Is the effect of monetary policy changing in the Eurozone?

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Abstract

The deflationary trend of the Eurozone suggests a decrease in effectiveness of the European Central Bank`s policy. In this paper the effectiveness of monetary policy is compared to see whether it has changed. To do so, first the functioning of the European monetary system is clarified. Subsequently, causes for change in its dynamics are discussed. This is followed by an empirical research comparing two 4-dimensional vector autoregression models in two different periods. The first period is directly before the crisis of 2008 and the other starts from 2013. The results are evaluated using impulse response functions. No evidence is found that the effectiveness of the ECB has changed, indicating that the effect of monetary policy remained the same.

Introduction

The last month in which the European Central Bank (ECB) reached its inflation target of 2% was January 2013. The following months have been infested with consistent decreases of inflation. Three years later, the downward cycle has still not been broken resulting in a small deflation. The ECB seems to desperately fight the cycle and announced to increase its quantitative easing program. Recently, an extra 20 billion euros is contributed to monthly asset purchases totalling 80 billion euro. By expanding the monetary base the ECB tries to lift the Eurozone out of its current deflationary environment, as it is perceived harmful for the economic growth.

Shortly after the financial crisis in 2008 the Eurozone also experienced a sudden short period of deflation. This happened after a fairly stable inflationary trend since the beginning of the European Union. The question arises why the ECB is not able to increase the price levels this time.

Previous research provides no definite consensus on the possible changes in effectiveness of the ECB`s monetary policy. Boeckx, Peersman and Stevens (2015) argue that the introduction of quantitative easing is working and increasing effectiveness leading to inflation. On the other hand, de Vries & van Marle (2015) suggest quantitative easing is harmful to the economy as it disturbs financial markets. Other research mainly focusses on the period before or after the crisis. For example, a study by Castelnuovo (2016) shows no significant results of inflation in response to monetary policy in the period until 2008. A different study by Hausken & Ncube (2013) compares monetary policy between different big central banks after the crisis. They predict increased effects of quantitative easing since the ECB stopped its sterilization program.

In this paper, effectiveness of monetary policy is measured by the ability of the central bank to influence the economy`s interest rates and its indirect effect on inflation. All previous research does not compare the ECB`s monetary policy effects over time. Therefore, the research question of this paper is: Has the effect of monetary policy by the ECB changed? The focus of this paper is the potential change after the crisis, compared to the stable period before. To help answering this question the effects of monetary policy on the economy is discussed.

First the monetary system in the Eurozone is discussed, to see how (new) money moves through the economy. Secondly, previous research concerning the effects of monetary policy is discussed. This is followed by a theoretical framework where an expectation is formulated. The paper proceeds with the data and methodology for a quantitative research. Two vector autoregressions (VAR) are performed, one before and one after the crisis. The results of the performed regressions are discussed after which the conclusion is presented.

Monetary system

ECB

The European Central Bank (ECB) is the central bank of the Eurozone, covering a total of 19 European Union members. It is headquartered in Frankfurt and holds strong ties with all the member National Central Banks (NCB). The ECB was established in 1998 and has issued the euro currency in January 2002. The ECB is an independent institution, meaning that it operates without being influenced by politics. The primary goal of the ECB according to the Maastricht treaty is to maintain price stability (ECB, 2016). This has been interpreted as yearly increases in the Harmonised Index of Consumer Prices (HICP) of little below 2%. This goal is known as the inflation target.

Monetary policy

The ECB is trying to influence the economy through its policy. The ECB communicates monetary policy decisions using announcements of actions to be taken place in the near future. These actions consist of five different financial instruments which make adjustments in the monetary base. The instruments are reverse transactions, outright transactions, issuances of debt certificates, foreign exchange swaps and fixed-term deposits. The reverse transaction is the most used instrument and consists of a loan to commercial banks in exchange for collateral. An outright transaction is the purchase of any government or commercial bond. Debt certificates are very similar to bonds issued by the ECB itself, temporarily raising money for the central bank. Foreign exchange swaps are transactions in which the ECB exchanges euros for other currencies. Fixed term deposits are deposits that have no option of withdraw until maturity (ECB, 2016).

Using these instruments the money supply is affected. If the ECB lends money to banks, there is money circulating that was not around before the loan started. The ECB thus creates new money that circulates through the economy following such expansionary policy. When the ECB buys dollars they pay for these with newly created euros. This also works the other way around. When a bank pays back a loan to the ECB, the amount of circulating money is decreased. The same principle holds when the ECB buys or sells bonds as part of outright transactions, where the monetary base increases when the ECB is spending money. Under expansionary policy the monetary base increases and the opposite for contractionary policy.

Banks need by law certain amounts of money to be deposited at the central bank. To fulfil these daily liquidity requirements, banks can lend from each other. The interbank rate is the price at which this lending occurs. In the Eurozone this rate is called the Euribor rate. The effect of monetary policy transactions is that they influence the interbank rate when there is more or less money in the system. If there is more money, money becomes cheaper (a lower interbank rate) due to a bigger supply (Brunetti, Filippo, & Harris, 2011).

The liquidity of banks and security dealers is affected positively by monetary policy. Under expansionary policy, dealers can increase borrowing as banks lend at lower rate. The ECB also improves liquidity if it buys assets from a dealer directly. The dealer now receives money in the present moment, instead of waiting for the future revenue. This results in a higher

demand for all financial securities, raising the prices of those securities and therefore reducing the yield (Mehrling, 2011). At the same time deposits of commercial banks increase. This is because dealers who sell assets to the central bank can also deposit their money at the bank instead of buying other assets. Even if they choose not to deposit their revenue right away and buy assets, the seller of those assets might choose to deposit the received money. This continues until the banks receive the money as deposits, what result in the same effect as direct loans to banks: lower interbank rates.

Banks who have access to cheaper money are willing to lend against lower rates. Therefore, a lower interbank rate results in lower interest rates for businesses and households. Empirical evidence confirms this positive relation of the interbank rate and other longer term interest rates. This effect is called the transmission mechanism of monetary policy.

Open market operations

The most common form of open market operations are the refinancing operations. These are reverse transactions in which money gets transferred to commercial banks to lower interest rates. The way the ECB executes these operations is by using auctions. The ECB specifies the loan they wish to lend and the bank who offers to pay the highest amount of interest receives the loan (Nyborg, Bindseil, & Strebulaev, 2002). This way, the loans are distributed fairly at the right price. Reverse transactions are often short loans with durations of only one week. If the ECB wants to achieve a permanent effect, it consistently rolls over the loans. Meaning that new loans are continuously started when old ones mature.

Minimum reserves ratio

A different tool to control the money supply and indirectly interest rates is trough minimum reserve ratios. Commercial banks have to make deposits at their NCB depending on the amount of checkable deposits (received deposits from clients) a bank has in possession. This ratio is currently 1%, meaning that for €100 worth of deposits €1 has to be deposited at the central bank. The effect of these required reserves is that a lower ratio raises the amount of possible deposits. This is elaborated further in the section of fractional reserve banking. Changing the reserve ratio can have a big impact and is therefore a measure hardly used, making the measure a less important instrument. Only in 2009 the ratio was changed, as it used to be 2%.

At the start of the Eurozone, banks used to receive interest on their obligated deposits (European Banker, 1998). This rate was quickly reduced to the current 0%. The other way around, if the bank does not deposit enough it receives a fine. This fine is based on a formula taking in account the amount of deposit in shortage, the number of days over which the shortage occurred and the penalty rate of 2,8 percentage points above the marginal lending rate. This stresses the importance of interbank borrowing, as it prevents getting fined.

Standing facilities

The ECB offers the commercial banks a possibility to lend or deposit money overnight when banks have sudden shortages or surpluses. The marginal lending facility provides an opportunity to lend money to banks to fulfil their reserve requirements for the day. Just like the open market operations, banks always need collateral to be able to borrow using this

channel. The marginal lending rate is higher than the Euribor rate since banks are expected to first deal reserves mutually or via open market operation auctions. The deposit facility on the other hand is an opportunity to deposit excess reserves. Excess reserves are commercial banks` money that is not lend out on any market, thus not including the required reserves. The current rate of interest on excess reserve deposits is -0.40%, meaning that banks have to pay the ECB for holding on to their money. This negative rate is possible as long as banks do not make risky loans or build safes to hold the excess reserves in cash.

Asset Purchase programs

The newest instrument is the asset purchase program used since the beginning of 2009. The ECB started to buy bonds trying to improve the governments' bad financial situations due to the financial crisis. Initially, for every bond bought the ECB would sell a different bond to keep the money supply fixed, a process called sterilization (Belke, 2010). The ECB considers the asset purchase programs as non-standard monetary policy measures, even though they do not defer much from open market operations. The biggest difference is that the securities are owned by the central bank instead of being used as collateral. Since 2014, the ECB started the process of quantitative easing by stopping to sterilize its purchases (Mattich & Blackstone, 2014). Besides this, the amount of purchases also drastically increased. In the expanded asset purchase program started June 2016, monthly security purchases amount to €80 billion. The securities are bought mainly from the public sector, contributing around €60 billion. These public sector purchases consists of 90% government bonds and 10% securities coming from international organisations. The remaining purchases of €20 billion are commercial bonds. The securities are not being sold as long as the program runs, which is currently until March 2017 (ECB, 2016).

Dealers

When a government is running a deficit and needs funding, the National Central Bank steps in to emit new government bonds to raise money. This is done through auctions with primary dealers. These primary dealers are big banks and trading firms willing to buy these bonds. To participate in these auction, a membership to the concerning NCB is necessary. The amount of these members is relatively small. For example, the Deutsche Bundesbank has a member list of 39 companies from different countries (Deutsche Bundesbank, 2016). The dealer that bids the highest price in the auction buys the federal security and can keep it or sell it in the secondary market.

The secondary market is the market where all security dealers can buy or sell bonds. Most of these transaction take place in over the counter transactions in stock exchanges (International Capital Market Association, 2016). This market is also where the ECB intervenes when buying or selling bonds. Therefore, the ECB cannot buy new bonds from governments directly. There is always a preceding auction by primary dealers to prevent the possibility of directly financing government deficits (Kaletsky, 2015). Finally, the people demanding these bonds from dealers are people who are looking for a safe return on their assets. Bonds are mainly used to reduce risk from higher yielding stock portfolios. For example, stocks can be combined with bonds using the widely known Capital Asset Pricing Model to achieve desirable

levels of risk and expected return (Mukherji, 2011). For banks, it is also important to possess bonds to use as collateral to borrow from the ECB.

ECB profit

When the ECB makes a profit it distributes this money fairly over all 19 NCB`s. Since NCB`s are governmental institutions their profit flows mostly to their governments. For example, the Dutch NCB pays 95% of its profit to the government (DNB, 2016). The ECB receives revenue on its assets, while the liabilities consist of new free money. The only costs the ECB incurs is the money spend to keep the system running. These costs include staff salaries, administrative expenses, depreciation and banknote production services. Therefore, the ECB makes a large profit on all its purchases since it receives interest payments from them.

This does not mean that all incoming money is considered revenue. On the ECB`s profit and loss account there are no records of received principal payments or revenue from sold assets. Under the asset purchase programs, principal payments are reinvested. And, if the ECB sells bonds it retracts the money from circulation. The ECB thus distinguishes incoming money. This facilitates implementation of contractionary monetary policy.

Money aggregates

A distinction has been made between different types of monetary aggregates. The broader the definition the less liquid the money is, since substitution to cash takes more time. The aggregates get bigger further down the liquidity hierarchy because money gets counted multiple times (Canzoneri, Cumby, Diba, & Lopez-Salido, 2008). This is due to the fact that debts are not taken into consideration defining the money aggregates.

The monetary base is equal to all currency in circulation plus the total reserves in the banking system. If the balance sheet of the ECB expands when it lends money or buys assets, the monetary base also expands. This is because the liabilities of the ECB consist of currency and reserves, which have increased. The distinction between the two is that currency is money in a physical form. Furthermore, a broader definition for money is narrow money (M1). This includes the monetary base as well as overnight deposits, deposits which can be converted into cash immediately. Subsequently, intermediate money (M2) is the following broader definition consisting of the narrow money aggregate and deposits maturing until two years or redeemable after notice within three months. The broadest money (M3) aggregate includes besides intermediate money also marketable instruments by monetary financial institutions. These marketable instruments are close substitutes of deposits like highly liquid shares in money market funds (ECB, 2016).

Fractional reserve banking

In modern times the commercial banks are responsible for the biggest part of money creation because of fractional reserve banking (McLeay, Amar, & Ryland, 2014). Banks receive deposits from people who open up bank accounts. To make a profit, these deposits are lend to people desiring to borrow. The amount of deposits a bank can lend out depends on the reserve requirements ratio. In the Eurozone this ratio is only 1 percent. This means that 99 percent of incoming deposits can legally be lend out. With fractional reserve banking, banks always needs some reserves to facilitate potential withdrawals by depositors. If there were no

reserves it would be difficult to retrieve deposits since all deposits are lend out to other people. Because banks are allowed to lend out other people's money, the broader money supply increases. Not only do deposits count as money, also the loans to other people are counted. This is because people with loans can spent the money, increasing deposits for the people they spent their loans on. This cycle is known as the money multiplier. It results in a 1/rr multiplier of increases in total deposits, with ''rr" as the reserve requirement ratio (Mishkin, 2013). In the case of the Eurozone, an extra euro would than theoretically lead to 1/0,01 = 100 euros worth of deposits. This thus increasingly expands the money aggregates M1, M2 and M3 even though the monetary base would only expand with a single euro.

Besides required reserves commercial banks are also obliged to maintain a certain capital to asset ratio at all time. This relative new measure, known as Basel Regulation, is being expanded further by the central bank due to bank failure during the crisis (ECB, 2015). The obligation to have more capital increases the absorption power of losses and reduces incentives to take excessive risks. Also, evidence has been found that well-capitalized banks have substantial cost-advantages (Gambacorta & Hyun, 2016).

Literature review

Deflation

The Eurozone is currently in a deflationary period. Deflation is generally considered a dangerous phenomenon for various reasons. First of all, the demand for goods is expected to decrease since the same goods get cheaper over time. This makes it profitable for consumers to postpone consumption. Lower consumption has negative effects on unemployment and is therefore lowering demand even further. Also, people are borrowing less since money only increases in value, which reduces the money supply, worsening deflation further. Deflationary trends are also believed to complicate the way the ECB conducts its monetary policy since deflation is an unfamiliar territory. For example, the ECB cannot stimulate economic growth by reducing interest rates indefinitely. Due to the zero lower bound of short term interest rates, interest rates are theoretically bounded not to go lower than 0%. This results in a more unclear policy stance as the ECB resorts to non-standard policy measures. Subsequently, effects of policy implementation are less clear. This makes that the private sector`s expectations are negatively affected, reducing the ability to make an optimal planning (Filardo & Bordo, 2005).

Following up on the reason why deflation is dangerous, the question arises why there is a current trend of deflation. Since the crisis in 2008 the rate of unemployment in the Eurozone has greatly increased (Pettinger, 2013). Unemployment causes a lower demand for products which leads to price decreases until a new equilibrium of supply and demand has been achieved. An extra problem for the Eurozone concerning unemployment is that individual countries do not have the option to devaluate or depreciate there currency since the Eurozone is a monetary union (Copeland, 2014). If a country has its own currency, that currency`s value can be reduced so that the exports increase, subsequently raising the level of employment. Since the Eurozone has one common currency, countries experiencing unemployment can only increase competitiveness by reducing prices and wages. Therefore,

the effect of unemployment strengthens the downward push on prices causing more deflation.

Prices are also decreasing due to influences from outside of Europe. One of those is that oil is globally getting cheaper, resulting in lower production costs in many sectors (Fairless & Hannon, 2016). A different cause is the inflow of cheap products coming from developing countries. China keeps targeting a low currency value and other countries like Russia have cheap currencies due to severe recessions. This leads to cheap imports from those countries what thus causes a drop in consumer prices (Economist, 2016). On the other hand, the emerging countries import less from the relative expensive Eurozone. This lowers the demand for products which again worsens the downward pressure on prices (Kennedy & Miller, 2014).

Long-run impact of money supply

The principle of money neutrality states that changes in money quantities affect only nominal variables in the macroeconomics system. This means that only prices change, and not real production, following a greater or smaller supply of money. This concept has been tested for the long-run in India, providing empirical evidence supporting the neutrality hypothesis (Moosa, 1997). The study found a stable relation between money changes and prices, while there was no long-run connection with economic growth. The reason that the study only took the long-run in account is because of the consensus that money is not neutral in the short run. It is believed that sources of nonneutrality, like sticky prices, disrupt the neutrality of money. In the long run these disruptive sources are less effective since price changes get more time to adjust.

Short-run impact of money supply

In the monetary model the demand for money is given by the Cambridge quantity equation. This equation states that money demand is the function: $M^D = kPy$. Here y is real national income, P the price level and k a positive parameter that indirectly represents the money velocity (velocity = 1/k). The function states that on the macro level the demand for money is equal to some fraction of total nominal income. The model assumes that both the real national income as the velocity are fixed. The money supply must equal the money demand. So when the money supply increases, the only adjustment possible is by changing the price level (Copeland, 2014). The price increases because of an excess demand for goods, lasting as long as the prices remain unadjusted.

A problem in this reasoning relates to the assumed constant velocity. Research provides evidence that the velocity of money is unstable (Wolters & Dreger, 2009). If the velocity is not assumed fixed in the model the illation changes. Now, the change in money supply does not lead strictly to price increases. Therefore, it is possible that the velocity of money decreases following supply increases. This keeps the price level constant.

Another problem keeping the price level from increasing arises as extra consumption of goods is not necessary. For example, debt pay offs can absorb the extra money. Also, the extra demand can flow towards purchases that do not influence goods prices included in the HCIP index for inflation. These purchases include assets like houses and equity. This causes the price level measured by the ECB to remain unchanged.

Furthermore, a different possibility of changes in the money supply is through interest rates. Wicksell`s cumulative process theory states that lowering the interest rate through the transmission mechanism creates excess demand for funding by firms. These funds are be used to invest and the money is thus spend. This ultimately leads to excess money holdings by households who will spend this money on consumer products (Amato, 2005). This results in a situation of excess demand in which the prices adjust upwards, resulting in inflation. However, inflation does not occur immediately. Changes in the price levels are caused by the lagged effects of monetary policy. A specification of the time span of these lags is described in a paper written by Batini (2006). Evidence is found that it takes approximately a year before monetary policy actions reach a maximum effect on inflation. These results remained consistent using different measures of defining the monetary stance, hereby including money aggregates. These results complement the idea of sticky prices, in which prices adjust slowly following changes in economic circumstances, like sudden demand increases (Farmer, 1991).

Empirical research effect policy

The literature does not provide a lot of research regarding the effect of ECB policy before and after the global financial crisis. Nevertheless, Hausken & Ncube (2013) did compare the effects of monetary policy after the crisis by the central banks in the Eurozone, United States, England and Japan. They found evidence that policy focusing primarily on bond purchases is more effective in reducing interest rates than policy based on the constant rolling over of reverse transactions. The Bank of England and the Fed equally influenced the interest rates effectively on government bonds using quantitative easing. The ECB had a much smaller influence on the interest rates as their policy relied heavily on increased lending. The evidence from this research provides an indication that the ECB increases its influence on the economy, as they changed their emphasis to quantitative easing in 2015.

Evidence against increased effectiveness of bond purchases is presented in a study by Gibson, Hall, & Tavlas (2016). They shows that the impact of the first asset purchase programs by the ECB were only modestly raising bond prices. However, the situation has changed. These programs took place during the crisis, and as the sterilization policy is now abandoned the current programs might have a better effectiveness. In a study by Castelnuovo (2016) other weak effects of ECB policy are found, based on a recursive VAR estimated over a sample from 1993 until 2008. The model`s estimation output returns no significant responses of inflation in response to monetary policy shocks.

Different research by Boeckx, Peersman and Stevens (2015) is suggesting increased effectiveness in the Eurozone after the crisis. Using extrapolation of monetary base expansions over the period of 2007 until 2014, they predict increased inflation following implementation of quantitative easing. On the other hand, more recent research by de Vries & van Marle (2015) is suggesting that these asset purchase programs are not stimulating the economy. They argue that quantitative easing disturbs both financial markets and governments fiscal policies. These negative consequences are expected to be greater than the possible positive effects of quantitative easing. This is based on the observation of the already growing economy and the empirical evidence that quantitative easing does not have direct effects. The described results above contradict each other, leaving space for further

research. Also, they both take the unstable financial crisis in account in their models, while this is not the focus of this paper.

Policy measurement

Bernanke and Mihov (1998) argue that there is no consensus regarding the approach of measuring monetary policy stance. They disagree with the traditional view that monetary policy consists of one or more monetary aggregate growth rates. According to them, growth rates are depending on several non-policy influences. For example, commercial banks can always use the marginal lending facility to borrow money. This would lead to growth rates reflecting changes in money demand. That is why they suggest using the interbank rate to reflect monetary policy stance. Despite this, numerous researchers used the monetary base as an important measure of policy stance in their modelling.

A general problem with measuring policy is the timing of policy. Before implementing certain policy decisions, the ECB announces its future planning on meetings. This forward guidance provides an opportunity for financial market players to anticipate on those decisions. Evidence is found that markets do behave forward looking (Andersson, 2010). In this case, monetary base changes occur later than interest rate adjustments. The time span between announcements and implementation are therefore crucial in determining the measurement of policy.

In July 2013 the ECB launched a new form of forward guidance in which policy decisions are made for longer periods. This means that the ECB sticks to certain decisions even if the economy`s circumstances change in a different way than expected. The idea of this forward guidance is a reduction of uncertainty about future monetary policy for the public. But, the main downside of forward guidance is when the central bank is confronted with new data or a new situation assessment in which a different form of policy is preferred. If the central bank does not react in such situation, a loss is incurred based on the opportunity cost of better preferred policy. If the central bank reacts by changing its policy, financial agents can incur losses because of anticipation on other policy. In addition, the central bank loses credibility by breaking its promise. This reduces future positive effects of forward guidance, as the uncertainty of policy remains. Therefore, a difficult trade off can arise when executing forward guidance (Shellock, 2013).

Theoretical framework

Money growth

The money supply changes in the Eurozone start off by the ECB making adjustments in the monetary base in line with its monetary policy announcements. New money enters the economy as loans or is exchanged for financial assets. A loan leads to a temporary expansion of the monetary base, except when loans are constantly renewed. The same principle holds for purchased asset purchases when the principal is paid back. As long as the central bank reinvests this money, the monetary base stays close to constant. For both cases it holds that when the new loan or purchase exceeds the old one, the monetary base grows. Besides this,

the ECB receives interest payments on their bonds and loans. Those relatively small profits are transferred to European governments, hereby structurally increasing the money supply.

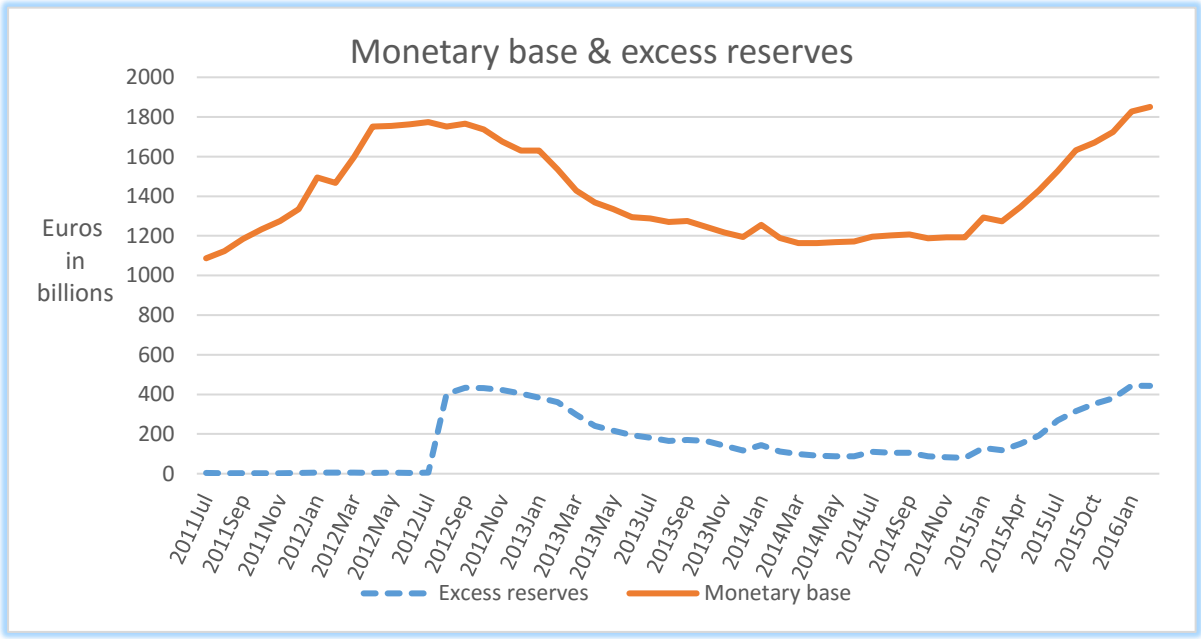
New money is flowing towards banks through direct loans or via dealers, lowering the economy`s interest rates via the interbank rate. Subsequently, the new money is subjected to the money multiplier. The commercial banks lend out the new deposits, only holding on to a small reserve requirement percentage deposited at the central bank. The money lend out is spend and deposited again by the people receiving it. This results in a big theoretical money supply. Theoretical in a sense that banks need to find people desiring and capable to borrow to proceed the multiplying of money.

Besides the understanding of the entrance of money it is also important to see what happens if the money supply shrinks. If loans do not get rolled over, banks loose reserves. This reduces the amount of money lend out, raising the interest rates. When dealers buy bonds from the ECB, the commercial banks loose these deposits. This restricts the commercial lending channel in the same way, raising interest rates on loans.

Inflation

Following expansionary policy in normal times, increases in the monetary base would be expected to cause lower interest rates and more liquidity in the economy. Low interest rates makes money cheaper, and more liquidity increases the availability of directly spendable money. These two effects cause a higher demand for goods or assets, thus raising the price level. On the other hand, contractionary policy has the opposite effect. Less money raises the interest rates and causes a lack of demand for goods, therefore lowering inflation. These effects both assume a constant velocity. A change in velocity can reduce (or increase) the strength of these effects, adding difficulty to finding the real cause of inflation.

Figure 1

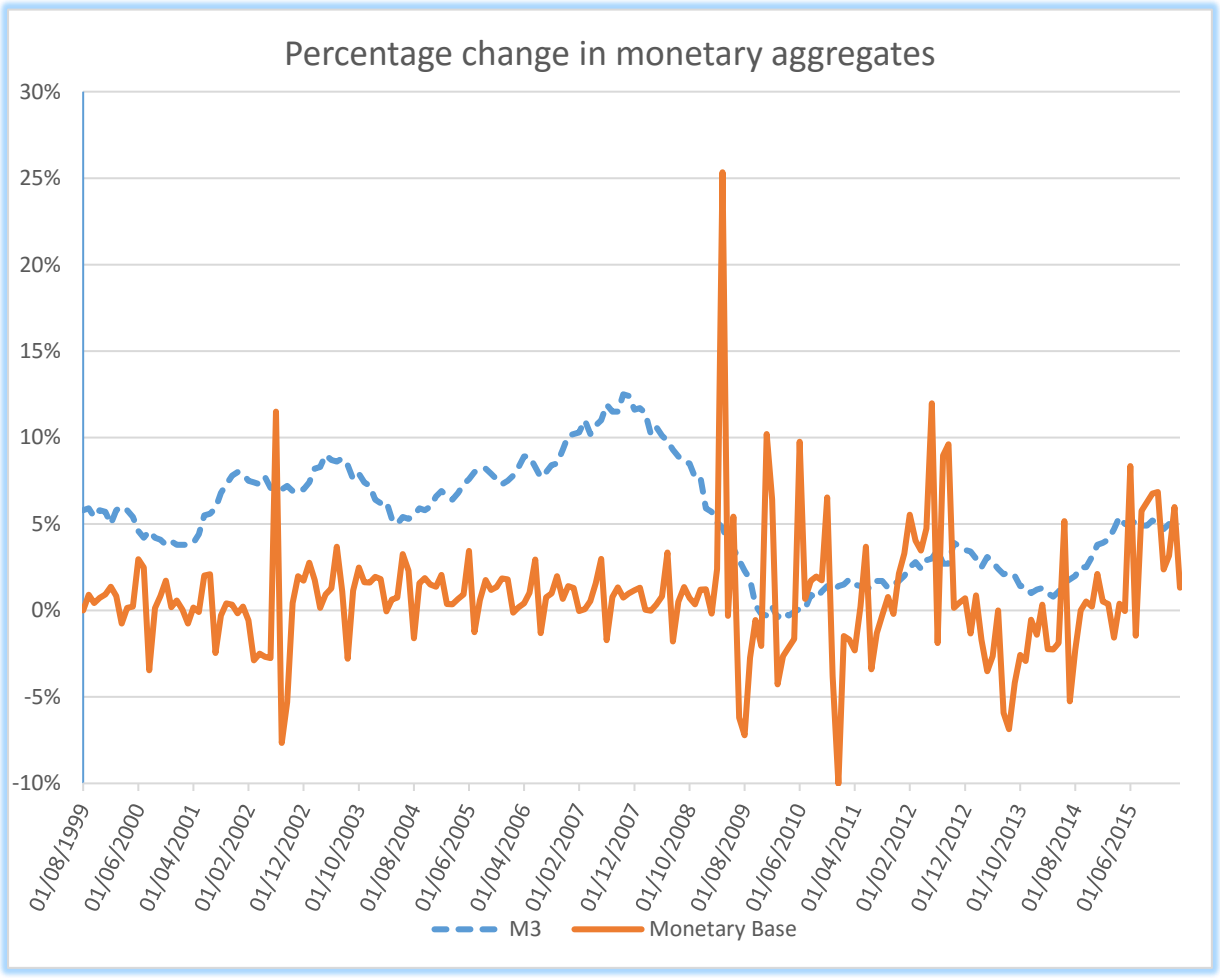


Source: ECB

Excess reserves accumulation

A problem in the theoretical money multiplier arises in 2012 when the excess reserves skyrocketed. Commercial banks deposit enormous amounts of reserves at the central bank. In this period the ECB wanted to recapitalize the commercial banks through enormous lending (Chorafas, 2013). Since this period the excess reserves have followed a similar pattern as the monetary base amounts, as can be seen in figure 1. This suggests that newly created money does not fully enter the economy, since the banks do not lend it out completely. Instead, the banks return the money as deposits at the ECB. Furthermore, contractions are being countered by reductions of excess reserves. This would mean that the effect of monetary policy is weakened after 2012 as the money supply is only changing in the level of the monetary base aggregate. The money aggregates up to M3 only slightly change, reducing the effect of more money in the economy. Also, from figure 2 it can be seen that changes in the monetary base before the crisis in 2008 had a larger impact on M3. Now, M3 is growing at almost the same rate as the monetary base. This, while the money multiplier effect would predict a higher growth like before the crisis. An equal growth rate of M3 and the monetary base is possible if the money multiplier effect reached a stable equilibrium, but this is unlikely due to the big shocks that hit the monetary base during the crisis.

Figure 2



Source: ECB

Interest rates

The interest rates on excess reserves deposits at the central bank is currently negative. This means banks have to pay a fine for not lending out enough money to the public. Currently the banks are paying this negative interest since they have these deposits. This is a strange observation as it would be expected that a lot of people are willing to borrow money from banks since the interest rate is expected to be low. Part of the problem is that banks are not willing to lend out money. This is to improve their balance sheets but also because banks are careful in lending. This result in high risk premiums demanded by the banks, which causes a greater gap between rates for firms (or households) and the ECB`s targeted interbank rate (Arnold, 2009). Another factor is that the small and medium-sized enterprises (SME) sector has suffered heavily from the credit crunch during the financial crisis. The companies are having difficulties to borrow, even though they want to. This because they suffer from decreases in both revenues and collateral value (Valverde, Fernandez, & Udell, 2016). Therefore, interest reductions by the ECB do not always affect companies and households. Firms are now not fully able to raise funding for investments. Therefore, the excess demand effect on prices resulting from lower interest rates is reduced. Before the crisis this was not a problem as the risk premiums were small.

Policy changes

The change in policy by the ECB on the other hand is stimulating the effects of the ECB more than before. Bonds are not being sterilized anymore, causing continuous monetary base expansion and leads to increased effect on interest rates. The reduction of the required reserve ratio to 1% is loosening commercial bank regulation and heavily increases the theoretical money multiplier.

Expectation

It is hard to say whether the monetary policy effects have increased in the period after the crisis since there are two forces in play. The first force predicts a decrease in effectiveness because of the disturbance of the transmission mechanism. Interbank rates are already low but companies are unable to borrow or pay high risk premiums. This leads to high excess reserves what reduces the money multiplier expansion. Ultimately, this restrains the excess demand effect on prices.

The other force increasing effectiveness is the change in policy. The recent start of quantitative easing policy is expected to increase the impact of the ECB on interest rates. The lower reserve ratio leads to increased possibilities of money multiplying. But, as there are already plenty of reserves, this does not stimulate lending.

Data

The dataset used in this paper is retrieved from the ECB`s statistical warehouse. The variables included are: The monetary base growth rate, the inflation rate, the Euribor rate and the rate of loans to corporations (loans). The frequencies for all variables are monthly, starting from January 2000 up to May 2016. The monetary base variable is transformed from absolute values to natural log differences to approximate growth rates. Table 1 provides an overview

of the mean and standard deviation of the 4 variables in total and over the two separate periods.

The period from January 2008 until December 2012 is not included in the VAR analysis, to prevent the unstable crisis period to bias the results. The sample continues in January 2013 because this is the last period in which the ECB achieved its target rate, preceding the deflationary trend. This leads to a total of 137 months used in the VAR research, of which 96 in the sample before the crisis.

The column ***total*** includes values for the whole period (including the crisis). This column provides an overview of the economic environment in the Eurozone over a longer period. It includes 197 months.

Table 1

	2000-2008		***2013-2016***		***Total***	
Variables:	**Mean**	**Standard deviation**	**Mean**	**Standard deviation**	**Mean**	**Standard deviation**
Inflation	2.20%	0.32%	0.47%	0.60%	1.81%	0.98%
Euribor	3.18%	0.95%	0.02%	0.16%	2.00%	1.65%
Loans	4.88%	0.79%	3.30%	0.48%	4.35%	1.01%
Monetary base growth rate	0.67%	2.09%	0.30%	3.58%	0.82%	3.60%

Source: ECB

Monetary base

Concerning the monetary base, a distinction is made between borrowed and non-borrowed reserves. In this subdivision, the non-borrowed reserves are the reserves and currency remaining if all debt is payed off to the ECB. The borrowed reserves consists of all loans the ECB makes. The effects of changes in these two types of reserves are assumed to be equal in this paper. Therefore, this distinction is not taken into account. The monetary base thus represents the sum of both.

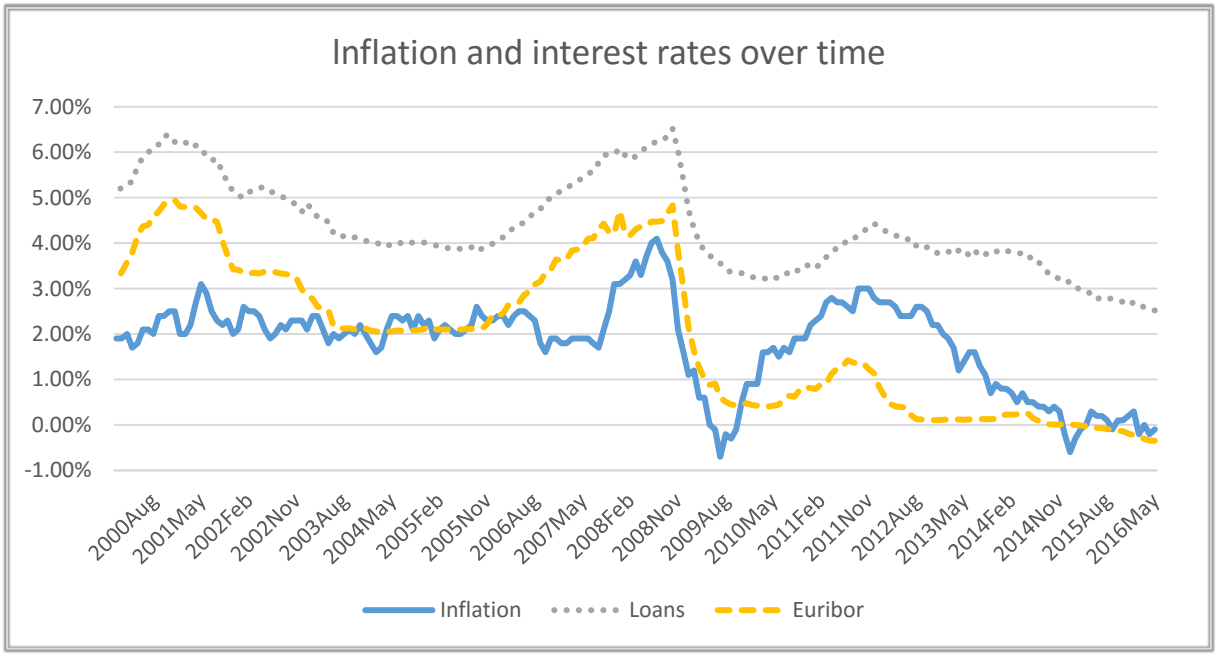
The growth rate of the monetary base has a relative big standard deviation, due to large monetary interventions. The increase in interventions can be seen in the difference of the mean of the monetary base growth rate in the two periods. In the period up to 2008, the monetary base steadily increased. In the other period the growth rate is lower due to monetary contraction during 2013, as also shown in figure 1. This is followed by strong a strong expansionary boost, explaining the high standard deviation and low mean in this period. The reason the standard deviation of the total sample is the largest, is because of huge monetary expansion during the crisis. In December 2007, the end of the first period, the monetary base is €821 billion. In January 2013 the monetary base is €1750 billion. This big growth between the two samples causes the big standard deviation in the total sample.

Inflation

The Harmonised Index of Consumer Prices (HICP) has been used as a measure of inflation. This overall index is calculated by the ECB based on data from Eurostat, a statistical institute. The data includes prices of the whole Euro Area.

Over the whole period, inflation averages in line with the ECB`s target slightly under 2 percent. The inflation average even exceeded the target in the period before the crisis. After the crisis, the inflation decreases sharply. Despite a lower inflation the standard deviation increases in this latter period. This is due to the decreasing inflationary trend that can be seen in figure 3. This figure shows graphically the inflation in the Eurozone over a time horizon bigger than the data points included in the samples. The graph also motivates the omit of the unstable crisis period, as this period includes a big deviation of inflation.

Figure 3



Source: ECB

Interest rates

The Euribor rate used is a short term rate. It consists of loans with only 1 month to maturity. The rate has been calculated based on the average of Eurozone banks offering to lend money on the interbank market. The commercial loan rate (abbreviated loan) consists of an average of loans to corporations amounting to a maximum of 1 million euros with a fixed duration up to 1 year.

The interest rates prove to be in line with the transmission mechanism. This because the Euribor has a constant lower rate than the loans to corporations. A decreasing trend is visible over the time, as both interest rates have a lower mean in the period 2013-2016. It stands out that the Euribor rate has decreased much more than the loans rate over time. This is in line with the idea of increases in risk premiums. The standard deviation of the interbank rate was higher than the one for loans in the first period, but is lower in the second period. The

reason of this change is that the negative trend of Euribor rates is slowed down as the rate was very low and approached the zero lower bound.

Methodology

To see whether the effects of monetary policy have changed a Vector Autoregression (VAR) is used. The main advantage of using VAR methods is that shocks in the variables of interest require only plausible identification on these shocks themselves, while the rest of the model can remain unexplained (Bernanke, Boivin, & Eliasz, 2004).

Vector Autoregression

A VAR in unrestricted form is a multivariate model that estimates the relations between all the dependent variables and lagged values of both their own and the other variables. Two periods are compared by applying the same VAR system twice. First in the stable period where the inflation target was achieved. Secondly, the VAR is applied starting 2013 as the deflationary trend kicked in. This because a regular Chow test for structural breaks is not applicable to VAR`s. The main downside of comparing two samples is that it is not possible to determine whether differences in estimators are significant.

First of all, the variables are tested for stationarity using the unit root test. When variables are not stationary the problem of spurious regression arises in which estimators and test statistics can be biased. Spurious regression arises when a correlation is found in trends of variables. It therefore indicates that variables have certain relations while in fact they can be fully independent. Besides requiring all its variables to be stationary, notated *I*(0), a VAR also needs them to be so in the same level. This means that variables made stationary by taking the first differences cannot be combined with stationary variables in their level. The reason to take the first differences is when the variables are nonstationary, notated *I*(1), in their level. To see if the variables are non-stationarity in their level, each variable is tested by checking if it has an unit root, using the Dickey-Fuller unit root test. If the unit root hypothesis is rejected, the variables are stationary in its level (Verbeek, 2013).

When all variables are *I*(0) in their level an unrestricted VAR can be estimated. If the variables do have a unit root, but are stationary in the first difference they still need to be tested for cointegration. Cointegration exist when the nonstationary variables share a common trend. This leads to a long-run equilibrium in which the estimators are being under- or overestimated. The Johansen Cointegration test can be used to detect cointegration. If this test suggest that none of the variables are cointegrated, an unrestricted VAR can be estimated using the first difference of the variables. When this is not the case, a Vector Error Correction Model (VECM) must be constructed. A VECM corrects the bias in the estimators caused by the common trend.

In a normal unrestricted VAR the dependent variable is regressed with lags of itself and the other variables` lags. All variables are endogenous in such model, making the VAR a dynamic model. For this paper an adaption is made to the unrestricted VAR, making the monetary base values leading by one month. This because the emphasis of this paper is the functioning of the transmission mechanism. Therefore, the monetary base is influencing the interbank rate

directly instead of lagged, assuming financial markets clear fast. Furthermore, the effect of interbank rates is assumed to have a lagged effect on the corporation because banks are expected to have a slightly rigid policy on lending. Inflation is assumed to be ultimately influenced by the lags of the rate on loans, since prices adjust slowly.

The direct effect of monetary base changes on the interbank market does not take in account the effect of policy announcements by the ECB. For this reason, the anticipation of financial markets on monetary policy announcements is assumed to occur in the same month as the implementation. This can be motivated by the fact that the ECB has a policy meeting every six weeks, with policy assumed to be executed before the next meeting. This results in the non-lagged monetary base variable. This causes all variables to be regressed on its own and the other lagged variables, except for the monetary base. A lag of the monetary base becomes the current value. The second lag becomes the value of the first lag, etc. This is the effect of leading the monetary base by one month.

The general model of a VAR(*p*) model of *k*-dimensional vector $\boldsymbol{Y}_t$ is given by:

$$\boldsymbol{Y}_t = \boldsymbol{\alpha} + \boldsymbol{\beta}_1 \boldsymbol{Y}_{t-1} + \cdots + \boldsymbol{\beta}_{\boldsymbol{P}} \boldsymbol{Y}_{t-P} + \boldsymbol{\varepsilon}_t$$

Where $\boldsymbol{Y}_t = (Y_{1,t+1}, Y_{2,t}, Y_{3,t}, Y_{4,t})'$ representing the *k*-dimensional vector of all dependent variables. In the same way $\boldsymbol{\alpha}$ represents the vector for all estimated constants. $\boldsymbol{\beta}$ is a $k \times k$ matrix of all estimators regressed on the vector of lags $\boldsymbol{Y}_{t-1}$. The term $\boldsymbol{\varepsilon}_t$ is a *k*-dimensional vector of white noise terms. The size of the VAR model depends on the number of lags included, indicated by $\boldsymbol{P}$ (Verbeek, 2013). This number of lags used in the estimation will be based on the Schwarz Criterion.

In this equation $Y_{1,t+1}$ is the monetary base. The inflation is given by $Y_{2,t}$. $Y_{3,t}$ the Euribor rate and $Y_{4,t}$is the loans rate for companies. The value of the monetary base is leading by one so it takes the non-lagged value $Y_{1,t}$ in the regression where the others are lagged. The error terms are expected to be independent of the history of the Y variables and are therefore white noise processes.

Using impulse response functions the effects of a single shock to a variable is not only transmitted directly on the shocked variable, but also on all the other endogenous variables. This is due to the dynamic structure of a VAR, in which all variables depend on each other. The shock on a variable is an one-time occurrence and takes the value of the standard deviation. The impulse response function traces these effects on the current and future values of all the endogenous variables. Besides the estimated effect, the function also estimates a confidence interval to evaluate the significance.

Results

VAR`s

Based on the Schwarz criterion a lag length of 1 is chosen, since this is where both VAR`s show the lowest value (Appendix 1). Using only one lag can also be motivated by the relative small amount of observations in the 2013-2016 sample.

Table 2 Dickey-Fuller Unit Root tests

	T-statistic:	**Probability:**
Inflation:	-2.078532	0.2637
Euribor:	-1.356828	0.6026
Loans:	-2.295664	0.1744
Monetary base growth rate:	-11.328700	0.0000

The variables Euribor, loan and inflation are not stationary in their level, since they have a unit root. This can be seen in table 2, where the probabilities of these values are bigger than 0.05. It can also be seen that the monetary base is satisfying this stability condition, as the unit root is rejected. Despite the test indicating non-stationarity, the variables are regressed in their level as stationary variables cannot be regressed with variables of first differences. This can be motivated by various reasons. First, the variables inflation and loans are not that far from being tested stationary. Also, the Euribor rate is known to closely follow the targeted rate set by the ECB. Big fluctuations in this rate are therefore mainly caused by changes in the rate set by the ECB. The performed test cannot take this in account and assumes the rate to be non-stationary. The effect of the targeted rate diminishes as maturities of interest rates increase, what can be seen in the variable of loans being almost stationary. At last, by staying in the levels, potential long term relations are preserved.

This results in two equal VAR(1) models estimated over different samples. The VAR`s both take the form given by[1]:

$$\begin{pmatrix} Y_{1,t+1} \\ Y_{2,t} \\ Y_{3,t} \\ Y_{4,t} \end{pmatrix} = \begin{pmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \end{pmatrix} + \begin{pmatrix} \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} \\ \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} \\ \beta_{31} & \beta_{32} & \beta_{33} & \beta_{34} \\ \beta_{41} & \beta_{42} & \beta_{43} & \beta_{44} \end{pmatrix} \begin{pmatrix} Y_{1,t} \\ Y_{2,t-1} \\ Y_{3,t-1} \\ Y_{4,t-1} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \\ \varepsilon_{3,t} \\ \varepsilon_{4,t} \end{pmatrix}$$

Period 2000-2008

For the stable period the VAR estimates are given by table 3. Significant effects are found on autoregression, except for the monetary base. Other than these, the estimate of loans is significant for the dependent variable Euribor. This also goes the other way around, where

[1] These are the same variables as explained for the VAR(p) model

Euribor is significantly regressed on loan. Besides the constants of the interest rates, no significant effects are found.

Table 3 VAR estimates

2000-2008	**Inflation**	**Euribor**	**Loans**	**Growth rate Monetary Base(1)**
Inflation(-1)	0.724* (0.077)	-0.014 (0.048)	-0.083 (0.066)	-0.029 (0.332)
Euribor(-1)	-0.036 (0.055)	1.110* (0.034)	0.288* (0.047)	-0.142 (0.236)
Loans(-1)	0.088 (0.063)	-0.132* (0.039)	0.668* (0.010)	-0.017 (1.633)
Growth rate Monetary Base	0.004 (0.024)	-0.002 (0.015)	-0.0002 (0.021)	-0.088 (0.105)
Constant	0.003 (0.002)	0.003* (0.001)	0.009* (0.002)	0.009 (0.009)
R-squared	0.551	0.981	0.953	0.03

The value in brackets is the standard error; the * denotes significance on 5% level

Period 2013-2016

In the period after the crisis the same variables show autoregression as can be seen in table 4. Other significant effects are inflation on loans, loans on monetary base and also the monetary base on loan. This time the constants of loan and monetary base are significant.

Table 4 VAR estimates

2013-2016	**Inflation**	**Euribor**	**Loans**	**Growth rate Monetary Base(1)**
Inflation(-1)	0.811* (0.088)	0.004 (0.012)	0.076* (0.028)	0.222 (0.472)
Euribor(-1)	-0.310 (0.758)	0.951* (0.10)	0.374 (0.239)	5.675 (4.060)
Loans(-1)	0.206 (0.305)	0.030 (0.040)	0.770* (0.010)	-4.305* (1.633)
Growth rate Monetary Base	-0.011 (0.030)	-0.002 (0.004)	-0.023* (0.009)	-0.027 (0.160)
Constant	-0.006 (0.010)	-0.001 (0.001)	0.007* (0.003)	0.142* (0.051)
R-squared	0.902	0.970	0.982	0.529

The value in brackets is the standard error; the * denotes significance on 5% level

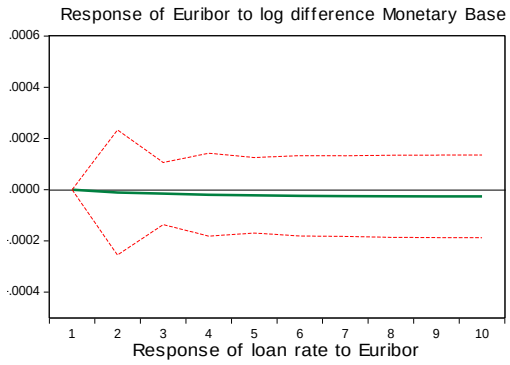
Both VAR`s show only minor significance in the effects between different variables. This can be the result of the variables being not strongly related. The significant effects found on the variables due to autocorrelation can be explained by the use of the variables in their level.

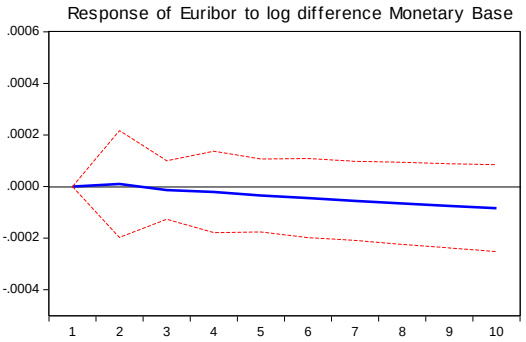
Impulse responses

2000-2008

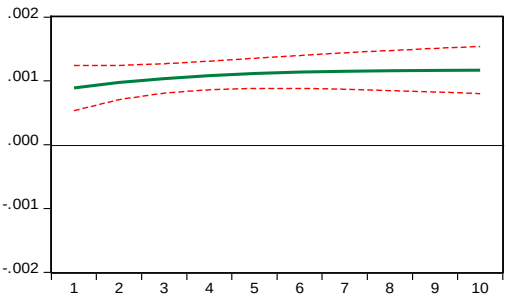
2013-2016

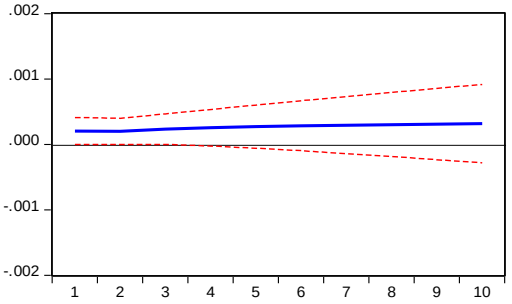
Graphs 1



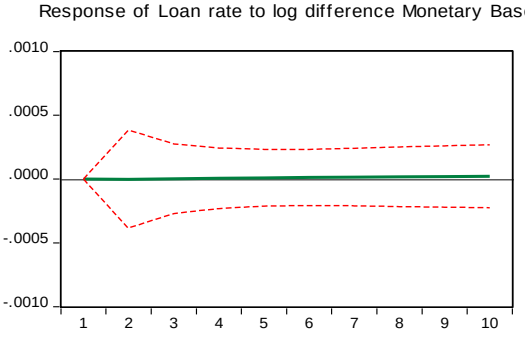


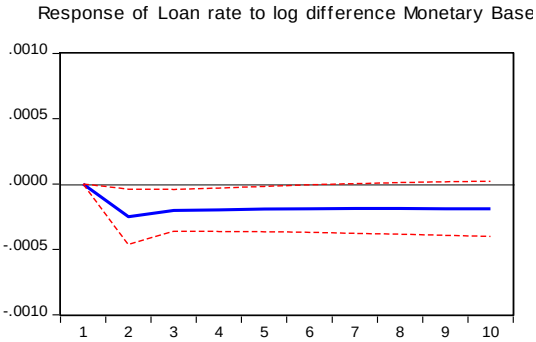
Graphs 2



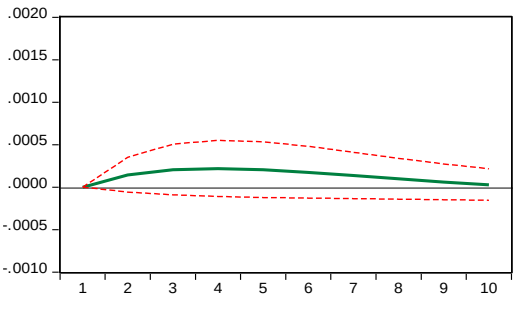


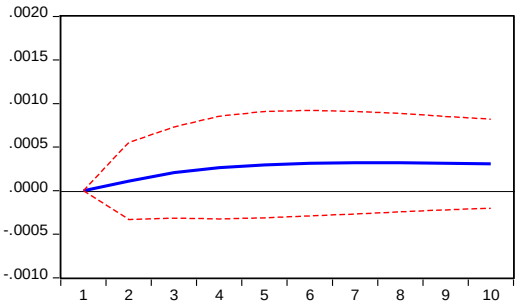
Graphs 3



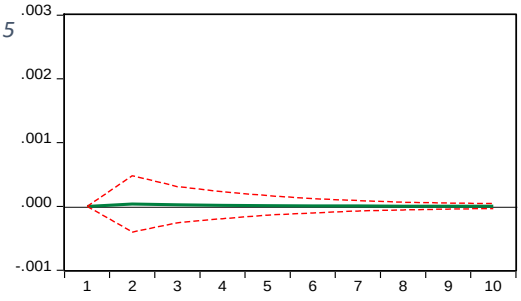


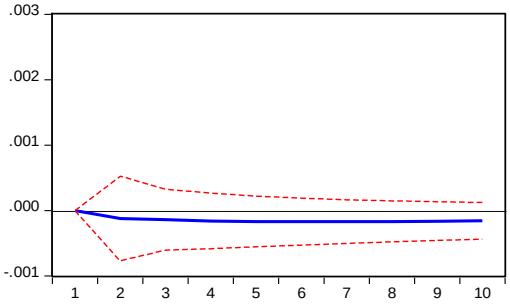
Graphs 4





Graphs 5





In the left column the impulse responses for the period before the crisis are given. The right column represents the same responses post-crisis. It immediately stands out how similar the graphs are. According to the impulse response in the first graph, the Euribor rate is hardly influenced by changes in the monetary base. Post-crisis a slight negative relation is found, but the effect is small and develops slowly over time. This is not in line with the strong expected negative relation, as more money leads to lower interest rates.

The next graph (graphs 2) shows how the Euribor interbank rate affects the rate on commercial loans. In both periods the intuitive positive relation is found. Intuitive in a sense that banks lend against a higher price if they have higher costs financing these loans using Euribor loans. The graph post-crisis shows a smaller response, suggesting a loss in effectiveness as interest rates in the economy are less responsive. This can be traced back to the already low interest rates post-crisis and the excess reserve accumulation, blocking the transmission mechanism. However, the difference between the periods is not substantial.

In the first period of the third graph, a counterintuitive reaction is found of the commercial loan rate following a positive shock in the monetary base. A negative relation is expected as an increase in the money supply lowers the interest rate, but is not indicated by the graph. The reason this relation is not found can be due responsive decision making by the ECB, causing simultaneous causality. If the interest rates increase, the ECB can decide to increase the monetary base to fulfil increased demand for money (Cancelo, Varela, & Sánc, 2011). This positive relation then cancels out the expected negative relation.

Furthermore, the third graphs are the only graphs that show a noticeable different reaction between the two periods. In the period of 2013-2016, the interest rates on commercial loans react significantly negative to changes in the monetary base. In contrast to the prior period, the expected negative relation is found. This indicates a better response of interest rates following expansionary policy in the post-crisis period. As the ECB stopped sterilizing its purchases in 2014, this complements the research of Hausken and Ncube stating quantitative easing is more effective in lowering the economy`s interest rates. Even despite the found negative effects being small.

Although the third graphs indicates a small change of effectiveness, it also represents a problem in comparing the two periods. As the ECB started with quantitative easing, the monetary policy instruments changed when comparing these periods. The problem arises that it is hard to compare the general effectiveness of policy, if policy differs over time. When the ECB loses effectiveness, and therefore stops sterilizing its purchases, it hereby compensates for the loss of power. This could lead ultimately to the same target rate of inflation, while different instruments were at play. Saying that the ECB did not lose effectiveness is therefore not fair, as it needed better tools to work with.

The fourth graph represents the response of inflation on a shock in the interest rate on commercial loans. In both periods an increase in the interest rate leads to a non-significant increase in inflation. This observation does not complement the theoretical effect of cheaper money leading to increased spending. The occurrence might also be the result of responsive behaviour of the ECB, in which interest rates are raised in response to higher inflation.

The last graph estimates the effect of a shock in the monetary base to inflation. In both periods no significant effect is found. Theoretically, a positive effect is expected but in the second period the effect even seems slightly negative. This can be traced back to the big monetary expansions to fight the deflation, which again is a form of simultaneous causality. A different reason that no significant effects are found in the fourth graphs is due to the short lag length. Literature expects a long term effect of money increases, whereas the impulse response function is an extrapolation of short term effects. Therefore, the direct effect of monetary base increases on inflation is likely missed in this impulse response function.

The impulse response functions provide no evidence of a change in effectiveness of monetary policy. The responses (or lack of responses) of variables on each other are very similar in the two periods. But, these results can be biased in a way that changes in policy are not taken into account. Especially the termination of the sterilization program can be a source of biased results. If quantitative easing is more effective than reverse transactions, then the potential loss of effectiveness is compensated. Meaning that the ECB made the decision to stop sterilizing because it anticipated on a decreased influence on the economy. Through this innovation, the ECB maintained its effectiveness.

Robustness

To test the VAR`s for robustness some measures are taken. The first is to replace the leading variable of log difference in monetary base with the same but non-leading variable. Doing so, the emerged VAR model does not show any big difference compared to the VAR with the variable leading by one. The impulse response functions do not change much and represent the same estimated effects.

A second measure is to include more lags. The models are adjusted by adding both 2 and 3 lags to the VAR systems. The VAR`s impulse response functions do not noticeably change. This consistency motivates the choice of only 1 lag by the Schwarz criterion. Adding more lags does not change the impulse response functions` illation.

The last measure taken is a change in Cholesky ordering of the shocks moving through the systems in determining the impulse response functions. A different ordering does not change the inference given by the functions.

Conclusion

The ECB is launching aggressive programs to pull the Eurozone out of the deflationary trend. It suggests the ECB is losing effectiveness in its policy as it can no longer hold on to the 2% target rate of inflation. In this paper this effectiveness has been compared over time via the transmission mechanism. Through mainly reverse transaction, the ECB historically influenced financial markets to control inflation. After the crisis the ECB started with big monetary expansionary policy, primarily focussed on bond acquisitions without sterilizing these purchases. At the same time, commercial banks started accumulating big amounts of excess reserves, blocking the effect of more money in circulation. To help answer the research question whether there has been a change in the effectiveness of monetary policy, two 4-dimensional VAR`s are compared covering different time periods. One period before the crisis, from 2000 until 2008, and the other at the beginning of the deflationary period from 2013 until May 2016. The performed VAR`s show no change in effectiveness in the two periods before and after the crisis. The impulse response functions hardly find significant effect or changes in effects following shocks to variables. This can be interpreted as a lack of change in effectiveness in policy between the two periods. It should be noted that it is difficult to compare the policy between the periods since the policy has changed. This innovation includes termination of the sterilization program and the required reserve ratio. Therefore, it seems the deflationary trend is due to the unemployment caused by the aftermath of the crisis, worsened by cheap goods imports and the cheap oil price. It is very likely the ECB lost some effectiveness under its old policy and therefore started with quantitative easing to compensate their loss, maintaining the same level of effectiveness. The ECB is not losing effectiveness but is mainly challenged by difficult external forces that were not in play before the crisis.

The launch of aggressive programs to fight inflation is understandable. The ECB made the right choice to start with quantitative easing. But, the policy makers should be careful for possible long term negative effects resulting from disturbance in financial markets.

Appendix

Lag length criteria

VAR 2000-2008:

Sample: 2000M01 2007M12
Included observations: 88

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1434.035	NA	9.02e-20	-32.50080	-32.38819	-32.45543
1	1699.425	500.6222	3.12e-22	-38.16875	-37.60572*	-37.94192
2	1725.755	47.27350	2.47e-22*	-38.40352*	-37.39006	-37.99522*
3	1736.272	17.92773	2.82e-22	-38.27892	-36.81503	-37.68915
4	1750.892	23.59011	2.94e-22	-38.24753	-36.33323	-37.47631
5	1757.367	9.860773	3.71e-22	-38.03107	-35.66634	-37.07838
6	1777.412	28.69987	3.48e-22	-38.12299	-35.30784	-36.98884
7	1802.568	33.73210*	2.93e-22	-38.33108	-35.06550	-37.01546
8	1811.746	11.47315	3.61e-22	-38.17605	-34.46005	-36.67897

* indicates lag order selected by the criterion

VAR 2013-2016:

Sample: 2013M01 2016M05
Included observations: 40

Lag	LogL	LR	FPE	AIC	SC	HQ
0	689.8030	NA	1.51e-20	-34.29015	-34.12126	-34.22909
1	832.2726	249.3218	2.72e-23	-40.61363	-39.76919*	-40.30831
2	842.9093	16.48694	3.65e-23	-40.34547	-38.82548	-39.79589
3	850.5288	10.28629	5.93e-23	-39.92644	-37.73090	-39.13260
4	869.5247	21.84526	5.82e-23	-40.07623	-37.20514	-39.03814
5	900.4586	29.38718*	3.49e-23	-40.82293	-37.27628	-39.54057
6	908.5662	6.080770	7.73e-23	-40.42831	-36.20611	-38.90170
7	949.5982	22.56756	4.36e-23	-41.67991	-36.78216	-39.90904
8	1006.387	19.87608	1.95e-23*	-43.71935*	-38.14605	-41.70422*

* indicates lag order selected by the criterion

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