Master Thesis

Interest rates changes and QE compared

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Abstract

This paper attempts to investigate if unconventional monetary policies such as quantitative easing are comparable in effect to conventional interest rate changes. The paper will look at if the policy of quantitative easing is more in line with the assumptions of the mainstream school of economic ideas or Post-Keynesian endogenous money theory on money creation. It will do this based on first looking at the relationship and impacts of the various policy tools on the M2 money supply and use that to show the effect of those tools on other economic factors for the same relationship with the money supply. The results of the models support the ideas that quantitative easing has had a significant relationship with the broad money supply and a roughly comparable effect to conventional monetary policy on relevant economic factors.

1. Introduction

Unconventional monetary policy and quantitative easing has been a central aspect of recent economic policy and has been the subject of much debate. Its use in the two most recent major economic crises: The Great Financial crisis of the late 2000s and the covid 19 pandemic crisis has many supporters and critics. Proponents of the use of such monetary policy implements say that it can and has been a way to conduct expansionary monetary policy in times of need and where traditional policies were not available. Critics often claim that the policies have had only limited effect and that those effects were or would be outweighed by negative side effects. With this debate ongoing some have looked into using these new policies to expand the goals of the central banks and monetary policy to use them to deal with issues such as inequality and green transition.

The goal of this paper will be to first investigate the extent that unconventional monetary policy and quantitative easing in particular has been useful in affecting economic factors often targeted by conventional monetary policy. Secondly this paper will explore the different proposals for use of unconventional monetary policy tools to affect factors that are not traditionally considered when conducting monetary policy.

1.1. Problem Formulation

In order to investigate this subject this paper sets out to answer the following questions with the first question being the main one.

- **Can unconventional monetary policies and quantitative easing in particular be useful as monetary policies?**

- What is unconventional monetary policy and quantitative easing?

- Can quantitative easing affect the money supply?

- Are the effects of unconventional monetary policies different from conventional monetary policy?

- Can unconventional monetary policy be used for unconventional goals?

2. Theory

This section will give an overview of the general workings of conventional and unconventional monetary policy. This will be done through first an exploration of the history of monetary policy and the context in which quantitative easing and other unconventional monetary policies were implemented. The section will go through the differences in ideas on the function and effectiveness of conventional and unconventional monetary policy through the perspectives of the mainstream school of economics and the Post-Keynesian school of economics with a focus on the ideas of endogenous money theory. This exploration will serve as the foundation to create hypotheses for the results of the models and will be used to identify what factors to include in the models.

This paper is obviously not the first or only attempt to investigate what effects the various unconventional monetary policies have had on the various economies they have been used in. As such this paper will use several previous papers to create a foundation for its analysis. First it uses several papers to establish a theoretical understanding of the function of monetary policy in general and of unconventional policies in particular. The paper "Unconventional monetary policy tools: a cross-country analysis" which is a collaboration between the ECB and the federal reserve is used to base an understanding of the mechanisms and underlying logic of the unconventional policies. As well as understanding of the use of conventional monetary policy tools.

Second, this paper will look at critiques from different schools of economics with a focus on the Post-Keynesian school for quantitative easing and asset purchase programs in general úsing endogenous money theory . This will be based on the papers of "Endogenous Money: What it is and Why it Matters", "Financial effects of QE and conventional monetary policy compared" and "Advances in the Post-Keynesian Analysis of Money and Finance" These papers will serve as the starting point for investigating the potential differences between the different policies and form the basis for the discussion.

Third, this paper will use papers that have attempted to measure the effect of asset purchase programs and other policies to serve as inspiration and a basis for the creation of models and their datasets.

2.1. What is monetary policy

Monetary policy is a wide term that over time has included many different policies and institutions but are centered on the idea of influencing the supply of money. In earlier centuries it would mainly be about the mint and the metal purity of physical money or about the strict convertibility into gold under the gold standard. In more recent times monetary policy refers to the actions of central banks in their respective countries and their attempts to influence the money supply and the rest of the economy. This is usually done through the setting of the short term interest rate. This is conventional monetary policy. However even more recently a new set of tools has been used by various central banks which are referred to as unconventional monetary policies.

2.2. What are the goals of monetary policy

There is technically no inherent goal for monetary policy. Each country and their central banks are capable of defining and changing their goal as they wish and at any time. But generally the goals of most central banks are to first keep inflation low and steady, usually around 2% annually. Second, there is often a goal of maintaining some kind of positive growth or employment measure at a certain level for the US this is known as the federal reserve's "dual mandate". This part can be significantly different from country to country. Third, is to prevent overheating of the economy, or in other words keeping the output gap around 0 to flatten the business cycle by conducting counter cyclical policy. This is usually accomplished through the targeting of the inflation rate and the output measures. Monetary policy goals are however not limited to output and inflation as various countries at various times have proposed or conducted monetary policy with different goals. The most obvious other goal is the exchange rate which can be incredibly important for countries that either import most of their goods or countries seeking to keep export businesses competitive. In recent times other goals have been proposed such as green monetary policy which would aim to use monetary policy tools to enable a green transition to counter climate change or qe for the people which would serve as a direct economic stimulus and counter inequality.

2.3. What is conventional monetary policy

Conventional monetary policy is conducted by the central bank primarily through the changing of the short term interest rate of the country. For the US this is often represented through the federal funds rate. The idea is that changes in the short term interest rate can have effects on the economy through various different channels which will over time have certain predictable effects on the economy. The short term interest rate is primarily changed through shifting the supply of reserves which will bring the effective short term interest rate closer to the announced interest rate the central bank will target. The channels through which the change in the interest rate affects the economy comes through effects on the financial sector which will make borrowing cheaper if the interest rate goes down or more expensive if the rate goes up. This then also affects the prices and yields of longer maturity bonds and they become more attractive to invest in compared to shorter interest bonds.This will then filter though into changes in aggregate demand as people and businesses borrow more or less which ultimately channels into output and inflation. (Bank for International Settlements, 2019).

Another aspect and channel which the interest rate affects the economy is the expectations of the future interest rate changes or levels. The channels of effects through the cost of borrowing would affect the economy even if done randomly but the central bank does not conduct its policy randomly. (Bank for International Settlements, 2019). The behavior of the central banks are telegraphed and communicated to a point that much of it is assumed as a truism. There is a widespread belief that the central bank will in times of high inflation always increase the interest rate. And also that it will always lower the interest rate should output have a negative shock. These expectations allow financial actors to price in future interest rate changes and make their choices less dependent on panic. These expectations are built on decades of observations of central bank behavior (and can differ from country to country) and can be changed if the central bank loses credibility.

2.4. What is unconventional monetary policy

Unconventional monetary policy is a broad category. At its most extreme it can encompass all statements and actions that a central bank does that is not changing the interest rate. This could include such policies as the Turkish central bank lowering interest rates in the early 2020s with the stated goal of lowering the inflation rate. It also could include some of the policies implemented by the Argentinian government under Millei such as mass devaluation and a goal of dollarisation. These policies and others that are not considered conventional are interesting to look at and their effects definitely worth studying. However they are not what this paper is interested in. Unconventional monetary policy in this context refers generally (and does in this paper) to a set of policies that for the most part began to be introduced by central banks in the 2000s usually in response to the Great Financial crisis of the late 2000s and its fallout over the following years. These policies are the policies which effects were analysed by the "CGFS Papers" "Unconventional monetary policy tools: a cross-country analysis" negative interest rates, lending operations, asset purchase programs and Forward guidance. (Bank for International Settlements, 2019).
The policies are generally all a different way of trying to stimulate the economy through increasing liquidity and raising demand. Generally these policies have not been widely used when there is the option to lower the interest rate (if the interest rate is positive and not near 0) There are several different policies in this definition that could be considered to be unconventional monetary policy, but the main one and the one that will be studied in this paper are Asset purchase programs also known as quantitative easing

2.4.1. Asset purchase programs (Quantitative easing)

Asset purchase programs also widely known as the name given to the program given by the United States federal reserve of Quantitative easing is the practice of the central bank purchasing assets from the market. These assets are usually government bonds but can also include stocks and other investments. (Bank for International Settlements, 2019). While the purchase of government bonds by central banks is normal and common and has been for a long time as it can smooth the financial aspect of the state taking loans, these purchases are different from asset purchase programs. In asset purchase programs the quantity of the purchased bonds is significantly higher as the intention is not to fund the government, but to stimulate the economy (Bank for International Settlements, 2019). The range of assets are much wider with the bonds purchased being able to be longer term bonds and even other

investments such as private bonds and stocks. Also in asset purchase programs the central bank can buy these assets from private holders rather than from the government. (Bank for International Settlements, 2019).

The goal of asset purchase programs is to stimulate the economy by increasing liquidity in the economy. As the assets are held by private holders either individuals or organizations they will receive liquid money instead of their illiquid assets while at the same time the interest rate of those assets will be reduced as their prices are increased by the increased demand. (Bank for International Settlements, 2019). This theoretically will have a similar effect as conventional lowering of the interest rate and lead to, all else being equal, an increase in the aggregate demand and hopefully a larger output. In certain types of financial crises that can be described as crises of confidence this increase in liquidity can also have an effect on the credibility of financial institutions thus making them less likely to collapse and reducing spending and investing hesitancy. This is however a secondary effect as there is another unconventional monetary policy more designed to do this called lending operations which involve direct loans to financial institutions.

There is a contractionary monetary policy equivalent of asset purchase programs. There is not really a generic term for reverse asset purchase programs other than quantitative tightening so it will be referred to as such. This policy is the opposite of asset purchase programs and requires that asset purchase programs have been used previously as it is just the selling of the assets acquired by the central bank in previous asset purchase programs. The reasoning of its effect is much the same as with asset purchasing. The selling of the central bank held assets will in theory lead to a lowering of prices of those assets thus increasing the interest rate of those assets leading to an overall lowering of liquidity and reducing demand and subsequently output. (Bank for International Settlements, 2019). The money gained by the central bank is effectively destroyed and removed from the economy thus lowering the money supply.

2.4.1. Zero lower bound

Within the framework of conventional monetary policy there is an idea of the zero lower bound which would make changes in the interest rate to or below have no or very little effect on the economy. The idea of the zero lower bound is the idea that if the interest rate should go below 0% and become negative then people will exercise their option to convert all their assets and accounts into cash which would completely isolate them from any effects of the negative interest. (Bank for International Settlements, 2019). The fact that several economies including the EU and Denmark had for a significant time negative interest rates and there was not a great conversion into cash (at least not a total conversion) suggests that the idea of interest rates having no effect below 0% is not true. It could still be true that there is some lower bound in the interest rate and that people would just be willing to deal with some loss to avoid dealing with withdrawing all assets to cash. Where this lower bound is not certain except that it probably cannot be below negative one hundred percent where you would lose more than was put in which seems impossible.

2.5. Other forms of unconventional monetary policy

There are many other policies that can be considered unconventional monetary policies. While they will not be analysed in this paper it can still be a good idea to go through them to compare them to the main policies and the conventional policies. This will allow discussion on the use of unconventional monetary policy for goals other than the standard goals of central banks and illustrate the wide array of possible policy implements.

2.5.1 Negative interest rates

The policy of negative interest rate involves, like the name implies, a policy where the interest rate is set at a point where there is a negative return on investment. While changes in the interest rate is what is considered conventional monetary policy, negative interest rates have historically not been attempted and 0% has for the most part been considered the lowest possible interest rate set by the central bank. Negative interest rates would encompass a negative return on investments for short term bonds and therefore for the average person having money in their bank account. The goal of such a policy is then to increase the demand of people by disincentivizing them from saving money and instead incentivising them to spend money thus stimulating the economy (Bank for International Settlements, 2019). A negative interest rate has been tried in some countries and its potential effects are fascinating

to think about. However, for reasons explained later, this paper is mostly interested in the effects of policies used in the United States and since the United States never implemented a negative interest rate its effects cannot be included in any way.

2.5.2. Lending operations

Lending operations or the lending of money to institutions by the central bank are not new nor unconventional as they have been used for a long time. The reason they have been included in the category of unconventional monetary policies are the extent and scope that they have been used since the Great Financial crisis. Before the Great Financial crisis, central bank lending operations were mostly short term loans with maturities measured in weeks intended to implement interest rate policy after the Great Financial Crises. For many countries in the wake of the Great Financial crisis it was greatly expanded in the amount lended out, the length of maturity, better loan terms and requiring looser restriction in quality of collateral (Bank for International Settlements, 2019). The goal and theoretical effect of these operations is to increase liquidity in the market to increase confidence. This would then lead to an increase (or at least a smaller decrease) in investing and spending as panic is quelled. The policies changed after the initial crisis passed and evolved to provide stimulus rather than confidence by increasing the availability of credit (Bank for International Settlements, 2019).

2.5.3. Forward guidance

Forward guidance is an attempt by a central bank to influence the behavior of economic actors through leveraging its credibility by declaring in advance goals for certain economic factors and threatening to make policy until those goals are met. These economic factors are for the most part the inflation rate or GDP growth. The reasoning behind forward guidance having an effect is the way that economic actors make decisions based on expectations on future instances of factors such as inflation, unemployment and the interest rate.
If people expect the inflation rate in the future to be high then they will make decisions today based on that. Those decisions will logically then be larger spending and more eager for loans as they expect the value of the money will decrease leading to a higher demand, growth and inflation. As the central bank job is partially to keep inflation down it will seek to counteract this inflationary cycle. In the conventional framework this will include increasing the interest rate thus lowering demand and growth and in the end inflation. The central bank might

however not be willing to raise the interest rate as much as would be required to lower the inflation rate due to damage to the output of the economy. Forward guidance could then be used as a way to ideally have the same effect as a major increase in the interest rate with a smaller increase or no increase in the interest rate. To do this the central bank would set out statements that they will raise or continue to raise the interest rate until the inflation rate comes down to a desired level. Ideally this would influence the economic actors to make their decisions in such a way, so that the inflation rate would come down, or at least would not be as high as without the statements. The guidance also works for expansionary policy by making statements that the interest rate will continue to go down or will remain at a low point until the economy improves, with the intention that this will cause people's behavior to change in the opposite direction.

The main issue with forward guidance is that it requires the central bank to have credibility that they will do as they say in their statements, otherwise the people will just ignore the statements. It also puts the credibility of the central bank at risk if they make the statement and don't follow them up. This can limit the flexibility of the central bank to conduct policy in changing situations by locking in their decisions in advance. It also cannot truly be a policy in and of itself and serves as an augment to other policies with the hope of improving their effectiveness. It would be difficult to include forward guidance into an analysis of the effectiveness of unconventional monetary policy. First because there are so many variables that can have an effect on the expectations of financial institutions and the general public that it will be extremely difficult to isolate the effect that it had. Second is the issue of quantifying the intensity of the statements of the central banks attempting to use the policy. It will probably also require using a measurement of the credibility of the central bank or the belief that the central banks will go through with their stated actions (Bank for International Settlements, 2019). Still it is worth noting that this policy was used in the same periods as the other policies.

2.6. How is quantitative easing theoretically different in effect from conventional monetary policy.

2.6.1. Mainstream school of economics perspective

The view of the mainstream school of economics is that the money supply can be and is controlled exogenously by the central bank. This allows the central bank to directly increase the money supply in the economy by increasing the liquid reserves of banks and financial institutions. The idea is that the ability of banks to give out loans is limited by their bank reserves and if they are increased by injection or changes in the bank reserve requirements they would then be able to give out more loans without fear of insolvency.

This will then enter the real economy through increases through monetary multiplier as the banks will through fractional reserve banking increase the money in circulation through loans and new deposits. This will then increase the broad money supply as average people will make use of it to spend on goods and services thus increasing aggregate demand, economic output and the inflation rate (Lavoie, 2019).

In this view the results and the mechanisms of how asset purchase programs will increase the money supply in the economy is much the same as the conventional policy of lowering the interest rate. In this view both policies aim to decrease the supposed limits of the banks to give out loans due to lack of reserves. The main difference is that it will do it by allowing the banks to give out more loans by increasing reserves rather than through making loan taking more attractive though lower interest rates. In the end they will in theory both just result in the increase in loans and thus the broad money supply. This view implies that quantitative easing will effectively just be the same policy as lowering the interest rate. It might be that the policies have some differences in magnitude of effect as some speculative actors might react differently as new policies introduce uncertainty (Lavoie, 2019).

If the mainstream position on quantitative easing and asset purchase programmes are correct you would expect to see that the policy had an impact on the money supply and that that impact had similar effects compared to a decrease in the interest rate for the same increase in the money supply.

2.6.2. Post Keynesian school of economics perspective

The Post-Keynesian perspective of quantitative easing is defined by the ideas of the endogenous theory of money. Endogenous money theory is as the name implies a theory of money supply where the money supply is endogenously defined. This goes against the traditional ideas of monetary policy where the money supply is exogenously defined and therefore controlled by the central bank through printing money. Endogenous money theory is often associated with the Post-Keynesian school of economics. Due to this the Post-Keynesian perspective is that quantitative easing and other asset purchase programs like it will not have the stimulating effect on the economy desired by the central banks that implement them. Their basic idea is that the banks who receive this increase in liquid monetary reserves will not change their behavior or circulate this money outside of the bank's accounts. This is due to the idea that the issuance of loans and behaviours of banks are independent from the amount of liquid reserves of the banks. This is because In Endogenous money theory the money supply is derived from the demand of the real economy where market forces together with some central bank adjustments dictate the money demand (Palley, 2002). In response to the demand for money generated by the real economy and the central bank, the banking sector will expand or reduce the money in the economy based on the demand for credit at a certain time for a given interest rate.

There will then be no changes in the number of loans taken in response to Quantitative Easing as nothing has changed to increase the demand of money or loans unlike the way a lowering of the interest rate would have (Lavoie, 2019).

Additionally there is the belief that the non bank financial actors who will also receive liquid money due to owning some bonds purchased by the central banks will not result in an increase in consumption. The belief is that due to risk aversion, the people selling their assets will be more likely to use that liquidity to reduce debt, save or purchase other bonds rather than spend on goods. Thus no matter how large the reserves of the central banks or the amount of assets purchased from asset holders, if there is not the will and demand from people to take loans then the broad money supply will not increase (Lavoie, 2019).

In the view of the Post-Keynesian the only way to increase the broad money supply then will be through the government giving money directly in stimulus to either people as a bank transfer or through the establishment of government contracts to businesses, or simply employing additional people.

If the Post-Keynesian view of quantitative easing and asset purchase programs are more correct you will expect to see that the policies do not have a real impact on the money supply and effectively no impact on the real economy. There are some theoretical exceptions where asset purchase programs can have some minor effects on the exchange rate and long interest rates as investors can react to the policies (Hein, 2017)

There have been in recent years been statements from some central banks that imply or admit that some or most money supply is created endogenously and that the central banks are not able to exogenously control the money supply. Like in an article from the Bank of England for the quarterly bulletin for Q1 2014 titled "Money creation in the modern economy" where they explain that "banks do not act simply as intermediaries, lending out deposits that savers place with them, and nor do they 'multiply up' central bank money to create new loans and deposits"(Bank of England, 2017). This seems to suggest that there is some truth to the claims of the Post-Keynesian school of economics. Whether or not this makes all forms of non interest rate related monetary policy useless is not as clear and is definitely worth looking at and modeling.

2.7. Potential differences in specific relevant variables

Having outlined the different perspectives on the theoretical effects of quantitative easing from the perspective of the mainstream and the Post-Keynesian schools of economics this section will explore and outline specific factors relevant to monetary policy and how they will be expected to react to quantitative easings use as a monetary policy. This will also include speculation on effects that can be different from conventional policy assuming quantitative easing has a significant effect.

2.7.1. Output and inflation

Output and inflation are the most relevant measures as most central banks center their goals on those variables. Obviously the idea is that from the mainstream perspective there will be an effect on the output and inflation while the Post-Keynesian will expect there to be no effect or a very small effect. Assuming that there is an effect on the measures it will be interesting to see if the effect is comparable to the effect of conventional monetary policy in magnitude for the same increase in the money supply.

2.7.2. Construction

Construction and home buying are some of the economic factors that are the most known for being affected by changes in the interest rate. This is theoretically justified by the disproportionate use of loans for the financing of projects and home buying. As the sector is relíant on loans for its demand then if loans are cheaper there will be more demand for it. The opposite is also true as more expensive loans leads to less demand for investing in construction. This effect is less of a given for quantitative easing. There will still logically (if quantitative easing has its intended effect) be a general decrease of interest rates for other longer investments that can then funnel the investment into construction. But it still might be a different magnitude compared to conventional interest rate cuts. This can be the effect of interest rate on construction due to cheaper loans used by homebuyers vs liquidity effect on people who might not want to spend on new houses as opposed to other assets or debt repayment.

2.7.3. Stock market (real equity)

Interest rates are known to have some effect on the prices of stocks. There tends to be an increase in stock prices should there be a larger than expected drop in the interest rate or they tend to go down should there be a larger than expected increase in the interest rate. This makes logical sense as the lower rate of return on holding bonds will make it more attractive to invest in alternative assets of which the stock market is one of the most prominent alternatives. As to the effect of the more unconventional policies the expected effects will logically be similar. There can be reason to believe that quantitative easing can have a different impact compared to conventional interest rate cuts. Due to the speculative nature of the stock market and the stock prices, the mere fact that people and institutions treat or have treated policies such as quantitative easing as separate or inferior to conventional monetary policy, it is possible that can be reflected on its effect on the prices. In this case it can logically lead to a lesser effect on the prices as the financial actors think that the equivalent of a 1% interest rate will not have the same impact or implications thus there will not be the same movement in the prices. But there can also logically be reasons to believe that specifically asset purchase programs such as quantitative easing can have a more significant effect on the prices in the stock market. As asset purchase programs increase the liquidity of investors by buying assets directly from the open market it can give liquidity to the people who will be most likely to seek to invest in the stock market rather than increase liquidity for people who might be looking to buy a house. It has also been argued that lowering access to low risk investments by purchasing them will lead to investors investing to a higher degree in higher risk and higher return investments. (Bank for International Settlements, 2019). Given this uncertainty it is extra interesting to investigate if there is a difference in the reaction to the different policies on the stock market. Depending on the goals of the central bank if there are any differences in effect on the prices of stocks that might influence future policy decisions.

2.7.4. Long interest rate

There is generally believed to be a relation between the short term interest rates and the long term interest rates. Generally, higher returns are necessary for people to be willing to wait longer for the full payout and as such yields of longer term bonds are higher than shorter term ones. This is the so-called yield curve where the yield of bonds goes up the longer the maturity is (Weale & Wieladek, 2022). There are some exceptions to this that occasionally occur. If the market begins to fear that there might be some turmoil in the market or major change in monetary policy in the near future it can massively increase the demand for longer term bonds as investors fear the short term. This is sometimes seen as an indicator that a recession is coming or at least an indicator that people believe that a recession is coming. Changes in monetary policy or at least expected changes to the short term interest rate is as mentioned a large factor in the yield of the longer term interest rates.

Many if not most of the unconventional monetary policy instruments are designed to have an effect on the longer term interest rates. This is especially the case for policies like forward guidance which attempt to assure speculators that the interest rate will remain below (or in some cases above) a certain point for some time thus changing the demand for longer term interest rates. The Wu Xia shadow interest rate is also a tool used to measure what the equivalent in interest rate cutting the total use of unconventional monetary policy measures has been. It uses the relationship between the long term interest rate and the short term interest rate to measure that so there is little doubt that there is some relationship that looks like the relationship between conventional and long interest rate (Wu & Xia, 2016

There is still the question of if the relationship has the same magnitude of effect. The way that the unconventional monetary policies have been used seem to imply that it is preferable to use rate cuts before using other measures. If that is true it would be expected to see that for the same level of money created that there will be a lesser effect on the lowering of long term interest

2.7.5. Exchange rate

Due to the speculative nature of the exchange rate the perspective of financial actors and people play a significant part in determining the exchange value of the currency. As such it is not unreasonable to think that for the same amount of money created that the interest rate cut and quantitative easing might have a different effect on the exchange rate, if not in direction of effect then on magnitude of effect. Due to the speculative nature of the foreign exchange market and prices it can be hard to predict what kind of effects new kinds of policies will have on it. Expansionary conventional monetary policies are generally thought to have a negative impact on the price of the domestic currency compared to foreign currencies (Bank for International Settlements, 2019). This is the case as lower interest rates will make investing in the country and its currency less attractive thus lowering the exchange value. The opposite is true for conventional contractionary monetary policy as the higher interest rate makes it more attractive to invest in the country's bonds. This would thus increase the demand for the domestic currency increasing the exchange value.

The unconventional policies and in particular asset purchase programs logically work in the same way. The increase in prices on financial assets and the lower yields leading to less incentive for foreign actors to invest thus lowering demand for the currency lowering its exchange rate value. However if this is to the same extent as the conventional interest rate changes is less certain. There is less possibility for the contractive version of the policy to be implemented given you can only sell assets that you own. (Bank for International Settlements, 2019). This leads to an interesting situation where conventional monetary policy can technically be conducted infinitely contractively but not expansionary while the opposite is true for unconventional policy that can be conducted infinitely expansionary but not contractively.

Measuring the effects of unconventional monetary policy compared to conventional monetary policy on the interest rate on the foreign exchange rates can give some insight (assuming that they have a difference in effect) to the most effective way for central banks to reach the goals of their institutions. Any differences in effects on currency exchange rates will also be very relevant for countries that might be more vulnerable to changes in their exchange rates. This can be countries that heavily rely on imports for basic necessities like food where the inflation can be driven much more by the value of their currency rather than their own internal economic state.

3. Method

This section will go over all the steps of creating the models used to analyse the effect of both the conventional policy implementations and the unconventional monetary policy implementations. This will include the models used to identify the equivalent of quantitative easing to a 1% interest rate cut. The section will go over all of the models used, how they work and what diagnostic tests will be included. The section will go over the identification of the countries whose data will be modelled and where their data is collected from. The section will also go through all the variables used, how they are used in the models and where they are collected from as well as a short justification for their inclusion.

3.1. Models used to compare effects

Two types of models will be used to compare relationships between the conventional and unconventional monetary policy tools. The first is an" Ordinary Least Squared" (OLS) linear regression which will be used to analyse the relationship of the two tools on the M2 money supply. There will then be created a "Structural Vector AutoRegression" (SVAR) model to analyse impulse responses to policy shocks for both policy tools.

3.1.1. OLS

Ordinary Least Squares (OLS) is a linear regression model that finds the best fitting trendline between two more variables by minimizing the sum of the square of the residuals from the data points to the trendline. OLS finds if the conditions of its assumptions are met, and there is a significant relationship the best linear relationship between the included variables. There are several ways that the results of the OLS regression can be biased or skewed. If there is correlation between the error term and one or more of the included explanatory variables then the model can be biased and the results less reliable. Often this is due to some significant variable that is not included in the model. It is however not always possible to find solutions to such problems when dealing with economic data and variables even if there is a linear relationship between the relevant variables. This can be due to lack of data or quality of available data which can be difficult to solve. OLS models can often show a very simple relationship where it can be complex and changing. OLS cannot also show any explicit causal relationship only correlation. It cannot say if a change in one causes a change in the other or

which causes which it can just as well be that both are caused by a third thing. The results of a given OLS shall thus not be discounted but be taken with a grain of salt.

3.1.2.SVAR

A VAR model is a model of regression in a time series, where the previous instances or lags of the variables are factored in the calculation of the dependent variable. For example inflation as a function of the unemployment rate, the interest rate and the past instances of the inflation rate, interest rate and unemployment rate. It is also a matrix of equations where all the variables are treated equally and there is no such thing as exogenous variables. This allows the model to better show the relationship between economic factors and to better be able to forecast the trends of the data. As every forward instance of time in the model changes the value of the lags that are used to calculate the dependent variable. This allows for the VAR model to be created based on previous data, and then predict where it will go without just presenting a trend line. A SVAR is a VAR model that includes more than one variable and its lags. including more than one requires a restriction or structure to avoid an identification problem.

In the reduced form VAR we assume that the error terms are uncorrelated. This assumption is not necessarily accurate and makes it difficult to analyze the effects of changes in the variables on other variables. The assumption is made since it is impossible to know the variance covariance matrix of the error terms. It is, however, possible to estimate it indirectly by using previous data for a reduced form VAR model and a restriction. A restriction to solve this problem can be the idea that the contemporary correlation only works one way, so that the contemporary value of Y affects the contemporary value of X, but the contemporary value of X does not affect the contemporary value of Y. The version, where some of the contemporary values have an effect on only some of the dependent variables, is called a recursive form VAR and allows the VAR to analyze structural shocks.
However, that is by no means the only way to fix the identification problem. The form the restrictions in VARs take, can take many forms and is only limited by the imagination of the person making them. For them to be valid, they are usually based on established economic theory and the subject of the data.

From the SVAR models there will be looked for the presence of Granger Causality then there will be created and analysed impulse responses.

Granger causality examines if one of the variables are useful in predicting changes on the other variables. It is used to test if there is a relationship between some of the variables. It is important to note that Granger causality is not actual causality, where the lagged variables are causally related to the dependent variable, but only show the extent it can predict it. A real life example that can show the distinction could be a currency peg. If a country decides to unilaterally peg its currency to another, a change in the first currency does not cause a change in the second, but it can perfectly predict and "Granger cause" it. It can also be that it merely shows correlation that two variables move in the same way only lagged. It can be that one variable is affected faster by a third variable than the second is, so that it is the third variable that causes the changes, but the first variable is able to predict the changes in the second.

Impulse responses show the effect of an unexpected and temporary shock of one of the current values of one variable, while holding the other variables constant. It does this by plotting the forecasts of the VAR model with this shock included, usually a default of 1% and comparing it to the forcast without the shock. This can be used to more clearly see the relationship between the variables, and gives an opportunity to see what effects unexpected events could have on the economy. This allows comparing models to real data and mold policy decisions after them. This can be used to predict for example the effect of a pandemic and its resultant removal of entire sectors of jobs. And what the effect of this can have on the rest of the economy represented by a large exogenous increase in unemployment in the model. Such forecasting can allow policy makers to better act if such a condition occurred. It is by no means flawless, there is a lot of variance and error in such forecasts, partly caused by imperfection of the model and mostly from inherent problems in economic data.

3.2. Comparing quantitative easing and interest rate cuts

This section will include the method and reasoning for establishing an equivalence of a one percent cut in the interest rate to a specific amount of asset purchased through quantitative easing. This will later be used to compare the effects of quantitative easing to the effects of changes in the interest rate. It will start with the economic reasoning for the relationship and then elaborate on the models that will be used to find the equivalence. It will also go through the data used and where they are coming from as well as reasoning for picking specifics of the datasets.

3.2.1. Finding equivalents in quantitative easing for a 1 point interest rate cut

In order to make any sort of comparison between the effects of an interest rate cut and quantitative easing there needs to be a basis to compare them to. There is a question of what amount of assets is the equivalent in action to a 1% cost in the interest rate.

A proposed way to do this has been the Wu, Xia shadow interest rate which is a way created by two chinese economists to attempt to find where the interest rate effectively will have been in periods where it is constrained by the zero lower bound, or where the central banks were unwilling to lower it further. The goal is to create a unified model, so that traditional models of the economy and monetary policy will still be able to track and make use of data from periods where the interest rate was at zero lower bound. The main issue with this is that it was created specifically to be the same as the interest rate cut. It does this by measuring the relationship between the short term interest rate and the longer term interest rates. This makes the shadow rate less usable as a way to evaluate the differences in policies as it is made to only show how similar they are.

An alternative can be to still use the effect on the long term interest rate to find what the effect there has been if it was a change in the interest rate. The same idea can be used to see what amount of Asset Purchase Programs it takes to have the same effect on the long term interest rate.

Another way, and the one that will be used in this paper, comes from the idea of the central bank's control of the money supply. If monetary policy has an effect through the amount of money supply created then the same money created through both policies (interest rate changes through the increase in loans and QE through increased liquidity and bank reserves) it would be expected to see the policies having effects on the money supply. If both kinds of

policies have an effect on the money supply then it becomes interesting to investigate if they have differing effects on other factors.

With the goal and the means of effecting the economy being through the increase of the money supply it makes sense to make that the equivalent. This is done by looking at the changes in the money supply and linking them to changes in the interest rate. Then doing the same for changes in the balance sheet of the central bank and the money supply. Comparing the two will show how much the an increase in the central banks balance sheet is associated with the same effect on the money supply as a 1 point cut in the interest rate.There will then be a comparison between these two relationships using the assumption of the mainstream school of economics and the Post-Keynesian school of economics.

Once an idea of the impact of quantitative easing and conventional interest rate changes have been established it can then be used to see if that impact (if it exists and is significant) has a different impact on other factors relevant to monetary policy like output and inflation.

3.3. Identifying countries to be used in the analysis

To make any form of analysis data will have to be found, and the decision of where to get them must be made. There will be effectively two different possible approaches to using countries. One approach will be to try to get a general understanding of how unconventional monetary policy or quantitative easing works for any given country, or to focus on one country and try to establish the effect there. The most ambitious thing would be to try and establish a general effect and framework for the effect on quantitative easing and asset purchase programs for all countries, and it would go the longest in answering the question if there is a difference between it and conventional policy. There are some issues with such an approach both practical and theoretical. The practical issues would relate to the problem of gathering data necessary and assembling them in models. Any attempt to create a comprehensive general effect would need to use data from a very large set of countries, ideally every country that has conducted that kind of policy. This causes issues first in the workload and the scale of this paper being probably too high and too small respectively, but also in the issue of data existing. Data collection from developing countries can be unreliable, if they exist at all, and can make their inclusion in models dangerous. From a more theoretical perspective there is also the issue that these countries are all very different and will have conducted their policies in different periods. There can be reason to believe that the effects of both conventional and unconventional monetary policy can have different effects

on the economy based on other factors. Attempting to create a unified model could then be skewed by not including those factors.

For those reasons this paper will primarily look at and analyse the effect of quantitative easing on specifically the United States, and comparing it to the effects of cuts to the federal funds rate. There will still be created models for the United Kingdom and the eurozone. This will be done to see if the results of the analysis is an outlier or if similar results can be seen in other countries.

3.4. Identifying periods for data collection and model creation.

The datasets used to create models for measuring the effect of interest rate cuts will by necessity need to come from different periods than those analysing quantitative easing. Both so that the effects that each will not bleed into the other, but also for practical reasons as they were generally not conducted simultaneously. This section is then about picking the time periods for the period where the effect of interest rate changes will be taken from and the period where the effect where quantitative easing will be taken from. Obviously this is not ideal and it would have been better if it was possible to look at both effects in the same period, but due to the way the policies have been conducted, there is no such period. You cannot look at the effects of quantitative easing in the United States in the 1990s as that policy did not exist then, and you cannot look at the effect on interest rate changes in 2009-2015 as it was unmoved at 0%.

3.4.1. Conventional policy

For the starting points it would be tempting to pick the earliest available datapoint, which (at least for the US) would be in the early 1950. There is however reason to think that it would not provide useful information to include that early datapoint in the models. This would include the fact that records of those times are less reliable and more likely to be less reliable estimates. There is also the case for measures like the M2 money supply and other measures would not exist or would be calculated differently that the modern equivalents. Also notable for discussion on monetary policy in the US and money supply is the fact that at that time the United States were still using the gold standard. It is likely that it would have an effect on the relationships between the relevant variables and how the states conducted policy.

Monetary policy and how it has been conducted has also changed over time as the

instruments focused on changed over time. This model will use the federal funds rate as the measure for the federal reserve's use of monetary policy as it is widely accepted to be a good measure for the current time, but that has not always been used that way. The federal reserve began some time in the 1980s to use the federal funds rate as a major force in monetary policy. Meulendyke (1998) argues that this began to be promised around 1987 and as such this paper will use that year as a starting point.

For the SVAR models due to the exchange rate measure being established in 1994 that is when the data period for the conventional SVAR model's dataset will begin.

The eurozone is the odd man out for data collection in this case. It has the shortest time where data is available only going back to 2002. This is due to the EURO and by extension the monetary policy power of the ECB only being in place by then. There is also the issue of the changing nature of the eurozone. The eurozone is defined as the countries that have officially adopted the euro as their currency and over time more and more of the members of the European Union join the eurozone. This can cause several issues in the data and the models created from it. One potential problem is that the rapid changes from sudden inclusion of entire countries in the data could lead to the appearance of effects from other factors leading to a skewing of the data. Another potential issue also works the opposite way, so that if those new countries are not included in the data it will not give a complete picture of the effects, as the changes in policy could potentially disproportionately affect either the countries included or not included.

Those issues are however mostly prominent in the periods where the unconventional monetary policy is prominent. The only country that joined the eurozone before the Great Financial crisis was Slovakia which is small enough to probably not cause significant issues either way.

3.4.2. Unconventional policy

The periods where unconventional monetary policy become relevant are the periods where the central banks are restricted or act restricted by the zero lower bound. Either that point or the point of announcement of each country's respective Asset purchase programs can be relevant starting points. This paper will use the point where the Wu Xia shadow interest rates go into the negatives for each respective country as the starting points for the periods of the unconventional policy models. The end point of the models for unconventional monetary policy are more complicated to decide. As the asset purchase programs have already acquired their assets and have not necessarily been sold by the point where the interest rate begins to be raised again, it can be useful to continue to attempt to measure the effect of the contractive part of asset purchase programs. This will also allow the model to look at both periods where significant asset purchase programs have been conducted, being the Great Financial crisis and the economic fallout of the Covid-19 pandemic. The main issue with doing that is that it sabotages the effort of separating the effects of the conventional and unconventional monetary policies as by that point they are being conducted simultaneously.

For that reason the period for unconventional monetary policy will have the endpoint being the point where the interest rate is no longer restricted by the zero lower bound. That being the first point where it is raised again after the period starts.

3.5. Measures for interest rate and quantitative easing

This section will include all of the variables that are used in the models comparing the effects of interest rate cuts and quantitative easing. This includes where the data for those variables are collected for each of the relevant countries included in the models. Where there are differing versions of the economic measure the version used will be clarified. There will be a short explanation of the reasoning used for their inclusion and what the expected interactions with the monetary policy variables will be for the two relevant schools of economic thought.

3.5.1 Data used for establishing equivalence

This part will cover the data used for finding an equivalent of quantitative easing measures compared to a change in the interest rate. This will cover a theoretical reason for inclusion, where the data is acquired from, what form it takes and what modifications was made to it. This includes the short term interest rate, the money supply, the quantitative easing estimate and the GDP estimate.

Short interest rate

The short term interest rate will be used to estimate the conventional monetary policy used by the relevant central banks. For the United States the measure will be the federal funds rate which will be gathered from the Federal reserve bank of St Louis's website. The measure for the eurozone will be the" Interest Rates: 3-Month or 90-Day Rates and Yields: Interbank Rates: Total for Euro Area" gathered from the Federal reserve bank of St Louis's website. The measure for the United Kingdom is "Interest Rates: 3-Month or 90-Day Rates and Yields: Interbank Rates: Total for United Kingdom" gathered from the Federal reserve bank of St Louis's website.

To maintain comparability and make sure the effects of the policies are not being tethered to an absolute value of interest rate the interest rates will be changed. The interest rates will be modified so it will be a percentage point change in the interest rate from the previous month.

Balance sheet of the central bank (Quantitative easing)

The measure of quantitative easing will be created using the value of the balance sheet of the relevant central bank. The measures for each of the values of the central banks balance sheets will be taken from their respective central banks. This is the federal reserve bank of St Louis for the United States, the Bank of England for the United Kingdom and the European Central Bank for the eurozone. In order to make the results of the analysis more general, the measure for the used quantitative easing will be the value of the central bank as a percentage of GDP using the nominal GDP measure.

There are some central banks that segregate the data, so that it would be possible to get the data for only the value on the balance sheet that is directly part of that bank's quantitative easing policy. However in order to make it easier to compare between countries the measure is kept simple by including the whole balance sheet. This also means that the variable includes the effect of some other unconventional monetary policies in the models such as lending operations. The used measure is taken from the estimate of the central bank assets as a percentage of GDP from the website Macromicro.com which uses data from the respective central banks and estimates of monthly gdp.

GDP

Nominal GDP is only released quarterly so the monthly data taken for the estimation of the central bank assets as a percentage is taken from estimates created by the website Macromicro.com. The data for the real gdp growth which is used as the measure for the change in output is taken from the Federal reserve bank of St Louis's website which is obtained from the OECD. The gathered data is a measure of how above or below the growth rate is from the trend for the given country; the first difference is then taken from it so it displays percentage point change.

Money supply (M2)

The effect on the broad money supply is what will determine what this paper will consider the equivalent of quantitative easing to an interest rate cut. There are many different measures for money supply, all of which are imperfect. For this paper the measure of the money supply is the estimate of M2.

The measure of M2 is an extension of M1. M1 is described by the German national bank on their website bundesbank.de as "M1 is the Eurosystem's narrow monetary aggregate and comprises currency in circulation outside the banking system and overnight deposits of non-banks held at monetary financial institutions in the euro area. It also includes overnight deposits denominated in foreign currencies held by euro area residents at monetary financial institutions in the euro area. However, M1 does not comprise deposits held at monetary financial institutions in the euro area which belong to non-residents.".

M2 is M1 plus "M2 comprises M1 plus deposits with an agreed maturity of up to and including two years, and deposits redeemable at notice of up to and including three months." The data for the M2 money supply is collected from the respective central banks of the relevant countries. Being the bank of england, federal reserve and the European central bank. To avoid the results being tethered to absolute values of M2 the measure is then changed so that it becomes percentage swings in the M2 money supply from the previous month.

Fiscal policy

One of the claims of the Post-Keynesian view on quantitative easing is that it and policies like it have no effect on the money supply but that fiscal stimulus and spending would. In order to see if the relationship shown between the M2 money supply and the quantitative easing variable (if it has any) is the result of bleedover from concurrent fiscal spending a variable representing fiscal policy is introduced in a separate model. There are many ways that fiscal spending could be represented and the forms that spending takes would probably have different effects from each other. One way to look at it could be using only spending used on for the specific purpose of doing stimulus in a time of crisis. However most all spending from the government should have some effect on the money supply so it would probably be unwise to not include it.

In the end the fiscal policy is represented by the percentage point change in US federal spending as a percentage of GDP. This should represent how the government responds to crises and prevent at least some of the effect of fiscal policy from bleeding out into the monetary policy variable. The data itself is taken from the Federal Reserve Bank of St Louis. It uses quarterly data so the data is transformed such that the data point for the quarter is placed in each of its respective three months.

3.5.2 Variables for measuring effect on the economy

There are endless potential ways in which it could be possible that conventional policy could have a different effect than unconventional monetary policy, and there are many sectors where that could manifest. It will however be impossible to include every possible dataset and combination in this paper. Therefore this paper will use several areas to highlight and test if there have been any significant or observable differences in effect between the two different policies. This section will go through and justify the various variables that will be used to compare the effectiveness of the different monetary policies. This will include the long term interest rate, Real GDP, Inflation rate, Construction spending, Real equity, exchange rate and construction spending. All but construction spending and exchange rate were used in the paper "Financial effects of QE and conventional monetary policy compared" by Weale, M. and Wieladek, T where they use a similar model.

Long interest rate

The long term interest rates that will be used in this paper are 10 year maturities. The data for these are taken from the website https://www.stlouisfed.org - Federal Reserve Bank of St Louis, They are taken as monthly and converted into percentage point changes to avoid having them tether themselves the other variables to absolute values of the long interest rate.

Construction rate

The construction rate will be based on data on the monthly spending on construction. It will be used as a percentage change from previous period spending on construction. For the US the data will be taken from the Federal Reserve Bank of St louis which gets it from the OECD. The US data will be changed to a percentage change from the previous period by making it an index with 2015 as the 100 years the data and then the first difference. This should enable the models to show the relationship between the monetary policy and construction.

Real equity prices

The stock market is a potential area of different effect. The used index is the SNP 500. The index is deflated and changed to percentage point change from previous period by taking the first difference. While there are an untold amount of variables that have effects on the price of stocks and other forms of equity and it will be impossible to get a complete, accurate picture, it can give at least some insight into the effects of the different policies to include it. Some other measures for the real equity can also be used if there is suspicion that monetary policy in general or quantitative easing can have different effects on different sectors. Such as the Dow Jones or the Nasdaq. It can well be the case that some indexes like the financial can benefit more than say the industrial sector from quantitative easing or similar policies.

Inflation

Stabilization of the inflation rate is one of the main goals of monetary policy. As such it is one of the most relevant factors to look at when comparing effectiveness of different types of monetary policies. There are different measures of the inflation rate that can be used. This paper will use the standard CPI consumer price index to represent the inflation rate. The measure included in the models will be the difference year on year inflation CPI rate. This shall allow the models to show at least the short term effects of monetary policy on the inflation rate. It is possible that the effects can be lagged which will require other models to

measure so that will be ignored for now. The inflation measure is taken from the OECD data website.

Real GDP

The effect on the output is one of the major parts of monetary policy. The measure will be the percentage change in the real GDP from period to period. This will allow it to show the short term effects of monetary policy on economic output. All the GDP measures will be taken from the OECD datasets. Further details are in the GDP section for the previous model.

Exchange rate

The exchange rate measure will be an index comparing the exchange rate value of the USD against a list of other currencies. This will help to isolate the measure from country specific events unrelated to the monetary policy or the country in general. The measure used to represent the exchange rate of the relevant countries is the "Real Broad Effective Exchange Rate" taken from the website https://www.stlouisfed.org - Federal Reserve Bank of St Louise who gets it from the Bank of International Settlements. The Measure is calculated as a weighted average of exchange rates for several global currencies and then adjusted with relative consumer prices. It is an index with 100 being equal to the exchange rate for the year of 2020. In order to be able to analyse the effect of changes the data is transformed to be changes in the exchange rate by taking the first difference. This should allow the models to see what effects a change in monetary policy can have on the exchange rate.

3.6. Diagnostics

This paper will make use of two types of econometric models. These models have their own assumptions that need to be true for the models to make accurate results. Obviously when dealing with economic data there are no perfect datasets and it is impossible to make a model that includes every variable and factor. It is still important to look at the models created and testing them to see where they could go wrong and how to improve them.

This section will go through the various diagnostic tests that will be used to evaluate the soundness of the created models and what the implications of failing then would have on results. As there are two types of econometric models used each will have a section of diagnostics to see how well they fit their assumptions.

3.6.1. OLS

Ordinary Least Squared (OLS) models are considered the "best linear unbiased estimator" (BLUE) if all of the assumptions of the OLS models are correct. These assumptions are the Gauss Markov assumptions. The Gauss Markov assumptions are that the relationship and model is. The diagnostic section will include a number of tests to test a number of these assumptions:

"linear in parameters". This assumption is that there exists a linear relationship between the modelled factors. It can be possible that the relationship between the different variables is non linear in which case the relationship will be better modeled by a different model. It can also be the case that the relationship between the models changes over time for a variety of different reasons which can skew the results. This is tested using a ramsey reset test where an alternative version of the model using the square of the explanatory variable is tested to see if it is a better fit.

There is homoscedasticity (no heteroscedasticity) and no autocorrelation. Heteroscedasticity is a situation where the error term changes over time gaining larger or smaller swings, in other words a not constant volatility. This is almost certainly going to be a problem for most of the data that is looked at, certainly for datasets such as real equity which is notorious for having changing levels of volatility. This is tested for using a breuch pagan test by adding the residuals of the original model to a new model and testing, if the residuals are too good at explaining the variance.

One of the assumptions is that the error terms are normally distributed, if this is not the case the model is not BLUE. If the errors are not normally distributed it can mean that the relationship is not best modeled in an OLS model, or that the model is missing some factor that is getting absorbed in the error term. This is tested for using a Shapiro Wilks Test which tests the goodness of fit on the residuals on a normal distribution.

The assumption of no autocorrelation is the assumption that each point is independent from the point that came before. This can be true in the effect that the policies can have on the money supply, however it cannot be true for the policy conducted in the first place as it is conducted by humans who make decisions based on previous acts. This is tested for using the Durbin Watson Test which is found by dividing the "sum of differences of squares" with the"sums of errors of squares".

3.6.2. SVAR

SVAR models have several assumptions which if they are not true for the dataset suggests that the results of the model are biased or unreliable. The models created will be tested on a number of those assumptions. For the SVAR models there will be tests for serial correlation, heteroskedasticity and normal distribution of the residuals.

Serial correlation

VAR models assume that there is no serial correlation between the error terms. If there is serial correlation in the error terms that suggests there is a missing factor that is getting absorbed in the error terms. A Portmanteau Test is used to test for serial correlation in all of the six VAR models. The null hypothesis is that there is no serial correlation and * indicates a significance of 10% **5% and ***1%

Normal distribution

If the residuals are not normally distributed, it suggests that there is some relevant variable which effects are being included in the error term which is biasing it .

Three tests are used for each of the models with a JB test, skewness only and kurtosis. * indicates a significance of 10% **5% and ***1% the larger the significance the more likely it is that the errors are not normally distributed.

Test for heteroskedasticity

Heteroskedasticity is where the mean of the errors of the model are not constant over time. Heteroskedasticity is a feature of some data and not a fault, but is not accounted for in VAR models, It can be tested for, by using an ARCH test to see if there are any ARCH effects (auto regressive conditional heteroskedasticity) in which case a ARCH or GARCH model might be more representative of the true relationship between the variables.

The null hypothesis is that there is heteroskedasticity and * indicates a significance of 10% **5% and ***1% which would mean that there is not heteroskedasticity

4. Analysis

This section will cover the creation and the results of the models created to measure the effects of interest rate cuts and quantitative easing. The section will start with the estimation of the equivalence of quantitative easing to a 1% interest rate cut. It will use that result in the subsequent models to compare the effects of conventional policy to quantitative easing. There will be a short analysis of the results and its implications on the hypotheses of the two relevant economic schools. The section will lastly cover the diagnostic tests of the models, their results and its implications on the results.

4.1. Creating equivalence between Asset purchase programs and interest rate cuts on the money supply.

In order to have any kind of comparison between the two types of monetary policy of interest rate changes and Quantitative Easing there needs to be established an equivalent of quantitative easing to the interest rate cuts. This section will cover the establishment of that equivalence by comparing the effects of a change in the interest rate on the M2 money supply to the effect of a change in the federal reserve balance sheet as a percentage of the GDP on the M2 money supply.

The model used will be a simple OLS model with only the two variables present. The included results will show the factor values and a graph of the linear regression as well as the standard error and the r squared.

If the assertions of the mainstream or traditional ideas of monetary policy and money creation are more accurate, then both changes in the interest rate and quantitative easing will have a significant correlation with the money supply. The interest rate through the money multiplier effect as an increase in loans through fractional reserve banking causes the money supply to increase. The quantitative easing policy through the increased monetary reserve leading to money in circulation, as banks and people circulate the money.

If the assertions of the Endogenous Monetary Theory are more accurate it would be expected to see that changes in the interest rate has a negative correlation with the money supply, but the quantitative easing aspect does not have any significant correlation. The interest rate cut will have an effect through an increase in the amount of loans conducted in the economy which will have an impact as they are what ultimately create money. The asset purchase

program of quantitative easing will not have a significant effect on the money supply, as the money will not circulate in the economy as it will not have an impact on the amount of loans in the economy thus effectively creating zero new money.

4.1.1. Results for Interest rate changes for the US

This will be the results of the linear model for the effects of percentage point interest rate changes on percentage changes in the M2 money supply.

Factor (interest rate)	Standard error	P-value
-0.27	0.09	0.01

The results suggest that there is a significant relationship between changes in the interest rate on changes in the M2 money supply. The relationship shown is a negative relationship where an increase in the interest rate is associated with a decrease in the money supply, and a decrease in the interest rate is associated with an increase in the monetary supply. The exact results show that a 1 percentage point drop in the interest rate is associated with about a 0.27% decrease in the M2 money supply. The P-value of such a low value shows that this is a statistically significant relationship.

This type of relationship or at least the direction is in line with the expected relationship between the two factors according to both the mainstream and Post-Keynesian schools of thought.

4.1.2. Results for quantitative easing for the US

This will be the results of the linear model for the effects of percentage changes of the size of the federal reserve balance sheet on percentage changes in the M2 money supply.

Factor (interest rate)	Standard error	P-value
0.48	0.04	<0.001

The results suggest that there is a significant relationship between changes in the central bank balance sheet share of GDP and changes in the M2 money supply. The relationship shown is a positive relationship where an increase in the federal reserve balance sheet is associated

with an increase in the money supply, and a decrease in the federal reserve balance sheet is associated with an increase in the monetary supply. The exact results show that a 1 percentage increase in the federal reserve balance sheet's share of total GDP is associated with about a 0.48% increase in the M2 money supply. The P-value being that small shows that this is a statistically significant relationship.

The fact that the model shows that there is a significant relationship between the two variables seems to go against the ideas of the Post-Keynesian school, and suggests that quantitative easing could have an effect on the money supply.

4.1.3. Comparing the two to theoretical assertions

This seems to suggest that the quantitative easing policies have had an effect on the broad money supply which would go against the ideas of the Post-Keynesian ideas on the topic. It can however still be a non causal relationship and the money supply is moved in a similar way. Either way for the purposes of this paper the results suggest that a change in the central bank balance sheet as a percent of the GDP of 1 percentage point is the equivalent to the effect of a change of the interest rate 1.6 percentage point. This will form the basis for comparing the effects that models will show the two policies will have on the relevant economic factors and sectors.

Another thing that can be modeled based on the assertions of the two economic schools of thought are the raw numbers of the change in the federal balance sheet to the raw broad M2 money supply.

4.1.3.1. Results from other countries

In order to see if these relationships are not some form of outlier or statistical illusion there
will be conducted the same statistical models for the eurozone and for the United Kingdom

Interest rate changes

Country	factor Conventional	Standard error	P Value
UK	-0,30	0.189	0.05
EU	0,22	0.149	0.7

Asset purchase programs

Country	factor Unconventional	Standard error	P Value
UK	0,25	0.083	0,001
EU	0,37	0,025	0.001

The results from the United Kingdom is in line with the results from the United States in the
direction of effect on the two factors on the M2 money supply, but the results show a
different effect on the magnitude of effect where the unconventional changes in the Bank of
England assets as a percentage of GDP is lower than in the US
The results from the Euro area show that there is no relationship between the two variables
for the conventional period and significant relationship for the unconventional period. For the
unconventional period the data is very aligned with the UK while remaining smaller than the
US. The most likely explanation of the results of the conventional period is the short amount
of observations included in the model, as the period stretched from the Eurozone's
establishment in 2003, to just before the interest rate hit the zero lower bound in 2008.

Modeling over time

One potential problem with this kind of modeling is the issue that there can be a difference in the effect of monetary policy depending on the time period or its economic conditions. As the models are divided, so that there is a period for the conventional model and a period for the unconventional model, it can be the case that the difference shown is not from a difference of policy, but from a difference of period. This can be the case, specifically due to the context of the period from 2008, as it is dominated by the Great Financial crisis and the covid 19 crisis. It could well be the case that monetary policy behaves differently in such a period or that effects of monetary policy change over time regardless.

To see if this is a problem or what its magnitude is, the periods will be divided into sections with the same kind of analysis done as the first model. The sections will be divided into periods of 10 years each. The same will be done for the unconventional model which will be divided into three periods based on the three chairmen of the federal reserve during that time. The first of 2008-2013 with Bernanke representing the period with responses to the Great Financial crisis. The 2014-2018

Janet Yellen period where there was no significant use of quantitative easing. And the 2018-2024 Jerome Powell period including the covid 19 pandemic and its response.

It's interesting to look at the significance of the effect being the r squared the magnitude of the effect, being the factor and the standard error. A large difference in either or all of those between the different periods can indicate that all monetary policy has a different effect in different periods.

Pre Great Financial Crisis

Period	Factor (interest rate)	Standard error	P-value
1987-1997	-0.23	0.06	0.01
1997-2007	-0.30	0.09	0.01

What does the results show

There is a difference in the factor coefficient of the interest rate on the money supply between the 1990s and the 2000s. It is not clear if that difference is large enough to say that the relationship from the whole time frame cannot be used for a general relationship between the two. The differences could be due to changes in other factors that could have an effect on the M2 money supply such as fiscal policy. In that case the general relationship will probably be more representative of the true relationship. Overall for the interest rate changes there does not seem to be a reason to not use the results for the overall data. There are some differences in effect, but they will seem to be consistent enough that an overall relationship can be used to compare between the periods. As such this paper will work with the results of the two general models. They say that generally the equivalent to a 1% change in the interest rate is the equivalent of monetary policy implementation as a 0.88% change in the central bank balance sheet as a percentage of gdp.

Post financial crisis

Period	Factor (fed balance)	Standard error	P-value
2008-2013 Ben Bernanke period	0.3	0.07	0.07
2014-2018 Janet Yellen period	0.15	0.05	0.50
2018-2024 Jerome Powell period	0.57	0.05	<0.001

What does the results show

There are some noteworthy results that can be analysed here. Notably the period of Janet Yellen shows a relationship that cannot in any way be described as significant with a P-value of 0.5. The main explanation and why it is noteworthy, is that quantitative easing is not used in this period and it will then also be expected that the changes in the fed balance sheet will not be as relevant to the money supply. There is a significant difference between the relationships in the periods of Bernanke and Powell with the policies of the Powell period resulting in a much larger magnitude of relationship and significance. The most plausible explanation for this will be the degree to which the policy of quantitative easing is used by the different charmen. The degree to which the policy is used by Jerome Powell in the covid 19 crisis dwarfed any amount of policy used by Bernanke in the aftermath of the Great Financial crisis.

4.1.3.3. Use of fiscal policy.

One of the claims of the Post-Keynesians is that quantitative easing will have no effect on the money supply while fiscal spending will. To see if the relationship shown by the previous models are only the result of bleedover from concurrent fiscal policy a variable representing US federal spending is added to the model. According to the mainstream view both of the variables should have a significant effect on the money supply in both the conventional and unconventional periods. According to the Post-Keynesians there should then with this variable included be only a significant relationship between the monetary policy variable in the conventional period and not in the unconventional period

4.1.3.4. Results for fiscal policy

Period	Factor Monetary Policy	Standard error	P-value	Factor Federal Spending	Standard error	P-value
1987-2007	-0.27	0.09	0.01	0.01	0,08	0.89
2008-2024	0.42	0.05	0.01	0,05	0.01	0.03

What does the results show

The results seem to show that when a variable is included that represents the use of fiscal policy, the relationship between the M2 money supply and the monetary policy representatives used remain mostly intact. The results seem to show that there was no significant relationship for the conventional period, but there was one for the unconventional period. It seems to suggest that there is some aspect of fiscal policy absorbed in the monetary policy variable but not enough that it wholly consists of it.

4.1.4. OLS Diagnostics

This section will cover the various diagnostic tests conducted on the OLS model. It will include tests described in the Method section.

4.1.4.1. Diagnostics OLS Conventional

Country	Reset Test	Breusch-Pagan test	Durbin-Watson test	Shapiro-Wilk test
USA	0.82	0.12*	0.07*	0.01***
EU	0.61	0.87	0.61	0,45
UK	0.16	0.96	0.92	0.01***

4.1.4.2. Diagnostics OLS Unconventional

Country	Reset Test	Breusch-Pagan test	Durbin-Watson test	Shapiro-Wilk test
USA	0.21	0.03*	0.01***	0.01***
EU	0.13	0.01***	0.01***	0.01***
UK	0.87	0.81	0.20	0.01***

The results of the resets tests suggest that there is a linær relationship between the two variables. The failure of the Breusch Pagan tests in the models using the Quantitative Easing measure seems to show that there is heteroscedasticity which could suggest that there is not a consistent effect of the measure. The Durbin Watson test show that there probably is presence of autocorrelation for both measures. All the models fail the normality of residuals test (except the conventional EU model which only has a small number of observations.

The models obviously are not perfect and the relationship between the variables are more complicated than a simple linear relationship. But it can still give a rough idea of the relationship between variables that can be used to compare its other effects.

4.2. Comparing equivalent effects on the monetary supply on other variables

This part will cover the creation and results of the models used to analyse the effects of the different types of monetary policy on different economic variables using a Structural Vector AutoRegression model (SVAR).

4.2.1. SVAR models

This section will cover the creation and results of the SVAR models used to analyse the effects of the conventional and unconventional monetary policy shocks.

4.2.1.1. SVAR model specificity

The order of the variables in VAR models cannot be decided objectively and must be based on economic reasoning. The reasoning is often related to the ability for some factors to be controlled by a central authority rather than as a consequence of the market or by observed lagged behavior. In the paper by Weale and Wieladek, the two authors reason that the order should be that way, and the variables be those for several reasons. For the long interest rate they reason that some financial frictions such as imperfect substitutability between long and short bonds, and preferred habitat investors (based on Harrison, 2012 and (Vayanos and Vila, 2009) will cause an increase in asset purchases. Which results in a decrease in the yield of long term bonds through the reduction of perceived risk. Even without those frictions, increases in asset purchases will signal that the lower interest rates are to be lower for longer, which will keep the long rate down (they cite Eggertson and Woodford, 2003). This lowering

in the yield will lead investment elsewhere away from bonds and cause an increase in demand for real equity and therefore impact the prices of them. The two factors that are added to this that differs from the one in Weale and Wieladek (2016) (exchange rate and construction spending) are added where they are based on the the idea that the exchange rate is also a major reason for changes in monetary policy and as such monetary policy is conducted in response to it. The construction spending is where it is based on the idea that it will react in much the same way as the prices of real equity as it is a very similar choice of when to invest.

The model is thus identified in a lower-triangular scheme as

1. The percentage change in the CPI is dependent on lags of all variables

2. The percentage change in GDP is dependent on contemporaneous percentage change in the CPI and lags of all variables

3. The exchange rate is dependent on the contemporaneous percentage of CPI and GDP and lags of all variables

4. Fed balance sheet/the federal funds rate is dependent on contemporaneous percentage change in the CPI and GDP, The exchange rate and lags of all variables

5. Long interest rate is dependent on contemporaneous percentage change in the Fed balance sheet CPI and GDP, The exchange rate and lags of all variables.

6. The real equity price is dependent on contemporaneous percentage change in the long interest rate, the Fed balance sheet CPI and GDP, The exchange rate and lags of all variables

7. Construction rate is dependent on contemporaneous percentage change in the long interest rate, the Fed balance sheet CPI and GDP, The exchange rate, The real equity price and lags of all variables.

4.2.1.2. SVAR Stationarity

For a VAR model to be valid all of the variables have to be stationary. If the variable is not stationary, then usually taking the difference of if will make it stationary. The number of times that the data has to be differentiated is the order of integration of the variable. All the data in the models used already using the first difference of the data as the models deal with changes from month to month. However all of the data used was still tested for stationarity using augmented Dickey Fuller tests and found to be stationary in the form they are used in the model.

4.2.1.3. Choice of amount of lags

Choosing the lags of a VAR model can be done in a number of different ways. There are the AIC (Akaike Information Criterion), HQ (Hannan-Quinn) SC (Schwarz) and FPE (Forecast Prediction Error). For simplicity's sake this paper will use AIC to guide the lag amounts for the VAR models. This results in 3 lags for the model for interest rate changes, and 2 lags for changes in the central banks balance sheet share of country GDP. The fact that there is a difference in the optimal amount of explanatory lags between the two measures could have some implications that one has longer lagged effects than the other.

4.3. SVAR model for quantitative easing

Included here are the results of the model for the period of 2008-2024 using percentage point changes in the federal reserve balance sheet as percentage of GDP as a measure of quantitative easing in Granger causality and impulse responses.

4.3.1. Granger causality of Quantitative easing

This will show to what significance level the changes in the interest rate are useful in predicting future values of the various other economic factors.

*   Signifies a significance level of 10%

** Signifies a significance level of 5%

*** Signifies a significance level of 1%

QE measure on variable	Granger causality significance
GDP	***
Inflation	*
10 year interest rate changes	*
Changes in exchange rate index	***
Changes in the SNP 500	***
Changes in construction spending	

The results show that changes according to this model changes in the federal reserve balance sheet as a percentage of GDP is useful in predicting future values of some but not all of the included economic factors.

Notably it is significantly useful in predicting the future values of GDP changes, exchange rate changes and changes in the value of the stock market. There is limited ability to predict the future values of the inflation rate and the long interest rates and no ability to predict changes in construction spending.
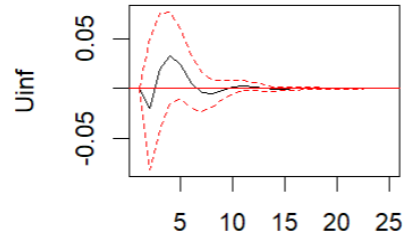
4.3.2. Quantitative easing Impulse response

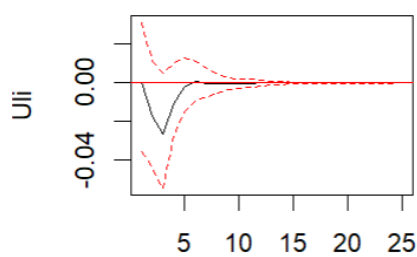Impulse of QE on output

Orthogonal Impulse Response from Usi
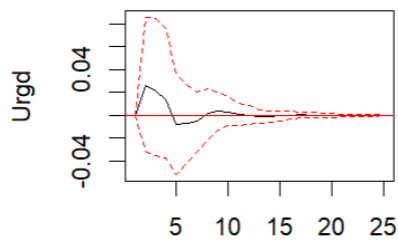
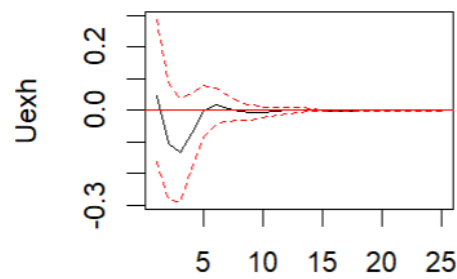Impulse of QE on Inflation

Orthogonal Impulse Response from Usi
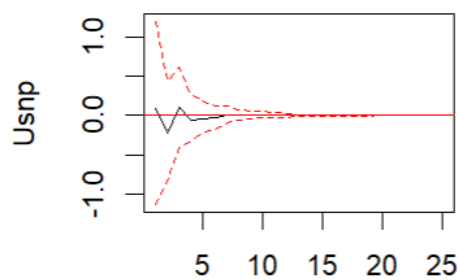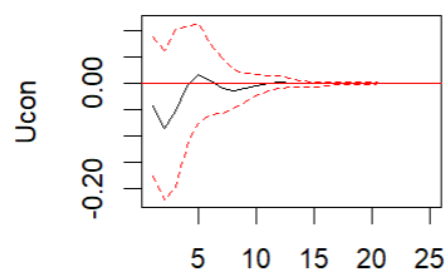

Impulse of QE on long interest rate

Impulse of QE on exchange rate

Orthogonal Impulse Response from Usi

Orthogonal Impulse Response from Usi

Impulse of QE on real equity

Impulse of QE on construction spending

Orthogonal Impulse Response from Usi

Orthogonal Impulse Response from Usi

Looking at the impulse responses that the Granger Causation tests show there is a significant degree of usefulness for prediction of future values. The effect on the GDP shows a small increase in the GDP growth as a result of the increase in the central bank balance sheet of about 0.02% before it levels out after about 5 months. The effect on the exchange rate shows a lowering of the exchange rate index at a peak of about 0.2% before leveling off after 5 months. The effects on the stock prices seems strange as it goes back and forth around 0 but with a large confidence intervals showing the volatility of the stock prices.

For the factors that there is some predictive power though the absolute values are generally small. There is shown to be a negative effect on the 10 year interest rate peaking at around 0.03%, which aligns at least in direction of effect with the goals of expansionary monetary policy. The effect on inflation shows an increase in the inflation rate changes peaking at about 0.02%.

4.4. SVAR model for Federal funds rate

Included here are the results of the model for the period of 1987-2007 using percentage point changes in the federal funds rate in Granger causality and impulse responses.

4.4.1. Granger causality of interest rate changes

This will show to what significance level the changes in the interest rate are useful in predicting future values of the various other economic factors.

* Signifies a significance level of 10%

** Signifies a significance level of 5%

*** Signifies a significance level of 1%

| QE measure on variable	Granger causality significance
GDP	**
Inflation	*
10 year interest rate changes	***
Changes in exchange rate index	*
Changes in the SNP 500	***
Changes in construction spending	**

The results show that changes according to this model changes in the federal funds rate is useful in predicting future values of most included economic factors.

Notably it is significantly useful in predicting the future values of GDP changes, 10 year interest rate changes in construction spending and changes in the value of the stock market. There is limited ability to predict the future values of the inflation rate and changes in the exchange rate index.
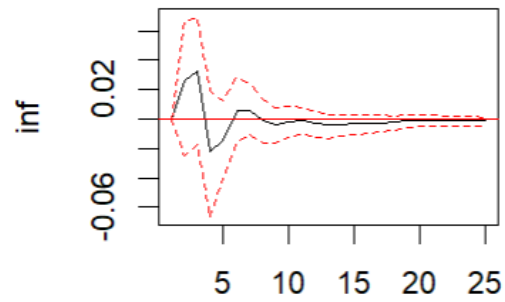
4.4.2. Federal funds rate Impulse response

Impulse of Interest rate on Output
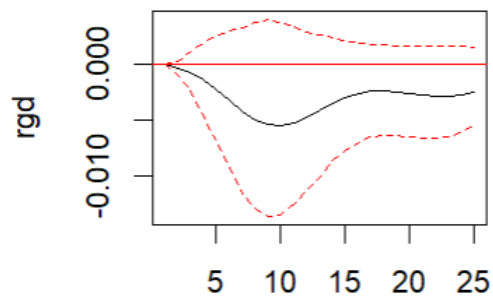
Impulse of Interest rate on Inflation

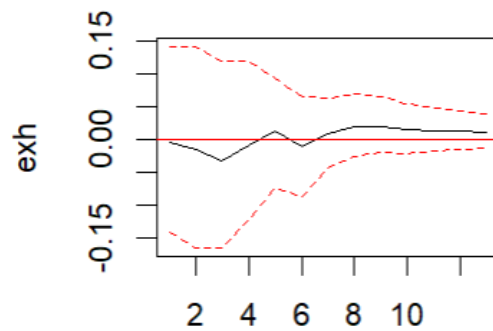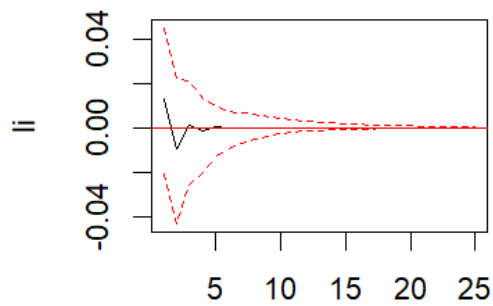Orthogonal Impulse Response from si

Impulse of Interest rate on Long interest rate

Impulse of Interest rate on Exchange rate

Orthogonal Impulse Response from si

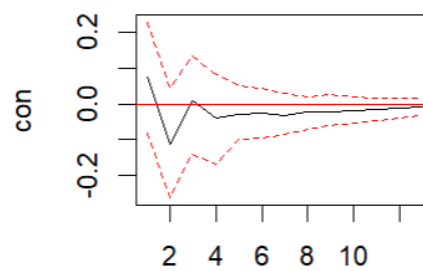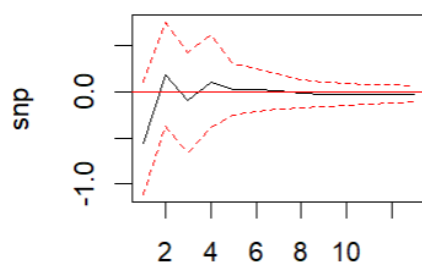Orthogonal Impulse Response from si

Impulse of Interest rate on real equity spending

Impulse of Interest rate on construction

Orthogonal Impulse Response from si

Orthogonal Impulse Response from si

Looking at the impulse responses that the Granger Causation tests show, there is a significant degree of usefulness for prediction future values. The effect on the GDP shows a small increase in the GDP growth as a result of the increase in the central bank balance sheet of about 0.01% which continues over the whole 2 year period. The effects on the stock prices show a large initial negative effect of about 0.5% before shortly leveling off. The effect on the 10 year interest rate shows a small initial effect on the changes in the long interest rate before leveling off.

The effect on inflation shows an increase in the inflation rate changes peaking at about 0.02% before going down. The effect on the exchange rate index shows a limited effect of an initial negative effect and then a persistent positive effect.

4.5. SVAR Diagnostics

4.5.1. Test for serial correlation

VAR models assume that there is no serial correlation between the error terms. A portmanteau test is used to test for serial correlation in all of the six VAR models. The null hypothesis is that there is no serial correlation and * indicates a significance of 10% **5% and ***1%

Type	Significance
Interest rate	**
Balance sheet percent of GDP	**

The fact that there is significant autocorrelation in all of the models does not reflect well on the usefulness of the models.

4.5.2. Test for normal distribution of the residuals

If the residuals are not normally distributed it suggests that there is some relevant variable which effects are being included in the error term.

Three tests are used for each of the models with a JB test, skewness only and kurtosis. * indicates a significance of 10% **5% and ***1% the larger the significance the more likely it is that the errors are not normally distributed.

	JD	Skewness	Kurtosis
USA Con	***	**	**
USA Uncon	***	***	***

4.5.3. Test for heteroskedasticity

Heteroskedasticity is where the errors of the model are not constant over time. It can be tested for by using an ARCH test to see if there are any ARCH effects (auto regressive conditional heteroskedasticity) in which case a ARCH or GARCH model might be more representative of the true relationship between the variables.

The null hypothesis is that there is no heteroskedasticity and * indicates a significance of 10% **5% and ***1% which would mean that there is not heteroskedasticity

| Country	Conventional	Unconventional
USA	***	

The fact that there is presence of heteroscedasticity in the model for quantitative easing could reflect the fact that several new policies including Quantitative Easing were introduced and reactions to those policies could change over time.

## 4.6. Comparison between negative interest rates and QE Using cumulative

In order to compare the actual effect of the different policing using the equivalence created in the OLS models, the cumulative effect of a year will be used as the numbers representing the effect that the policy shock has had on the economy. This will allow for comparison for the effect for the different policies locked to their relationship with the M2 money supply.

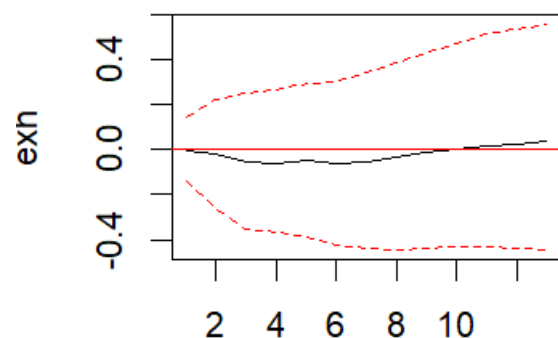### 4.6.1. Interest rate shock Impulse response Cumulative
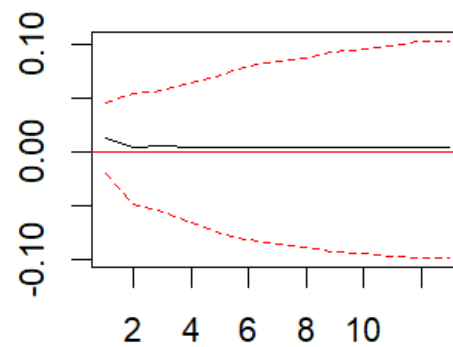
Cumulative Interest response on output
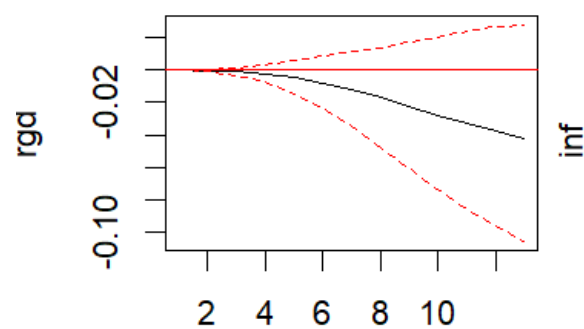
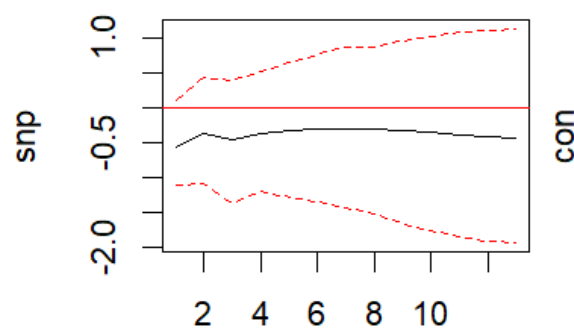Cumulative Interest response on inflation
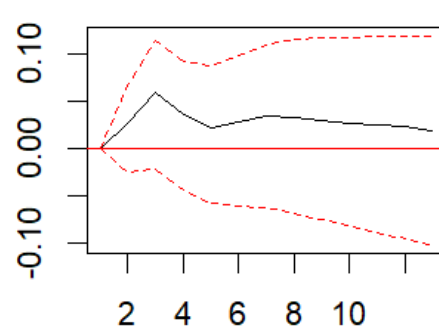
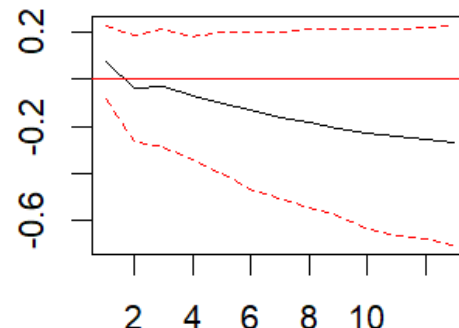Cumulative Interest response on exchange rate interest

Cumulative Interest response on long

Cumulative Interest response on real equity   Cumulative Interest response on construction

Looking at the results on the change in the real GDP from an interest rate cut of 1%. After 12 months it has impacted the real GDP by lowingering it from its steady state by about 0.05% It does however look like the effect will continue to worsen for some time as seen by the curve of the relationship and the impulse response from earlier showing up to 2 years.

The effects on the inflation rate is strange, as it is the opposite of the effect that would be expected from an increase in the interest rate. This phenomena is however a known aspect of SVAR analysis and is known as "the price puzzle" (Estrella, 2015) as the interest rate is often raised just before inflation rates begin to increase which then results in this initial increase in inflation from the impulse. It could be best to look at the second part of the inflation impulse response where the effect goes down and see that as the effect of the interest rate shock. But it's still strange that it results in an overall positive effect.
If looked at it that way then the inflation result is around a -0.04% change.

The effect on the exchange rate shows a persistent negative effect but with huge confidence intervals. This together with the weak Granger Causality shows that there seemingly has only been a limited effect on the exchange rate.

The results for the long interest rate are strange in that one would expect a much more clear relationship between the two interest rates. But it seems to show that the short interest rate is not affecting the long run interest rate.

The effect on the stock market shows a persistent effect of about 0.5% on the SNP 500 from an increase in the fed funds rate of about 1%. This is in line at least in direction of effect with the idea of the relationship between the interest rate and the stock market.

The effect on construction spending shows an effect of about 0,2% decrease after a year from an interest rate increase of about 1%.

4.6.2. QE shock Impulse response Cumulative

Culminative QE response on output   Culminative QE response on inflation
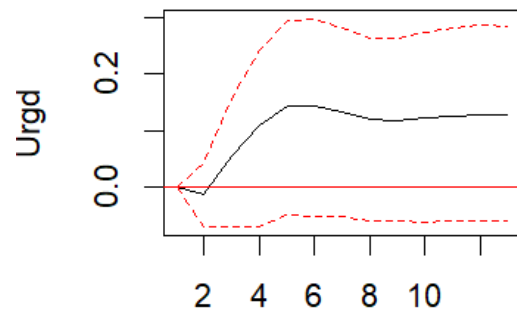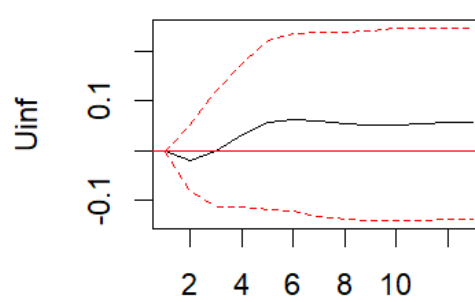
Culminative QE response on exchange rate   Culminative QE response on long interest
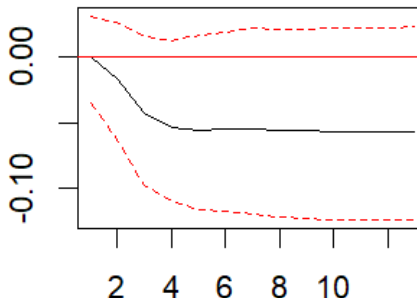
Culminative QE response on real equity
construction
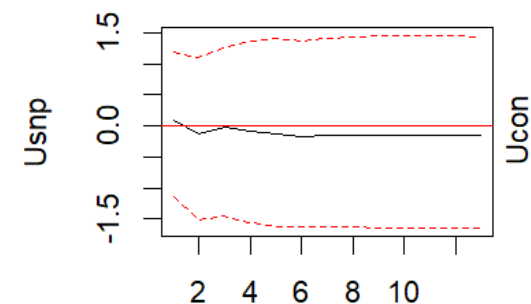
Culminative QE response on
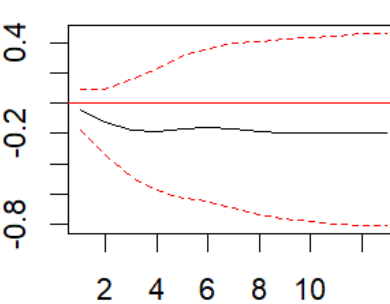
Looking at the results on the change in the real GDP from an increase in the federal reserve's balance sheet as a percentage of GDP by 1 percentage point. After 12 months it has impacted the real GDP by lowering it from its steady state by about 0.1%

The effects on the inflation rate seems to show an effect from an increase in the federal reserve's balance sheet as a percentage of GDP by 1 percentage point o be around 0.05%

The effect on the exchange rate shows a persistent negative effect of about 0,2% from an increase in the federal reserve's balance sheet as a percentage of GDP by 1 percentage point.

The results for the long interest rate seems to show an decrease of about 0,05% from an increase in the federal reserve's balance sheet as a percentage of GDP by 1 percentage point

The effect on the stock market shows a persistent negative effect of about 0.1%. This will be strange as one will expect the opposite. It can be as a result of much of the same kind of effect as that of the effect of interest rate on inflation where it's the timing that confuses the causation.

The effect on construction spending shows an effect of about 0,2% decrease after a year from a interest rate increase of about 1%.

4.7. Results after equivalence.

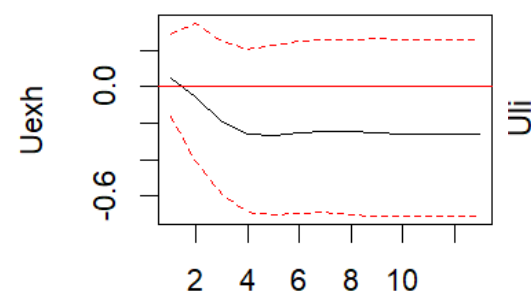Applying the equivalence that was established by the OLS models showing the relationship between the two types of policies to the results of the impulse responses we get:

Factor	Output	Inflation	Long int	Exchange rate	Construction	Real equity
QE effect for same M2	0.059	0.029	-0.03	-0.12	-0.12	-0.05
Interest rate effect	-0.05	-0.02 /0.02	0.01	0.01	-0.2	0.5

The result for the effects of the policies for the same effect on the M2 money supply seems to show that broadly the two kinds of policies are aligned in effect. On the effect on the output it seems to have roughly the same effect for the same associated M2 relationship. On the inflation rate this depends on if the results are looked at as the total, or just the later dip and the results are inconclusive. The results of the effect on the long interest rate are somewhat similar, but one would expect a larger relationship. The effect on the exchange rate seems large and can imply that foreign investors will be more affected by Quantitative Easing than by interest rates. However, there can also be other market forces at play. There are some areas where the effect becomes much different such as in the effects on the construction

spending and on the effects on the real equity market. That there is an identical effect in direction for the construction spending is strange, but can imply that quantitative easing is not as effective in that area. The massive difference in the effect on the stock market seems to be in two different leagues. The results will imply that quantitative easing is much worse at predicting the stock market than changes in the interest rate.

5. Discussion

This section will contain the implications of the results on the research questions and problem formulation of the paper. It will also go through alternative uses of quantitative easing and unconventional monetary policies and a discussion of potential problems with the models and results and ways they can be mitigated in the future.

5.1. What the models say about the effect of quantitative easing

5.1.1. Does Quantitative easing have an effect

While the models are not perfect and there are some differences in the magnitude of effect of the use of QE on the money supply between the countries and to some extent in different periods, it seems hard to deny the idea that quantitative easing has at least some effect comparable to conventional policy. There is something to be said for the idea that the policy did not have the desired effect in the 2008 crisis and that can suggest that quantitative easing will not always be a useful policy for reaching monetary policy goals. However the period and policy use in the 2020 pandemic period seems to show that its use can have some significant effect if nothing else then on the money supply. It can be a bit unclear if this is due to the specific circumstances resulting from the pandemic, or from its more extensive use that caused this more noticeable effect. But the results and data shows that in at least some cases there is merit for using asset purchase programs to effect the money supply. It shows this even when fiscal policy is accounted for using federal spending as a proxy. This does go against the ideas of the endogenous money theory's ideas on the subject and will strengthen the viewpoint that the central bank can to some degree control the money supply at zero lower bound using asset purchase programs.

5.1.2. Is the effect different from conventional monetary policy

The results suggest that in many ways the effect of quantitative easing are similar to the effect of conventional interest rate changes. It seems that the use of asset purchase programs and quantitative easing can be used to fulfill the role of expansionary monetary policy, at least in a period of zero lower bound. It seems to have had a similar effect to the effect of conventional monetary policy when it comes to effects on economic output and inflation, which is important as the main stated goals of monetary policy for the same impact on the money supply. It seems to potentially have a much less clear effect on the construction sector which could have some implication on the use of the policy and can make it less attractive to use if other options are available.

There are some unanswered questions about the models that show up in the results, such as the effect on the exchange rate and the real equity. If taken at face value the results imply that quantitative easing is much better at influencing the exchange rate while the interest rate is much better at influencing the stock market. The differences in effect on those factors seem to be so large compared to the other variables that it seems unrealistic that they will have such a different effect compared to the other factors. But the general idea could still be true. Whether this is a genuine difference or a result of the specific times that were included in the models is not clear, but it does suggest there may be some difference in how the different policies affect those areas even if the real difference is not what is shown in those results.

One aspect that was not looked at in detail, but might be showing in one of the results is the idea that quantitative tightening or the selling of assets acquired by the central bank in Quantitative Easing might have a different effect than the initial Quantitative Easing. This will be shown in the results for the OLS model for the period roughly corresponding to the tenure of Jannet Yellen as chair of the federal reserve. This period features mostly a reduction in the federal reserve balance sheet as a percentage of GDP while showing a significantly less significant effect on the M2 money supply. An issue with this period is that it also coincides with increases in the interest rate such that conventional and unconventional contractive monetary policy are conducted at the same time which makes it harder to conclude anything definitive from the results. It can be the case that an increase in the central bank balance sheet can have an effect analogous to interest rate cuts, but the opposite might not be true.

5.1.3. What do the results imply for future use of unconventional policy

The results of the modeling seem to show that in at least some circumstances and at least to some degree quantitative easing can be used effectively as expansionary monetary policy. If this usefulness can be applied to all possible circumstances, or if it is interchangeable with conventional monetary policy is not clear. The results show some differences in effect for the same increase in money supply in some areas which can suggest that there are some different effects that, if accurate, can influence the use of the policies depending on the goal of the central bank.

The results do seem to show that quantitative easing does not have a significantly worse outcome that will make its use unpreferred when there is a possibility to use conventional policy. This is a moot point however as it is also very possible that the effectiveness of policies such as Quantitative easing can be significantly different when used in times not characterized by the zero lower bound. It would however be interesting to see what would happen should such a policy be conducted in a period with interest rates above the zero lower bound. It would also be worth exploring how policies such as quantitative easing would interact and compare to negative interest rate policies.

5.1.4. Counterpoint to the results

While the results taken at face value seem to support the mainstream ideas about quantitative easing and money creation the explanation of the endogenous money theory of the results will be different. The most obvious rebuttal from the point of view of the Post-Keynesians will be that all the relationships that are seen (from the QE side) will be the result of concurrent use of fiscal policy. Most governments at various times during the relevant crisis conducted their own policies in their attempt to stimulate the economy. Some of these policies can look, in practice, very similar to monetary policy and all are intended to have roughly the same effect on the economy. The central bank is rarely acting alone in times of crisis and it is conventional wisdom for the government to also conduct countercyclical fiscal policy. Indeed the Post-Keynesian posit that it is only the fiscal policy that has an effect. This will mean that most if not all of the effects shown in the models will come from the government stimulus that is conducted at the same time as the unconventional monetary policy. The fact that the United States is the country that showed the largest relationship between the money supply and the federal reserve balance sheet is also the country that conducted the largest stimulus packages in 2008 and 2020 will support that idea.

For concrete examples these policies will include the stimulus packages given out to people like the ones done by the Obama administration in 2009 giving every person 300 dollars. Or similar instances of one time payments given in response to the covid 19 pandemic by the first Trump administration and the Biden administration totaling about 2000 dollars per person. Policies such as the TARP (troubled asset relief program) can also be under this category. The TARP and policies like it essentially involved the United States government lending enormous amounts of money directly to the struggling banks that were affected by the crisis. This is almost indistinguishable from lending operations. Arguably the only difference is that the government is acting as a middle man which makes it fiscal policy technically by definition as the banks are loaning from the government rather than from the central bank.

While this is attempted to be dealt with by using changes in federal spending that will not include all factors and does not take into account how it is spent. It also requires converting quarterly data into monthly and as such is much less responsive than the monthly monetary policy variables. It is also limited to showing only the federal responses to the crisis and does not include the policies of the individual states. It is not a perfect measure and even if all those factors from all different monetary tools and the fiscal equivalents become accounted for it will still be hard to claim that there will be no bleed over from other factors not accounted for. The economy is a complicated thing with a million different inputs and outputs that all affect each other all of which are constantly changing. There are many things that can happen and have a similar effect to monetary policy which can bleed into the data and the result. Obviously this can include other government policies, especially fiscal policies meant to stimulate the economy, but can also include events that can have a negative effect on the economy. This is especially true for the relevant periods used in the models which, for the unconventional monetary policy models, are characterized by economic crisis and uncertainty. Should an economic crisis or downturn be caused by a political issue such as a trade war or actual war then the end of that conflict might show up in the effect of monetary policy.

A major issue with this is also that it makes the comparison between different countries significantly more difficult. This is because all the different countries will have conducted their own different fiscal policies in response to the economic situation. So not only is there a factor that easily bleeds into the unconventional monetary policy variable, but also that factor can vary widely between involved countries. Also it is not the case that all of those countries

will only have a difference in magnitude of effect of fiscal policy. Some of the relevant countries will respond to the Great Financial crisis with austerity and contractive fiscal policy. This is especially the case when looking at the model and data for the Eurozone as each member country will have their own independent fiscal policy while being in the same model. Any inclusion of fiscal spending will likely have to separate the eurozone to account for separate fiscal policies.

5.2. Other potential issues with the models.

Monetary policy and its effects is a wide and complicated area and there will be many things that are not included in the models made for this paper. This paper is also not complete and perfect analysis as there are many places the models can be expanded or improved. This section will cover some of the issues encountered with this paper's chosen models and will also include some of the areas that will be considered unconventional monetary policy that is not included in the paper.

5.2.1. Other unconventional monetary policies that were not included

Due to the nature of the money supply and the time of crisis involved in the periods used in the models there is a significant risk that much of the actual effect of the policy decisions are either being lost in the effects of other factors or being exaggerated by them. There are no real experiments in economics where it is possible to keep all else being equal. This is also the case for unconventional monetary policy. This is because the models used in this paper only really take into account the asset purchase programs part of the wider selection of monetary schemes. Lending schemes, forward guidance and fiscal programs are all to one extent or another present and used at the same time as asset purchase programs. Lending operations are to some extent included in the models as they will also show up on the central bank balance sheet. However there is no reason to believe that they will have an identical effect as quantitative easing and as such probably to some degree bias the estimate. By not having them in the model it is possible that it can skew the effect shown on the asset purchase programs. Forward guidance is another form of policy that is not included and it have a variety of strange potential interactions that make estimating its effect difficult.

5.2.2. Changing effect over time and by country

Due to the way that unconventional monetary policy has been conducted (being only after all conventional policy is exhausted) the models for unconventional policy are based on data from different periods than those models of the conventional policy. While this is necessary as 1, there are no real times where both policies are conducted simultaneously and 2, it makes it possible to separate the effects without having them bleed into each other. It does leave the potential problem of period specific factors showing up in the results and giving a skewed look into their effects compared to each other. When the interest rates relationship with the money supply was looked at in truncated 10 year periods it shows that while there was a rough similarity there were still noticeable differences. There was also a not insignificant difference in the effects of changes in the federal reserve's balance sheet based on year. As such it should not be taken as a given that showing the same policy had a certain effect in one period would mean that it has had or would have had the same effect on in all periods or that it will have that same effect in the future.

While it is unlikely that the general direction of effect of monetary policy will change it is not impossible that the magnitude of effect can be different over time. There are several reasons that this might be true. This can be due to the difference in economic crisis or context that the policy is conducted in. Monetary policy might have a better ability to influence for example inflation and output in the case of a crisis of confidence where lack of liquidity is one of the main drags rather than a crisis driven by political or environmental turmoil like a war/embargo or destruction from an earthquake or hurricane. This can be possible in the case of the period of the Great Financial crisis and the covid 19 pandemic. The Great Financial crisis was more a crisis of confidence in the financial system the covid 19 pandemic led to massive changes (at least temporarily) to the supply aspect of the economy which can not return no matter any increase in liquidity due to lockdowns. Expectations of the general population and financial institutions is a variable that can have a significant effect on the effectiveness of some monetary policies. Inflation expectations are known to be a major factor on future inflation as people change their behavior to hedge against it which obviously will affect policies aimed at keeping inflation at a fixed percentage.

It is almost certainly the case that monetary policy has to some degree a difference in effect between some countries, at least compared to other factors. If this is not the case there would not be any countries that choose to give up their own monetary policy independence and either join a currency union or unilaterally adopt another countries currency. Some countries,

especially those who are reliant on imports, might be more vulnerable to changes in the exchange rate. In this case even the Post-Keynesian idea that policies such as quantitative easing will only have an effect through the exchange rate might agree it can have a significant effect, at least on the inflation rate.

It can also be that the effect of the monetary policy is affected by the confidence of the given population and financial institutions so that if that is lost or gained it can lead to future policies having a lesser or greater effect. If the expected effects have an impact on the effect of the policies then it is also possible that due to their recent invention that the unconventional policies can in future have a different effect than those in these periods due to the lack of experience and data from which expectations will arise. People might change their behavior differently in response to certain policies when more is known about the effects those policies have had before.

Another aspect is that the effects of specific monetary policies can have different effects at different times through fundamental changes in society and technology rather than crisis specific. The world of banking and finance are very different today than they were even 50 years ago. The obvious way that this is seen is through the exchange of information where information can now be constantly transmitted in real time to everywhere on the planet. Investors and businesses can make their decisions based on new information much faster than they could before. It's therefore not crazy to think that the difference between the two policies' effects can be explained by the difference in time periods.

5.2.3. Counterfactuals

Because monetary policy is not conducted randomly, but in a relatively predictable way based on the goals and missions of the central banks, there is the possibility of the data showing an opposite effect from what would be the intended effect, as there is no place where we can look at what would have happened if a decision had not been made. If monetary policy is always conducted countercyclical then the interest rate is always lowered when the GDP growth rate is lowered until it stops falling, then it can appear that the two are correlated in such a way it appears that the interest rate cut had negatively affected GDP growth when what it had done was decrease the intensity of the fall. Another aspect of this is that we cannot see or analyse what would have happened if the central banks had done nothing. This is possibly seen in the models in the effects on inflation for interest rate changes. As mentioned, SVAR models are known to show a relationship between interest rate changes and

inflation that goes against the traditional understanding of the relationship between the two which is also present in the models used in this paper. its possible that a better specified model would show a more accurate view of the effects of the interest rate changes on the inflation rate (and the other variables).

5.3. Other criticisms of quantitative easing and unconventional monetary policy

The focus of this paper has been on whether quantitative easing and asset purchase programs in general are effective in their goals based on the criticisms of the Post-Keynesian school of economics. While the results of the models suggest that quantitative easing can be used as an expansionary monetary there can be other reasons than effectiveness that suggest not using it. There have been other criticisms laid on asset purchase programs such as quantitative easing that are not exclusive to the Post-Keynesian school of economics or schools of economics in general. While they will not be gone into detail or analysed based on statistical models it is probably worth pointing them out and discussing them.

5.3.1. Moral hazard

Quantitative easing in particular was criticised for having the potential of leading to moral hazards for the financial institutions that they purchased those assets from. This is to some extent a result of the context that it was first implemented, being the subprime mortgage crisis that led to the Great Financial crisis of about 2008.

The general criticism is that the origin of the crisis was a massive risk taking by banks and financial institutions in creation and holding of subprime mortgage bonds which for some time made those financial institutions significant profits. However when the housing double burst those same financial institutions were not allowed to face the consequences of that risk as the government to a large extent used policies like quantitative easing to save those institutions in order to avoid damage to the wider economy as they were deemed too big to fail. (Guizani, 2021).

The worry is then that there could arise to these policies a moral hazard where the financial institutions, if they are large enough that their fall would lead to significant damage to the economy would be able to take on as much risk as they would like and if it fails they would

be saved by the government in part through purchase of their bad assets. This will in theory then lead to a bigger likelihood for a similar crisis to occur again as there will be even more incentive to act in the ways that lead to the original subprime mortgage crisis. This can also apply a moral hazard to governments as quantitative easing can conduct reckless policies with no worry about spending in the belief that quantitative easing can rescue the economy when it goes bad (Guizani, 2021).

It is unclear if this is a significant cause for alarm or if it is inherent in asset purchase programs as a policy. The goal of asset purchase programs are not primarily to save financial institutions that have made bad investments. The goal is to increase liquidity and the money supply. As such it's not hard to imagine that this criticism could be rendered null and void through the purchase of assets that are not bad or troubled so as to not create incentive to invest in such assets in the hope that the central bank will purchase them. Although this will probably have an effect on the effectiveness of the policy.

If moral hazards are or have been a significant issue caused by the use of quantitative easing and other policies then you would expect to see, all else being equal, an increase in the amount of risk taken by financial institutions. That is an increase in the amount of leverage used by financial institutions at least of the size that they could be considered too big to fail. While it is not looked at in this paper it could be an interesting topic to look into as a potential consequence of policies like quantitative easing and lending operations. One of the worst aspects of this problem, if it exists, is how to remove that expectation in the future once it has already been established. Once the expectation that a "too big to fail" bank or other institution will be saved before it will fail then no matter what kinds of statements the central bank or government makes that impression or expectation will remain in some capacity. This could make the only way to reverse that impression and remove the moral hazard (if it is actually significant) would be to wait until one of those institutions would fail and then not help them. This would then lead to the very problem the policies were attempting to avoid and could have helped to make it more likely.

5.3.2. Distribution

Another criticism of quantitative easing and asset purchase programs and Quantitative Easing have been its perceived focus on helping what are essentially the richest parts of the society rather than the more poor parts of society. The argument and criticism is that the purchase of assets such as loans and bonds only provide liquidity for banks and for those who have the money to make such investments in the first place, when in times of crisis the people they argue who need the most aid are those who would not have any assets to purchase (Lee, 2021).

There are two aspects to this claim and criticism. The first aspect of this is the idea that policies such as quantitative easing which aims to increase liquidity and through that output and inflation will be more effective if that liquidity is available to the poorest in the country. There can be something to this idea. This is similar to the Post-Keynesian criticism of quantitative easing that the people who will have the assets available for purchase will be likely to use it to pay debt or invest in other assets rather than increase consumption. While this might be a valid criticism and it can be the case if the data shows that quantitative easing might have a lesser effect on economic output than conventional policies it does not give a simple solution as those less well off will not have any assets to purchase and thus there will be limited options to give them liquidity. If such a policy is to be carried out it will be significantly different from regular quantitative easing. As regular quantitative easing is effectively just allowing asset holders to cash out by providing a market for their assets thus giving them liquidity for the value they already have it is arguably value neutral. There can be no way to conduct such a policy with people who do not have assets to be converted into liquidity and as such it will involve adding value from nothing making it a fundamentally different policy. This also adds a dimension of legality as it is not all central banks that will have the authority to conduct such a policy. While this can be irrelevant from an economist's perspective of whether it will be a good policy or not in theory, it can make discussion on it almost a moot point as it cannot be implemented.

Another aspect is the claim of unfairness that is caused by this claimed unequal distribution of help. This is more of a political argument and can apply whether or not the first claim of limited effect has any merit. It is partly a claim or assertion that the central bank ought to be concerned with inequality and should add that to one of its goals along with managing inflation and output. It can be debated if the central banks should attempt to conduct monetary policy in a way that combats inequality and it is not clear that QE for the people

will be the most effective or effective at all in reaching that goal. It can still be the case that central banks would or should consider conducting such a policy or similar policy. Inequality and its effects on the economy is a subject that has gathered a lot of interest and discussion in economic circles for many years now. There is a fairly intuitive idea that all else being equal, a lower inequality is probably more healthy for a country and economy than a higher level of inequality. It is however not clear central banks can create policy that will affect inequality in a productive way or if it can do it in a way that will not damage the central banks other goals. How that is to be done is not clear as mentioned before, there are no assets to purchase from these people. There have been some proposals for this including things like "qe for the people" that will be discussed in a section on "QE for the people".

5.4. Could unconventional monetary policy have other uses

Discussion on the difference between conventional and unconventional monetary policy must take account on how differences between the two, both in effect and in policy flexibility can have depending on the goals of the central banks. There are some that believe that central banks should include other priorities other than inflation and output when they conduct their monetary policy. This could be one way that unconventional monetary policies could be used even if they are not as effective at dealing with inflation and/or economic output as conventional interest rate cuts. Conventional interest rate cuts do not give the central bank the flexibility to conduct policy aimed specifically at other areas that could potentially be desirable to affect.

In this case it could be conceivable that unconventional policies such as quantitative easing could be used in conjunction or as a supplement to conventional monetary policy even in periods not characterized by the zero lower bound. This could be done as the central banks could use the conventional interest rate changes for goals related to inflation and output while at the same time pursuing goals like equality and green transaction with unconventional policy.

There have previously been laid out several different ways that central banks can conduct their policy with a goal that is different from the traditional dual goals of stable inflation and stable growth. This paper will highlight two of these types of proposed policies, go through their means and goals along with some discussion on challenges such policies could face.

5.4.1. Green monetary policy

Green monetary policies are a collection of proposed (and sometimes implemented) policies that are meant to use the powers of the central bank to address the growing climate change issue. The reasoning for including climate change mitigation for the central bank is effectively that it is an issue where monetary policy could potentially help and the problem is severe enough that it might be necessaryThere is also the fact that climate change could in the future cause issues for the financial sector and economy in general in the future. This could include massive changes in the insurance markets due to increased risks from natural disasters, droughts, extreme weather and rising sea levels among other issues. (Klooster & Monnet, 2023). The central bank will then have to deal with the fallout of those issues anyway so it can be advantageous to address it before it becomes a problem.

The types of unconventional monetary policy that are proposed or have been used include lending operations for green investments and exclusion of fossil fuels from central bank considerations as collateral. It all boils down to the central bank providing effectively subsidised loans and credit to investments and actors who invest in green projects while restricting access to loans and credit to investments and actors who invest in fossil fuel projects (Klooster & Monnet, 2023)

A potential problem with this type of policy is that it could potentially have a negative impact on the more traditional goals of the central banks, being stable, low inflation and 0 output gap. It is not impossible that the choices of central banks regarding loans and investments can cause distortionary effects on the economy in general or the energy sector in particular. If the green projects that are invested in do not provide the required energy and fossil fuels are held back, it could lead to an increase in the energy prices that could have a variety of negative impacts on the particular country. This is because the price of energy flows down into almost all manufacturing thus reducing competitiveness/productivity and increasing prices both of which hurt the traditional goals of central banks. Nevertheless it could be argued that should that pain arrive it will be worth the potential climate benefits.

However in order to truly evaluate the effectiveness of such a policy in practice there will need to be a thorough analysis of those policies, probably looking at the green monetary policy that has been enacted by The Bank of England. However this is not the aim of this paper, but it does show that there can still be an argument to use forms of unconventional policies even if they are less effective for the conventional goals of central banks.

5.4.2. QE for the people / helicopter money

Qe for the people or quantitative easing for the people is a proposal for monetary policy that is primarily aimed at addressing the criticism of quantitative easing that it is allegedly only or mostly helping the richest in the society and not the poorest (Lee, 2021).As described earlier there were two parts of the criticism of unequal distribution of help through quantitative easing. One was a claim that liquidity will benefit the economy more if it is accessible to the poorer in the society. The other part is the idea that central banks and monetary policy should or needs to take inequality into consideration.

Qe for the people is effectively a proposed version of helicopter money or the idea that you can throw money out into the economy and that will increase liquidity and create demand. This proposed policy despite including the name of QE will function very differently from quantitative easing and other asset purchase programs. The major difference is that there are no assets that will be purchased. Instead of allowing people and institutions to access liquidity by providing a market for their assets at a favourable price, the policy will involve the central bank printing money and giving that money equally throughout the population by directly adding money to their accounts. This gives some practical issues to the policy as it is not all central banks that have the authority to conduct that kind of policy. This is not actually a criticism of the policy itself, but can explain why it has not been conducted seriously by central banks. It does also make it less interesting to look into as a theoretical policy that will not be conducted in practice is a bit like asking if a tree falls in the woods but no one hears it, did it really fall. Nevertheless such a policy does have some supporters and there are different ideas of how such a policy will work and what kind of effect it will have.

The term helicopter money was first used by the prominent economist Milton Friedman as such the mainstream view of helicopter money or QE for the people is sometimes referred to as the Friedmanite view.

Friedman's helicopter money parable envisions a scenario where the central bank prints some amount of cash and as a one time and never believed to be repeated event drops that money in an area where it is equally picked up by all the inhabitants. In this thought experiment it is shown that using that sort of policy the central bank could if it wanted to create inflation and output by directly increasing the money supply as the perceived increase in wealth would lead to an increase in demand. It is a policy that has been stated to be a kind of last resort by former federal reserve chairman Ben Bernanke (Bernanke 2015).

As such it is not a crazy idea to implement, but is clearly seen as a solution that will or should only be used as a last resort. A difference to Friedman's idea of helicopter money could also be the idea that it would be or would be thought to be a one time event. Should such a policy be pursued and the central banks lacks credibility the market might react in a negative way which depending on the severity could have more negative effects than doing nothing. Associations with printing money to pay for policy or giving them to people could lead to disproportionate increases in inflation expectations as comparisons are made to countries which have experienced hyperinflation. This might not be a major issue for a country like the United States, but could be an issue for a country which does not have the same economic clout.

At first glance the idea of helicopter money seems to go completely against the idea of endogenous money theory. The central bank seemingly wills money into existence and without going through the regular banks as middlemen. According to the Post-Keynesian view it's effectively a fiscal stimulus financed by debt. As such it according to that school of thought will have a much more pronounced effect on the aggregate demand and therefore inflation and output than regular quantitative easing. A comparison would be if there is a meaningful difference between the government loaning money to give every citizen some liquidity like the Trump and Biden covid 19 stimulus checks compared to the central bank directly adding them to the peoples account which would go on its account. The Post-Keynesians argue that eventually in both cases the transfer will end up on the central bank's balance sheet and as such there is no meaningful difference at least in economic effect (Lavoie 2019).

Since according to the Post-Keynesian view it is essentially the same as a fiscal tax funded stimulus it leaves the question if it should be conducted instead of fiscal stimulus or at all. Since this paper does not deal with any empirical measurement of the effectiveness of Quantitative Easing for the people or helicopter money it cannot comment on the veracity of the claim of equivalent effect. If you assume that the claim is correct and that it will have the same impact on the economy (in inflation and output at least) that will make the question of which type of policy to use a political question. Regular fiscal policy can be slow to react as (in the west) policies have to be proposed, debated and voted on before they can be conducted. There are also many ways that policies can be slowed down, watered down or be made contradictory due to the political situation of the given country at the particular time. This can make a central bank's ability to conduct an identical policy make that policy arguably superior to regular fiscal policy. The question then becomes if the central bank

should have the authority to conduct what is effectively fiscal policy that for the most part at least in western countries should be exclusively the power of elected representatives. For economists it can be tempting to put so much power in what would be effectively technocrats and it could make policy making more decisive and could be done free of political bias or concerns. However even if it could be done it probably would only be a matter of time before the power is reclaimed and might lead to unforeseen consequences anyway.

6. Conclusion

There are some results that suggest that unconventional monetary policies and QE in particular has had a measurable effect that is in many ways comparable to the effects of more conventional monetary policy. Quantitative easing seems to at the very least be in some cases a useful tool to achieve the conventional goals of monetary policy in effect on output inflation and the money supply. While the results are not conclusive and have their own issues this does lead some credit to the idea that the behavior of treating unconventional monetary policy and quantitative easing in particular are not dissimilar to conventional tools and have a place in future policy decisions. In addition there are other ways that the use of policies such as quantitative easing can be used for goals other than those of conventional monetary policy goals such as climate and inequality. The potential for such policies in those areas are bound more by questions of political nature about legality and the responsibility of central banks rather than purely on practicalities and effectiveness.

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