of household debt, as the legislative and macroprudential environments have developed differently. The results presented in this section, however, could therefore be interpreted as an indication that the results from Figure (7) and (8) indeed are being more fueled by a difference in the policy environment, rather than debt.

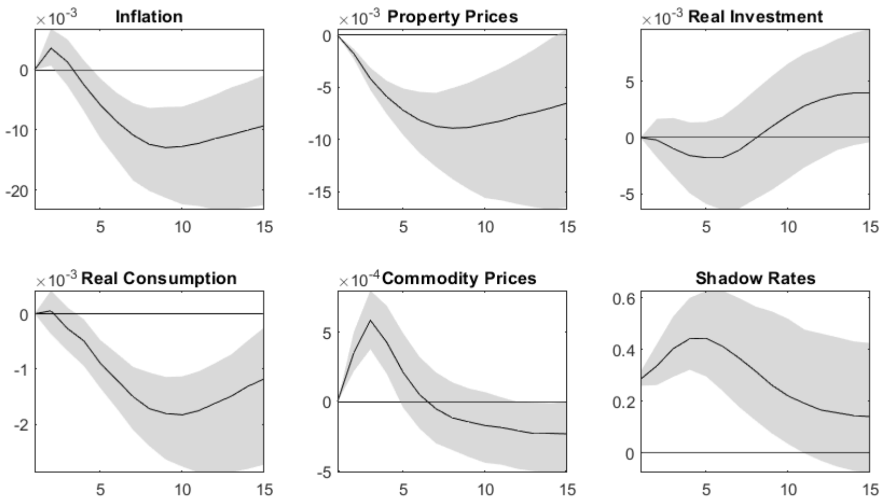
One should still bear in mind that even though this is the result from a within-country comparison, it is yet too early to decide which comparison is the more robust one. The different time periods making up the high and low debt samples for Sweden could also potentially be subject to systematic differences due to time trends. Hence, we will now proceed to the same within-country comparison in the US, which encompasses a (almost completely) different time horizon, to see if the results are coherent independently from time.

### 6.3.2 USA

Just as the preceding results, figure (11) and (12) splits the sample period into high and low debt states respectively, this time for the US. Generally, the IRFs for the high debt state appear more volatile than for the low debt state. Inflation in the low debt state shows some delayed response to the shadow rate shock before turning negative for the rest of the horizon. Relative to the low debt state, inflation in the high debt state decreases more rapidly following the shock, but the negative response dissipates within a year of the shock, as the CI encompass the zero mean line for all subsequent periods. The inflation in figure (12) thus shows an effect more in line with the aims of a contractionary policy measure. The response of property prices in the high debt state is somewhat ambivalent, increasing temporarily in the beginning of the period before turning negative for several periods between period five and ten. Meanwhile, in the low debt state, the response in property prices is negative throughout the forecast horizon.

**Figure 11:** High Debt Contractionary Shock USA


**Figure 12:** Low Debt Contractionary Shock USA




As with the results presented in Sweden, the results for the US indeed contradict the results found in the country comparison, and instead shows that monetary policy is more effective when household debt is low. This, again, goes against the works of Kim and Lim (2020), Hughson et al. (2016), Cloyne et al. (2020), etc., by suggesting that monetary policy is more effective if households are less indebted. Instead, it is in line with Alpanda and Zubairy (2019), Mian and Sufi (2014, 2015) and Melzer (2017), as well as our within-country comparison of Sweden.

Drawing definitive conclusions from the results presented for Sweden was, as discussed, difficult since we could not definitively conclude that the different results were not driven by differences in the financial and political environment between the sample periods. The sample periods for the US is however, by and large mirrored, and we still observe the same results, namely that monetary policy is more effective in times of low debt. In addition, the low debt sample for the US corresponds to the period of increased macroprudential policies, something that should reduce the households responsiveness to monetary policy, if that was indeed the force driving the results in Section (6.2).

An important distinction to make is that, although these results contradict much of the previous empirical work on the household debts effect on the monetary transmission channels, it does not contradict the existence of the bank balance sheet as an operative transmission channel. There is a clear response in consumption and inflation in the high debt state to a shock in the shadow rate, as the balance sheet channel would suggest (Bernanke and Blinder, 1988). What our results do imply is that the emphasis that earlier research has placed on the balance sheet channel as one of (or even *the* most) important channels, when discussing household indebtedness and effective monetary policy, might be overstated. There appears to be other channels at work as well that become more pronounced when the shadow rate is used as a measure of monetary policy rather than the traditional policy rate.

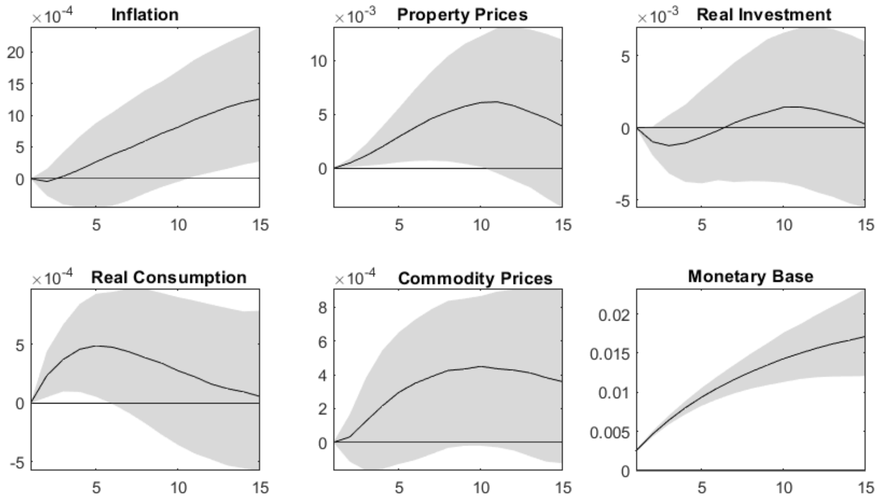
As mentioned, Alpanda and Zubairy (2019), Melzer (2017) and Mian and Sufi (2014, 2015) all discuss debt overhang as a, plausible, dominant transmission channel when debt is high. However, we note that this is mainly an explanation for expansionary monetary policy. Due to the linear nature of a SVAR model, we cannot draw any asymmetric inferences from the analysis, but theoretically we cannot find an explanation as to what transmission channel would be dominating the balance sheet channel when monetary policy is contractionary. Intuitively, the debt overhang as well as the balance sheet channel should both suppress aggregate demand more in a high-debt than low-debt state. Nevertheless, our results (so far) show less effective monetary policy in times of high debt. One explanation is that monetary policy might become less effective in times of high debt because policy makers are hamstrung as a result. Every nominal raise of the policy rate and its potentially detrimental effect to indebted households becomes relatively much larger, the closer it is to the ZLB. Due to the lack of literature on this topic, we leave the explanation of the active transmission channel in this scenario open to speculation and encourage future research to provide theoretical explanations. Perhaps there is no answer to this yet, simply because almost no contractionary monetary policy has been conducted since the Great Recession, as it is precisely one of the defining pillars of the New Normal and reasons to the very unconventional monetary policy measures we are examining.

## 6.4 Country Comparison Using Monetary Base

The first country comparison (Section 6.2) showed a relatively more effective monetary policy for Sweden, in accordance with the arguments of e.g. Kim and Lim (2020), given that Sweden is a proxy for (increasingly) high household debt in the country comparison. Comparing that insight with Figures (13) and (14), i.e., a positive shock to the central bank monetary base instead of the shadow rate, we see contradictory results, once again. Inflation remains largely unresponsive to an increase in the monetary base for the entirety of the horizon in Sweden, whereas it does respond according to expectations in the US, although with quite a delay.

**Figure 13:** Expansionary Shock Sweden

**Figure 14:** Expansionary Shock USA




Even though the CI is too large to make a useful interpretation in the investment response in Figure (13), we can see hints of property prices rising as well as an assertive decrease in consumption. The fact that investments do not increase with rising property prices and (indirectly) decreasing interest rates speaks for the debt servicing caused by a debt overhang, as suggested by Alpanda and Zubairy (2019) and Melzer (2017). Instead of an increased inflation fuel by consumption and investments due to the increase in households' disposable income, in line with the balance sheet channel (Kim and Lim, 2020, etc.), the lowered interest rates through QE makes it more profitable to service debt (Melzer, 2017). This would make households more prone to substitute consumption for debt servicing, potentially explaining the decrease in consumption observed in Figure (13).

Figure (14) instead, displays more "reasonable", although quite weak, responses to the expansionary monetary policy in the US. However, keeping in mind that QE often comes complementary to announcements and forward guidance for full potential (Filardo and Hofmann, 2014), which the shadow rates arguably capture (De Rezende and Ristiniemi, 2020), it should not come as a big surprise that the isolated effect of QE shows weaker results. Nevertheless, the comparison between Sweden and the US in terms of only QE policy supports the majority of our findings so far, namely that high household debt in fact seems more detrimental to monetary policy than what the bulk of the literature would predict. Again, we are now comparing countries, so different financial and political environments need to be taken into account. As QE is solely the act of introducing money into the economy, going back to our figures for the evolution of the money multipliers

(Figures 2 and 3) could be insightful. As the figures show, the money multiplier breaks down to a large extent in Sweden every time the Riksbank aggressively expands its balance sheet. Comparatively, in the US we see one distinct structural break around 2008 but for the remainder of the period it remains stable, despite continuous expansionary QE measures. Additionally, when QE is pursued by the central banks in both countries, the money multiplier remain systematically higher in the US than in Sweden. With this in mind, we remain reserved to the idea that these results might again be driven by an inherent difference between the countries other than the level of household debt, for example the mechanism of each country's financial system and/or differences in to which extent cash is used. So, QE may just be a more important tool in the US than in Sweden, where, for example, the communication of the Riksbank's intentions (i.e. forward guidance) might comparably get more attention.

For increased confidence we will now proceed to examine whether the country comparison results stay coherent with the relative debt comparison within each country, just as we did for the shadow rates.

## 6.5 Comparing High and Low Debt Using Monetary Base

### 6.5.1 Sweden

Figures (15) and (16) show the IRFs for the high and low debt periods, respectively, in Sweden. The results seem to support the findings from the previous section(s), i.e., that a higher level of debt is detrimental to the effectiveness of monetary policy. Inflation can be observed to decrease in response to an increase in the monetary base, during the high debt state in Figure (15). The decrease in inflation happens about a year after the shock and seems to correspond to a decrease in consumption. Whereas the consumption recovers and returns to the steady state by roughly period ten, the inflation remains negative throughout the horizon. This is contrasted by an increase in investments and property prices. Consumption appears to be substituted by investments in the high debt state when the central bank expands the monetary base, similar to what we saw in Figure (13) of the country comparison. It appears again that other channels, such as the debt overhang, dominate the balance sheet channel.

**Figure 15:** High Debt Expansionary Shock Sweden


**Figure 16:** Low Debt Expansionary Shock Sweden

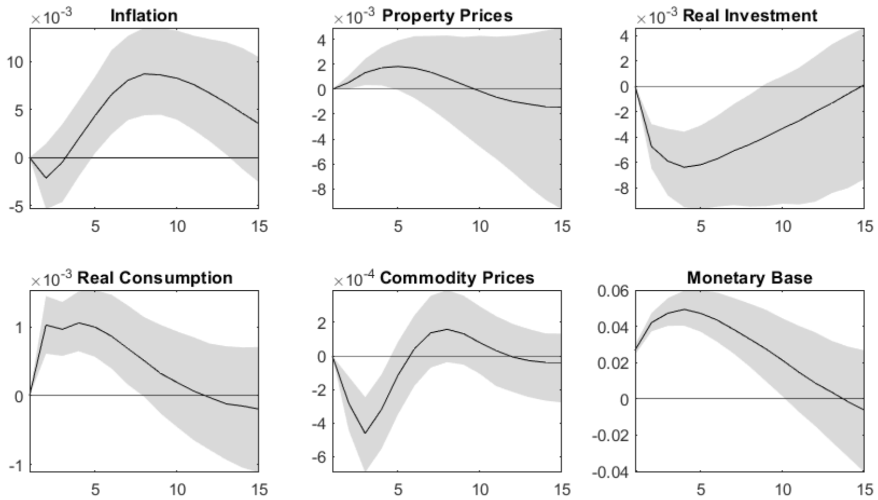

Looking at the low debt state, inflation yet again behaves more like economic theory would expect by increasing in response to an increase in the monetary base (Friedman, 1970). The increase is, however, both slight and delayed, coming over two years after the shock. This ambivalent response is by and large shown in all variables of interest. Consumption just barely increases positively to the shock for a single period in the beginning, before starting to revert to the mean, and investment and property prices both decrease. Whereas the expansion of the monetary base, for the most part, failed to induce a response in inflation in Figure (16), it did not lower consumption and inflation, as was the case in Figure (15). This, again, strengthens our previous results related to the higher effectiveness of monetary policy in a low household debt environment. The lack of response in the low-debt state could, again, be attributed to QE simply not being a strong monetary policy tool (in Sweden) isolated from other complementary tools, such as forward guidance.

### 6.5.2 USA

Figures (17) and (18) show the IRF's in the high and low debt period in the US. The difference between the effectiveness of monetary policy in the two states of indebtedness is less pronounced for the US than it was for Sweden. Inflation increases with the shock to the monetary base in both periods, more so in the low-debt period. Both of these results seem to be driven mostly by an increase in consumption. Again, more so in the low-debt period, in line with most our previous results.

**Figure 17:** High Debt Expansionary Shock USA

**Figure 18:** Low Debt Expansionary Shock USA




It should be noted that investments and property prices have an inverse relationship in the US. This counter-intuitive result may simply stem from the fact that the period of substantial QE in the US coincides with a big reversal in property prices following Great Recession (see Figure 5). This sharp drop in property prices was not directly followed by reductions in household debt, making the variables diverge quite heavily in that period. As our sample mean of high household debt for the US revolves around precisely this event, we observe that this might have been picked up by the model. Considering that the remainder of the results in the high-debt period respond in line with traditional economic theory (Beyer et al., 2017), this seems a plausible explanation.

Consumption in the low-debt period is substantially higher than in the high-debt period, as shown by the scale of the Y-axis. The discrepancy could be explained by the findings of Mian and Sufi (2014) who concluded that households that used home equity loans to finance consumption in the short term, were hurt by it following the Great Recession. Again, the high-debt period in the US sample starts and stops around the years of the crisis. This sample thus includes both the period when households were leveraging home equity loans (for consumption) as well as the period after the crisis when consumption subsequently dropped substantially as a result of the ill-advised loans (ibid.). The drop in consumption after the crisis might help explain why the overall response of the variable is more muted in times of high debt.

To summarize, although these last two figures show some puzzling results and should thus be interpreted with caution, it could still be argued that solely by examining the response of inflation and consumption, a low-debt environment is more desirable for conducting effective monetary policy.

## 6.6 Limitations and Our Position in the Literature

Due to the nature of endogeneity in macroeconomic variables caution should be used when we accrediting our empirical findings to isolated effects, especially in the country comparisons. Differences in macroprudential policies and legislation following the Great Recession have been acknowledged, but are difficult to control for completely. For example, heterogeneity in attitude toward the financial or mortgage market between the two countries have not been controlled for. These two factors are not unthinkable to differ as the recession was caused by a crash in these markets in the US, and was subsequently subjected to scrutiny. Hence, possible omitted differences between the countries should be kept in mind when observing the country comparisons.

Comparing the low and high household debt periods within each country accounts for many of the caveats mentioned above, especially considering the mirrored time periods in both countries. However, due to the conditioning on household debt, half of the observations are, by construction, excluded per IRF produced, making the estimates comparatively less precise. An alternative approach would be to include household debt as an exogenous variable with an interaction-term, but that would also quickly consume degrees of freedom (Enders, 2015) as well as come with an assumption of exogeneity. A strong assumption when macro-variables are used. A third option would be to do a panel-VAR approach with an interaction term, similar to Kim and Lim (2020), but then lose the ability to provide clear distinctions between the countries, which was of interested for this paper.

Because the shadow rate measure is fairly new, it would be of great value to see if the results can be replicated in future research, when more observations can be included, provided these unconventional measures continue to be key elements of modern monetary policy and that the shadow rates database keeps being updated. Another point of interest would be to examine the debt overhang effect more isolated. Hughson et al. (2016) for example, managed to isolate the effect of the balance sheet channel by dividing their sample in lenders and borrowers. As our results show that the balance sheet channel might be trumped by the debt overhang in relatively highly indebted households, a closer examination of how these households *choose* to repay their loans and/or change their consumption behavior when interest rates change would be a compelling insight. Measuring the effect of the debt overhang and what other transmission channel might be dominating the balance sheet channel when contractionary monetary policy is conducted in times of high debt is also of interest. A final suggestion for future research is to compare the effects of QE in different countries more closely, as our results give reason to believe that there was a substantial discrepancy in its impact in Sweden and the US. For example, one could look at to what aspects of QE affects investment and consumption behavior more. Perhaps by distinguishing between forward guidance and the actual increase of the money supply.

# 7 Conclusion

Following the Great Recession in 2008, unconventional monetary policies became increasingly prominent in the western economies. This was a result of an undershooting of the inflation target, coupled with the policy rate (the conventional monetary policy method) being at, or very close to, the zero lower bound. Now, following more than a decade of near constant expansionary policy and yet a weak inflation rate, both in Sweden and the US, discussions about debt have gained more attention. Since the Great Recession, household debt in Sweden and the US has been developing in opposite directions, making these countries interesting objects of comparison when examining the effectiveness of monetary policy, conditional on household debt.

Most of the research on this topic finds that higher household debt is advantageous to the transmission of monetary policy into the economy. The results of these earlier findings indicate that the balance sheet channel is the main (or at least a large) transmission channel of monetary policy. However, the results have almost exclusively used the policy rate as their main measure of monetary policy.

In this paper, we argue for the use of more contemporarily relevant measures of monetary policy, which could better capture the current outlook of unconventional methods such as quantitative easing and forward-guidance. One of those measures is called the shadow rate, which incorporates information about the extent of unconventional monetary policies. The second one is the monetary base, used as an isolated measure of quantitative easing.

Using a SVAR (2) model, estimated with data from Sweden and the US spanning more than 25 years, we have tested the effectiveness of monetary policy conditional on household debt with these alternative monetary policy measures. First, we conducted country comparisons between Sweden and the US, due to their mirroring development of debt levels from the time that the unconventional monetary policy measures were introduced. Then, we compared periods of relatively high and low debt within each country. This procedure was done twice, one for each policy tool.

Our results show that low household debt rather than high is more suitable in order for monetary policy to be effective. Thus, our results question, not the existence of, but rather the strong emphasis that previous research has put on, the balance sheet channel. Instead, we suggest that this transmission channel might be trumped by the effect of a so called debt overhang, making households focus more on repaying debt rather than consuming or taking more loans, on the margin, even in times of expansionary monetary policy. For contractionary policy, there is hardly any literature to lean on in regards to why the balance sheet channel would not be the dominating one. Perhaps because almost no contractionary monetary policy has been conducted since the Great Recession and is one of the defining pillars of the New Normal, and reasons to the very unconventional monetary policy measures we are examining.

The findings of this paper are not fully coherent. In the first country comparison, monetary policy in Sweden (which has an increasing household debt) is shown to be more effective, whereas the subsequent sets of results show the opposite. Our interpretation of the misalignment between the one country comparisons and the rest of the results is that there might exist omitted variables affecting the transmission channels of monetary policy, such as a differences in the macroprudential environment between the countries. Considering the similarities to previous research regarding the selection of variables and model, we attribute the difference between our results and said research to our alternative measures of monetary policy.

In the debate regarding whether or not household debt leads to more effective monetary policy, our results supports the latter. By using alternative measures to modern monetary policy in the ZLB environment, we provide evidence for household debt having a detrimental effect on the effectiveness of monetary policy, at times even leading to opposite, than desired, results. Hence, we conclude that households perhaps should not bear the majority of the risk associated with indebtedness, and advise for a reduction of household debt in Sweden, if monetary policy is to affect key macroeconomic variables in its intended way.

# A Appendix: SVAR Variables: Plotted

**Figure 19:** Shadow Rates

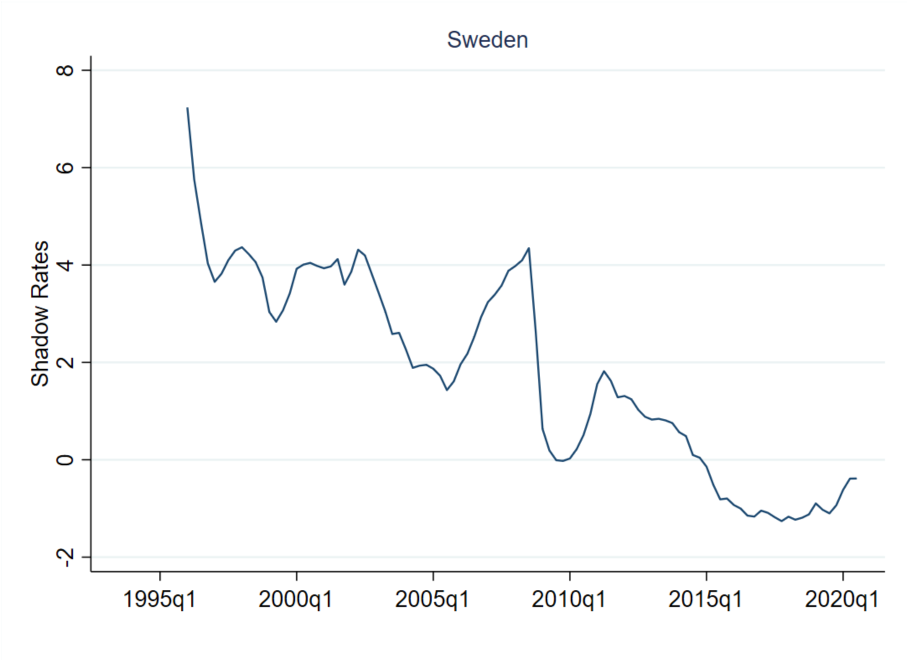



**Figure 20:** Log Monetary Base

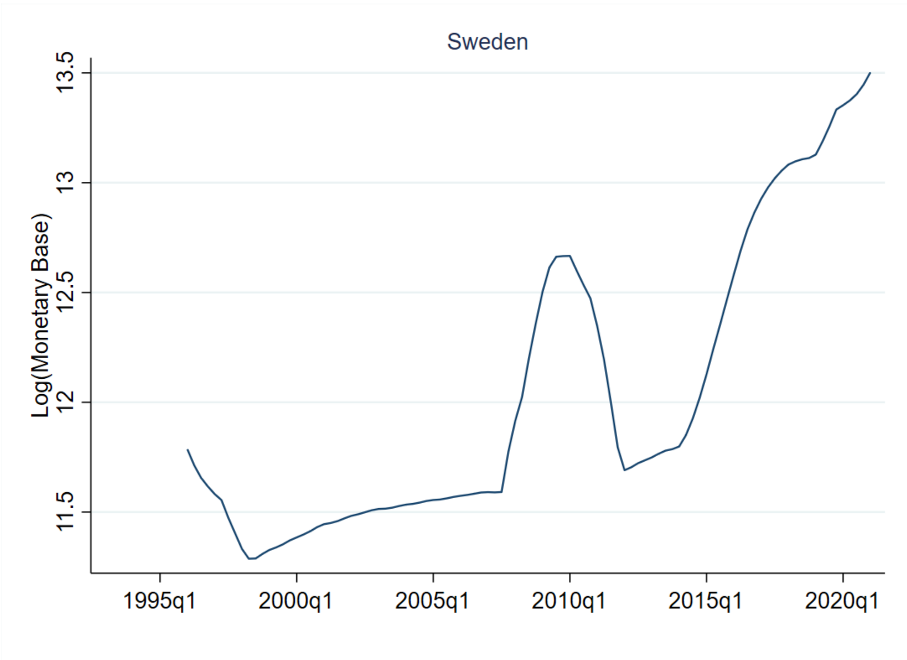


**Figure 21:** Log Consumer Price Index

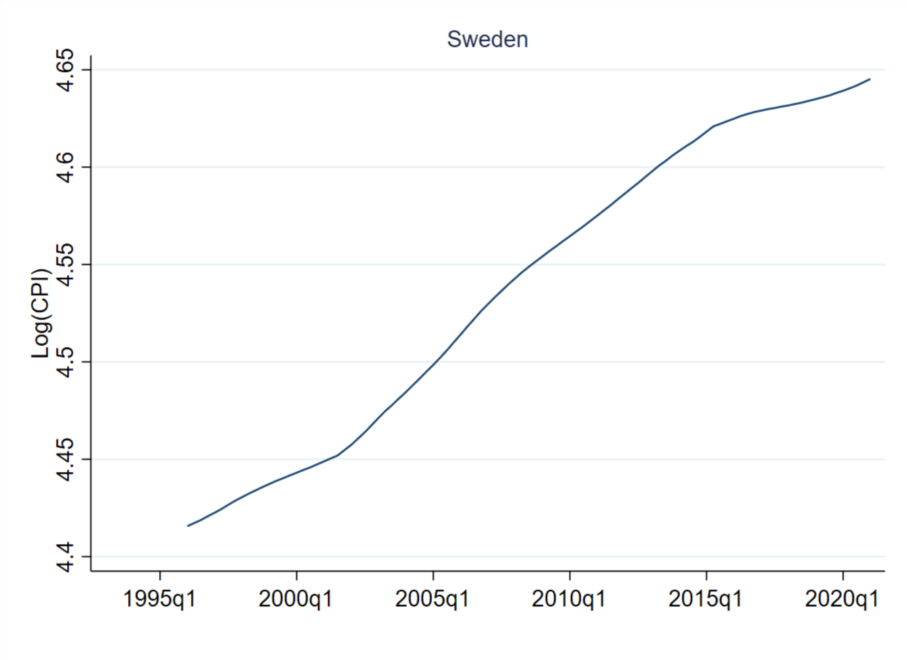



**Figure 22:** Log Household Consumption to GDP

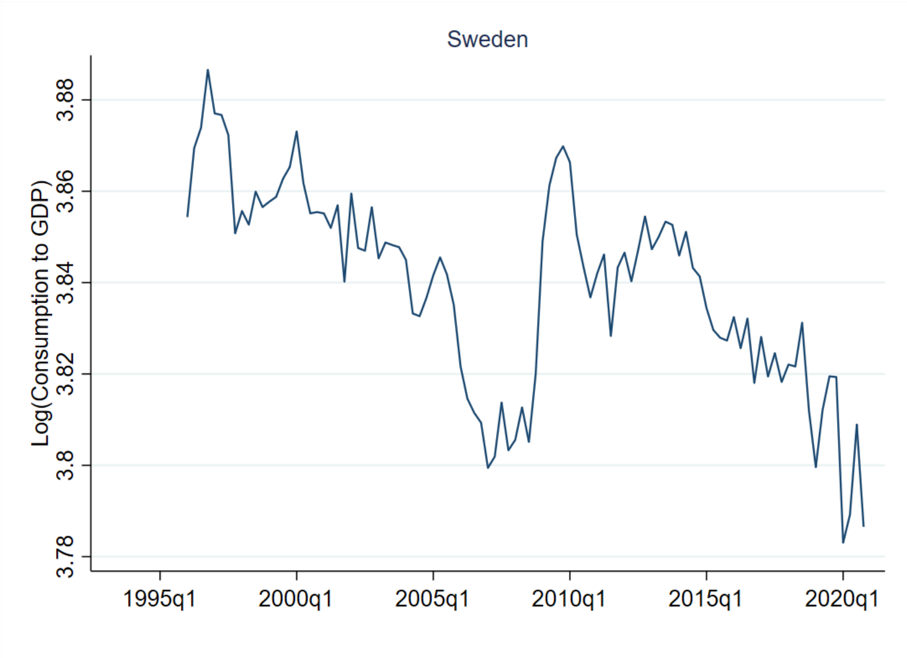


**Figure 23:** Log Household Investments to GDP

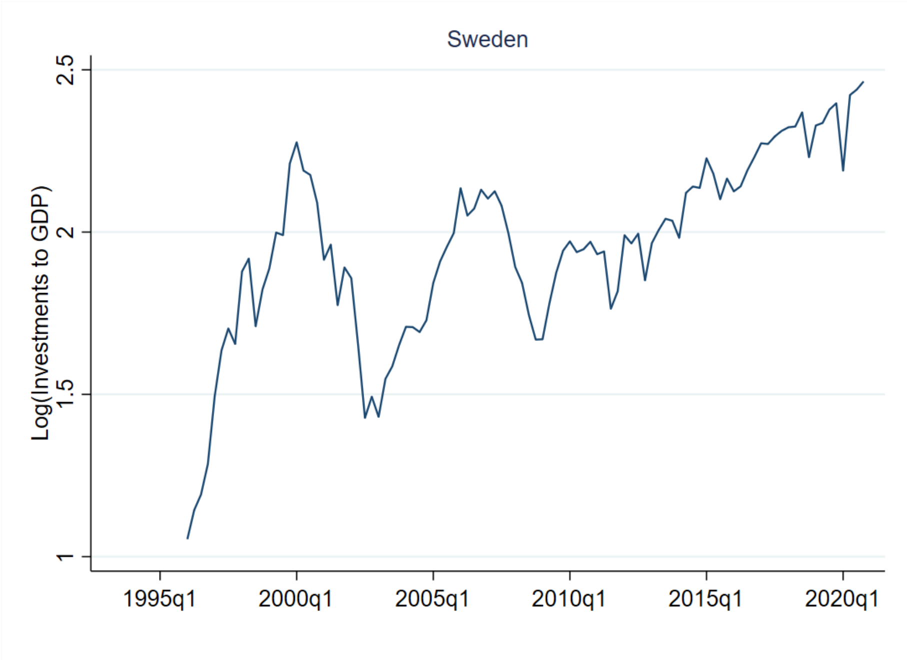



**Figure 24:** Log Property Price Index

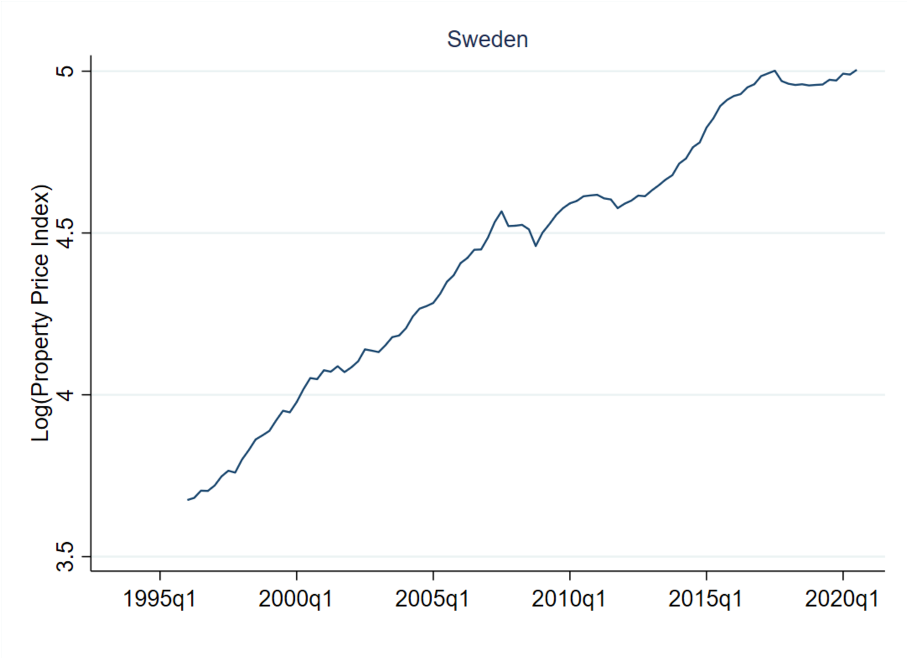


**Figure 25:** Log Commodity Price Index

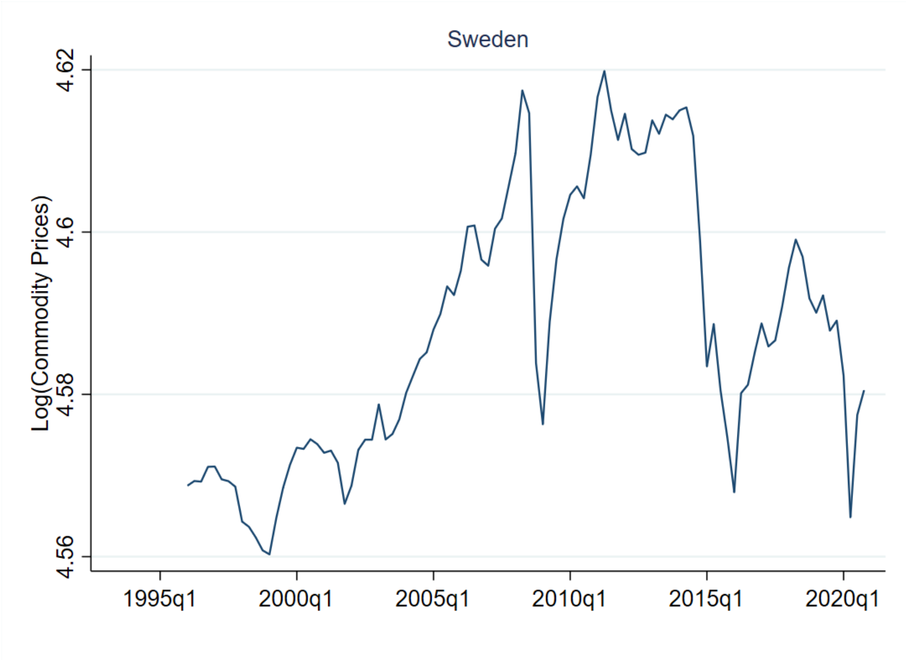



**Figure 26:** Real Exchange Rate

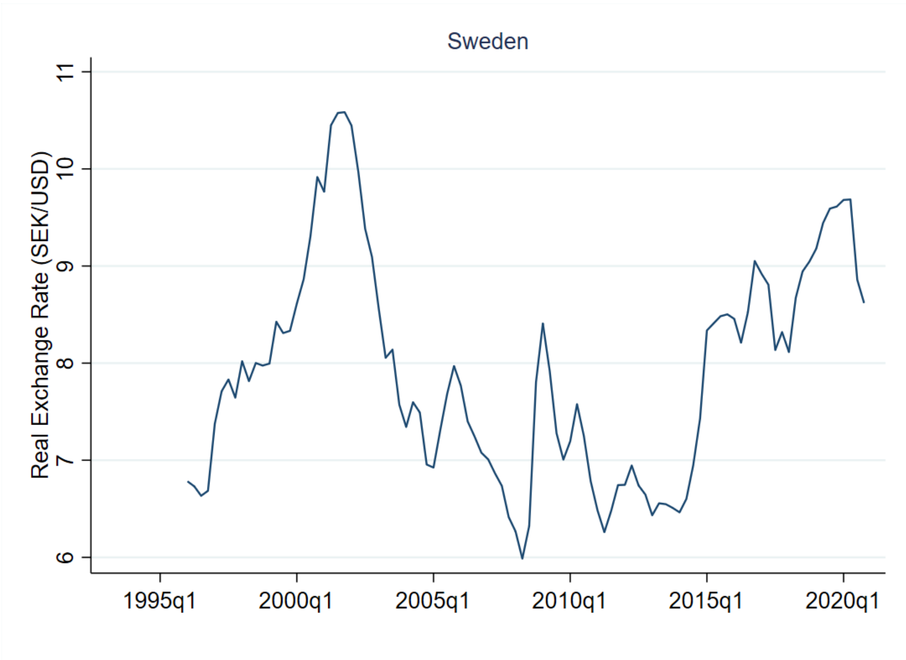


**Figure 27:** Shadow Rates

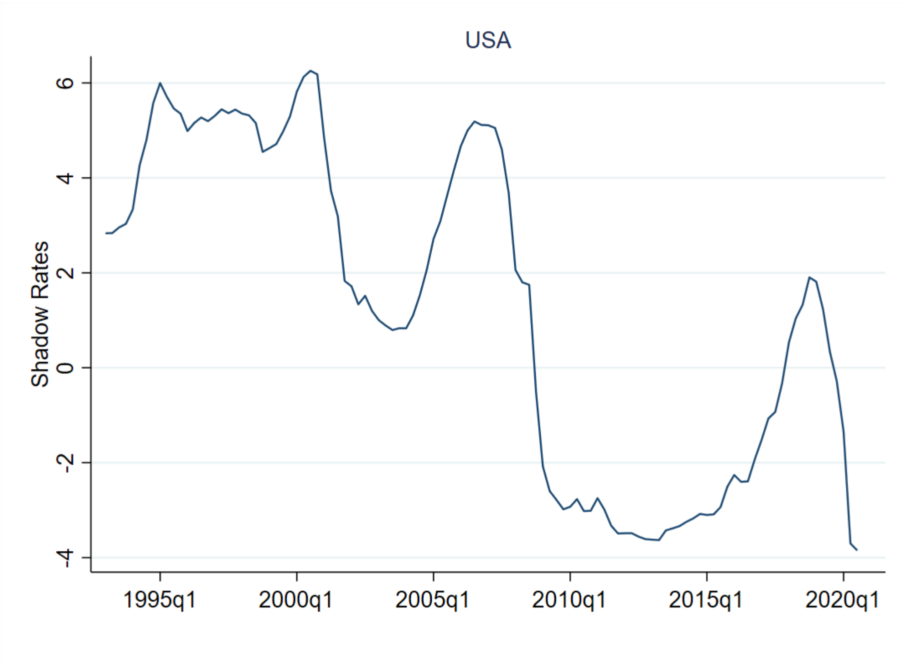



**Figure 28:** Log Monetary Base

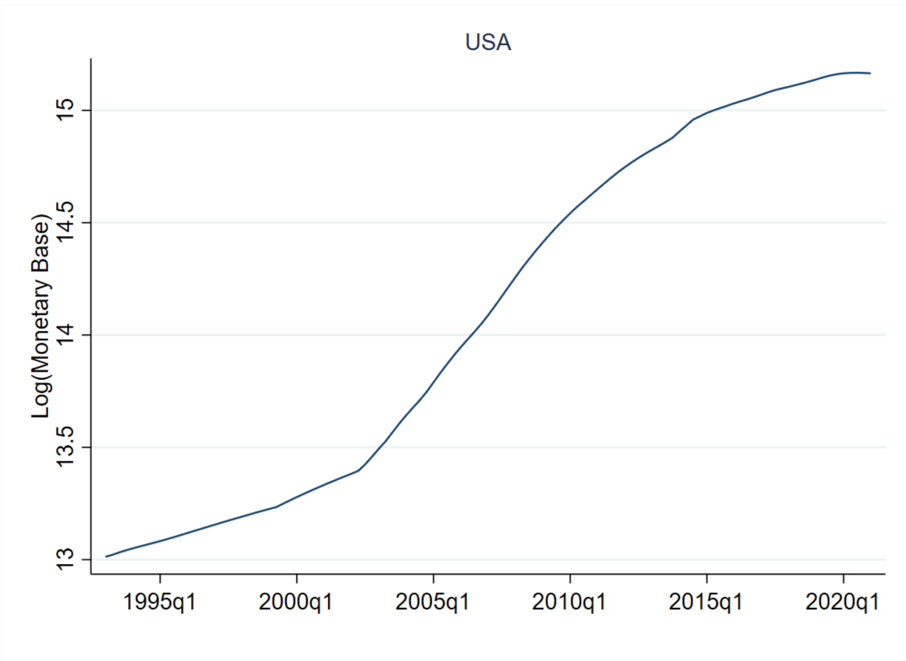


**Figure 29:** Log Consumer Price Index

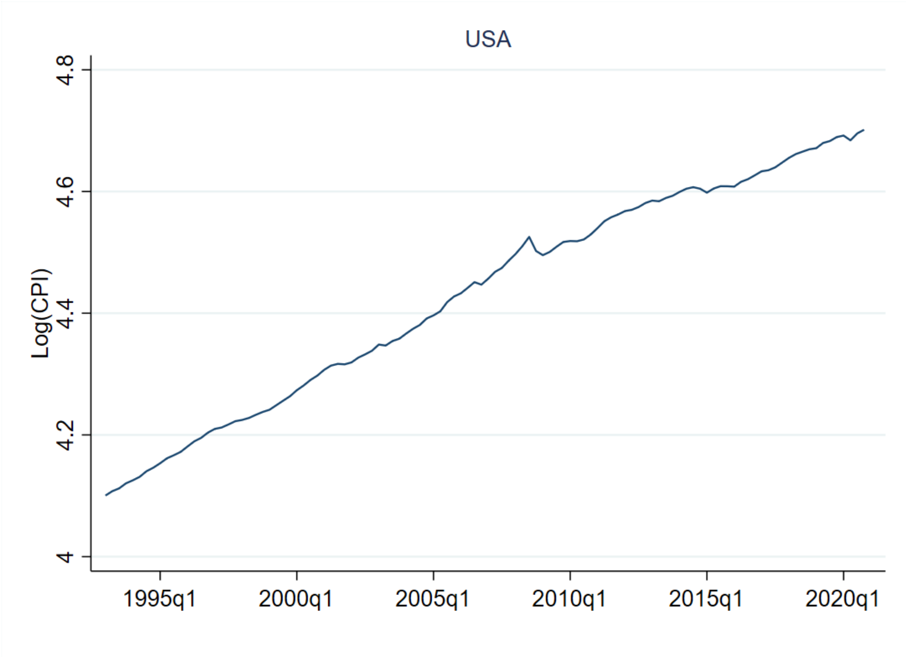



**Figure 30:** Log Household Consumption to GDP

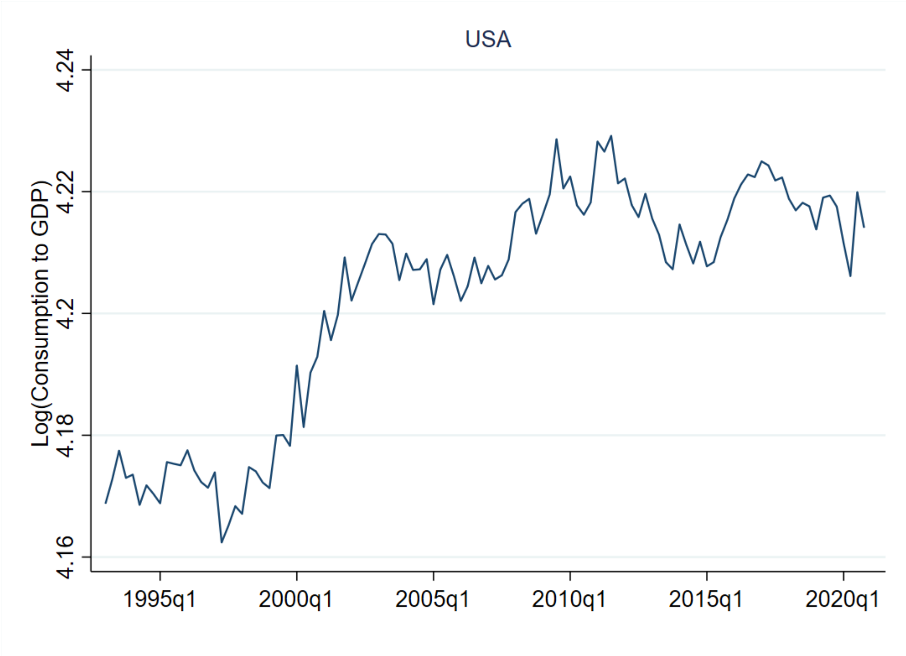


**Figure 31:** Log Household Investments to GDP

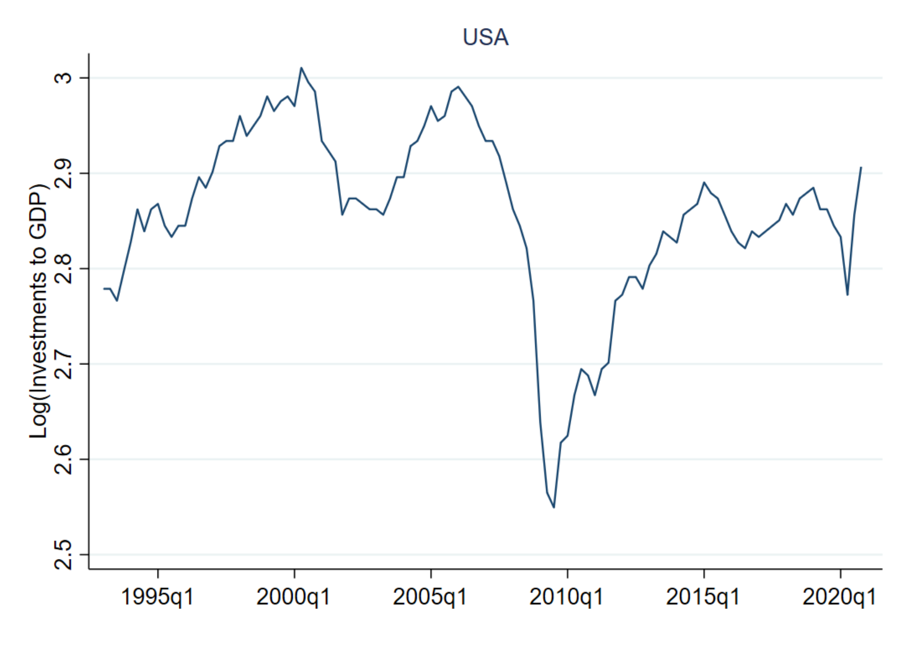



**Figure 32:** Log Property Price Index

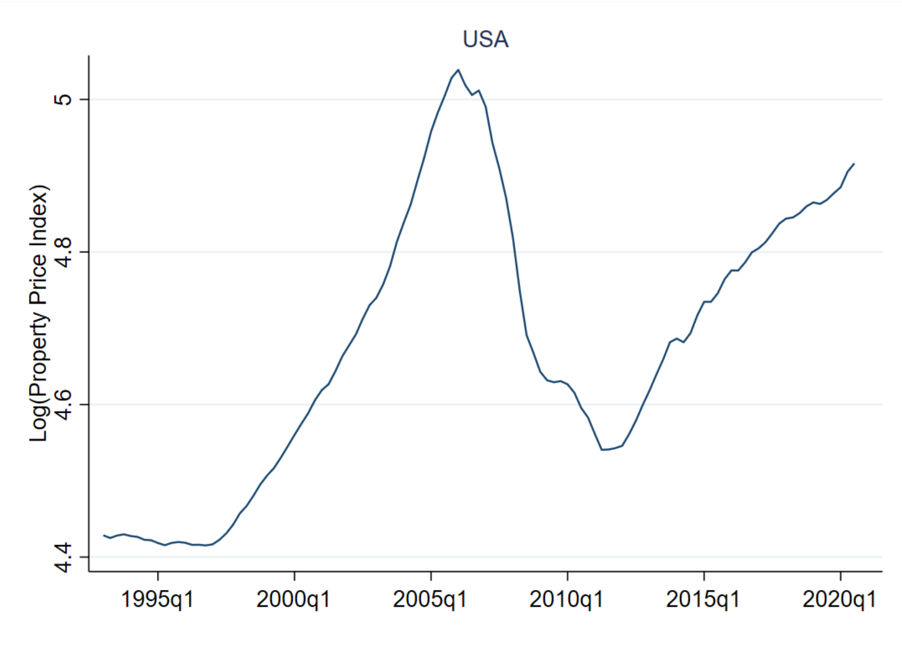
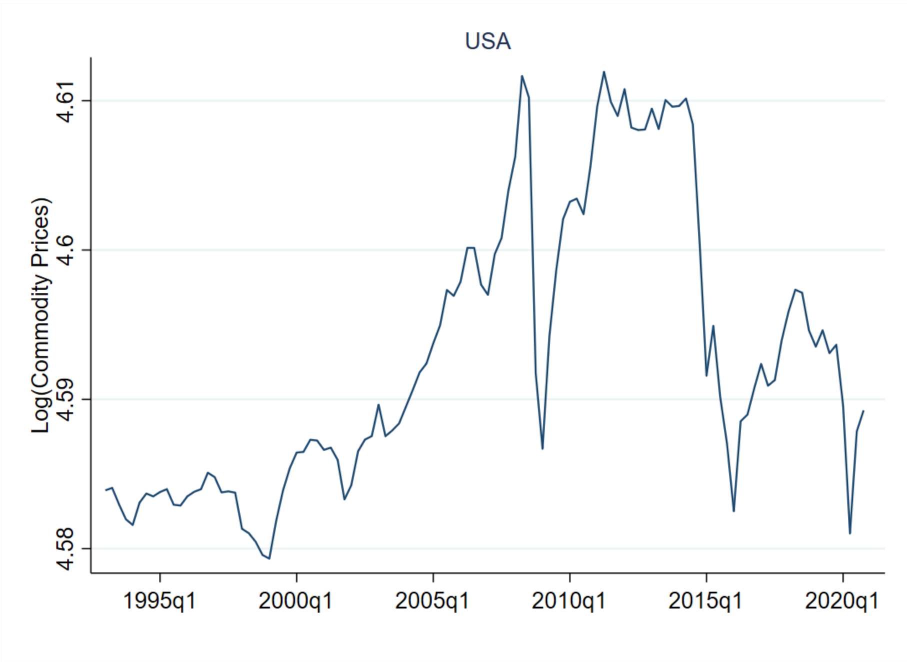


**Figure 33:** Log Commodity Price Index



# B Appendix: IRF Robustness Checks

**Figure 34:** Contractionary Shock Sweden

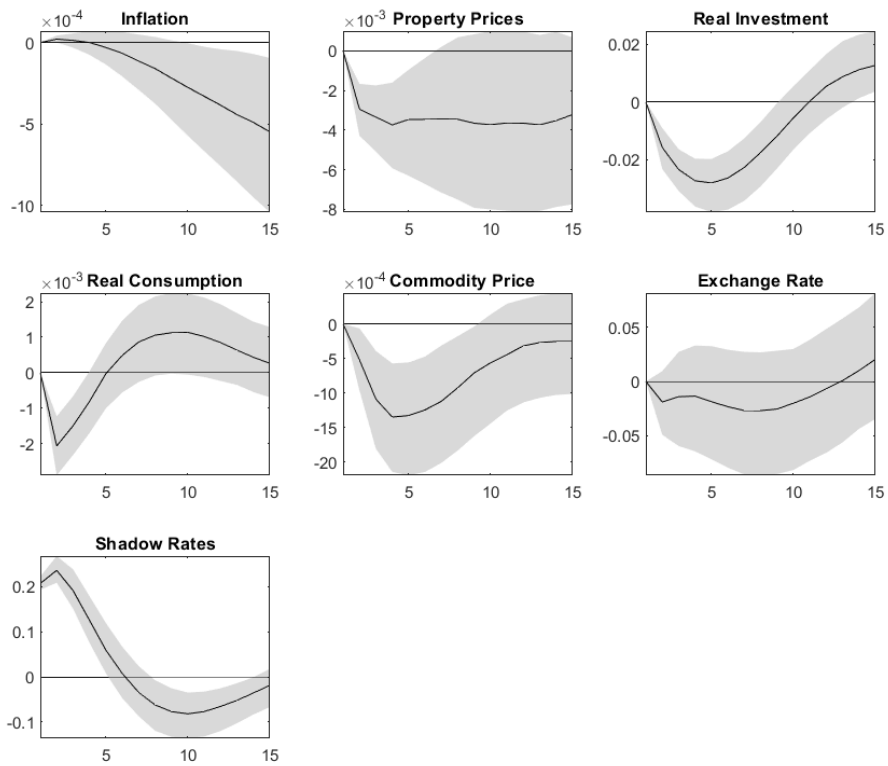



Figure (34) corresponds to Figure (7) and shows the inclusion of exchange rate in the graphs.

**Figure 35:** High Debt Contractionary Shock Sweden

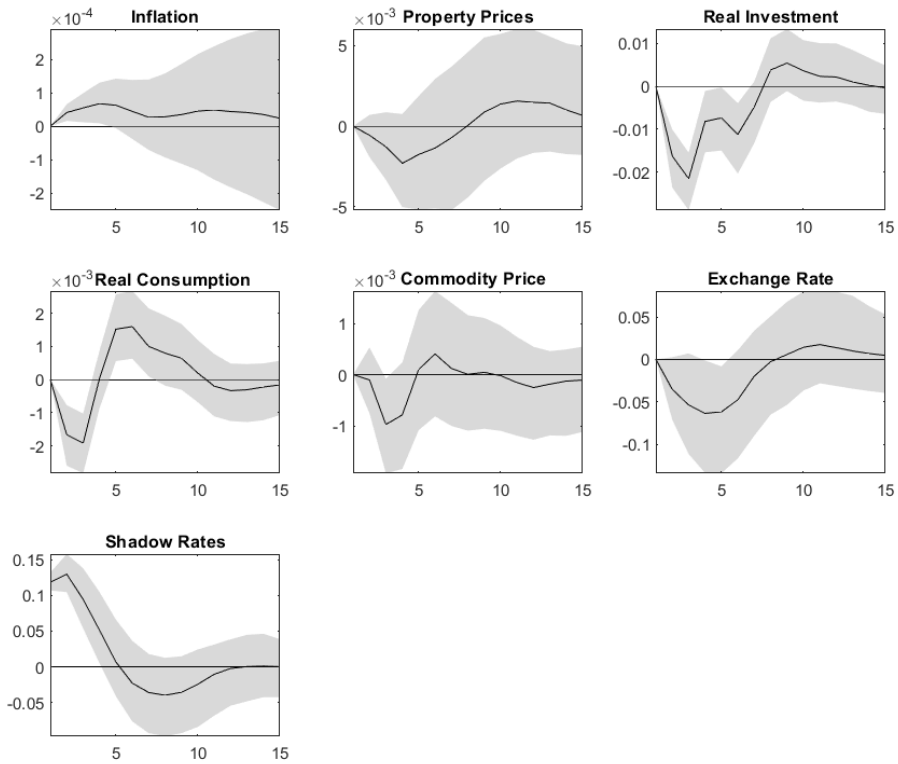



Figure (35) corresponds to Figure (9) and shows the inclusion of exchange rate in the graphs.

**Figure 36:** Low Debt Contractionary Shock Sweden

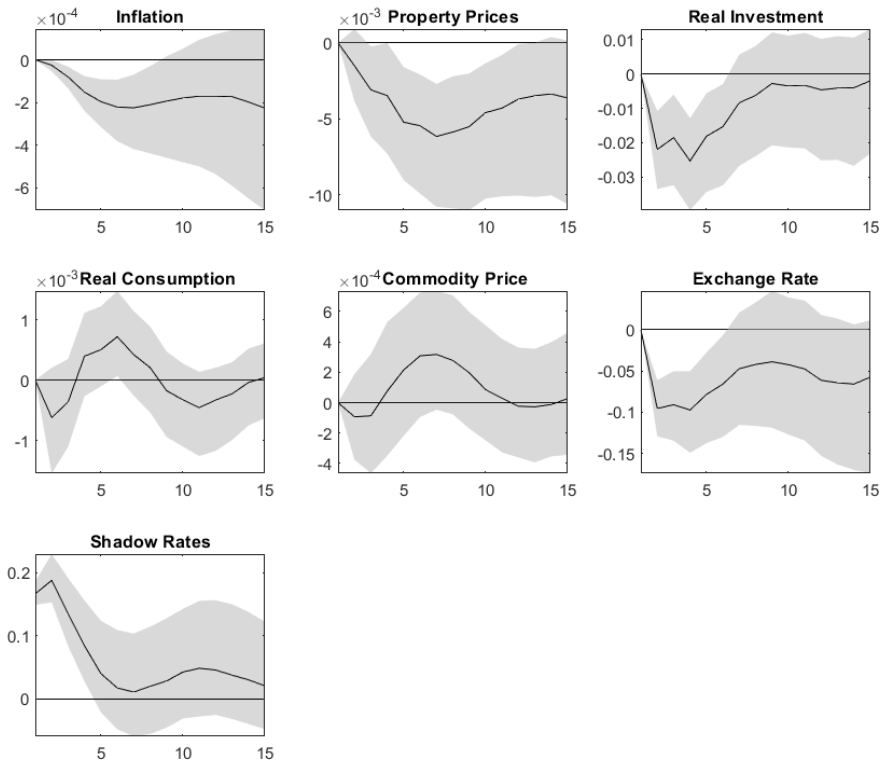



Figure (36) corresponds to Figure (10) and shows the inclusion of exchange rate in the graphs.

**Figure 37:** Expansionary Shock Sweden

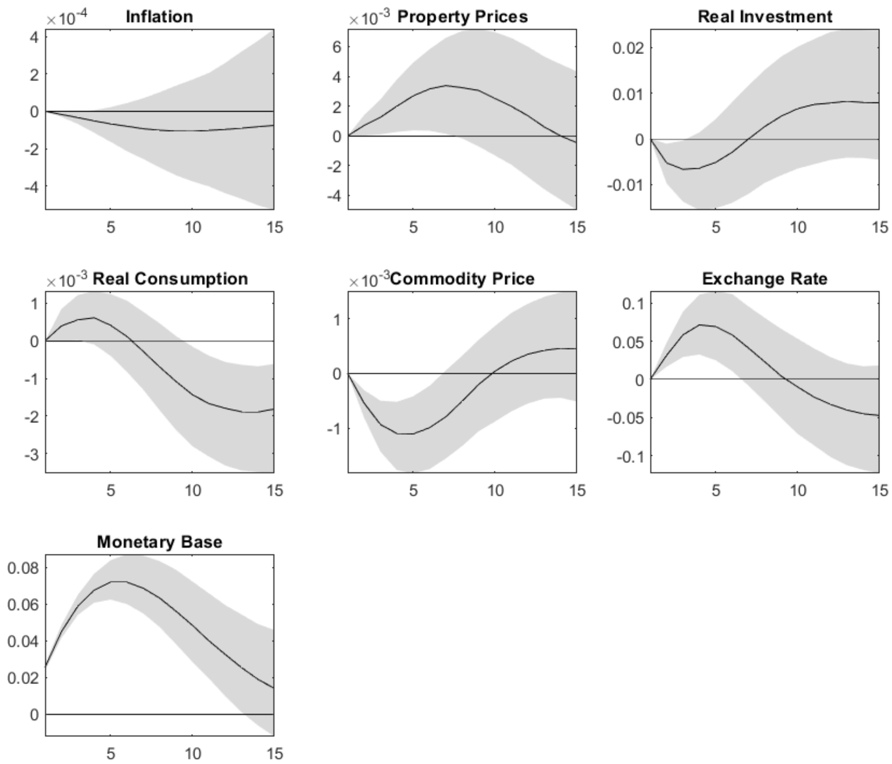



Figure (37) corresponds to Figure (13) and shows the inclusion of exchange rate in the graphs.

**Figure 38:** High Debt Expansionary Shock Sweden

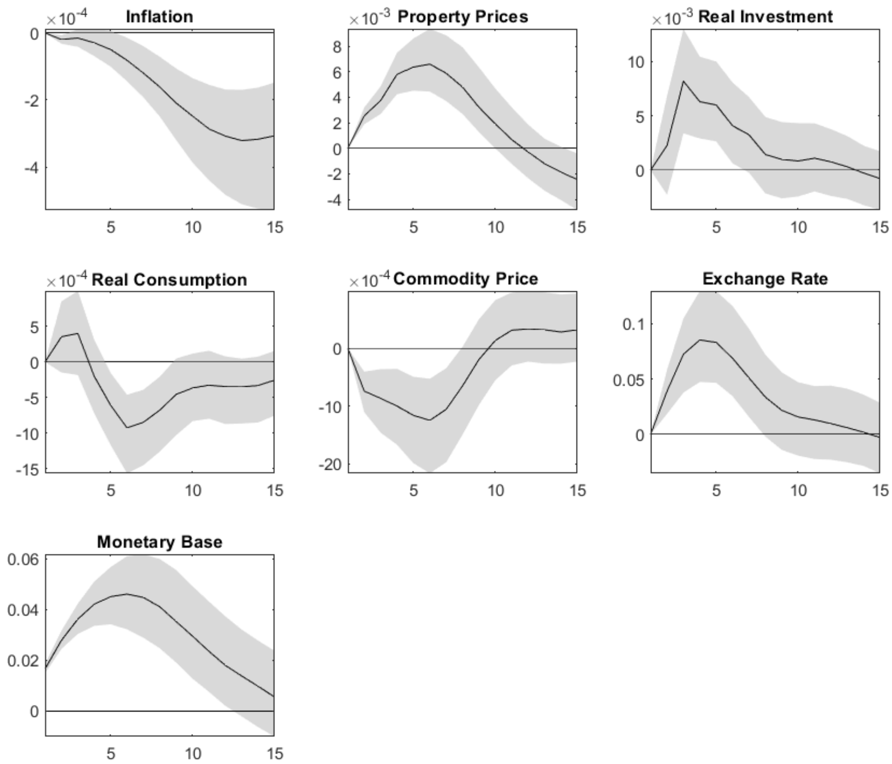



Figure (38) corresponds to figure (15) and shows the inclusion of exchange rate in the graphs.

**Figure 39:** Low Debt Expansionary Shock Sweden

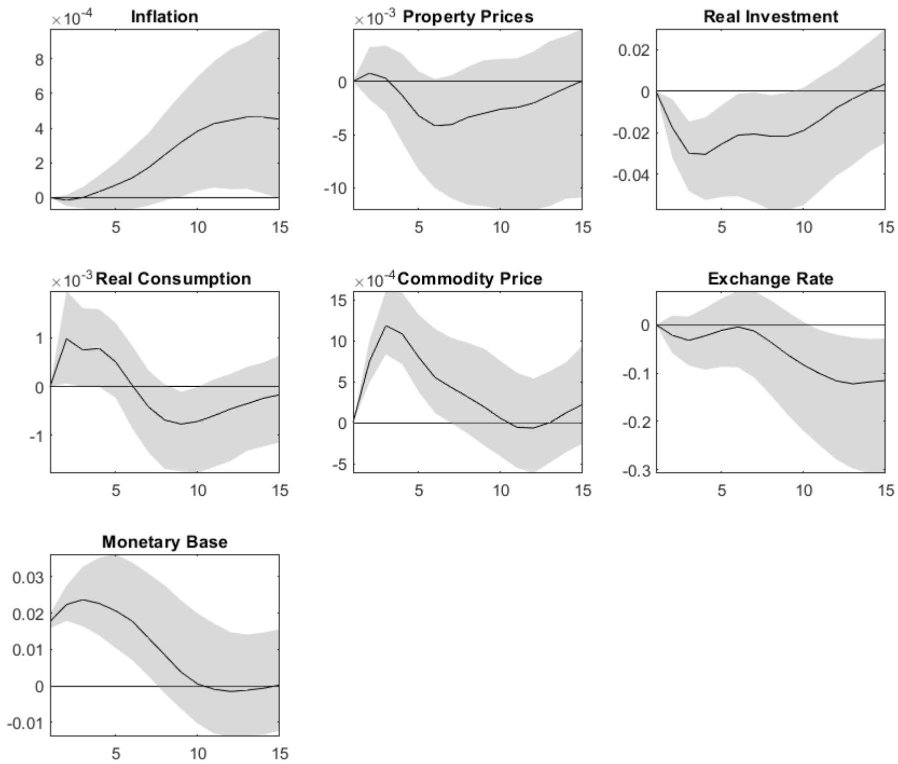



Figure (39) corresponds to Figure (16) and shows the inclusion of exchange rate in the graphs.

**Figure 40:** 1996 US Sample Using Shadow Rate

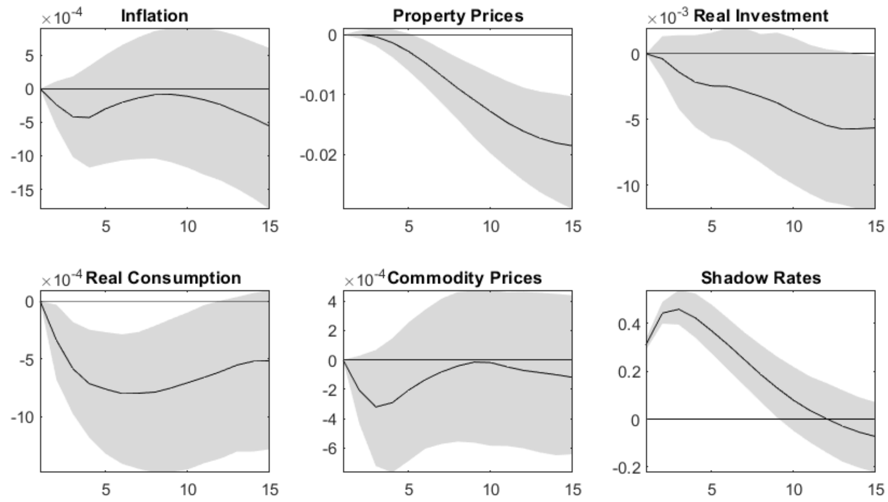



Figure (40) shows the results from the US sample when the period 1993 Q1 to 1995 Q4 was excluded. The graph should be compared to Figure (8). As no systematic difference could be found between the models, the full US sample was used.

**Figure 41:** 1996 US Sample Using Monetary Base

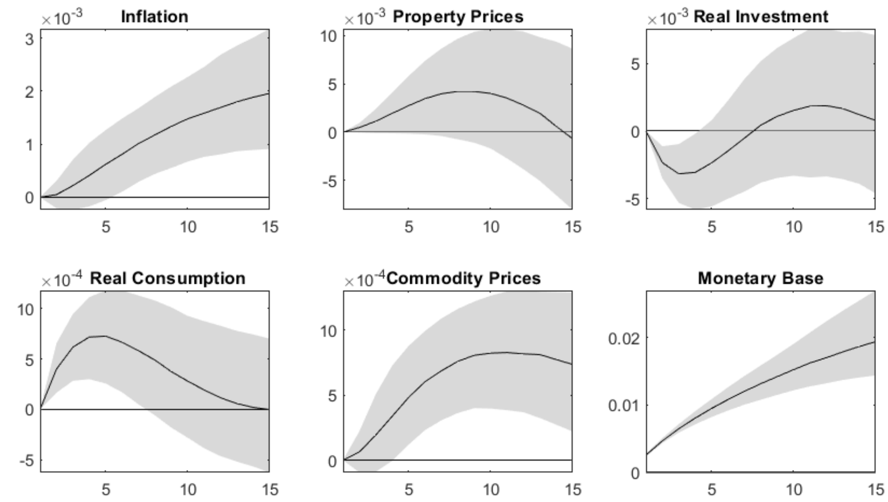



Figure (41) shows the results from the US sample when the period 1993 Q1 to 1995 Q4 was excluded. The graph should be compared to Figure (14). As no systematic difference could be found between the models, the full US sample was used.

**Figure 42:** Inclusion of Exchange Rate in US Using Shadow Rate

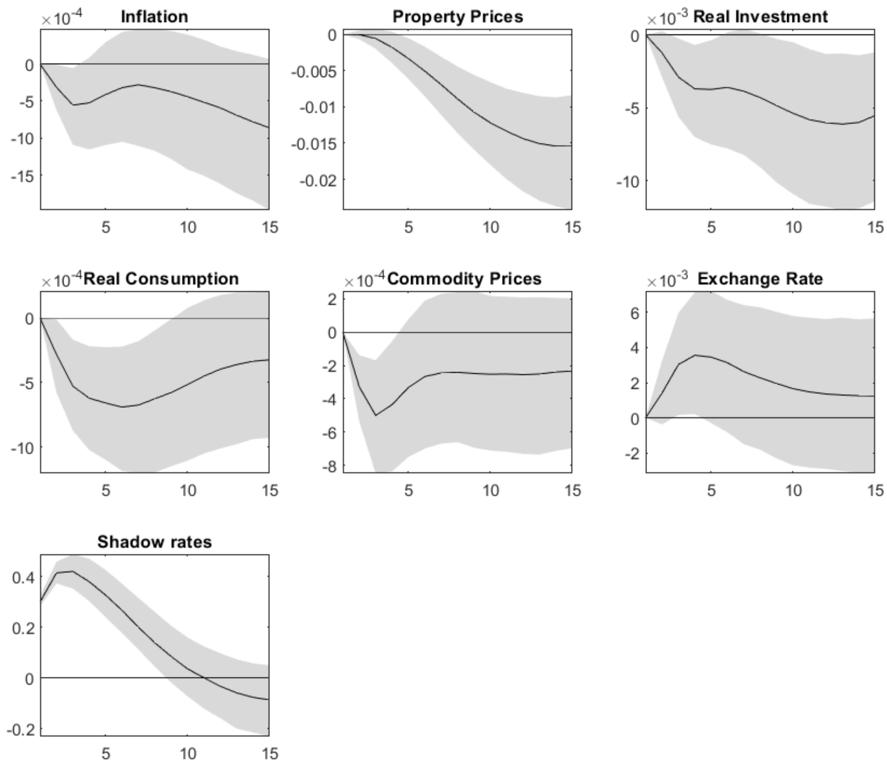



Figure (42) shows the results from the IRFs for the US sample when exchange rate was included in the model. The graph should be compared to Figure (8). As no systematic difference could be found between the models, the exchange rate was not included in the final model in the interest of persevering degrees of freedom.

**Figure 43:** Inclusion of Exchange rate in US Using Monetary Base

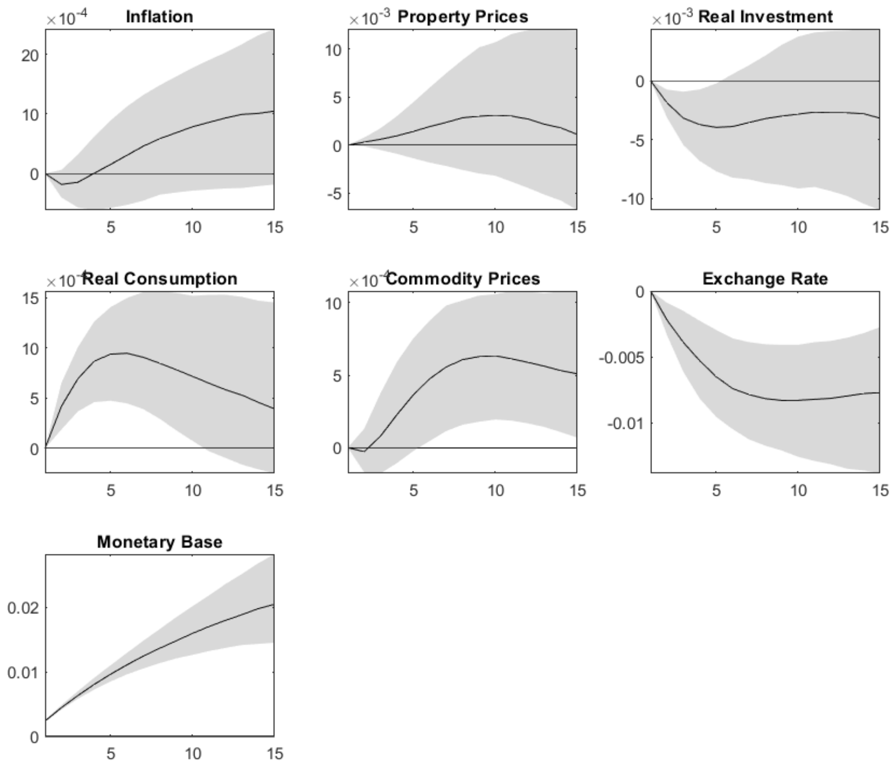



Figure (43) shows the results from the IRFs for the US sample when exchange rate was included in the model. The graph should be compared to Figure (14). As no systematic difference could be found between the models, the exchange rate was not included in the final model in the interest of persevering degrees of freedom.

# References


Alpanda, S. and Zubairy, S. (2019), 'Household debt overhang and transmission of monetary policy', *Journal of Money, Credit and Banking* **51**(5), 1265–1307.

Armelius, H., Claussen, C. A., Vestin, D. et al. (2020), 'Money and monetary policy in times of crisis', *EconStor Open Access Articles* pp. 1–15.

Bank for International Settlements (BIS) (2021*a*), 'Credit to the non-financial sector'.
**URL:** *https://www.bis.org/statistics/totcredit.htm*

Bank for International Settlements (BIS) (2021*b*), 'Effective exchange rate indices'.
**URL:** *https://www.bis.org/statistics/eer.htm*

Bank for International Settlements (BIS) (2021*c*), 'National sources, bis residential property price database'.
**URL:** *https://www.bis.org/statistics/pp$_d$etailed.htm*

Bartocci, A., Notarpietro, A., Pisani, M. et al. (2019), *Non-standard monetary policy measures in the new normal*, Banca d'Italia.

Bayoumi, M. T., Dell'Ariccia, M. G., Habermeier, M. K. F., Griffoli, M. T. M. and Valencia, M. F. (2014), *Monetary policy in the new normal*, International Monetary Fund.

Bernanke, B. (2004), 'The great moderation', *Washington, DC* .

Bernanke, B. S. and Blinder, A. S. (1988), 'Credit, money, and aggregate demand'.

Bernanke, B. S. and Gertler, M. (1995), 'Inside the black box: the credit channel of monetary policy transmission', *Journal of Economic perspectives* **9**(4), 27–48.

Beyer, A., Nicoletti, G., Papadopoulou, N., Papsdorf, P., Rünstler, G., Schwarz, C., Sousa, J. and Vergote, O. (2017), *The transmission channels of monetary, macro-and microprudential policies and their interrelations*, number 191, ECB Occasional Paper.

Black, F. (1995), 'Interest rates as options', *the Journal of Finance* **50**(5), 1371–1376.

Board of Governors of the Federal Reserve System (US) (2021*a*), 'Households and nonprofit organizations; debt securities and loans; liability, level [cmdebt], retrieved from fred, federal reserve bank of st. louis'.
**URL:** *https://fred.stlouisfed.org/series/CMDEBT*

Board of Governors of the Federal Reserve System (US) (2021*b*), 'Households and nonprofit organizations; equity and investment fund shares; asset (ima), level (discontinued) [hnoefsq027s], retrieved from fred, federal reserve bank of st. louis'.
**URL:** *https://fred.stlouisfed.org/series/HNOEFSQ027S*

Board of Governors of the Federal Reserve System (US) (2021*c*), 'Monetary base; total [bogmbase], retrieved from fred, federal reserve bank of st. louis'.
**URL:** *https://fred.stlouisfed.org/series/BOGMBASE*

Board of Governors of the Federal Reserve System (US) (2021*d*), 'Sweden / u.s. foreign exchange rate [exsdus], retrieved from fred, federal reserve bank of st. louis'.
**URL:** *https://www.bis.org/statistics/pp$_d$etailed.htm*

Brainard, L. et al. (2016), The "new normal" and what it means for monetary policy: a speech at the chicago council on global affairs, chicago, illinois, september 12, 2016, Technical report.

Canova, F. and Ferroni, F. (2020), 'A hitchhiker guide to empirical macro models'.

Carpenter, S. and Demiralp, S. (2012), 'Money, reserves, and the transmission of monetary policy: Does the money multiplier exist?', *Journal of macroeconomics* **34**(1), 59–75.

Cloyne, J., Ferreira, C. and Surico, P. (2020), 'Monetary policy when households have debt: new evidence on the transmission mechanism', *The Review of Economic Studies* **87**(1), 102–129.

De Rezende, R. B. (2021), 'Shadow rates for the us, sweden, euro area and the uk'.
**URL:** *https://rafaelbderezende.wixsite.com/rafaelbderezende/shadow-rates*

De Rezende, R. and Ristiniemi, A. (2020), 'A shadow rate without a lower bound constraint'.

Di Casola, P. and Iversen, J. (2019), *Monetary policy with high household debt and low interest rates*, Sveriges Riksbank.

Disyatat, P. (2011), 'The bank lending channel revisited', *Journal of money, Credit and Banking* **43**(4), 711–734.

Enders, W. (2015), 'Applied econometric time series fourth edition'.

Fawley, B. W., Neely, C. J. et al. (2013), 'Four stories of quantitative easing', *Federal Reserve Bank of St. Louis Review* **95**(1), 51–88.

FED (2020), 'Why does the federal reserve aim for inflation of 2 percent over the longer run?'.
**URL:** *https://www.federalreserve.gov/faqs/economy_14400.htm*

Filardo, A. and Hofmann, B. (2014), 'Forward guidance at the zero lower bound'.

Fleming, J. M. (1962), 'Domestic financial policies under fixed and under floating exchange rates', *IMF Econ Rev* **9**, 369–380.
**URL:** *https://doi.org/10.2307/3866091*

Flodén, M., Kilström, M., Sigurdsson, J. and Vestman, R. (2021), 'Household debt and monetary policy: Revealing the cash-flow channel', *The Economic Journal* **131**(636), 1742–1771.

Friedman, M. (1961), 'The lag in effect of monetary policy', *Journal of Political Economy* **69**(5), 447–466.

Friedman, M. (1970), 'A theoretical framework for monetary analysis', *journal of Political Economy* **78**(2), 193–238.

Galí, J. and Gambetti, L. (2009), 'On the sources of the great moderation', *American Economic Journal: Macroeconomics* **1**(1), 26–57.

Gelos, M. R., Griffoli, M. T. M., Narita, M. M., Grinberg, F., Rawat, U. and Khan, S. (2019), *Has higher household indebtedness weakened monetary policy transmission?*, International Monetary Fund.

Gilchrist, S., López-Salido, D. and Zakrajšek, E. (2015), 'Monetary policy and real borrowing costs at the zero lower bound', *American Economic Journal: Macroeconomics* **7**(1), 77–109.

Giordani, P. (2004), 'An alternative explanation of the price puzzle', *Journal of Monetary Economics* **51**(6), 1271–1296.

Heikensten, L. and Vredin, A. (2002), The art of targeting inflation, *in* 'Swedish Riksbank Economic Review, Fourth Quarter 2002', Citeseer.

Holmberg, U., Janzén, H., Oscarius, L., van Santen, P. and Spector, E. (2015), 'An analysis of the fixation period for swedish mortgages', *Sveriges Bank Economic Commentaries* .

Hughson, H., La Cava, G., Ryan, P., Smith, P. et al. (2016), 'The household cash flow channel of monetary policy', *RBA Bulletin, September* pp. 21–30.

International Monetary Fund (2021), 'Commodity terms of trade'.
**URL:** *https://data.imf.org/?sk=2CDDCCB8-0B59-43E9-B6A0-59210D5605D2*

Joyce, M., Miles, D., Scott, A. and Vayanos, D. (2012), 'Quantitative easing and unconventional monetary policy–an introduction', *The Economic Journal* **122**(564), F271–F288.

Keynes, J. M. (1936), *The General Theory of Employment, Interest and Money*, Palgrave Macmillan.

Kim, Y. and Lim, H. (2020), 'Transmission of monetary policy in times of high household debt', *Journal of Macroeconomics* **63**, 103168.

Krugman, P. (1988), 'Financing vs. forgiving a debt overhang', *Journal of development Economics* **29**(3), 253–268.

Leigh, D., Igan, D., Simon, J. and Topalova, P. (2012), *Growth Resuming, Dangers Remain*, World Ecoconomic Outlook (WEO), International Monetary Fund.

Lewbel, A. (2019), 'The identification zoo: Meanings of identification in econometrics', *Journal of Economic Literature* **57**(4), 835–903.

Library of Congress (2010), 'Text - h.r.4173 - 111th congress (2009-2010): Dodd-frank wall street reform and consumer protection act.'.
**URL:** *https://www.congress.gov/bill/111th-congress/house-bill/4173/text.*

Melzer, B. T. (2017), 'Mortgage debt overhang: Reduced investment by homeowners at risk of default', *The Journal of Finance* **72**(2), 575–612.

Mian, A. and Sufi, A. (2014), House price gains and us household spending from 2002 to 2006, Technical report, National Bureau of Economic Research.

Mian, A. and Sufi, A. (2015), *House of debt: How they (and you) caused the Great Recession, and how we can prevent it from happening again*, University of Chicago Press.

Mishkin, F. S. (1996), The channels of monetary transmission: lessons for monetary policy, Technical report, National Bureau of Economic Research.

Mundell, R. (1963), 'Capital mobility and stabilisation policy under fixed and flexible exchange rat', *Canadian Journal of Economics and Political* **29**(4), 475–485.
**URL:** *https://www.jstor.org/stable/139336*

OECD (2021), 'Main economic indicators - complete database'.
**URL:** *https://www.oecd-ilibrary.org/content/data/data-00052-en*

Rahal, C. (2016), 'Housing markets and unconventional monetary policy', *Journal of Housing Economics* **32**, 67–80.

Sims, C. A. (1980), 'Macroeconomics and reality', *Econometrica: journal of the Econometric Society* pp. 1–48.

Sims, C. A. (1992), 'Interpreting the macroeconomic time series facts: The effects of monetary policy', *European economic review* **36**(5), 975–1000.

Sims, C. A., Stock, J. H. and Watson, M. W. (1990), 'Inference in linear time series models with some unit roots', *Econometrica: Journal of the Econometric Society* pp. 113–144.

Sims, E. (2011), 'Graduate macro theory ii: Notes on time series', *Rap. tech., University of Notre Dame, URL http://www3. nd. edu/~ esims1/time_series_notes. pdf* .

Statistics Sweden (SCB) (2021*a*), 'Financial accounts, balances, sek million by counterpart-sector, sector, item and quarter'.
**URL:** *https://www.scb.se/en/finding-statistics/statistics-by-subject-area/financial-markets/financial-accounts/financial-accounts-quarterly-and-annual/*

Statistics Sweden (SCB) (2021*b*), 'Financial market statistics, march 2021'.
**URL:** *http://www.scb.se/fm5001-en*

Sufi, A. (2015), 'Out of many, one? household debt, redistribution and monetary policy during the economic slump', *Andrew Crockett Memorial Lecture, BIS* .

Uhlig, H. (2017), 'Shocks, sign restrictions, and identification', *Advances in economics and econometrics* **2**, 95.

U.S. Bureau of Economic Analysis (2021), 'Personal consumption expenditures [pce], retrieved from fred, federal reserve bank of st. louis'.
**URL:** *https://fred.stlouisfed.org/series/PCE*

Von Hayek, F. A. (1937), 'Economics and knowledge', *Economica* **4**(13), 33–54.

Wu, J. C. and Xia, F. D. (2016), 'Measuring the macroeconomic impact of monetary policy at the zero lower bound', *Journal of Money, Credit and Banking* **48**(2-3), 253–291.

Wu, J. C. and Xia, F. D. (2020), 'Negative interest rate policy and the yield curve', *Journal of Applied Econometrics* **35**(6), 653–672.