Bachelor Thesis

The Impact of Unconventional Monetary Policy Shocks on Economic Aggregates and Wealth Inequality in the US

Department of International Macroeconomics and Finance

Eberhard Karls Universität Tübingen

David Bügel, 5436578

Tübingen, January 31$^{\text{th}}$, 2023

Supervised by Prof. Dr. Ralph Luetticke

Abstract

This bachelor thesis analyses the impact of unconventional monetary policy shocks on main economic aggregates and wealth inequality in the United States. Using the Wu-Xia Shadow Federal Funds Rate and the Romer-Romer model to create a series of exogenous unconventional monetary policy shocks, I can quantify the effect of unconventional monetary policy shocks on various economic variables in a simple vector autoregressive regression model. The results show a contractionary impact of unconventional contractionary shocks on the economy. Wealth inequality seems to decrease, which differs from the results regarding conventional MP shocks.

Contents

1 Introduction

The aftermath of the 2008 global financial crisis showed the limitations of traditional monetary policy in achieving its goals. These goals typically include maintaining price stability, achieving full employment and stabilizing the economy, as well as promoting economic growth. Setting short-term interest rates, which is the main traditional tool of monetary policy, was no longer sufficient in tackling economic downturn. Thus, central banks had to take more drastic measures and resolve to the usage of unconventional monetary policy tools. Even though short-term interest rates remained at zero, by applying unconventional monetary policy tools, the true cost of borrowing money and the benefits of saving became such as if the nominal interest rate were negative. This true cost and true measure of unconventional monetary policy can be quantified by the Wu-Xia Shadow Federal Funds Rate (Wu and Xia (2016)). While the impact of unexpected MP innovations has been extensively analyzed by the literature, the impact of unexpected changes in the unconventional MP - in the form of shadow interest rate innovations - has been largely untouched. This bachelor thesis will analyze the impact of exogenous unconventional monetary policy innovations (shocks) on economic aggregates and wealth inequality in the U.S..

Using the model introduced by Romer and Romer (2004), which estimates monetary policy shocks by purging changes of the federal fund rate of expectations in the form of Greenbook forecast data, I'm able to quantify a measure for unconventional monetary policy shock in the U.S. for the period from 2009 until 2016 by purging the change of the shadow federal funds rate of anticipatory movements and endogeneity. This yields a series of shocks which allow me to estimate their impact on economic variables using a simplified version of the aggregate effect model used in Romer and Romer (2004) and Coibion et al. (2017). I also estimate the impact of conventional monetary policy shocks. Therefore, it is possible to compare the impact of conventional and unconventional monetary policy shocks. The results show a contractionary impact of unconventional contractionary shocks on GDP, consumption, and the unemployment rate. This impact is comparable to the findings of previous literature, and my benchmark analysis of conventional shocks yields the same results. The ”price puzzle”, which was brought to light in previous research, is reinforced by my analysis of unconventional shocks, with the puzzling effect being even stronger for unconventional shocks. Further puzzles manifest themselves in the effect of unconventional contractionary shocks on industrial production, investment, and money supply. To measure impacts on inequality, I use data from the Distributional Financial Accounts (DFAs) to calculate the ratio of the top-ten's net-wealth to the bottom-ninety's net wealth. This measure will serve as my measure for wealth inequality. Analyzing the impact on wealth inequality, I find a negative impact of unconventional shocks on wealth inequality in the U.S.. This effect differs in sign from the impact of conventional shocks on wealth inequality. Based on research done by Kuhn et al. (2020), I show a heterogeneous composition of household portfolio along the wealth distribution, with the top-ten owning the majority of corporate equity and mutual funds, and the bottom-ninety owning the majority of real estate. Therefore, to explain the effect on inequality, I analyze the effect on prices which constitute a big part of household portfolios. After showing a positive relationship between wealth inequality and the ratio of share prices to house prices, I link the effect of MP shocks on inequality to the effect of MP shocks on the price ratio of these two portfolio components. I find a conflicting impact of unconventional MP shocks on the ratio of share prices to house prices. Over a period of eight quarters, unconventional shocks have an increasing effect on the price ratio. Therefore, my efforts to explain the negative impact on inequality fail. Nonetheless, the finding that unconventional contractionary shocks decrease wealth inequality is noteworthy. Conventional shocks, however, have a positive impact on the price of shares relative to the price of housing, which corresponds to the positive impact of conventional shocks on wealth inequality. By analyzing data on aggregates and inequality for the U.S., this bachelor thesis will provide a comprehensive understanding of the effects of unconventional monetary policy on key economic indicators and wealth inequality. A comparison of these effects with the effects of conventional MP shocks, will yield further policy implications regarding the implementation of unconventional monetary policy. The structure of the thesis is as follows. Section 2 addresses the difference between conventional and unconventional policy and how to measure the latter. Section 3 explains how to estimate unconventional MP shocks. Section 4 compares the impact of conventional and unconventional MP shocks on main economic aggregates and wealth inequality. Section 6 will conclude.

2 Conventional and unconventional monetary policy

Monetary policy is the process by which a central bank, such as the Federal Reserve or the European Central Bank, manages the money supply and interest rates in order to achieve certain macroeconomic goals, such as price stability, full employment, and economic growth. Central banks use a variety of tools to influence the money supply and interest rates. Most of the time, this included traditional MP tools, however, in recent past unconventional MP tools have become more widely used. First, it is important to clarify the difference between conventional and unconventional monetary policy.

2.1 The difference between conventional and unconventional monetary policy

Conventional monetary policy refers to the use of traditional policy tools, such as the setting of short-term interest rates, to influence the economy. A decrease in the interest rate will encourage borrowing and spending, which will in turn increase economic activity, while an increase in interest rate will discourage borrowing and spending, which will help to slow down an overheating economy.

Unconventional monetary policy, on the other hand, refers to the use of non-traditional policy tools by central banks in response to economic downturns or other exceptional circumstances. These tools include quantitative easing, forward guidance. The main goal of unconventional monetary policy is to stimulate economic growth and combat deflation. It is used when the traditional policy tools have reached their limits, such as when interest rates are already at or near zero. Quantitative easing is one of the most well-known unconventional monetary policy tools. It is a monetary policy in which a central bank creates new money and uses it to buy financial assets such as government bonds or other securities from banks, in order to increase the money supply and lower interest rates. This increase in the money supply can help to stimulate economic activity and boost inflation. Forward guidance is another unconventional monetary policy tool. It is a communication strategy used by central banks to influence long-term interest rates by providing information about the future path of monetary policy. This can be done by providing guidance on the future path of interest rates.

2.2 Quantification of unconventional monetary policy

The Wu and Xia (2016) shadow rate is calculated by estimating a modified Taylor rule, which relates the federal funds rate to the level of economic activity. The modified Taylor rule includes additional terms to account for the impact of unconventional monetary policy tools, such as quantitative easing and forward guidance, and the zero lower bound on nominal interest rates. Using data from the period in which unconventional monetary policy was in effect, it is possible to calculate an estimate of the federal funds rate that would be consistent with the observed level of economic activity. Therefore, it is possible to quantify the true cost of borrowing money as well as the additional monetary policy stimulus provided my unconventional monetary policy. It's important to note that the Wu and Xia (2016) shadow rate is an estimate and is subject to estimation errors.

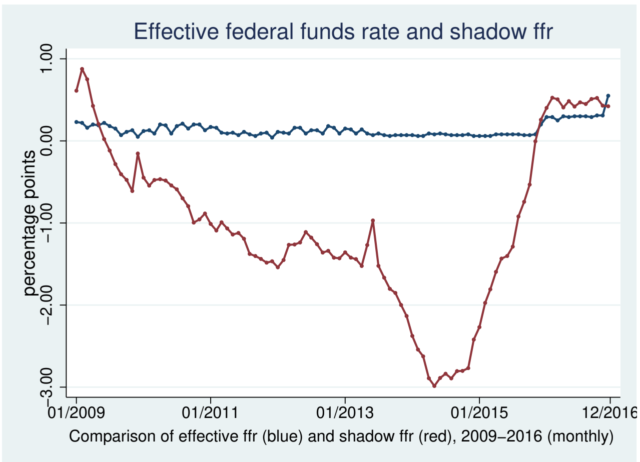

Figure 1: This figure shows the effective federal funds rate and the Wu-Xia shadow federal funds rate from 2009 until 2016 with monthly ticks.

Figure 1 illustrates the difference between the effective federal funds rate controlled by the federal reserve and the, through unconventional measures, implied shadow federal funds rate. From early 2009 until late 2015 the shadow ffr was negative and deviated from the effective ffr. From October 2010 until July 2013 the sffr was between 100 and 150 basis points below the zero lower bound. This deviation was even stronger from August 2013 until October 2015, as the sffr reached a level of minus 299 basis points in May 2014.

3 Measuring monetary policy shocks

Several problems arise when analysing of the effect of monetary policy on the economy. Endogeneity and anticipatory movements constitute the biggest obstacle as decisions regarding monetary policy are often based on the current state of the economy as well as the future outlook. Because of that, it might be difficult to separate the cause-and-effect relationship between monetary policy and the economy. This identification problem makes it difficult to distinguish the effect of monetary policy tools, such as changes in interest rates, from all other factors influencing the economy at the time. Moreover, the effects of monetary policy can take time to materialize and can vary depending on the specific policy action and the state of the economy. All these factors make it difficult to estimate the true impact of monetary policy.

There is, however, a way to isolate the exogenous part of monetary policy changes. If changes of monetary policy are defined as changes of the target federal funds rate, it is possible to purge the change of the monetary policy of endogenous components. This would yield a series of ”shocks” - unexpected changes in monetary policy. Then, instead of analyzing the impact of MP per se, an analysis of the impact of MP shocks on the economy could provide better insight into the transmission mechanism of MP and how the economy is actually affected by changes in the monetary policy. This requires an accurate identification of the shocks. Therefore, it is necessary to precisely match changes of MP, i.e changes of the target interest rate, with economic events or expectations in order to purge the interest rate changes from endogeneity and anticipatory movements. To achieve this, it is imperative to have reliable data on what expectations were like at the time changes in monetary policy occurred.

This estimation comes with model uncertainty, as there are various methods and model that estimate MP shocks and there is no consensus on the best model. Different estimates for MP shocks across model also come with different estimates for the effect of shocks. I decided to use the model established by Romer and Romer (2004).

3.1 Monetary policy shock model

Romer and Romer (2004) came up with a model which addresses the problem of endogeneity and anticipatory movements. In order to derive a new, more exogenous measure of monetary policy shocks, they use Greenbook forecasts as the set of information which constitutes the "expectations" the Federal Open Market Committee (FOMC) had at the time changes in the monetary policy were decided upon. The Federal Open Market Committee is the principal monetary policy-making body of the Federal Reserve System. They are responsible for formulating and implementing monetary policy to achieve the central bank's goals. They typically hold regular scheduled meetings, typically meeting eight times a year, twice a quarter, to review economic and financial conditions, make policy decisions, and assess the implementation of monetary policy. After each meeting, the FOMC releases a statement detailing its policy decisions and the economic outlook. The statement includes the new target range for the federal funds rate and an assessment of the economic conditions that influenced the policy decisions and any changes to the policy outlook. The Greenbook data is presented to the members of the FOMC before each of their meetings. Greenbook data typically includes the latest information on economic activity, such as GDP, employment, inflation, and monetary and financial conditions. And, very importantly, projections for economic growth, inflation, and other key economic indicators for the next several quarters. This Greenbook data plays a central role in the FOMC's decisions. As the Federal Reserve used a lot of resources to produce accurate forecasts, Romer and Romer (2004) assume the FOMC had knowledge on anticipatory movements. They control for this knowledge in the form of forecast date on changes of economic variables that impact interest rate changes when estimating measure of MP changes purged from endogeneity.

To estimate MP shocks, Romer and Romer (2004) derive a series of changes in the federal funds rate agreed upon in the FOMC meetings. They regress these actual MP innovations Δff_m on Greenbook forecast data, controlling for the forecasts of the changes of three major macroeconomic variable, which are assumed to determine the federal funds rate. The variables controlled for are the Greenbook forecast growth rate of real GDP ($F_m \Delta y_{m,i}$), the Greenbook forecast inflation rate ($F_m \pi_{m,i}$), i.e. the predicted growth rate of the GDP price deflator, and the unemployment rate ($F_m u_{m,i}$). The subscript m denotes the specific FOMC meeting. Their vector autoregressive model (VAR) includes

not only contemporaneous predictions for the economic variable, but also predictions for changes in future quarters as well as in the preceding quarter (which in some cases is the actual estimated variable), denoted by the subscript i. For all variables, they control for the forecasts for the preceding, current and following two quarters, expect for the unemployment rate, where only the prediction for the current unemployment rate is included. By regressing the series of monetary policy innovations $_m$ on these forecasts, Romer and Romer (2004) assume endogeneity to be accounted for. The residuals ϵ_m of the regression are defined by Romer and Romer (2004) as exogenous MP shocks.
To estimate unconventional MP shocks, I used the model created by RR. However, I took the series of the shadow federal funds rate innovations Δsff_m as the dependent variable. The style of the equation follows Coibion et al. (2017). Thus, I estimate equation 1:

$$\Delta sff_m = \alpha + \sum_{i=-1}^{2} \gamma_i F_m \Delta y_{m,i} + \sum_{i=-1}^{2} \lambda_i (F_m \Delta y_{m,i} - F_{m-1} \Delta y_{m,i}) + \sum_{i=-1}^{2} \varphi_i F_m \pi_{m,i} + \sum_{i=-1}^{2} \theta_i (F_m \pi_{m,i} - F_{m-1} \pi_{m,i}) + \mu F_m ue_0 + \epsilon_m \tag{1}$$

The series of residuals ϵ_m is the series of unconventional MP shocks, which will be used to estimate the impact of unconventional MP on main economic aggregates and wealth inequality in the US. It is important ti note that the series of unconventional shock is an estimation which is prone to estimation errors. Therefore, all results obtained later shall be interpreted with this notion in mind. As a benchmark for comparison, I re-estimated conventional MP shocks, now using Δff_m as the dependent variable, receiving a series of conventional MP shocks from 1969 until 2008. In Section 4 I will estimate the impact of conventional shocks next to the impact of unconventional shocks to make a comparison of the aggregate effects possible.

3.2 Conventional vs. unconventional shocks

Having estimated two series of MP shocks, conventional and unconventional, it is important to compare the size of the shocks. The unconventional shocks should be of a comparable magnitude as the conventional shocks to validate the use of the Romer-Romer model to estimate unconventional shocks. Moreover, on average, both shocks should equal zero, as a shock is by construction random. Figure 2 illustrates both shock series together with their corresponding series of MP innovations. The left graphs depicts changes in the ffr and conventional shocks from 1969 until 2008. The great moderation is observable. Starting in the mid 1980s, MP and the economy in general became less volatile, which can be seen in the graph as overall changes of MP and shocks become significantly smaller. The graph in the middle shows unconventional shocks and changes in the shadow ffr from 2009 until 2016. The different scale of the y-axis is important to note. The third graph depicts the combined series of all MP shocks. Unconventional shocks (blue) seem to be comparable in size as conventional shocks (red). On average, both shock series are close to zero.

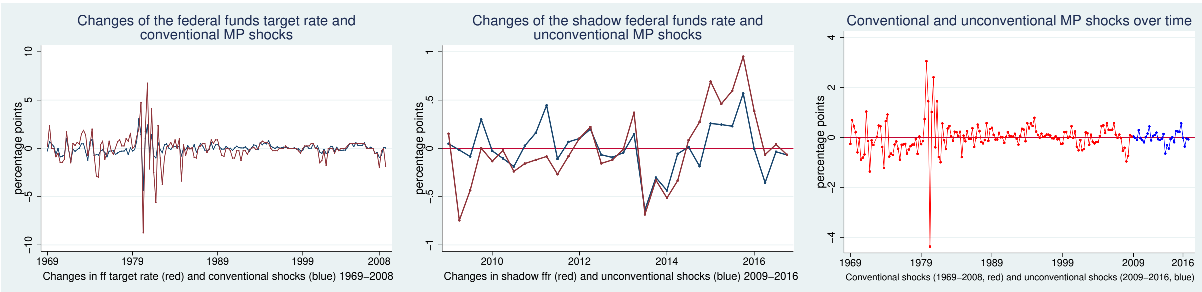

Figure 2: The left graph shows conventional MP shocks and changes in the federal funds target rate (1969-2008). The middle graph shows unconventional MP shocks and changes in the shadow federal funds rate (2009-2016). Shocks are in blue, (shadow) federal funds rate in red. The graph on the right illustrates the combined shocks series of unconventional and conventional MP shocks from 1969 to 2016. Conventional shocks in red, unconventional shocks in blue.

Figure 8 in the appendix compares the conventional shocks I estimated with the original ones estimated by Romer and Romer (2004). As they are very comparable in size and sign, I decided to use my series as a benchmark for the comparison of the effect of unconventional and conventional shocks.

The following section will analyze the aggregate impact of both series of shocks on economic aggregates and wealth inequality.

4 The impact of unconventional monetary policy shocks

After constructing two, less endogenous series of shocks - one for conventional and one for unconventional monetary shocks - it is possible to analyze the relationship between the two different kinds of shocks and the change of economic variables. A comparison of the size of the impact as well as statistical significance is now possible. To estimate the impact, I use the model created by Romer and Romer (2004). This vector autoregressive model (VAR) controls for lags of the dependent variable as well as for the dependent variable, which is the MP shock. The exact specifications of the model are discussed in the following section.

4.1 Aggregate effect model

Romer and Romer (2004) introduced a vector autoregressive model that controls for lags of the dependent variable to control for normal dynamics of the dependent variable as well as lags of the shock to estimate the direct impact of monetary policy shocks on the growth rate of economic variables. By combining elements of the original model created by Romer and Romer (2004) and the model revised by Coibion et al. (2017), I came up with the following regression model:

$$\frac{x_{t+h} - x_t}{x_t} = c^{(h)} + \sum_{j=0}^{J} \alpha_j^{(h)} \frac{\Delta x_{t-j}}{x_{t-j-1}} + \sum_{i=0}^{I} \beta_i^{(h)} e_{t-1} + \epsilon^{(h)}, \qquad h = 1, ..., H \tag{2}$$

Romer and Romer (2004) analyse monthly data and use interaction terms to estimate the overall impact of one monetary shock over the horizon H. Therefore, their estimations and equation differ from mine. The overall style of equation 2 follows Coibion et al. (2017). H is the horizon in quarters for which the impact of a monetary shock on the economic variable is analyzed. The dependent variable on the left side ($\frac{x_{t+h}-x_t}{x_t}$) is the aggregate relative change of the analysed economic variable that occurred from the base period t until the period $t+h$. Although the model looks similar to the model used by Coibion et al. (2017), they don't regress the aggregate relative change of the economic variable on lags of the variable and monetary shocks. Instead, they estimate first-differences followed by advanced econometric methods to estimate accumulated impulse response to shocks.

I decided to use a simpler regression model with a more straight-forward implementation in STATA. Using the aggregate relative change of the analysed economic variable from t until $t+h$ as the dependent variable, allows me to estimate H equations to get a overview of the aggregate relative impact of one MP shocks over the whole horizon. $\frac{\Delta x_t}{x_{t-1}}$ denotes the relative change of the economic variable x from period $t-1$ until period t and e_t denotes the MP shock in period t. The aggregate relative change of the economic variable x until the point $t+h$ in the horizon is regressed on $J+1$ lags of the relative change of the same economic variable as well as $I+1$ lags of MP shocks. Due to my data on unconventional MP shocks being limited to 32 quarters, I set $H = 8$, i.e. I analyze the impact of a monetary policy shock that occurs in the period t on the next eight periods. I set $J = 1$ and $I = 7$ to include two lags of the relative change of the economic variable and the current as well as the last seven monetary shocks. The regression coefficient I am interested in is $\beta_0^{(h)}$. This is the effect of a one-percent contractionary shock in the current period t on the aggregate relative change of the analyzed variable x from $t+1$ until $t+8$. This is followed by a joint estimation which combines the parameter estimates and (co)variance-matrices into one. This allows for intramodel and cross-model hypothesis testing. This is helpful when testing for joint-significance of the coefficients $\beta_0^{(h)}$. The p-value for this test is the probability that the impact of e_0 on all aggregate relative changes of the economic variable across the horizon is not significant. Therefore, if this null is rejected, we can observe a significant positive or negative aggregate impact of monetary shocks. By plotting $H = 8$ coefficients $\beta_0^{(h)}$ and each coefficient's confidence intervals, I obtain an aggregate effect path.

I will use the above-mentioned model specification in the analysis of unconventional and conventional shocks. As my aim is to compare the parameters and significance of unconventional shocks with those of conventional shocks, it is necessary to use the same model specifications to make a comparison viable. In doing so, my results regarding the impact of conventional shocks will naturally differ from the results obtained by Coibion et al. (2017) as a smaller horizon is observed. As they only analyse the impact of conventional shocks, for which a much bigger set of historical data is available, they control for 20 lags of monetary shocks and estimate across a horizon of 20 quarters. This, naturally, yields a different estimate of the overall impact over a period of 20 quarters.

4.2 The effect of unconventional monetary policy shocks on main economic aggregates

First, I analyze the impact of unconventional and conventional shocks on main economic aggregates. This includes GDP, consumption and the unemployment rate. Furthermore, I analyze the impact on inflation, industrial production, investment and money supply. It is important to analyze the effect of conventional and unconventional shocks. Generally, it is agreed upon that conventional contractionary MP has a dampening effect on the economy, and vice versa for expansionary MP. If similar results are obtained for unconventional contractionary shocks, this implies similar policy implications for the two different kinds of MP.

4.2.1 The effect on gdp, consumption and unemployment

The relationship between a one-percent contractionary MP shocks and GDP, consumption and the unemployment rate is displayed in Figure 3. The results for conventional and unconventional contractionary shocks are to be compared.

Looking at the third column, there seems to be a contractionary impact of contractionary unconventional MP shocks on the economy. GDP and consumption decrease significantly following an unconventional shock, while unemployment rises significantly. The maximum effect on GDP is reached six quarters after a one-percent contractionary shock, decreasing by about 1.2 percent. This relationship seems to be highly significant. Compared to the effect of conventional shocks, which lower GDP by about 0.6 percent after eight quarters, GDP seems to decrease to a higher, more significant degree following unconventional shocks. However, if the data on conventional shocks is limited to the period before 2001, a very similar impact of conventional shocks on GDP, decreasing by about 1.3 percent after eight quarters, can be observed. Consumption decreases by about 3.2 percent after eight quarters following a one-percent unconventional shock, although the effect seems to become less significant as time goes on. This effect is higher compared to the effect following conventional shocks, after which consumption drops significantly by 1 percent eight quarters. Again, limiting the data to the period before 2001 yields more significant and bigger effects of conventional shocks on consumption, lowering consumption by about 1.7 percent after eight quarters. The unemployment rate seems to significantly rise by 0.55 percent eight quarters after a unconventional shock, although,

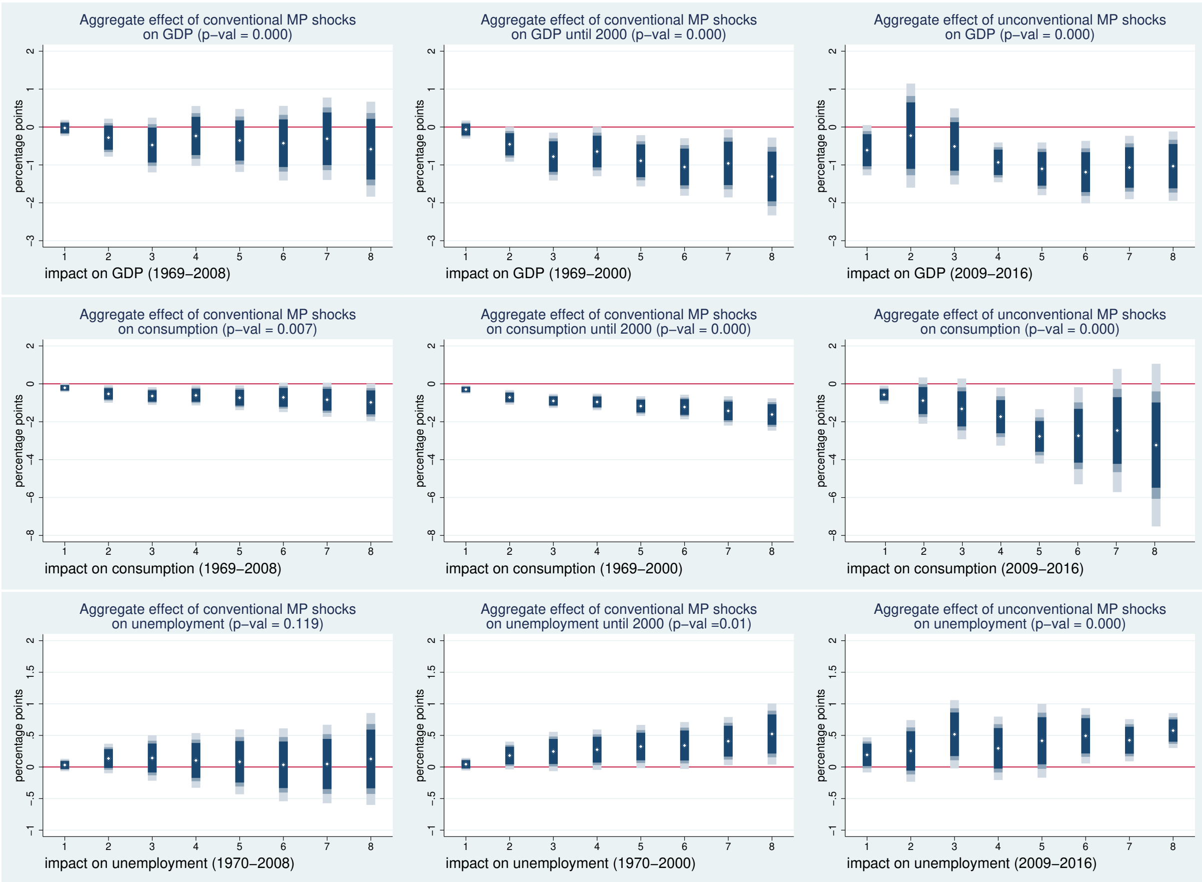

Figure 3: This figure shows the impact and significance of a one-percent contractionary MP shock on GDP (first row), consumption (second row) and the unemployment rate (third row). The first column shows the impact following a conventional shock until 2008, the second column following a conventional shock until 2000 and the third column following an unconventional shock from 2009-2016. The aggregate relative change is shown for eight quarters after the shock occurred. The confidence intervals are 0.99, 0.95 and 0.9 respectively. P-values are for the null-hypotheses that the aggregate effect at every point on the horizon is zero.

a similar, less significant increase of 0.5 percent can already be observed three quarters after the shock. Conventional shocks, on the other hand, seem to not have a significant impact on the unemployment rate. This, however, is counter-intuitive and does not correspond with previous findings, such as in Miranda-Agrippino and Ricco (2021) and **?**. Looking at the restricted aggregate effect before 2001, there is a significant increase of the unemployment rate by about 0.5 percent after eight quarters after a one-percent conventional contractionary shock. This means the impact of a conventional shock (before 2001) very comparable to the impact of unconventional shocks. Different results due to limiting the date to the period before 2001 might be explained by unusual circumstances in the early 2000s, therefore, excluding this period yields more significant results for the impact on GDP, consumption and unemployment. More research has to be put into the exact reason why this is the case. For all regressions - except for the impact on unemployment following conventional shocks (until 2008) - the null-hypothesis that the aggregate effect following the shock is zero, can be rejected.

4.2.2 Puzzling effects on inflation, industrial production, investment and money supply

This section will analyze the aggregate impact of unconventional shocks on inflation, industrial production, investment and money. Figure 4 compares the impact of a conventional and unconventional one-percent contractionary shock.

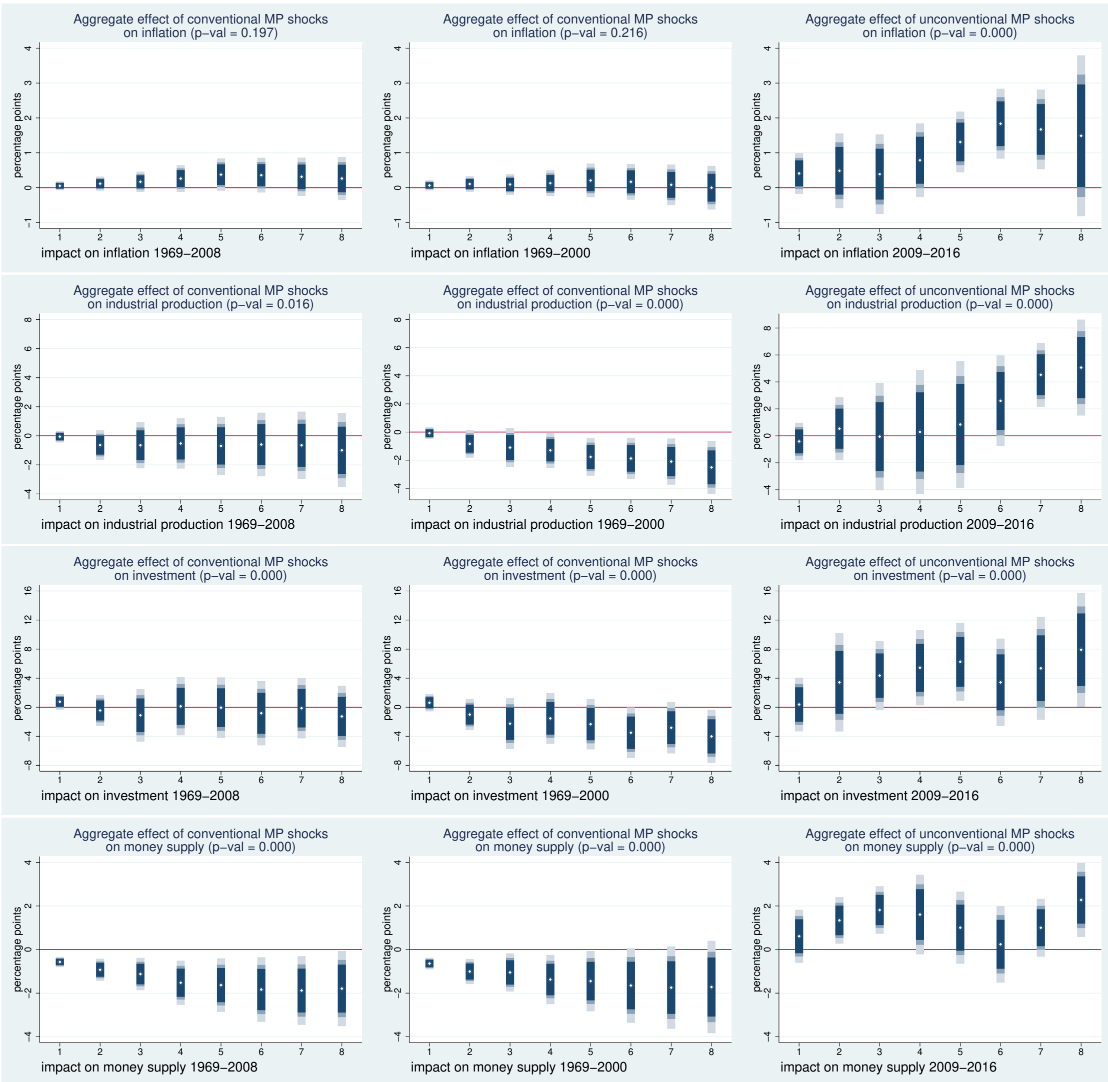

Figure 4: This figure displays the impact and significance of a one-percent contractionary monetary shock on inflation (first row), industrial production (second row), investment (third row) and money supply (fourth row). The impact of a conventional shock until 2008 (first column), of a conventional shock until 2000 (second column) of a unconventional shock from 2009-2016 (third column) is shown. Aggregate impact is shown for eight quarters after the shock. Confidence intervals are 0.99, 0.95 and 0.9. P-values for the null-hypotheses that the aggregate effect at every point on the horizon is zero.

The third column shows the impact of an unconventional shock. There seem to be puzzling effects for all variables. The impact on inflation amounts to an increase of prices by about 1.8 percent after six quarters. Comparing this result to the impact of conventional shocks on inflation, shows a similar puzzle following conventional shocks, however, is less significant for conventional shocks. Following convectional shock, prices increase by about 0.4 percent after five quarters. The effect of conventional shocks is smaller when limiting the analysis to the period before 2001, increasing inflation by about 0.25 percent after five quarters. It is important to not that the aggregate effect of conventional shocks is insignificant, whereas the aggregate impact of unconventional shocks is significant. It is interesting to observe a ”prize puzzle”, which is even stronger for unconventional than for conventional shocks. A puzzle exists because contractionary shocks should lower inflation due to lowering demand and, thus, decreasing prices. This ”price puzzle” was first documented by Sims (1992) and later affirmed and challenged by - among others - Barakchian and Crowe (2013) and Christiano et al. (1999). Interestingly, the paper which constitutes a benchmark for my analysis, Romer and Romer (2004), although creating a less endogenous measure for shocks and controlling for commodity prices (which seems to mitigate the price puzzle), still finds a price puzzle. The ”price puzzle” attracts a lot of research, and an even stronger puzzle for unconventional MP has to be analyzed further. The effects of a conventional MP shock on industrial production, investment and money supply seem intuitive. For all three variables, there is a significant decrease after a conventional shock, which corresponds to the expected effect of contractionary MP. Industrial production increases by about 0.9 percent after eight quarters, with there being a significant aggregate effect over the horizon H. The aggregate effect of conventional shocks on investment is also puzzling, as we would expect a negative relationship. Although the null-hypothesis that there is no significant effect over the horizon H can be rejected, the aggregate effects are small and individually not significant. The maximum impact amounts to a not individually significant aggregate decrease of about 1.2 percent after eight quarters. Following a conventional shock, money supply significantly decreases. The aggregate effect amounts to a decrease of about 1.9 percent after seven quarters. The aggregate effect over the whole horizon is highly significant. This reaction of the money supply to a contractionary shock is no surprise, as an increase in short-term interest rates leads to a decrease in spending by discouraging borrowing and encouraging saving, as the opportunity cost of holding money increases. Therefore, the money supply decreases. Limiting the analysis of conventional shocks to the period before 2001, industrial production decreases by about 2.6 percent after eight quarters. The null-hypothesis that the effect is zero for the whole horizon can be rejected. This is comparable to the effect found by Romer and Romer (2004). They estimate a response to a 100-basis-points contractionary shock of 2-3 percentage points. Moreover, Coibion (2012) finds that omitting monetary policy shocks from the Volcker-period significantly decreases the negative impact on industrial production following conventional Romer-Romer shocks. Moreover, the negative effect of conventional contractionary shocks on investment becomes stronger and more significant, lowering investment by about 4 percent after eight quarters. The effect on money supply doesn't change by limiting the time period; the significance even becomes slightly lower. Now, having discussed the benchmark results of conventional shocks, the impact of unconventional shocks on industrial production, investment and money supply seem puzzling. Industrial production seems to stagnate for the first five quarters following a shock, followed by an significant increase of about 5 percent after eight quarters. Investment also seems to increase following unconventional shocks, with the maximum increase of 8 percent being reached after eight quarters. Money supply increases by about 2.2 percent after eight quarters. This effect is similar to the effect of conventional shocks on money supply, however, with a different sign. The aggregate effects of a one-percent unconventional contractionary MP shocks on industrial production, investment and money supply are all highly significant. A puzzle, with effects having the opposite sign compared to the effect of conventional shocks, seems to exist.

4.3 The effect of unconventional monetary policy shocks on inequality

In this section i will analyze the impact of unconventional MP shocks on wealth inequality in the US and try to establish a link of the results to the ratio of share prices to house prices. To determine a measure for inequality, I used data from the Distributional Financial Accounts (DFAs), which is a set of statistics that provides a comprehensive picture of the wealth distribution across wealth and income classes in the US. This data includes information on household wealth and the distribution of wealth across different groups of households. I decided to look at the distribution of net wealth across wealth percentiles. By modifying the data I obtained the share the top-ten and top-ninety of the wealth distribution have in net-wealth. I took the ratio of the top-ten's net wealth to the bottom-ninety's net wealth as a measure for wealth inequality. Henceforth, this measure will be called the "10/90 measure (of inequality)".

4.3.1 The effect on the 90/10 wealth distribution measure

Figure 5 displays the aggregate effect of conventional and unconventional contractionary MP shocks on wealth inequality (in the form of the 10/90 measure).

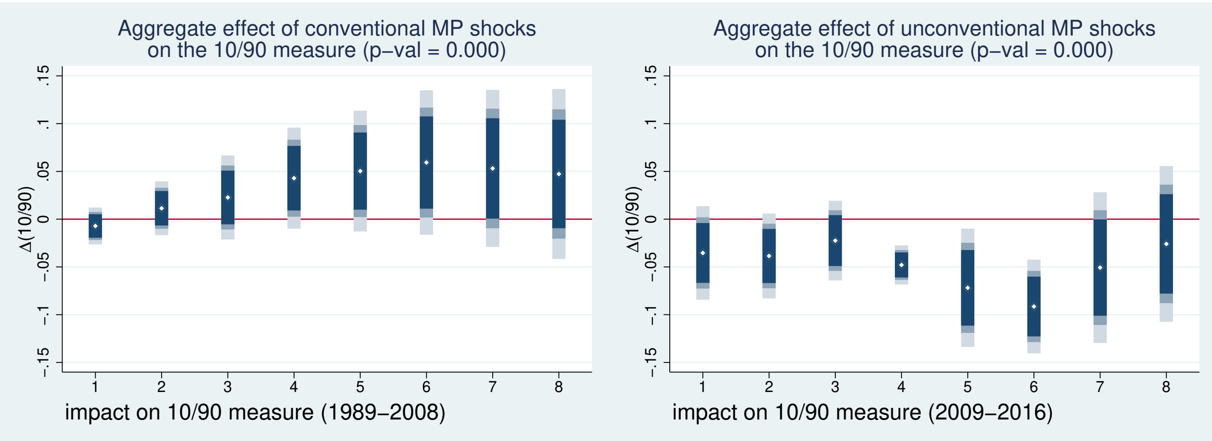

Figure 5: This figure illustrates the impact and significance of a one-percent contractionary monetary shock on the 10/90 wealth inequality measure. The impact of a conventional shock from 1989 until 2008 is shown in the left graph, while the impact of an unconventional shock from 2009-2016 is shown in the right graph. The aggregate impact is shown for eight quarters after the shock. Confidence intervals are 0.99, 0.95 and 0.9 respectively. P-values for the null-hypotheses that the aggregate effect at every point on the horizon is zero for conventional and unconventional shocks.

The left graph shows a positive impact of a one-percent conventional contractionary shock on the 10/90 measure. This means wealth inequality increases. The maximum effect of a 0.06 increase of the 10/90 measure is reached six quarters after the shock. In other words, six quarters after a one-percent conventional contractionary shock, the ratio between the top-ten's and the bottom ninety's wealth increases by 0.06. This impact is significant and the p-value of the null that the aggregate effect is zero for all points on the horizon quals 0.000. This corresponds well with other findings, such as the extensive analysis of the relationship between monetary policy and inequality undertaken by Coibion et al. (2017). They find a positive impact of conventional contractionary MP shocks on income-, earnings-, expenditure- and consumption-inequality. Although they don't specifically analyze the effect on wealth inequality, a similar relationship between conventional shocks and wealth inequality doesn't seem surprising. Looking at the results following an unconventional contractionary shock, however, a decrease of inequality can be seen. The 10/90 measure decreases by a maximum of 0.09 six quarters after the shock. This decrease is highly significant. In the following two quarters, the effect becomes smaller and less significant. In other words, an unconventional expansionary one-percent MP shock seems to increase wealth inequality by 0.09. This means the effect of unconventional shocks is bigger and has the opposite sign compared to the effect of conventional MP socks.

4.3.2 Possible link to the ration of share-to-house prices

The finding of the previous section, that conventional shocks increase and unconventional shocks decrease wealth inequality, is very noteworthy and I will further analyze this relationship. Previous research, such as by Kuhn et al. (2020) has created a link between wealth inequality in the US and the heterogeneity of household portfolios. Due to the composition of household portfolios varying along the wealth distribution, they create a link to price-developments of certain portfolio components. Mainly, they focus on asset and house prices - asset prices because rich households tend to own relatively more equity, house prices as the middle class tends to own housing. I will base my analysis on these findings. First, to confirm the link between wealth inequality and the relationship between equity and house prices, I created a measure which sets the share prices of all shares in the US into relation with house prices. The first graph in Figure 6 shows the relationship between this newly created measure "share/house" and the measure for inequality "10/90".

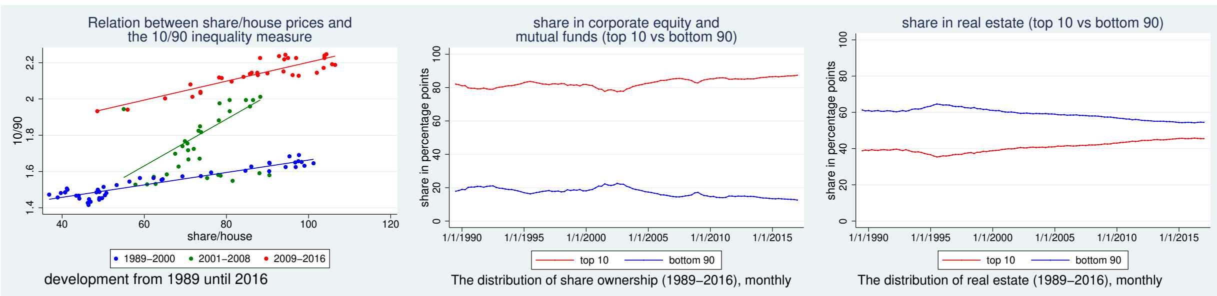

Figure 6: The graph on the left shows the relationship between the ratio of share to house prices with wealth inequality in the form of the 10/90 measure. Colors represent different periods. The middle and right graph show the development of the top-ten's (red line) and bottom-ninety's (blue line) share in corporate equity and mutual funds (middle plot) as well as in real estate ownership (right plot). The development is shown for the period from 1989-2016.

The relationship is split into three periods, with the first one (blue) showing the relationship of the two measures from 1989 until 2000, the second one (green) from 2001 until 2008, and the third one (red) from 2009 until 2016. A positive relationship can be observed. A higher ratio of share-prices to house prices correlates with a higher wealth inequality in the form of a higher 10/90 measure. For all three periods, the slope of the line fitted through the data is positive. The slopes of the blue and red lines are similar, which means that for those periods an increase in the price ratio was connected to a similar increase in the inequality measure. However, the slope of the green line is notably higher, which means for that time the increase in inequality was stronger compared to the increase in the price ratio. It is important to note that the green fitted line does not take into account the observations in 2001 and 2002. I did this to emphasize higher slope for the period from 2003 until 2008. It can be seen that in times of major financial turmoil, such as in 2007-2008 and 2000-2001 the ratio of share to house prices and, possibly because of that, wealth inequality decreases. Now that a positive relationship of the prices of these two household portfolio components was established, I want to confirm the findings by Kuhn et al. (2020) regarding the components of household components. Using the Fed's data from the Distributional Financial Accounts, I analyze the ratio of shares and real estate owned by the top-ten and bottom-ninety of the wealth distribution. The graph in the middle of Figure 6 depicts the top-ten's (red) as well as bottom-ninety's (blue) share in corporate equity and mutual funds ownership. The distributions seems pretty clear, with the top-ten owning the clear majority of shares. In 1989 the top-ten owned 82.1 percent of shares. Until 2016 this percentage increased to 87.1 percent. The distribution of real estate ownership (depicted in the right graph), however, reveals a more balanced distribution. Although the bottom-ninety own a bigger share in real estate, the difference in shares is smaller compared to share ownership. In 1989 the bottom-ninety owned 61.3 percent of real estate while owning 54.6 percent in 2016. Moreover, the bottom-ninety's share in real estate decreased stronger than their share in corporate equity and mutual funds. I established a positive relationship between the ratio of shares prices to real estate prices with wealth inequality in the US. This finding is linked to the distribution of share and real estate ownership. Next, to explain the negative impact of unconventional contractionary MP shocks on wealth inequality, I will analyze the impact of unconventional MP shocks on the share to house price ratio. If unconventional shocks decrease the share/house ratio, and this decrease is usually associated with falling inequality (Figure 6), the sign of the relationship between unconventional shocks and inequality estimated earlier (Figure 5) becomes clearer.

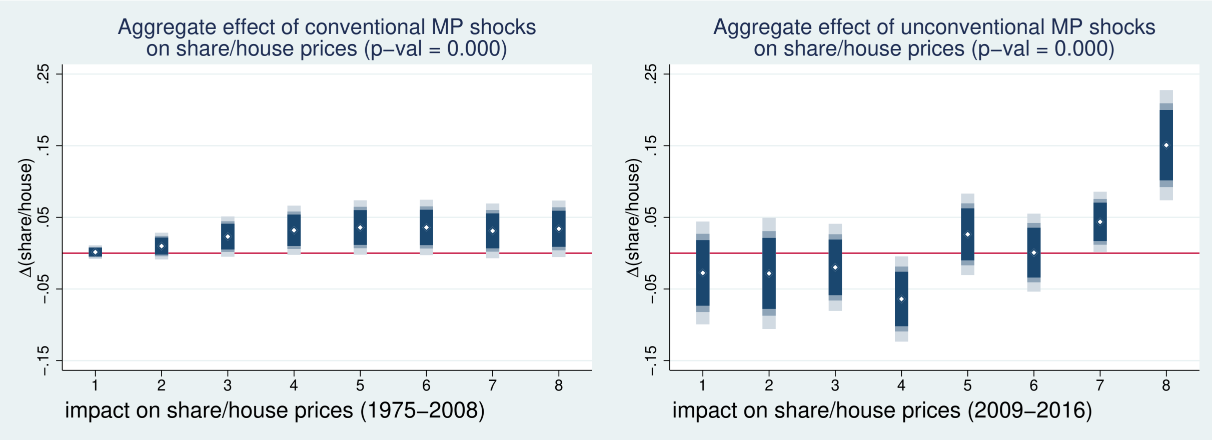

Figure 7: This figure compares the aggregate impact and significance on MP shocks on the ration of share to house prices. The impact of a one-percent conventional contractionary shock (left) is shown for the period from 1975-2008. The impact of an unconventional contractionary shock (right) is show for the period from 2009-2016. The aggregate impact is shown for eight quarters after the shock. Confidence intervals are 0.99, 0.95 and 0.9. P-values for the null-hypotheses that the aggregate effect at every point on the horizon is zero for conventional and unconventional shocks.

Figure 7 depicts the impact a one-percent contractionary MP shock has on the share/house ratio. The impact of conventional shocks is estimated for the period from 1975 until 2008. A one-percent conventional contractionary shock significantly increases the share/house ration by 0.04 after five quarters. This finding corresponds to the increase in inequality following conventional shocks estimated earlier. A one-percent unconventional contractionary shock decreases the price ratio by 0.07 after four quarters, however, the ratio increases in the following quarters and after eight quarters the aggregate change of the price ratio is an increase of 0.15. This result is difficult to link with the results obtained in Figure 5. Figure 5 depicts a decrease of inequality until six quarters after the shock, followed by a reduction of the the aggregate effect until the end of the horizon, when the aggregate effect is still negative. Comparing these two results, it is not possible to explain the decreasing effect of unconventional shocks on inequality. Although a logical framework exists, it is difficult to obtain certain explanations, as to why unconventional shocks decrease wealth inequality. Data limitations regarding unconventional MP shocks makes an analysis even more difficult.

5 Previous findings regarding the impact of unconventional monetary policy

6 Conclusion

This bachelor thesis managed to make the impact of unconventional monetary policy on the economy clearer. Using the model introduced by Romer and Romer (2004), I created as series of shadow federal funds rate innovations purged of anticipatory movements in the form of FOMC Greenbook forecasts. Therefore, as a result, I received an exogenous series of shocks which allowed me to analyze the impact of unconventional MP shocks on main economic aggregates and wealth inequality in the U.S.. By implementing a simplified version of the vector autoregressive model developed by Romer and Romer (2004) and Coibion et al. (2017), the impact of unconventional shocks on main economic aggregates, such as GDP, unemployment rate and consumption, inflation, industrial production, investment and money supply, as well as the 90/10 inequality measure could be estimated. The analysis showed a clear contractionary impact of unconventional contractionary shocks on GDP, consumption, and the unemployment rate. The results are similar to the effect of conventional shocks, with the effect on consumption being significantly bigger for unconventional shocks. Interestingly, limiting the data on conventional shocks to the period before 2001 makes the impact of conventional shocks more significant. Puzzling effects were found regarding the impact on inflation, industrial production, investment, and money supply. Like in previous literature, a ”price puzzle” seems to exist for unconventional and conventional MP shocks. Unconventional contractionary shocks seem to decrease wealth inequality in the U.S., measured by the ratio of the top-ten-percent's wealth to the bottom-ninety-percent's wealth. This is the opposite of the effect found following conventional contractionary shocks. I tried to link the decreasing effect on inequality to the effect on the ratio of share to house prices, taking heterogeneous household portfolios, as in Kuhn et al. (2020) into account. However, the impact on the price ratio doesn't seem to explain the relationship between unconventional shocks and inequality. Nonetheless, my finding regarding the impact of unconventional MP shocks on economic aggregates and wealth inequality sheds new light on policy implications regarding the implementation of unconventional MP measures. A contractionary effect of unconventional contractionary shocks on the economy was to be expected. However, my findings regarding the effect on inequality, and those findings being different from those regarding conventional MP shocks, imply the necessity of additional considerations when deciding on the implementation of unconventional monetary policy tools.

A Appendix

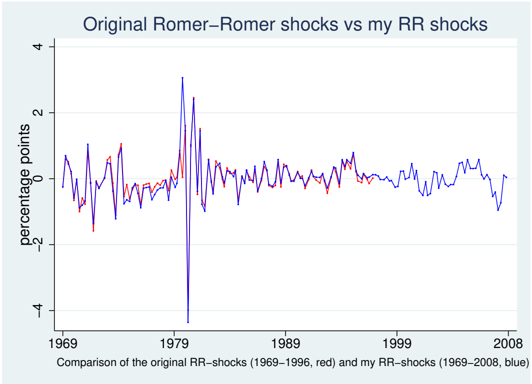

Figure 8: This figure shows the original RR shocks (red) calculated by Romer and Romer (2004) for 1969-1996 and the conventional MP shocks I created (blue) using the RR-model for 1969-2008.

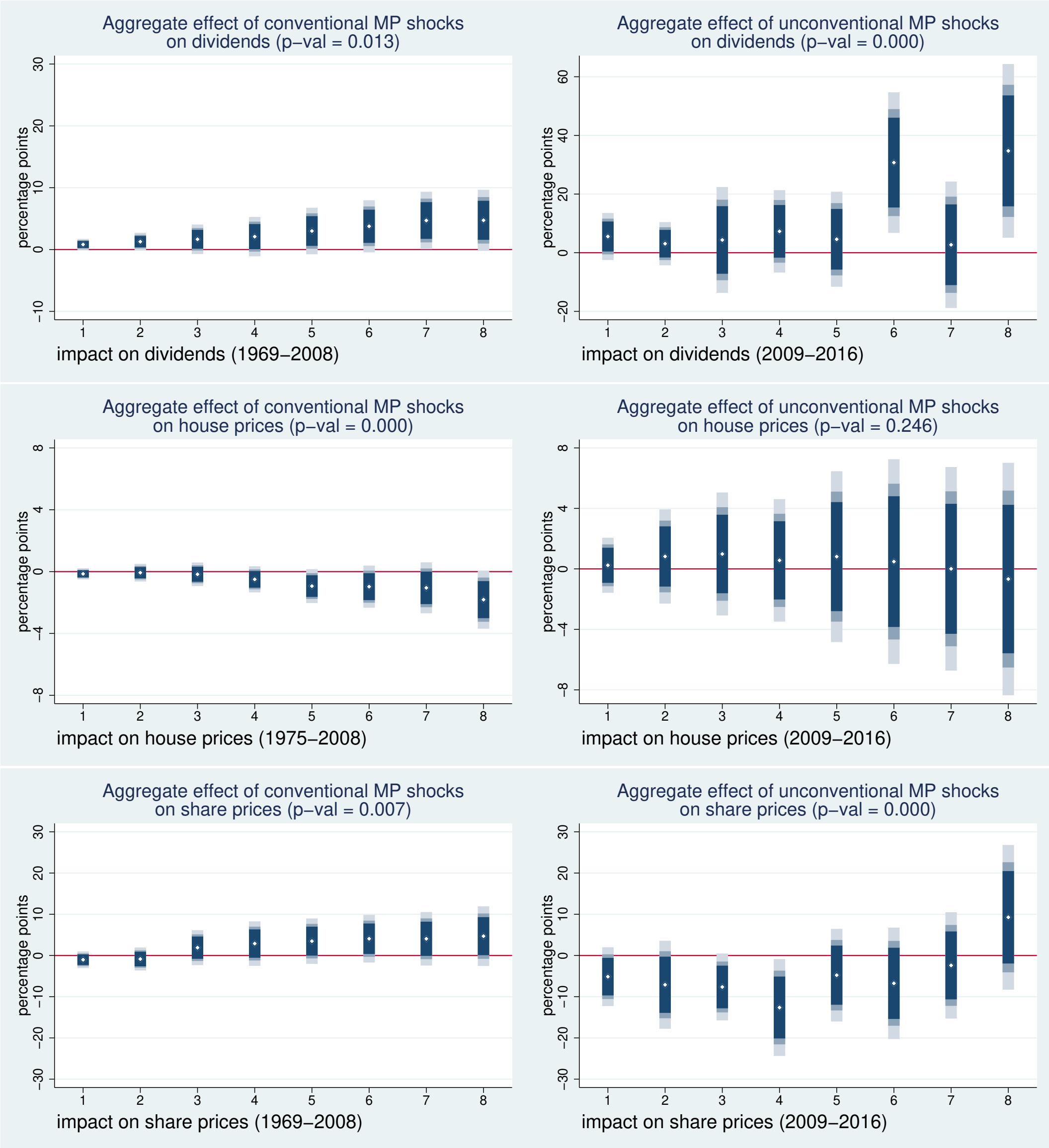

Figure 9: This figure shows the impact and significance of conventional contractionary MP shocks (left column) and unconventional shocks (right column) on dividends (first row), house prices (second row) and share prices (third row) in the US. The graphs on the left side show the effect for the period from 1969-2008, and the graph on the right side for 2009-2016. Confidence intervals levels are 0.99, 0.95 and 0.9.

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