The Monetary Policy’s Efficiency during a Recession
A Description, Evaluation and Empirical Analysis

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Executive Summary
The objective of this thesis is to describe, analyze and discuss the traditional monetary policy and its instruments during a recession. There are some discussions amongst different schools of economists, the Keynesian and the Monetarist, on whether the monetary policy will have an effect on the real economy. Where fiscal policy affects the economy directly through the multiplier effect the monetary policy will only indirectly affect the real economy through the transmission channels. Its efficiency has especially been questioned when the economy is caught in a liquidity trap where the monetary interest rates are close to the zero-limit bound. Four alternative strategies that could help the economy to escape the liquidity trap are therefore presented in section 6.

Most central banks agree on price-stability as the most important medium to long term target that a central bank can pursue. Denmark has for a long time had a fixed exchange rate first to the deutschmark and later to the euro. Since the Danish krone is fixed to the euro the degree of freedom in terms of monetary policy is rather limited as the spread between the two monetary interest rates can not be too significant. This is to make sure that the exchange rate is held within a certain bound. Other regimes, i.e. inflation targeting, have been used by other central banks in order to reach the goal of price-stability. Research has shown that both fixed exchange rate policy and inflation targeting are almost equally efficient in terms of reaching price stability.

After years of global economic boom and high inflation the economic situation changed with the start of the financial crisis. Negative growth rates in real GDP in 2008 and 2009 had severe consequences for the economy in general. The start of the financial crisis challenged the stability of the financial sector and the distrust amongst the financial institutions in the Danish economy meant that the money market froze. The spread seemed to be the result of a money market where the counterparties were extremely risk-averse and were very careful as to take on more risk. This is supported by the empirical data analyzed by an econometric model that measures credit- and liquidity risk influences on the money market interest rate. The interest rate in the traditional monetary policy can in such a situation, as we saw under the financial crisis, be ineffective as it can not reduce the risk premium on the money market by itself. The analysis shows that Danmarks Nationalbank and other central banks have used alternative monetary strategies besides its traditional monetary strategy in order to stabilize the financial sectors. The economy
has still not fully recovered and looking at the Danish monetary policy isolated it has not been found sufficient but have been necessary supplement to other economic alternatives, i.e. fiscal policy and banking packages.
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1. Introduction

The consequences of the financial crisis have challenged the traditional monetary strategies making it necessary for central banks to look for alternative monetary instruments. The price-stabilizing strategies have been the cornerstone of most of the world’s central banks’ strategies as uncontrollable inflation has been the main concern up until the start of the financial crisis.

The financial crisis that started with the subprime crisis in the USA changed the macroeconomic scene of European countries including Denmark. Stock markets fell, the money market froze and increases in the credit and liquidity risk of the banks made the countries sink into a recession. To help the economy recover the traditional instruments of lowering interest rates were used by the central banks, as can be seen in figure 1.

Figure 1

Monetary Interest Rates

Note: Interest rates are in percent pr. annum
Source: Datastream and ECB’s homepage (www.ecb.int)

USA, Euro-area and Denmark’s interest rates were already relatively close to the zero-limit bound before the crisis which limited how much the interest rates could be lowered when the crisis hit. The monetary policy now faced a new challenge as nominal interest rates could not be negative and the economy was still in a low inflationary or deflationary state. This scenario also called the liquidity trap was first mentioned by John Keynes in his book “The General Theory of Employment, Interest and Money”, cf. section 2.6.
The state of the economies around the world and the theory of the liquidity trap have started a discussion among economists on the efficiency of lowering the interest rate and the transmission mechanism affecting the real economy. The official framework for the fixed exchange rate is called the “Exchange rate mechanism” or “ERM II. The primary task of the Danish central bank “Danmarks Nationalbank” has been to keep the exchange rate between the Danish krone (DKK) and the euro (€) within the margin of +/- 2.25 from the central rate of 7.46038 DKK pr. euro. Following the financial crisis Danmarks Nationalbank has sought to “escape” the liquidity trap through alternative monetary strategies while still having a fixed exchange rate policy, see figure 2.

Figure 2

![Diagram of Exchange Rate Mechanism, ERMII](image)

**Note:** The spot rate is a monthly average of the daily observations
**Source:** Statistikbanken and Nationalbanken

This thesis will look at the efficiency of traditional and alternative monetary strategies in an economy caught in a liquidity trap.

### 1.1 Problem Statement

The recent events in the global economy has made economists question the traditional monetary policy and how it affects the real economy. The purpose of this thesis is to establish a profound understanding of the monetary policy of the ECB and Danmarks Nationalbank and its efficiency during a recession where the economy is caught in a liquidity trap, cf. section 2.6, like the one we have seen under the financial crisis. A quantitative analysis with a known econometric model
will together with the theory make ground for an evaluation and discussion of the efficiency of the monetary policy and the alternatives to the traditional monetary strategy\textsuperscript{1}. This will hopefully give an insight on how monetary policy can be conducted to escape a liquidity trap.

The thesis is not thought to be explorative alone but rather an empirical evaluation, cf. section 5, and discussion of known theory. The thesis will look at relevant theory on the subject like the Taylor Rule, transmission channels, term structure of interest rates, theory on the liquidity trap etc. and describe the strategies and operational framework of the ECB and Danmarks Nationalbank. Denmark being a small open economy with a fixed exchange rate policy to the euro is very dependent on the monetary policy decisions of the ECB. Because of this close dependency it would not be possible to analyze and discuss Danish monetary policy without looking at the monetary policy of the ECB.

1.2 Delimitation:
Fiscal policy will have a significant influence on macro economic factors and therefore also on the effectiveness of the monetary policy. Writing about the diverse fiscal policies within the euro, let alone their influence on the monetary policy, would be a thesis in itself. Therefore I acknowledge the fiscal policy’s influence but concentrate on looking at implications and effectiveness of the monetary policy in a recession.

For the same reasons as for the fiscal policy the bank packages launched by the Danish government during the crisis will not be analyzed or discussed despite of their significance to the credit creation in the Danish economy.

As the macroeconomic environment has changed so has the operational strategic framework of both the ECB and Danmarks Nationalbank. This thesis will only look at the current framework of both central banks. How the strategic framework was under Bretton Woods or the gold standard might give a historical perspective but will have no relevance in answering the problem statement of the thesis. I argue that as the knowledge of their effect in practice has grown the adjustments made on the monetary instruments and strategies over time diminish the chance of them being more effective, cf. section 3.

The ECB will be seen as an integrated unit and not as a group of member central banks with a fixed exchange rate policy. This means that the framework, monetary instruments etc. will be presented on an EU level but not on a national level.

An econometric model used to estimate the effect of the credit and inflation risk on the risk premium will be of own creation. Only the results found by other econometric models will be analysed, as discussing how the econometric models is constructed will not contribute significantly to the purpose of the thesis. Instead only reliable sources will be used.

Primarily Danish data from the period just before the beginning of the financial crisis to present time will be used for the econometric model. Though it would have been interesting to analyze and compare Danish data with data from other European countries in the same period in time I have chosen not to. Focussing on Danish data allows me to take a more in-depth approach in the analysis.

1.3 Method

1.3.1 Thesis Framework

The first part of the thesis will consist of the introduction, problem statement and the method used in the thesis. The purpose of this part is to introduce to the reader the topic, outline the problems addressed in the thesis and give an insight to the framework of the thesis.

The second part will present and explain to the reader relevant theory on money supply and demand, monetary policies and regimes, credit and liquidity risk, the transmission channels, term structure of interest rates and the liquidity trap which will be used in the analysis and discussion.

The third part will describe the operational and strategic framework of Danmarks Nationalbank and the ECB. This includes the monetary instruments of the two central banks and their present strategy. The operational framework is important when analysing the monetary responses by Danmarks Nationalbank and when discussing the effectiveness of the monetary instruments in different monetary policy strategies.

As a continuance of part three the fourth part will consist of a review of the monetary responses by Danmarks Nationalbank and the ECB during the crisis. Key real economic data will also be presented and both will be used to analyze the central banks’ responses to the crisis in section 6.
The fifth part of the thesis is an econometric estimation of the influence of the credit and liquidity risk on the risk-premiums of the money market interest rates before, during and in the aftermath of the financial crisis. The results will be used to evaluate the monetary responses and policies of Danmarks Nationalbank and make grounds for the discussion of alternative monetary policies.

Part six will analyze the findings in section 4 and 5 and present alternative monetary strategies in theory when the economy is caught in liquidity trap. Besides a theoretical discussion an evaluation of the responses of the NB from central banks and own suggestion will be presented.

Part seven will be a conclusion that will recapitulate the findings to see if the problem statement of the thesis has been answered. Figure 3 illustrates the structure of the thesis.

**Figure 3**

![Diagram](Source: Own creation)
2. Theory

2.1 Purpose of Section
As described in section 1.3.1, relevant theories that will be used to analyze the monetary policy of the Danish central bank will be presented in this section. The theoretical framework of monetary policy and how it is transmitted through the transmission channels to the real economy will first be presented. This will be followed by a description of the liquidity trap and the problems associated. How credit and liquidity risk affects the financial institutions and thus indirectly the money market will be explained. In extension of the section on credit and liquidity risk the section on the structure of interest rates and how it is affected both horizontally and vertically will round off the theory chapter.

2.2 Monetary and Fiscal Policy
The theory on macroeconomics has evolved significantly in the last 100 years. Monetary theory has sought to explain how changes in the money supply and interest rates affect the macroeconomic factors in the economy. The classical theory had, up until the publication of Keynes’ “The General Theory of Employment, Interest and Money” in 1936, been the main theoretical framework of macroeconomics and monetary and fiscal policy.

Fiscal policy according to the classics and Milton Friedman have been viewed as ineffective in creating growth and should only be used to avoid budget deficits. The argument was that wages and output would only be in in-equilibrium in short term and would without government interference quickly fall back to their natural state². Monetary policy on the other hand was, according to the classics and Friedman, more effective but due to the complexity it should only be used to stabilize prices.

Keynes theory challenged the classical view on the fiscal and monetary policies only being used to avoid budget deficits and stabilize prices³. Although both policies could be used as countercyclical policy Keynes argued that fiscal policy would be more efficient than monetary

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policy\textsuperscript{4}. His argument was that the government could use fiscal policy to affect the macroeconomic environment directly through the multiplier effect whereas monetary policy could only influence the environment indirectly through the transmission process. The transmission channels will be presented in section 2.5 and its inefficiency in a liquidity trap will be presented in section 2.8.

This thesis will as stated in section 1.2 only focus on the efficiency of the monetary policy. To be able to evaluate the efficiency of the monetary policies the basics of monetary theory will be presented below. This includes the relationship between money demand and money supply and how different transmission channels influence on the real economy.

2.3 Money Supply and Demand for Money

2.3.1 Money Supply

Money supply is normally regarded as an exogenous variable controlled by the central bank since the central bank controls the monetary base in the economy that indirectly controls the secondary money supply. The monetary base will have a constant relationship with the secondary money supply through the credit multiplier under the following prerequisites\textsuperscript{5}

- The secondary money supply (M) consists of money in the form of cash (N) and deposits (D)
- The citizens will hold a proportion of the secondary money supply in cash (N) equal to c
- The banks will hold an amount of cash (R) proportional to deposits (D) to meet the demand for holding cash (N). This relationship between deposits (D) and the amount held by the banks (R) is equal to r.
- The monetary base (B) is equal to the amount held in the form of cash (N) and the amount held by the banks (R)
- The relationship between the holding of cash instead of deposits (c) and the relationship between deposits and the amount of cash held by the banks (r) are both constant.
- An efficient loan market where the banks are willing and able to supply loans and there is a demand for loans in the market.

\textsuperscript{4} Niels Thygesen and P. Nørgaard Rasmussen (1969). Udviklingslinjer i makroøkonomisk teori - page 312
\textsuperscript{5} Bodil Nyboe Andersen (1972) Noter til Makroteori - page 13
When all prerequisites are met the secondary money supply (M) will be equal to:

$$M = B \times \frac{1}{c + r \times (1 - c)}$$

Where $\frac{1}{c + r \times (1 - c)}$ is the credit multiplier which ensures a constant relationship between the monetary base (B) and the secondary money supply (M). This means that the higher c and r is the lower the effect of the changes to monetary base will have on money supply.

2.3.2 Demand for Money

In section 2.3.1 we found that money supply can be controlled by the central bank controlling the monetary base. In Keynes theory money demand serves as the link between the central bank and the real economy through the interest rate as it is the main determinant for the relationship between savings and investments. In more than one way it affects the investments in the economy through the transmissions to the real economy which will be presented in section 2.5.

2.3.2.1 Classical Quantity Demand for Money

In the classical quantity theory the transaction motive is the determinant of the money demand and money supply is exogenous. Fisher shows the relationship in his equation of exchange:

$$M \times V = P \times T$$

The equation in its basic form is an identity stating that the value of the total transactions in the economy (right side of the equation) is equal to the quantity of money times its velocity.

The Cambridge scholars Marshall, Pigou and Keynes further developed Fishers exchange equation. To formulate the identity into a theory they had to make certain assumptions.

- The velocity (V) was constant where the Cambridge k is equal to the inverse velocity ($\frac{1}{V}$)
- The variable of total transactions in the economy (T) moves parallel with real GDP (Y)

Under these assumptions changes in the money demand (M) will be proportional to changes in prices (P) and output (Y).

$$M_d = k \times P \times Y$$

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6 Bodil Nyboe Andersen (1972) Noter til Makroteori - page 16-20
Money demand is therefore solely determined by changes in nominal income. It is positively correlated with prices and income since the demand will increase as more money is needed for transactions. Given a stable relationship between the variables above and that the money supply is an exogenous variable the central bank can control and stabilize prices (P) with monetary targeting.

2.3.2.2 Keynesian Demand for Money
As mentioned above the classics saw the transaction motive as the main determinant of money demand and did not include interest bearing assets in their definition of the money term. Keynes on the other hand felt that Irvin Fishers redefinition of the money term, which included interest bearing assets, was more correct as the interest rate was the real determinant for money demand in Keynes’ theory.

Because of this he also questioned the classics view of transactions, where only money is used, being the total wealth of an economy. His definition of wealth included money (M) which is considered a liquid asset but unlike the classics he also included illiquid assets like bonds (B). His argument was that only one type of asset would be held in an economy and money demand would be determined by the relationship between the two. The uncertainty of holding an illiquid asset like bonds (B) instead of money (M), meant that the bond holder would demand to be paid an interest. The relationship between holding money (M) and holding bonds (B) was therefore determined by the liquidity preferences in the economy. Keynes found that the liquidity preferences could be explained by three motives for holding liquid assets.

I. Transaction motive or income motive which is the same motive described in the classical theory.
II. Precautionary motive where a part of the total wealth will be held in liquid assets to be able to pay unforeseen expenses. This motive has become less significant as credit cards have become more common.
III. The speculation motive where expected changes in prices and interest rates on bonds (B) will decide whether it’s sensible to hold money (M) instead of bonds (B).

In the first two motives money demand is a function of the income (Y) in an economy. The third motive on the other hand will be determined by the interest rates. This explains why the interest
rate \( (i) \) is also a key determinant in the demand for money. Total money demand \( (L) \) when combining the three motives can therefore in its simplest form be described:\(^7\)

\[
L = L(Y, i)
\]

Over the years different economists supporting Keynes theory have added to his theory on how interest rates affect the money demand. Tobin and Baumol\(^8\) are examples hereof as they contributed by explaining how the demand for non-interests bearing money or the transaction motive is also determined by the interest rates.

Opponents of Keynes theory do not believe interest rates to be the main determinant for money demand. According to Friedman money demand is determined by the total wealth which is a function of five variables\(^9\): Permanent income \( (Y) \), expected nominal return on bonds \( (R_b^e) \), money \( (R_m^e) \) and stocks \( (R_s^e) \) and expected inflation \( (\pi^e) \). Unlike Keynes theory Friedman used expected return on bonds and stocks relative to the return on money, making expected return on bonds \( (R_b^e) \) and stocks \( (R_s^e) \) negatively correlated. Expected inflation \( (\pi^e) \) and money demand were also negatively correlated while permanent income \( (Y) \) is positively correlated.

### 2.4 Monetary Targets - Price Stability, Monetary Regimes and Taylor Rule

The strategy of the monetary policy can be divided into four groups of targets that serve as the links between the operational instruments and the objectives of the central bank. The central bank uses its monetary instruments to reach the set operational targets. By reaching the operational targets the intermediate target should be met which if met should lead to the central bank fulfilling its final target. All of this should, if the monetary policy is efficient, lead to the ultimate target. Figure 4 illustrates the process going from the operational to the ultimate target.
2.4.1 Ultimate Target
The ultimate target is the first and most important target for the central bank. It is the main objective in the central bank’s strategy and most central banks today agree on that it is to minimize the loss of welfare\textsuperscript{10}. Losses in welfare can, according to Svensson’s loss function\textsuperscript{11}, occur from deviations in expected output and inflation.

\[
L_t = \frac{1}{2} \left[ (\pi_t - \pi^*)^2 + \lambda \left( \frac{Y_t - Y^*}{Y^*} \right)^2 \right]
\]

Where:

\( L_t \) = Loss at time \( t \), \( \pi_t \) = Actual inflation at time \( t \), \( \pi^* \) = Inflation target, \( \lambda \) = Weight, \( Y_t \) = Output at time \( t \) and \( Y^* \) = Potential output

2.4.2 Final Targets
Economist therefore considers the targeting of nominal GDP and price stability as the most relevant final target of the central bank\textsuperscript{12}. To minimize the loss of welfare in Svensson’s loss function the central bank can set \( \lambda \) to \( \lambda = 0, 0 < \lambda < 1 \) or \( \lambda = 1 \) which gives the following three

\textsuperscript{10} Peter Bofinger (2001). Monetary policy: Goals, Institutions, strategies, and instruments - page 128
\textsuperscript{11} Peter Bofinger (2001). Monetary policy: Goals, Institutions, strategies, and instruments - page 128
\textsuperscript{12} Peter Bofinger (2001). Monetary policy: Goals, Institutions, strategies, and instruments - page 129
combinations of inflation and output targeting. Depending on the chosen combination output and inflation are used as intermediate targets, see section 2.4.3.

- Strict inflation targeting where only inflation is targeted
- Flexible inflation targeting where mainly inflation is targeted
- An equally targeting of both inflation and output.

Most central banks today focus mainly on price stability but can also have other final targets that influence their monetary strategy, i.e. employment. Especially in the 70’s employment targeting was considered an important strategic target. The Phillips-curve created by William Phillips showed a trade-off between inflation and unemployment where allowing higher inflation would cause unemployment to fall. Even though the Philips-curve in its original has been questioned by economists as the theory does not seem to hold in the long run, the FED still has employment as a final target\textsuperscript{13}.

2.4.2.1 Price Stability

The reason why price stability is the predominant final target is that the positive effect of other final targets is neutralized in the long run due to a higher expected inflation. Other final targets are therefore only considered short-term targets where price stability is a long-term target.

A high and volatile level of inflation will make the relative prices less transparent for households and companies and make investment and saving decisions more difficult. Total investments in the economy will furthermore be affected negatively by inflation as nominal interest rates will increase, as creditors will demand a higher risk premium. The in-transparent relative prices associated with high inflation also affect the goods-, labour- and financial-markets as a very volatile inflation will have to be taken account for when negotiating contracts. Although the costs of inflation can be high central banks do not target a zero % inflation rate. This is because a low level of inflation also can help make the labour and price market more efficient as real wages and relative prices can be adjusted without changing the nominal wages and prices.

Deflation can have the same complicating effects as inflation and it can lead to the problem of the liquidity trap, cf. section 2.6. A low level of inflation is therefore considered price stability and in practise the targeted inflation rate is typically around 2 % annually.

\textsuperscript{13} Peter Bofinger (2001). Monetary policy: Goals, Institutions, strategies, and instruments - page 130
2.4.3 Intermediate Target

The intermediate targets are used as guiding points in the monetary policy to reach the final targets of the central banks. The final targets price stability, employment, sustainable real growth etc. are more abstract and difficult to measure than the operational targets. The central bank can set an intermediate target that will serve as a link between the operational and final targets. The intermediate target will therefore be closely correlated with the final target and be indirectly influenced by the operational targets. The two most common used intermediate targets are inflation- and exchange rate targeting where the interest rate is used as an operational target. The interest rate indirectly influences the exchange rate through the interest rate parity. In inflation targeting the central bank steers the market’s inflation expectations indirectly through its interest rates. The relationship between interest rates and inflation will be described by the Taylor rule in section 2.4.4.1.

The choice of intermediate target seems to be influenced by whether it is a small open economy or a large open economy the central bank facilitates. The monetary regime will depend on the intermediate target of the central bank and the different monetary regimes will be presented in section 2.4.3.1.

2.4.3.1 Monetary Regimes

Monetary regimes that follow a price-stability-oriented monetary policy will typically have inflation targeting or exchange rate targeting as intermediate targets. A small open economy will be more depended on import and export and therefore more exposed to exchange rate risk than a large open economy. Fixing the exchange rate to a larger economy that has price-stability as final target will therefore make more sense for a small open economy as the price-stability policy of the larger economy has been found to transmit to the small.

Inflation targeting regimes where the inflation is the intermediate target of the central bank is found in a number of western countries. The Bank of England and Sveriges Riksbank are examples hereof where an inflation target is chosen and sought reached through the operational targets. Although the ECB targets price stability it is not considered an inflation targeting regime.
as other factors than the level of inflation are taken into consideration when it conducts its monetary policy, cf. section 3. The fixed exchange rate regime has been chosen by a number of smaller economies, i.e. the Danish central bank. Danmarks Nationalbank has fixed its exchange rate to the euro and its monetary policy will be presented in section 3.

Both inflation targeting- and exchange rate targeting regimes have been found efficient in reducing the level of inflation but only the exchange rate targeting regimes have reduced volatility in the inflation\textsuperscript{17}.

\textbf{2.4.4 Operational Targets}

The monetary base, the interest rates and the exchange rate are all operational targets which the central banks can use in their monetary strategies. They can be reached by using the monetary instruments of the central bank which means that they are affected directly or indirectly through the central bank’s instruments. The specific monetary instruments, used for inflation rate- and exchange rate targeting by the ECB and Danmarks Nationalbank, will be presented in section 3. Since both the ECB and Danmarks Nationalbank use interest rates as an operational target in their price stability-oriented monetary policies, see section 3, only interest rate targeting will be presented.

The central bank reaches its interest rates target through the monetary instruments. Only two instruments that set an upper and lower limit on the money market interest rate are needed for the central bank to be able to directly control the money market interest rates. The upper limit on the money market is set by the central bank by giving the financial counterparties access to central bank money at a refinancing rate. The counterparties will be able to borrow money at the refinancing rate as borrowing money in the money market at a higher interest rate will not make sense. The lower limit is set by setting an interest on deposits as the financial counterparties can always deposit money at this rate. It would not make sense to lend money at a lower interest rate in the money market.

Interest rate targeting is superior when the central banks intermediate target is either inflation- or exchange rate targeting as fluctuations in the short term money market rate can influence the exchange spot rate and the price level in the economy\textsuperscript{18}.

\textsuperscript{17} Ander Møller Christensen and Niels Lynggård Hansen (2009). The monetary-policy Regime and the Development in Central Macro-economic Variables in the OECD Countries 1970-2005 - page 216-235
2.4.4.1 Taylor rule\textsuperscript{19}

The Taylor rule describes the relationship between the interest rate and inflation and output and the rule will therefore be summarized in this section. It has been used by the FED in setting the value of the operating target, the short term interest rate, and is formulated in the following equation:

\[
i_t - \pi_t = R + \alpha(\pi_t - \pi^*) + \beta\left(\frac{Y_t - Y^*}{Y^*}\right)
\]

Where \(i_t\) is the short term interest rate, \(R\) is the average short term interest rate, \(\pi_t\) is actual inflation, \(\pi^*\) is the target inflation, \(Y_t\) is actual output, \(Y^*\) is potential output and \(\alpha\) and \(\beta\) are the weights.

Whether the rule suggests an increase or decrease in the real interest rate depends on the deviation of output and potential output and deviation in actual inflation from the target inflation. Looking at the determinants separately we can see that if actual inflation has been higher than the targeted inflation the interest rate should be increased and vice versa. By looking at output we see that if actual output is less than potential output the term in the equation will be negative and therefore the interest rate will be decreased and vice versa. Combining the two determinants we can see that the real interest will be determined by the changes in the output gap and inflation. The weights determine what the central bank considers more important for the interest rate to react to.

2.5 Transmission Channels

The transmission channels are the link between the monetary policy and the real economy. As mentioned in section 2.4 the ultimate goal of the monetary policy is to create welfare in the economy through the final targets of the central bank. The theory on the transmission channels tries to explain the relationship between the monetary policy and the final targets of the central bank and thus how it affects the real economy. Even though most economists agree on the ultimate goal of the monetary policy, the final target and the theory on the transmission channels have been the subject of much discussion. The main channels are the interest rate channel which

\textsuperscript{18} Peter Bofinger (2001). Monetary policy: Goals, Institutions, strategies, and instruments - page 326
\textsuperscript{19} Peter Bofinger (2001). Monetary policy: Goals, Institutions, strategies, and instruments - page 268 - 274
includes the money and the credit view, the expectation channel, the equity channel and the exchange rate channel which all will be presented in this section.

2.5.1 Interest Rate Channel – Money View

The theory formulated by Keynes on the transmission through the interest channel has been the cornerstone of the monetary theory for over half a century. The IS/LM-model constructed by Hicks tries to incorporate Keynes formulation in a model that shows the relationship between the investment and saving side (IS); and money supply through the liquidity preferences in the economy (LM), see figure 5.

Figure 5

Source: Own creation

Prices are assumed sticky in the model which will cause a change in nominal interest rates to lead to a change in real interest rate. Given that the long term nominal interest rate is a function of a series of expected short term interest rates a change in the short term interest rate will also affect the long term interest rate, see section 2.8.

When expanding or contracting the money supply (M) the change in nominal interest and thus the real interest rate ($i^r$) will be negative correlated. The change in real interest rates ($i^r$) will affect the cost of capital and thus the investment decisions of both private consumption and businesses. A change in investment spending (I) will have a direct influence on the output of the economy.

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20 Based on Hicks Theory and similar to figures made by others
economy through the aggregated demand. An increase in the money supply \((M)\) will therefore have the following effect on the output\(^{21}\):

\[
(M \uparrow) \rightarrow (i^r \downarrow) \rightarrow (I \uparrow) \rightarrow (Y \uparrow)
\]

As mentioned in section 2.2 Keynes deemed the monetary effect on the real economy ineffective or complex at best opposed to the effect of fiscal policy where he found a direct relationship between action and effect on the economy. He pointed out two issues being the reasons for the increased uncertainty of the effects of the transmission mechanism on the real economy\(^{22}\).

The notion that a decrease in \(i^r\) will transmit into an increase in investment spending depends on the investments’ interest elasticity. If interest rates are inelastic for investments a change in interest rates will not have an effect on the real economy as investments will not increase or decrease.

The other issue presented by Keynes is called the liquidity trap and will be presented in section 2.6.

2.5.2 Credit View

2.5.2.1 Lending Channel

In the credit view lending channel the monetary policy affects the supply of loans and thus the investment decisions in the economy. Bank loans in this transmission channel are the only way for companies to fund themselves as especially smaller companies will have difficulties of funding themselves in other ways. As we know from the money supply theory in section 2.3.1 the supply of loans depends on the reserves of the bank as only part of the deposits \((D)\) will be used for lending \((L)\) and the rest will be held in required reserves. This means that the central bank through the credit multiplier can influence the amount of lending in the economy by increasing or decreasing the money supply \((M)\). A change in the amount of lending will affect the investment spending \((I)\) in the economy which will lead to a change in output \((Y)\). The transmission mechanism for an increase in the money supply can therefore be shown in the following form\(^{23}\):

\[
(M \uparrow) \rightarrow (D \uparrow) \rightarrow (L \uparrow) \rightarrow (I \uparrow) \rightarrow (Y \uparrow)
\]


\(^{22}\) Bodil Nyboe Andersen (1972) Noter til Makroteori - page 30

The lending channel has met some criticism when applied to the American economy since the non-financial lending has become a common source of funding with increasing securitization\textsuperscript{24}.

\textbf{2.5.2.2 Balance-sheet Channel\textsuperscript{25}}

In the balance-sheet channel the interest rate affects the loan supply in the economy due to the creditworthiness of the borrowing company. A change in the interest rate will increase or decrease the net worth of the company on the balance-sheet. A loss in net worth will decrease the amount of collateral the company can set when borrowing. Furthermore a loss in net worth can potentially increase the equity holder’s risk willingness to regain the loss taking on more debt to pursue riskier projects with potentially high returns, also known as “moral hazard”. Lenders are aware of the increased risk willingness and will demand a higher interest rate on their loans to compensate for the higher risk associated with lending to companies that are taking on more risky projects.

\textbf{2.5.3 Expectations and the transmissions channels\textsuperscript{26}}

Market expectations can in some way be linked to all the other transmission channels as the central banks seek to influence the counterparties’ expectations when conducting their monetary policy. As the central bank can influence the interest rates and interest rates affect the price level in the long run the central bank can control the market’s inflation expectations. In the short run wages and prices are fixed as it is costly to negotiate wages and change prices. High inflation will, as mentioned in section 2.4.2.1, have some cost for the economy as the uncertainty of the future price level increases making it more difficult to negotiate wages and set prices. If the market expects that the central bank will keep inflation at a low level the uncertainty of the future price level is reduced. Whether the central bank is able to form market expectations depends on its credibility. Independence and transparency are vital for the central bank’s credibility. If a central bank is not independent from the government and is used to fund government deficits by depreciating the exchange rate even though inflation is at a high level the central bank loses its credibility. By being transparent and communicating how it will conduct its monetary policy the central bank can increase its credibility and therefore control market

\textsuperscript{24} Michael Woodford (2010). Financial Intermediation and Macroeconomic Analysis - page 24
\textsuperscript{26} Peter Bofinger (2001). Monetary policy: Goals, Institutions, strategies, and instruments - page 95-115
expectations. Having the market expect that the central bank will reduce inflation can become an issue if the economy is caught in a liquidity trap. This will be presented in section 2.6

2.5.4 Exchange Rate Channel

The exchange rate channel affects the net exports (NX) of a country through the foreign demand for domestic goods and domestic demand for foreign goods. The short term interest rate is also the key factor here as it affects the exchange rate (E) through the interest rate parity. A relative change in the short term domestic interest rate to a short term foreign interest rate through a change in the domestic money supply (M) will affect the demand for domestic deposits. The relationship between the domestic interest rate (i_\text{r}) and the demand for domestic deposits is positively correlated as an increase in the demand for domestic deposits will lead to an increase in the demand for domestic deposits. The increase in demand for domestic deposits means that foreign currency will be exchanged to the domestic currency. This will lead to an increase in demand for the domestic currency relative to the foreign currency leading to an appreciation (E) of the domestic currency. All else being equal we know through the theory of Purchasing Power Parity (PPP) that the appreciation of the domestic currency makes it more expensive for the foreign consumers to buy domestic goods leading to a fall in foreign demand for domestic goods. At the same time domestic consumers will find foreign goods less expensive leading to an increase in domestic demand for foreign goods. The combination of the increase in domestic demand for foreign goods and fall in foreign demand for domestic goods will cause a fall in net export (NX) which will lead to a fall in aggregated demand and output (Y).

\[(M \downarrow) \rightarrow (i_\text{r} \uparrow) \rightarrow (E \uparrow) \rightarrow (NX \downarrow) \rightarrow (Y \downarrow)\]

The exchange rate channel will have a significantly larger impact on a small open economy than in a large open economy, i.e. Denmark contra the USA. This is due to net exports having a larger influence on the state of the economy in a small open economy that relies on foreign demand for domestic goods than a larger open economy where most of the trade stems from domestic demand.

\footnote{Frederic S. Mishkin (1996). The Channels of Monetary Transmission: Lessons for Monetary Policy - page 5}
2.5.5 Equity Channel
The theory on Tobin’s q can be used to describe the equity channel. Tobin’s q is the relationship between the market value of a company and its replacements costs\(^{28}\). The higher the market value of the company relative to the replacement costs the higher the q.

A change in the money supply (M) will as we know affect the interest rate (\(i^r\)) and the prices on bonds \(P_b\) because the demand for bonds is correlated with the change in the interest rate. The demand for equity that is considered an alternative to bonds will depending on whether it is a monetary expansion or contraction respectively decrease or increase relative to the demand for equity leading to an increase/decrease in equity prices (\(P_e\)). Price on equity (\(P_e\)) depicts the market value of the company and a company with a high q will have the incentive to increase its investments funding itself through emissions\(^{29}\). An increase in equity prices will thus lead to an increase in investments (I) which will as we know from the other transmission mechanisms lead to an increase in output (Y).

\[
(M \uparrow) \rightarrow (i^r \downarrow) \rightarrow (P_e \uparrow \text{relative to } P_b) \rightarrow (q \uparrow) \rightarrow (I \uparrow) \rightarrow (Y \uparrow)
\]

2.6 Liquidity Trap
As mentioned in section 2.2 the monetary policy was deemed inefficient by Keynes as it could only indirectly influence the real economy through the transmission channels. In a situation where the liquidity-trap is present the interest rate transmission channel will be inefficient as expanding the money supply (M) will not affect the nominal interest rates.

So far we have assumed that the nominal interest rate cannot be lower than zero and have assumed that the interest rate is inversely proportional to money supply. Keynes questioned the certainty of the interest rate being inversely proportional with money supply as he meant that the elasticity of the LM-curve would depend on the interest rate level. In an economy with very low interest rates the demand for liquid assets will be higher since the alternative cost of holding money instead of bonds is low. Furthermore the market will expect the interest rate to increase when interest rates are close to the zero limit bound which will increase the incentive of holding money instead of bonds\(^{30}\). This will only become a problem in an economy which is trapped in a

\(^{29}\) Peter Bofinger (2001). Monetary policy: Goals, Institutions, strategies, and instruments - page


\(^{30}\) Bodil Nyboe Andersen (1972) Noter til Makroteori - page 30
deflationary state as the economy will then be caught in the liquidity trap where nominal interest rates cannot be lowered any further. Therefore the central bank cannot affect the real economy through the transmission channels and create growth to escape the deflationary state. Market expectations can further reduce the monetary policy’s wish of creating growth through lowering its monetary interest rates as the market expects that the central bank will respond to inflation by increasing interest rates. The IS/LM graph in an economy caught in a liquidity-trap will therefore not be the same as in figure 5 but instead as presented in figure 6.

**Figure 6**

![Graph showing IS/LM model with IS and LM curves crossed at point Y*, indicating liquidity trap.](source:

Source: Own Creation

The monetarist on the other hand rejects the inefficiency of the interest rate channel in a liquidity trap. Expanding the money supply (M) will not affect lower nominal interest rates but the sticky prices will cause an increase in expected prices and therefore also an increase in expected inflation. The increase in expected inflation will lead to a fall in real interest rates thus affecting the investment decisions in the economy increasing investments and output (Y)\(^2\):

\[
M \uparrow \rightarrow P^e \uparrow \rightarrow \pi^e \uparrow \rightarrow i^r \downarrow \rightarrow I \uparrow \rightarrow Y \uparrow
\]

---

\(^1\) Based on the known theory and similar figures made before


2.7 Credit- and Liquidity Risk

2.7.1 Credit Risk
Credit risk affects the money market in the way that it affects the total risk of the financial institution. Financial institution will have to consider the risk of not getting back the full amount of the principal paid and interest payments promised on their investments due to the counterparty not being able to pay his obligations.

The risk depends on the creditworthiness of the counterpart and the type and maturity of the loan, see section 2.8. The higher the creditworthiness of the counterpart the less risky the loan will be as the probability of default is low. To determine the amount of risk of the loan the financial institutions perform a credit rating that determines the firm specific of the borrower systematic risk in the economy. Firm specific risk can be significantly reduced through portfolio diversification. Despite performing these credit ratings and the diversification of the loan portfolio credit risk will not be completely eliminated. To compensate the financial institutions for this risk a credit-risk premium is incorporated into the interest rate which the borrower pays.

The type and maturity of the loan will have an effect on the credit risk of the loan. A loan with a long maturity has a higher risk of the counterparty defaulting. This can be explained by the uncertainty of the company defaulting due to firm specific and macro-economic shocks in the near future being smaller than the uncertainty several years from now. The financial institutions will therefore also take the maturity of the loans into account when performing the credit rating. To further reduce the risk the financial institutions can choose loan types that increase the probability of getting the principal of the loan back. An example of this could be the collateralized loans where the borrower uses collateral equal or close to the value of the loan as a guarantee of repayment.

Performing a credit rating of a firm can be costly and complex, as many factors have to be taken into account. Different rating bureaus have specialized in evaluating the credit ratings of different companies. This should make the market more transparent as the rating bureaus give an objective rating of a firm that can be compared to the rating of another company.

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Unexpected changes to the credit rating of the different companies in the economy whether it is due to a decrease in systematic or firm specific risk will reduce the total risk of the financial institutions. Conversely a general drop in the credit rating of the economy will increase the total risk of the financial institutions’ loan portfolios as the value of the loans will decrease.

2.7.2 Liquidity Risk

Liquidity risk can be decomposed into a market and a balance sheet risk that are closely correlated\(^{35}\). Both affect the total risk of the financial institutions and thus the money market.

Market liquidity is the risk of not being able to immediately sell or buy an asset at market price but instead at a bid and ask price. The spread between the bid and ask price will depend on the level of liquidity in the market. The higher the level of liquidity the lower the bid/ask spread will be and vice versa. A high level of market liquidity has been associated with low volatility in the financial markets\(^{36}\).

From transaction motive in Keynes theory we know that the financial institutions assess on a weekly basis the amount of assets they will need to keep in liquid form to satisfy the liquidity preferences in the economy. The balance sheet liquidity risk is the risk of an increase in the demand for cash where the financial institution will have to sell illiquid assets at a lower price or borrow liquidity at a higher interest rate. Since liquid assets generate a very low or no interest the financial institutions have the incentive to hold as much interest bearing assets as possible. As the illiquid assets can be costly to convert to cash the interest rate of illiquid assets will also consist of a liquidity risk premium to compensate for this risk.

Typically the liquidity risk will increase due to either an unexpected increase in the general demand for money or a drop in the trust of the financial claim holders to the financial institution or a combination of the two. Unexpected increases in the demand or decrease in the supply of liquidity will make it more difficult for the financial institutions to obtain more liquidity. Because the financial institution will have to borrow the money or sell illiquid assets to satisfy their demand, the cost hereof will increase. This can push the financial institutions into a


solvency problem and hurt the profitability of the company. From a macroeconomic view this can worst case scenario decrease the financial claim holders’ trust in the financial institutions to a level that it will create a bank run where people in fear of the bank going bankrupt withdraw their deposits. This will only add to the likeliness of a bankruptcy causing other people to withdraw their deposits.

Asset management reduces the risk and is vital for a company to optimize the ratio between liquid and illiquid assets. Managing the liquidity of the liability side is just as important as managing the asset liquidity side and contributes in reducing the risk. Certain regulatory requirements like taxation and monetary policies will also have an effect on the liquidity risk and can be used to indirectly reduce the liquidity risk in the economy\textsuperscript{37}. An example of this is the monetary policy of restricting the amount of liquid assets that the financial institutions have to keep as reserves to absorb sudden fluctuations in liquidity demand and reduce liquidity risk. Normally the financial institutions will be able to refinance in the money market but shocks to the economy like the one seen under the financial crisis can freeze up the market. Monetary policies can therefore be implemented to reduce liquidity risk, i.e. under the crisis the central banks provided liquidity to meet demand and guaranteed financial claim holders claims up to a certain amount to prevent a bank run.

2.8 Structure of Interest Rates\textsuperscript{38}

The structure of interest rates can be defined as the relationship between the returns on different types of claims that vary in coupon rate, credit risk, maturity etc. The term structure of interest rates, also called the horizontal structure of interest rates, focuses on the maturity as the only variable and seeks to explain the relationship between the effective interest rate and maturity. Conversely the vertical structure of interest rates is the other factors’ influence on the interest rates, i.e. credit risk, see section 5. The V-curve in figure 6 shows the interest rates at different maturities determined by expectations, cf. 2.5.3, and liquidity preferences, cf. 2.3.2.2.

Assuming investors will maximize the return on their portfolios over an investment period they will choose assets with maturities that give the highest expected return. If all investors construct

\textsuperscript{37} i.e Basel III
\textsuperscript{38} Elsebeth Rygner (1979). Den Danske Rentestruktur i den Forløbne Del af 1970’erne. page 91 – 106
their portfolios after this principle interest rate expectations will be aligned in the market and will then determine the interest spot rate. For this to be true investors’ risk aversion will have to be small or non-existing as the uncertainty of the expected future interest rate grows over time. To account for investors’ risk-aversion the liquidity preferences of the investors will also have to be considered. The longer the maturity the more illiquid the asset will be. Depending on the individual investor’s liquidity preferences investors will choose assets with short or long maturities, i.e. insurance companies will typically prefer assets with longer maturities whereas banks will prefer assets with short maturities. Expectations and liquidity preferences are therefore as mentioned above the main determinants for the term-structure of interest rates.

The H-curve on the other hand shows the risk premium of other factors than maturity. The risk-premium will normally consist of a liquidity risk and a credit risk premium\(^\text{39}\). Expected inflation will be incorporated in the nominal interest rate but in economies with stable prices inflation will not have an effect on the term structure as the expectation of the future changes in prices are the same independent of maturity, see section 5. High volatility in inflation will make creditors ask for a higher risk premium the longer the maturity.

As will be discussed in section 6 both the horizontal and the vertical can be influenced. This can be done through influencing market expectations to the future interest rate or through other alternative monetary procedures i.e. operation twist where the FED flattens the H-curve by buying assets with long maturities and selling assets with short term maturities.

\(^{39}\) Niels Blomquist, Niels Arne Dam and Morten Spange (2011). Monetary-Policy Strategies at the Zero Lower Bound on Interest Rates - page. 86
2.9 Recapitulation

In chapter 2 the theory on how the central bank can construct the framework of its monetary policy and how it is transmitted to the real economy has been presented. It can be concluded that a stability-oriented strategy due to the cost of inflation is the most common strategy of central banks. The optimal regime for such a strategy has been found to be inflation targeting or fixed exchange rate. Both uses the short term interest rate as the primary monetary instrument. In a situation where the economy is caught in a liquidity trap the interest rate cannot be lowered any further and monetary policy will be ineffective. Furthermore the money market interest rate may be influenced by an increase in credit- and liquidity risk as both the interest rate and the financial counterparties will be affected by the increase in risk.

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3. The ECB and Danmarks Nationalbank

3.1 Purpose of Section
The purpose of section 3 is to present the framework of the two central banks, the ECB and the Danmarks Nationalbank. Comparing the monetary and operational instruments of the two central banks will give an understanding of how the monetary targets of the two central banks can be reached, cf. section 2.4.

3.2 The ECB
In this section ECB’s strategic and operational framework will be presented.

3.2.1 ECB’s Monetary Strategy
ECB’s monetary policy strategy is a “stability-oriented monetary policy strategy“, see section 2.4.2.1, and is formulated by the ECB as follows: “The primary objective of the ESCB shall be to maintain price stability. Without prejudice to the objective of price stability, the ESCB shall support the general economic policies in the Community with a view to contributing to the objectives of the Community as laid down in Article 2.” In Article 2 these objectives or final targets are described as “high level of employment and non-inflationary growth”.

As formulated by the ECB it first and foremost focuses on price stability in the Euro-area. To achieve this goal of price stability the ECB conducts its monetary strategy on the basis of a monetary analysis of inflation expectations and an economic analysis that determines other potential economic and financial factors that can distress the price stability in the Euro-area. On the background of the monetary and economic analysis the ECB steers towards its main operational target, the monetary interest rates, cf. section 2.4. To reach the operational target the ECB uses the monetary instruments available, e.g. lowering the short-term interest rates through Open Market Operations (OMO’s).

3.2.2 ECB’s Monetary Instruments
As mentioned in 3.2.1 the monetary instruments are used to meet the ECB’s operational target. The instruments are used to absorb and provide liquidity in the economy and influencing money

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42 Peter Bofinger (2001). Monetary policy: Goals, Institutions, strategies, and instruments.
market interest rates. The objective of the instruments is defined by the monetary strategy described in section 3.2.1. Changing interest rates, the liquidity situation or market expectations make it possible for the ECB to reach its final targets, cf. section 2.4, of price stability, high level of employment and non-inflationary growth. The following three monetary instruments are available to the ECB:

- Open market operations
- Standing facilities
- Minimum reserve demand

3.2.2.1 Open Market Operations\(^{44}\) (OMO)

Open market operations are used by the ECB to influence the interest rates, the liquidity in the market and market expectations through the transmission channels, see section 2.5. Market expectations are formed by the ECB by communicating their monetary policy to the market, cf. 2.5.3. OMO’s can be performed on a regular basis weekly or monthly or as scheduled before the start of the year but extraordinary or non-scheduled OMO’s can also be conducted if necessary. Financial institutions use OMO’s to refinance their liquidity position. They are typically conducted in the money market with transaction maturities < 1 year and for the most part influence the short-term interest rates. All of the OMO’s are performed in a decentralised manner by the member-states’ national banks and are only performed by the ECB in rare cases. Depending on the form of the instrument used the OMO’s will have different effects on the interest rates and the liquidity in the market. OMO’s can be divided into the following four categories (A, B, C and D) by their effect on the liquidity in the market, their maturity and their frequency.

A) Main refinancing operations (MRO’s):
B) Longer term refinancing operations (LRO)
C) Fine-tuning operations (FTO)
D) Structural operations
A) Main refinancing operations (MRO’s):

MRO’s are used by the ECB to provide liquidity to the counterparties. They are performed weekly with maturities of a week and play an important part in reaching the final targets of ECB’s monetary strategy. They are used to provide liquidity to the market and steer interest rates to signal the primary objectives of its monetary policy to the counterparties. They are performed as standard tenders with variable or fixed interest rates and the dates of MRO’s are planned and announced by the ECB ahead of the start of the new year.

B) Longer term refinancing operations (LRO)

LRO’s are used to provide longer-term refinancing to the counterparties through reverse transactions with maturities of three months. Unlike MRO’s LRO’s are not used to steer interest rates but only provide liquidity. This is to ensure that the LRO’s do not conflict with the wished signalling effect of the MRO’s. They are performed as standard variable rate tenders on a monthly basis and planned the same way as MRO’s.

C) Fine-tuning operations (FTO)

FTO’s can be used to provide and absorb liquidity in the market and can help steer short term interest rates. They are primarily used to absorb unexpected fluctuations in interest rates and the liquidity in the market caused by macro-economic shocks. They are not scheduled but will be performed as quick tenders or as bilateral procedures between the central bank and one or a couple of counterparties whenever there is a need.

D) Structural operations

Structural operations can, like FTO’s, be used when the ECB wants to provide and absorb liquidity in the market. Unlike FTO’s structural operations are not performed to absorb fluctuations but will be performed when there is a need for the ECB to restructure their net liquidity position to the counterparties. They can be scheduled or be performed when there is a need as either standard tenders or as bilateral procedures.

To perform the OMO’s the ECB uses 5 different operational instruments. All instruments vary in form, which makes it possible to use them only in certain operations and not in others. Because
of their significance reverse transaction will be described more in depth than the other instruments. The operational instruments available to the ECB to perform the OMO’s are as follows:

1. Outright transaction
2. Reverse transaction
3. ECB issuance of debt
4. Foreign exchange swaps
5. Fixed-term deposits

Outright Transactions

The ECB buys or sells marketable assets directly in the market and depending on whether it buys or sells assets it provides or absorbs liquidity in the market. This instrument is only used when conducting structural operations.

Reverse Transactions

Reverse transactions are the most used form of instrument and are transactions of eligible assets with a predetermined repurchase date or given credit through collateral loans. They can be used as an operational instrument in all four different categories of OMO’s and are also used in the liquidity providing part of ECB’s standing facility.

The idea of a repurchase agreement is that the ECB can provide or absorb liquidity to/from the market by “buying/selling” eligible assets from/to counterparties but with the agreement that the counterparty will buy/sell the assets back at a predetermined date. The asset is bought/sold at a discount and bought/sold back at market value. The difference in the discount and market value is the interest paid by the one borrowing. As mentioned above the repurchase agreement can be used for both providing and absorbing liquidity and is used in all the four categories of OMO’s.

Another form of reverse transaction is credit through collateral loans. It is given to financial counterparties to provide liquidity to the market and is similar to the repurchase agreements in providing liquidity to the counterparties. Unlike repurchase agreements, where the ECB can both provide and absorb liquidity, credit operations through collateral loans can only be used to provide liquidity. The form and procedure also differ from repurchase agreements. Credit is
given to the counterparties which means that the amount of the loan can vary from one day to the next. Therefore the counterparty pays an accrued interest of the amount borrowed calculated on a daily basis. Also where the asset changes hands in every transaction in repurchase agreements the ownership of the asset set as collateral only transfers from debtor to creditor if the debtor does not fulfil his obligations in collateral loans.

Foreign Exchange Swaps

Foreign Exchange swaps are used by the ECB in fine-tuning operations to provide and absorb liquidity in the market by buying/selling euro spot exchange rate against a foreign currency and at the same time selling/buying forward exchange rate. This is done to hedge the position against any changes in the exchange rate. The spread between spot exchange rate and the forward exchange rate is decided on market terms and cost of carry is calculated in the spread.

ECB Issuance of Debt

The ECB can issue debt and is used to absorb liquidity in the market. Counterparties are able to buy a zero coupon bond where the bond is bought at a discount and face value is paid at maturity. Like outright transactions ECB issuance of debt is only used for structural operations but differs in the way that it can only be used to absorb liquidity in the market where outright transactions can both be used to provide and absorb liquidity.

Fixed-term Deposits

Like foreign exchange swaps this instrument is used in fine-tuning operations but it can only be used to absorb liquidity in the market. The ECB and the counterparties agree on a fixed term and interest rate that the ECB pays at maturity but no collateral is given to the counterparty by the ECB.

3.2.2.2 Standing Facilities

The second instrument, standing facilities, consists of an overnight deposit- and a marginal lending facility. OMO’s, see section 3.2.2.1, give the financial institutions the opportunity to refinance on a weekly basis where the standing facilities permit them to do it on a day to day basis. They are used to decrease daily volatility in the money market and set a corridor for the overnight interest rates. By setting the interest rates on the marginal lending- and deposit facility
the ECB can control respectively the upper and lower limit of its operational target interest rate targeting.

The standing facility is not set to be a substitute to the money market but rather an addition that makes the money market work more effective. To ensure that they are not used as the primary deposit channel the deposit interest rate is set to be lower than the interest rates in the money market and the open market operations. Conversely the marginal lending interest rate is set higher to make sure that it is the last resort for financial institutions when refinancing.

3.2.2.3 Minimum Reserve Demand
The third and last instrument used by the ECB in its monetary policy is minimum reserve demands. Financial institutions are obliged to deposit a minimum reserve on average over a month which effect is described in section 2.3.1. Because of this the financial institutions have a negative net liquidity position to the ECB. The amount, each counterpart has to deposit, is calculated by the following formula:\(^{45}\):

\[
\text{reserve requirements} = \text{reserve base} \times \text{reserve ratio} - \text{lump sum}
\]

The reserve base is the sum of liabilities, deposits and debt securities issued, on the financial institutions’ balance sheet. Liabilities to financial institutions under the same minimum requirements, the ECB’s or the member states national central banks (NCB’s), are not included in the reserve base\(^{46}\).

The reserve ratio depends on the types of liabilities in the reserve base. Most liabilities demand a positive non-zero reserve ratio. Certain deposits and debt securities with longer maturities and repos will have a zero reserve ratio applied\(^{47}\).

The lump sum is a fixed amount of 100,000 euro that every institution can deduct from the reserve base. The lump sum will eliminate administrative costs of dealing with the minimum

\(^{45}\) The European Central Bank (ECB) (2011). The Monetary Policy of the ECB - page. 104
reserve demand as it is not supposed to be a financial strain on the financial institutions\textsuperscript{48}. Also the minimum reserves will accrue interest close to the interest rate of the MRO’s\textsuperscript{49}.

There are two main reasons for implementing a minimum reserve demand. The first reason is that it smoothen shocks to overnight interest rates by giving the financial institutions the incentive to lend in the market (hold reserves) when the overnight interest rate exceeds (is lower) than the interest on reserves. The second reason is that the short term interest rates are more easily manipulated through the monetary transmission channels when the net liquidity position of the financial institution to the ECB is negative\textsuperscript{50}.

3.2.3 Risk Reduction
The ECB exclusively controls which financial institutions are able to be counterparty. Except for outright issuance of debt where there is no restriction on who is allowed to buy and sell only financial institutions that meet the ECB’s demands are able to act as a counterparty to the ECB. Because all counterparties have to meet ECB’s criteria\textsuperscript{51} it reduces the risk of default.

Besides controlling the range of counterparties the ECB also controls which type of asset is eligible for the counterparties to use as collateral to reduce the risk of the assets loosing value. In other words by restricting what kind of assets the counterparties can use as collateral the ECB decreases its own exposure to the risk of holding assets. The ECB applies “Haircuts”\textsuperscript{52} where the assets value is “cut” under market value so that the volatility of the asset does not become a risk to the ECB. Even if the assets fall below the amount borrowed the ECB can make a margin call which means that the counterparty will have to replace the loss in value of the assets at a certain level with an equal amount of collateral\textsuperscript{53}.

3.3 The Danish Central Bank – Danmarks Nationalbank
The purpose of this section is to look at the Danish central bank’s strategic and operational framework and compare it to the one of the ECB.

\textsuperscript{48} The European Central Bank (ECB) (2011). The Monetary Policy of the ECB - page. 102
\textsuperscript{49} The European Central Bank (ECB) (2011). The Monetary Policy of the ECB - page. 102
\textsuperscript{50} Danmarks Nationalbank (2003). Monetary Policy in Denmark - Page 41
\textsuperscript{51} The European Central Bank (ECB) (2011). The Monetary Policy of the ECB - page. 96
\textsuperscript{52} The European Central Bank (ECB) (2011). The Monetary Policy of the ECB - page. 99

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3.3.1 Danmark Nationalbank’s Monetary Strategy
Danmarks Nationalbank’s strategy is divided into three final targets\textsuperscript{54}, cf. section 2.4:

1) Price stability
2) Secure transactions
3) Stability in the financial sector

The ultimate goal is also social welfare through price stability reached by using a fixed exchange rate policy, which figure 2 shows.

Having a fixed exchange rate policy means that Denmark “targets” a certain level in the exchange rate between the DKK and the currency of a larger economy.

Danmarks Nationalbank has a long history of using a fixed exchange rate policy. In 1982 Denmark began its monetary strategy of targeting the German currency “Deutschmark” to control the high level of inflation in Denmark at the time and regain trust in the DKK. Trust was restored by removing the opportunity of devaluation and as a result of this inflation and nominal interest rates fell significantly. Today the DKK is targeted to the euro which it has been since the launch of the euro in 1999. A certain level of flexibility from the targeted exchange rate between the euro and the DKK of plus minus 2.25% is allowed for operational reasons.

Even though the ECB and Danmarks Nationalbank do not share the same monetary strategy they share the same goal of price stability and use almost the same monetary instruments to achieve their targets.

As mentioned in section 2.4 having a fixed exchange rate strategy does not come without some cost. Where the euro is a somewhat floating exchange rate the ECB has no obligation to steer its exchange rate in a certain direction. Danmarks Nationalbank on the other hand has to react to changes in the exchange rate to the euro. Therefore Danmarks Nationalbank is not able to pursue other objectives through its monetary policy, as it would without a fixed exchange rate policy.

3.3.2 The Monetary Instruments of Danmarks Nationalbank
As described in section 3.2 the ECB uses its monetary instruments to influence money market interest rates and control liquidity in the market. Their strategic objective is to stabilize price through monetary and economic considerations. Since Danmarks Nationalbank has committed to

\textsuperscript{54} Danmarks Nationalbank (2009). Monetary Policy in Denmark - page 9
a fixed exchange policy it will have to react to the changes in the exchange rate between the DKK and the euro. Therefore the monetary policy instruments are, like the ECB’s, used to influence interest rates and the liquidity position in the market but with the objective of controlling the exchange rate. The market operations and standing facilities used by Danmarks Nationalbank in its monetary policy are very similar to those used by the ECB, see section 3.2.2. Danmarks Nationalbank’s monetary policy instruments are as follows.

- Open market operations
- Standing facilities

3.3.2.1 Open Market Operations
Danmarks Nationalbank conducts its open market operations through collateralised loans and certificates of deposit issued by Danmarks Nationalbank with maturities of typically a week. They are performed to control the liquidity situation in the market. The interest rate levels of the loans and deposits are fixed and set by Danmarks Nationalbank. No restrictions are made on how many certificates of deposits and collateralised loans the counterparts can hold. Some restrictions apply with deposits in the standing facility that will be described in section 3.2.2.2.

The financial institutions have to plan their liquidity position after what they think their demand will be during the week. To meet the counterparts’ liquidity needs regular open market operations are performed every week to provide or absorb liquidity in the market. During the week the financial institutions can exchange liquidity with each other if there is a need. The objective for Danmarks Nationalbank is not to compete with the money market but instead to steer short term interest rates. Extraordinary operations can also be conducted when there is a need or excess of liquidity. They are typically performed as a fine-tuning of the liquidity whenever there is an unexpected demand that the money market by itself cannot satisfy, i.e. in the period around the bankruptcy of Lehman Brothers.

3.3.2.2 Standing Facilities
The current account or “foliokontoen” is Danmarks Nationalbank’s standing facility. All transactions of deposits, loans and currency between the financial institutions and Danmarks Nationalbank are accounted for on the current account. It differs from the standing facility of the

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55 Danmarks Nationalbank (2009). Monetary Policy in Denmark - page 30
ECB in the way that the sum of the counterpart’s overnight net liquidity position cannot be negative as Danmarks Nationalbank does not have a marginal lending facility. In the absence of a marginal lending facility, financial institutions will have to borrow money in the money market thus creating incentive for an effective money market. By setting the interest rate on deposits lower than the market interest rates banks with a positive net liquidity position have an incentive to lend money to financial institutions with a negative net liquidity position. Besides the restriction of not being able to have a negative overnight net liquidity position the financial institutions are also restricted by a ceiling on deposits. The sum of all of the counterparts’ deposits cannot exceed the amount set as ceiling by Danmarks Nationalbank. Having a ceiling reduces the risk of speculation against the Danish krone as counterparts can only deposit a certain amount and the effect of changes in the interest or exchange rates will be limited.

In situations where the sum of the net liquidity position is either negative or above the “ceiling” Danmarks Nationalbank will perform extraordinary OMO’s to either provide or absorb liquidity in the market.

3.3.3 Exchange Rate Instruments
The monetary instruments are used to steer interest rates and control the liquidity situation in the economy. Theoretically Danmarks Nationalbank uses the exchange rate as both an operating and an intermediate target, see sections 2.4.3 and 2.4.4. Depending on whether the exchange rate is an operational or intermediate target the exchange rate is directly or indirectly affected by the operational instruments. To steer the spot exchange rate between the DKK and the euro towards the central exchange rate Danmarks Nationalbank buys and sells foreign currency and uses its interest rates. Using interventions in the foreign exchange market by buying and selling foreign currency with DKK Danmarks Nationalbank can directly affect the exchange rate. Using the monetary instruments to influence interest rates on the other hand indirectly influences the exchange rate. Both methods can be used independently from each other or in a combination depending on the time span and the severity of the fluctuations in the exchange rate. As long as the exchange rate of the DKK/euro is lying within the upper and lower limit of the central rate Danmarks Nationalbank is not obliged to intervene, see figure 2. Only if the spot-exchange rate is lying outside the limits Danmarks Nationalbank will be obliged to intervene by using the instruments described below. Danmarks Nationalbank will adapt the degree of the interventions
used to the severity of the shock to the interest rate so that small fluctuations are not met by high increases in spread and large interventions in the foreign exchange market. This stabilizes the exchange rate which is the primary goal of the fixed-exchange rate policy.

### 3.3.3.1 Interventions in the Foreign Exchange Market

Minor fine tuning of short term fluctuations in the exchange rate is typically done through interventions in the foreign exchange market. In a market with a weak DKK Danmarks Nationalbank will use its foreign-exchange reserve to buy up DKK with foreign currencies. This creates a demand for and strengthens the DKK. Conversely when the DKK is relatively stronger than the euro Danmarks Nationalbank will buy foreign currencies to weaken the demand for DKK.

The foreign-exchange reserve plays a vital role in the fixed-exchange rate policy when Danmarks Nationalbank conducts its interventions. Besides being the source of funds for interventions in the foreign exchange market, having a foreign-exchange reserve big enough to withhold speculative pressure can reduce the risk of speculation against the DKK. It consists of liquid assets in different currencies that quickly can be sold to buy other liquid assets in other currencies although the largest part of foreign currency is in euro due to the euro being the target currency of the fixed-exchange rate strategy. Besides interventions changes in the foreign exchange reserve stem mainly from transactions of foreign currencies between Danmarks Nationalbank and the Danish banks and government through its role as the bank of the banks and the government.

### 3.3.3.2 Interest Rates

Interest rates are also used as an operational target to influence the exchange rate and reach the intermediate target. Normally an increase in interest rates by the ECB will be followed by an increase in interest rates by Danmarks Nationalbank but in situations where intervention is not sufficient, i.e. because the fluctuations are of longer duration, Danmarks Nationalbank can choose to increase or decrease the spread in the monetary interest rates between Danmarks Nationalbank and the ECB to steer the exchange rate, DKK/euro. Increasing the spread will strengthen the DKK as a relative higher interest rate will be more attractive for investors and increase demand for DKK and vice-versa. The credibility of Danmarks Nationalbank will

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intervene is imperative in reducing the risk of speculation. Speculators know that a move against the DKK will be met by Danmarks Nationalbank increasing its interest rate spread significantly and by buying DKK with foreign currency the incentive to speculate against the DKK will fall. The following four monetary interest rates are used by Danmarks Nationalbank as operational instruments.

1) The primary instrument used, “Foliorenten”, is the day to day interest rate on the current account.
2) “Indskudsbevisrenten” is the weekly determined interest rate on certificates of deposits.
3) “Diskontoen” or the discount rate is the interest rate that signals the level on which Danmarks Nationalbank will keep their interest rates to the financial counterparts.
4) “Udlånsrenten” is the lending interest rate on loans with a maturity of up to 7 days

3.3.4 Risk Reduction and New Monetary Measures

Danmarks Nationalbank reduces its risk the same way as the ECB does by deciding who can have access to its facilities, deciding what assets can be used as collateral and applying haircuts on assets. Danmarks Nationalbank has found it necessary to follow the ECB and expand the range of assets to loans from the banks’ loan portfolio that can be used as collateral. By expanding the list of assets that can be used as collateral Danmarks Nationalbank eases the financial institutions’ access to liquidity. Furthermore Danmarks Nationalbank has decided to provide loans with longer maturities to the counterparties. Once a month counterparties can get loans against collateral with the maturity of 6 months and with a variable interest rate. Furthermore loans with variable interest rates and a maturity of 3 years are offered via bilateral agreements between Danmarks Nationalbank and the counterparties. These initiatives will paribus ceteris increase the risk of Danmarks Nationalbank. Margin calls and other risk reducing measures are used to reduce the risk of the initiatives and even if they increase the risk of Danmarks Nationalbank the initiatives should be seen as a reaction to provide liquidity in the absence of an ineffective money market. This will be described in greater detail in the analysis in section 6.

57 Danmarks Nationalbank (2011). New Credit Facilities at Danmarks Nationalbank - page 42
3.4 Recapitulation
The purpose of the section was to look at the monetary strategies of the two central banks and their operational framework. Although both central banks pursue a stability-oriented monetary policy the framework and monetary instruments differ to some extent. This is mainly due to Danmarks Nationalbank pursuing a fixed exchange rate policy. To recap, the main differences between Danmarks Nationalbank and the ECB will be presented.

The Danish Central Bank has since the 1980’s had a fixed exchange rate policy where the policy of the ECB has been primarily to target inflation but also pursue higher employment and growth. Since the Danish krone is fixed to the euro its interest rates are constricted by the changes in the ECB’s interest rate. Danmarks Nationalbank can therefore use its foreign-exchange reserve to intervene in the exchange rate market to keep the exchange rate within the upper and lower bound.

The interest rate is the main operating target for them both but Danmarks Nationalbank reaches its target through the monetary instruments that differ a little from the monetary instruments of the ECB. Both use OMO’s but Danmarks Nationalbank does not allow for the overnight net position of the counterparties to be negative, as it can be used as speculation against the krone.
4 Monetary Response by Danmarks Nationalbank and the ECB during the Crisis

4.1 Purpose of Section
The purpose of this section is to describe the economic trends from 2000 – 2011 with emphasis on the period 2007 – 2011 and how Danmarks Nationalbank and the ECB acted during the crisis. The description will later on be used for the analysis and discussion of the monetary policy’s efficiency.

4.2 Global Economic Trend from 2000 to 2011.
The economic trend during the period from 2000 – 2010 in Europe and the USA has been rather unique compared to other historical periods in time especially during the financial crisis starting ultimo 2007. This can be seen in figure 7 that shows the real GDP growth in the USA, the Euro-area, Denmark and China. The GDP growth rate in the USA as well as in the Euro-area has been positive throughout the period from 2000 – 2007 but in 2008 and 2009 both economies had negative growth rates. The negative growth rates can be seen as a consequence of the sub-prime crisis in mid 2007 that led to the financial crisis starting with the collapse of Lehmann Brothers in September 2008.

In 2010 the growth rates in GDP was once again positive for both the USA and the Euro-area although smaller than during the period from 2000 - 2007. The difference in growth rates pro and post the financial crisis for the USA was respectively 2.7 % in 2006 and -3.5 % in 2009. The same trend can be seen for the Euro-area that had growth rates of 3.3 % in 2006 and -4.3 % in 2009. Even though both economies have seen positive growth rates in 2010 and 2011 total production of both economies are still not at the same level as in 2007.\[58\]

\[58\] Danmarks Nationalbank (2011) Recent Economic and Monetary Trends - page 2
China also experienced a fall in annual real GDP growth rates due to the financial crisis. The consequences have not been as severe for them as they have for the other economies. Growth rates in China have not been under 8% during the whole period with a max of 14.2% in 2007.

As mentioned above the collapse of Lehmann Brothers signalled the start of the financial crisis. The American government decided not to intervene and the American investment bank went bankrupt. The bankruptcy escalated the already present fear in the financial markets which led to huge drops in stock prices and made the money market freeze. The declines in equity-based indices, increases in money-market interest rates and high unemployment have been major contributors to the economy still not being fully recovered. The fall in stock and house prices has had a negative effect on consumer demand for goods because of reduced consumer wealth. Especially the financial sector has been affected which high spreads in monetary interest rates and money market interest rates indicate. An ineffective financial sector and low stock prices have made it difficult for companies to raise capital for new projects. The uncertainty is further strengthened by a high volatility in the stock markets, see figure 8, due to an increase in the systematic risk.

Source: Own Creation with data from Eurostat and Worldbank

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59 Danmarks Nationalbank (2011) Recent Economic and Monetary Trends - page 6
60 Danmarks Nationalbank (2011) Recent Economic and Monetary Trends - page 4
The financial crisis sparked the beginning of the European sovereign debt crisis. The financial markets began losing faith in the countries’ ability to pay back their debt due to rising debt levels of certain European countries after years of deficits in government budgets. The interest rates on the countries’ government bonds increased as a consequence of the added risk.

In 2011 the USA also faced a new problem following the economic downturn when Standard Poor downgraded it due to expectation of low future growth rates and Congress not being able to agree on an economic plan to change the economic situation. 2011

All of the macroeconomic indicators mentioned above tell us that there has in fact been a global economic setback. Having said that, a country like China has not felt the same economic strain on their economy as the USA and the Euro-area that experienced negative real GDP growth rates.

4.3 The ECB and the Global Monetary Response
The negative economic trend has had an enormous impact on the fiscal as well as monetary policies around the world. The financial crisis had governments giving state guarantees and making recapitalization schemes to calm down the financial markets and ensure that domestic banks could refinance. Also as a response to the European sovereign debt crisis the governments of countries like Greece, Italy etc. have introduced fiscal austerity to avoid state bankruptcy. The fiscal austerity was part of an agreement to get other European countries to support a rescue programme, as Greece itself could not lower interest rates to a level low enough to avoid bankruptcy.

In mid 2007 an increasing mistrust in the interbank money market made it difficult for the banks to get the liquidity they needed. The ECB responded by providing liquidity against collateral to the banks on an overnight basis, performing extraordinary OMO’s and making bilateral swap agreements with the FED. Where the FED reacted to the financial disturbance by lowering interest rates the ECB was more concerned about the pressure of an increasing inflation and raised its minimum bid rate on interest rates. Basel II was introduced in 2007 in both the USA and Europe including Denmark which was a tightening of the requirements of capital for the banks.
An array of the western world’s central banks including the FED and the ECB found it necessary to significantly ease their monetary policies as a reaction to the financial crisis. An example of this is the coordinated lowering of interest rates in 2008 by most of the world’s central banks. The ECB had just increased its interest rates as a reaction to high inflation in the Euro-area but the implications of a frozen money market had it lower them again. Since then the FED and the ECB have kept their interest rates at a level lower than that of before the financial crisis which is shown in figure 1. China who did not experience the same economic setback is almost back at the same level as regards interest rates as before the financial crisis. To ensure that an inefficient financial sector did not neutralize the effect of lowering the interest rates the ECB introduced full allotment of demanded liquidity against collateral, extended the list of eligible counterparties and the list of assets that could be used as collateral, and made bilateral agreements of providing euro liquidity with different central banks, among them Danmarks Nationalbank. Also additional LRO’s with longer maturities were introduced in 2008 and 2009.

In 2009 and 2010 the ECB tried a non-standard monetary measure of buying Euro-denominated covered bonds. The purpose of the measure was to give the banks additional access to liquidity to revive the asset-backed security market. The market had since the start of the financial crisis experienced high spreads and this made it an inefficient market to recapitalize.

As mentioned in section 4.2 the USA faced a macro-economic challenge in the beginning of 2011. In the fall of 2011 Standard Poor downgraded the USA, which caused disturbances on the financial markets. The indecisiveness of the American congress and the expectation of low future growth rates had the FED communicate that it would continue to keep interest rates low until the summer of 2013. At the same time the FED introduced another initiative that was meant to support the struggling real-estate market this initiative will be discussed in section 6. By selling bonds with short-term maturities and buying bonds with longer maturities the FED also tried to shift the horizontal curve in the term structure, cf. section 2.8, lowering the interest rate on longer term bonds called “Operation Twist”.

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63 The European Central Bank (ECB) (2010). The ECB’s Response to the Financial Crisis – page 69
Europe started out strong in 2011 and as a consequence of this the ECB increased its interest rates twice in the first two quarters. The financial unrest due to the downgrade of the USA and continued troubles with debt in Greece and other countries in the Euro-area had a negative effect on the European real economy. To stabilize the European economy and a fallen stock market the ECB bought up sovereign debt and provided liquidity to the European banks in the form of loans with 3 years maturity.

The economic trend in Denmark is very similar to those of the USA and the Euro-area. The period from 2000-2007 is apart from a brief economic slowdown from 2001-2003 generally characterized by continuous positive real GDP growth rates from 2000 to 2007 which is shown in figure 6 in section 4.2. The period is furthermore characterized by low unemployment, increased house and stock prices and increased demand for goods.

The positive economic trend was followed by a significant drop in GDP in 2008 and 2009 similar to the drops seen in the global economy due to the financial crisis. Besides negative GDP growth rates Denmark has, as the USA and the rest of the Euro-area, also been affected by increased unemployment (still low compared to other countries), reduced wealth and demand for goods and an inefficient bank sector.

Compared to other European countries Denmark’s economy has proven strong. This is partly due to national debts being kept low which has made the Danish government bond safe harbor during the European sovereign debt crisis.

4.5 Monetary Response by Danmarks Nationalbank
In this section the economic trend in Denmark during the period 2007-2011 and Danmarks Nationalbank’s monetary responses to it will be described in detail year by year. Most of the data stems from the 2007-2011 “Report and Accounts” reviews from Danmarks Nationalbank unless stated otherwise. Graphs of inflation and net-liquidity position are presented in Appendix A as respectively figure 1a and 2a.
4.5.1 Monetary Response in 2007\textsuperscript{64}

After years of high economic growth the Danish economy looked strong going into 2007. The unemployment rate was at the end of the year 3.0 \% of the workforce\textsuperscript{65} which was historical low\textsuperscript{66} and demand for Danish goods and services was high.

The Danish government faced the challenge of declining competiveness compared to other countries due to lower productivity, increasing wages and higher exchange rates. The economic slowdown and falling prices on houses in the USA in mid 2007 spread to the financial markets and the Danish real estate market. Despite the challenges the real GDP grew by around 1.6 \% see figure 8 with a surplus of 4.5 \% of GDP in public finances.

Inflation was 1.7 \%\textsuperscript{67} and the exchange rate to the euro was kept inside the 2.25\% band. When the ECB raised the minimum bid-rate on interest rates by 0.25 percentage points to keep inflation around the targeted 2 \% Danmarks Nationalbank followed. Besides raising the minimum bid-rate interest rates Danmarks Nationalbank converged its list of assets that could be used as collateral to that of the ECB.

4.5.2 Monetary Response in 2008\textsuperscript{68}

Despite positive growth in most of 2007 the Danish economy had already begun to slowdown due to the falling Danish competiveness. The negative development in the economy worsened as the consequences of the financial crisis began to show. The banks’ willingness to lend money and the prices on the Danish real estate market and stock market fell significantly during 2008. The huge losses the banks had suffered due to the crisis created mistrust amongst the banks. The spread between collateralized and uncollateralized interest rates in the money market increased, see figure 9,

\textsuperscript{64} Danmarks Nationalbank (2007). Report of Governors
\textsuperscript{65} www.dst.dk -> find statistik -> arbejdsmarked -> sæsonkorrigeret bruttoledighed -> AUS07:
\textsuperscript{66} Danmarks Nationalbank (2007). Recent Economic and Monetary Trends - page 1
\textsuperscript{67} http://epp.eurostat.ec.europa.eu/portal/page/portal/hicp/data/database -> prc_hicp_aind
\textsuperscript{68} Danmarks Nationalbank (2008). Report of Governors
and when Lehmann Brothers went bankrupt in September 2008 the money market froze completely. This made it very difficult for the Danish banks to refinance and a few financial institutions were forced into liquidation due to their losses and their inability to raise capital. To avoid depositors withdrawing their money the Danish government introduced a guaranty that in case of bankruptcy depositors would not lose their deposits. Danmarks Nationalbank reacted by expanding the basis for which the financial institutions could borrow money. The net-position between Danmarks Nationalbank and the financial institutions fell significantly after the bankruptcy of Lehmann Brothers indicating an ineffective money market.

The drop in house and stock prices meant a decline in wealth and this combined with a declining consumer trust contributed to a drop in domestic demand. The Danish economy was under pressure and the result was that for the first time since 1993 Denmark experienced a negative growth in GDP of -0.8 %, see figure 8, and the surplus in public finances fell to 3.0 % of GDP. Inflation was 3.6% in 2008 despite reduced demand and negative growth.

The falling interest rate spread between Denmark and the ECB and investors’ reservations about investing in small economies like the Danish weakened the DKK. Danmarks Nationalbank had to intervene multiple times during 2008 and buy DKK with foreign currency and in October

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Danmarks Nationalbank raised the interest rate on certificates of deposits and lending from 4.6 \% to 5 \% and the interest rate on the day to day current account and the discount rate from 4.25 \% to 4.5 \%. To ensure that the financial institutions still had access to Dollars and Euros Danmarks Nationalbank made swap-agreements with the FED and the ECB. In late 2008 as the DKK grew stronger Danmarks Nationalbank lowered its interest rate and on the 19th of December the interest rate on certificates of deposits and lending was 3.75 \% and the interest rate on the day to day current account and the discount rate was 3.5\% converging with the interest rates of the ECB.

4.5.3 Monetary Response in 2009\textsuperscript{70}
GDP continued to fall in the first three quarters of the year after which it stabilized and started to grow in the fourth quarter. Despite the positive growth rate in GDP in the second part of 2009 the Danish economy still ended up with a negative growth rate in GDP for the year and GDP fell by 5.8 \% compared with the year before. Besides the fall in GDP other indicators started showing how the negative effects of the financial crisis had transmissioned to the Danish real economy.

The domestic demand continued to fall as the real estate market continued to slow down and unemployment increased. The unemployment rate which had kept declining during 2008 grew in 2009 by 2.5 percentage points to 5.9 \%\textsuperscript{71} of the workforce. Exports as well as imports fell significantly in 2009 due to a fall in the global demand. The fall in demand meant that inflation which had been high the year before fell to 1.1 \%\textsuperscript{72} further indicating an economic slowdown. The Danish government reacted by using an expansive fiscal policy to create growth and the public finances ended up with a deficit of 3 \% of GDP.

The financial markets on the other hand began to loosen up during 2009. Stock markets that had been declining since the bankruptcy of Lehmann Brothers and decreasing consumer wealth, regained some of their value lost in stock prices. The net-position between Danmarks Nationalbank and the financial counterparties increased following a decline in interest rate spreads contributing to a relatively more effective money market. Despite a seemingly more

\textsuperscript{70} Danmarks Nationalbank (2009). Report of Governors
\textsuperscript{71} www.dst.dk -> find statistik -> arbejdsmarked -> sæsonkorrigeret bruttoledighed -> AUS07:
\textsuperscript{72} http://epp.eurostat.ec.europa.eu/portal/page/portal/hicp/data/database -> prc_hicp_aind
effective money market Danmarks Nationalbank still found it necessary to further expand the list of assets that could be used as collateral.

Danmarks Nationalbank followed the expansive monetary policy of the ECB and lowered its interest rates multiple times during the year. The lending interest rate and the interest rate on certificates of deposits were lowered from 3.75 at the beginning of the year to 0.95 % and 1.2 % at the end of the year. The day to day interest rate on the current account and the discount rate was also lowered from 3.5% at the beginning of the year to 0.85 % and 1 % at the end of the year which is very close to the zero limit bound, cf. section 2.6. The DKK, which had been under pressure during 2008, was stable in 2009. This meant that Danmarks Nationalbank increased its foreign exchange reserve as it did not need to intervene in the currency exchange market significantly.

4.5.4 Monetary Response in 2010

In 2010, after two years with a negative growth rate, Denmark experienced a positive annual growth rate in real GDP of 1.3 %, see figure 7. The annual positive growth rate was a result of growth in GDP in the first three quarters of 2010 followed by a small drop in the last quarter.

The Danish and other EU-members’ real economies had been hit hard in 2009 and even though the global economy was getting stronger the financial crisis had evolved into a sovereign debt crisis for EU. Despite the new challenges Denmark faced and a growing unemployment of 6.2 % Denmark still experienced growth in domestic demand, the real estate market, and in imports and exports. Domestic demand that fell by 6.5% in 2009 grew by 1.3 % in 2010 and imports and exports which both fell significantly in 2009 grew respectively by 3.5 % and by 3.2 % in 2010.

The positive economic activity meant that Denmark had regained half of the loss in GDP lost since 2008 but the expansive fiscal policy in 2009 and 2010 in order to create growth increased national debt and inflation grew by 2.2 %.

Danmarks Nationalbank continued an expansive monetary policy and lowered its interest rates and expanded the list of assets that could be used as collateral. The DKK was stable towards the

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74 http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/ - [nama_gdp_k] - Domestic demand
euro and grew stronger during 2010. This meant that Danmarks Nationalbank bought foreign currency by intervening in the currency exchange market to weaken the DKK. To further stabilize the exchange rate between the euro and the DKK Danmarks Nationalbank lowered its interest rates seven times, except for the official discount rate, while the ECB kept its interest rate level decreasing the interest rate spread. At the end of the year the lending interest rate dropped from 1.20% to 1.05 % and the interest rate on day to day current account interest rate, certificates of deposits and the discount rate dropped by 0.25 percentage points to respectively 0.6 %, 0.7 and 0.75 %.

4.5.5 Monetary Response in 2011\textsuperscript{76}

The Danish GDP grew by 1 % during 2011, see figure 7, even though employment was negative which indicates an increase in productivity. Especially during the first half of 2011 the real economy seemed to be recovered from the economic downturn in 2008-2009. The problems with poor competiveness due to high wages and high inflation faced in 2007-2008 did not have the same relevance in 2011. Inflation grew by 2.7 % but a weak labor market and reduced wages did not grow significantly in 2011. Danish competiveness was further strengthened by a low exchange rate between the DKK and the euro which also had a positive effect on net exports that grew by 1.2 %. Despite higher public investments than in 2009 the deficit was reduced to 0.2 percent point from 2010.

In the second half of 2011 the economic growth slowed down due to the downgrade of the USA as well as the worsening of the European debt crisis, cf. section 4.3. The unrest in the second half of 2011 influenced consumer confidence, domestic demand and investments in the private sector negatively despite a low exchange rate of the DKK that had increased the Danish competiveness compared to other countries.

A strong DKK meant that Danmarks Nationalbank had to intervene and buy foreign currency with DKK to stabilize the exchange rate. Danmarks Nationalbank increased its interest rates twice during the first half of 2011 for the first time since 2008 where it increased its interest rates to strengthen a weak DKK. This time it was only as a reaction to the increase in interest rates by the ECB who feared a growing inflation in the Euro-area.

\textsuperscript{76} Danmarks Nationalbank (2011). Report of Governors
The increased interest rates did not last for very long as the economic unrest set in in the fall of 2011. The money market which had experienced falling spreads in interest rates between covered and uncovered bonds in the first half of 2011 was once again affected by unrest in the financial markets causing interest rate spreads to increase. Access to liquidity in the money market tightened although not in the same degree as in 2008 and Danmarks Nationalbank further easened the access to liquidity, i.e. late in 2011, making it possible to obtain loans with 6 months and 3 years maturity.

Furthermore Danmarks Nationalbank lowered its interest rates and intervened in the foreign exchange market as the DKK appreciated against the euro and as a consequence of the fall in expected growth and inflation the ECB lowered its interest rates in November and December and Danmarks Nationalbank followed.

4.6 Recapitulation
It can be concluded that the global economic trend including the Danish economy after an economic boom with relative high inflation rates suffered a setback inflicted by the financial crisis starting with the sub-prime crisis in 2007 that reached its peak in 2008 and 2009. Although the Danish central bank responded by lowering its interest rates the economy has not fully recovered. Especially the money market has been affected by the crisis and alternative measures have been taken by the central banks in order to unfreeze it. The fixed exchange rate policy has also meant that that the Danish central bank could not react as freely as the ECB and the FED and had to increase the monetary interest spread to the ECB to strengthen the DKK and keep the exchange rate fixed. After a small recovery in 2009 the European economy fell into a sovereign crisis in 2010 which has also affected the strategy of the ECB and therefore also Danmarks Nationalbank’s monetary policy.
5 Econometric Model and Analysis

5.1 Purpose of Section
The thesis has so far presented the theory behind the monetary strategy of Danmarks Nationalbank and the actions taken during the financial crisis. In this section the econometric analysis of the effects of credit risk and liquidity risk on the money market will be presented. This will make grounds for the discussion in section 6 of the traditional and alternative monetary strategies’ efficiency during a recession. The framework of already known models will be used as inspiration especially in deciding on which proxies should be used as variables.

5.2 Economic Reasoning
Although the money market interest rates have decreased, see figure 9, during the financial crisis the spread between collateralized and uncollateralized money market interest rates have increased, see figure 11. The money market froze and the increasing credit and liquidity risk made it impossible for the financial institutions to refinance through uncollateralized loans in the money market like before the crisis. Danmarks Nationalbank followed the ECB and lowered its monetary interest rates, cf. figure 1, and performed extraordinary OMO’s in the hope of providing enough liquidity in the market to unfreeze the money market. Furthermore the distrust between banks made the banks choose the secure option of using the facilities of Danmarks Nationalbank instead of the money market making the lending facilities of Danmarks Nationalbank a substitute for the money market.

An inefficient money market can affect the transmission channels in the economy, as it affects the short term interest rate which is the operating target of the central bank, see section 2.4.4. This will make the monetary policy less efficient as the liquidity provided by the central bank is held by the banks and does not leave the banks through the credit multiplier, see section 2.3.1. In other words the relationship between money supply by the central bank and commercial bank

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lending becomes inelastic. If this is true the traditional monetary policy can be deemed ineffective as the economy will be caught in a liquidity trap. It can therefore be argued that the central bank in combination with the traditional monetary policy should look at alternative strategies that focus on credit and liquidity risk in the money market. This will be discussed in section 6.

The following econometric model will therefore evaluate the effects of credit risk and liquidity risk on the risk premium in the money market before, during and in the aftermath of the financial crisis.

5.3 Single Equation Times Series Model and OLS-estimation
A single equation model with time series data using Ordinary Least Squares (OLS) estimators will be used in the econometric analysis. It will be used to estimate the parameters and measure the effect of credit risk and liquidity risk on the money market risk premium.

The model will be using OLS-estimates as this is a very common estimation method used in econometric analysis and its estimates, according to the Gauss-Markov theorem, are the “Best Linear Unbiased Estimates” (BLUE) when certain criteria are met\(^81\). If these and other criteria which will be tested in section 5.3 and 5.7 are not met other types of estimators can be used instead, i.e. generalized least squares (GLS).

5.4 Description of Variables and Dataset
5.4.1 Decomposition of the Money Market Interest Rate
From section 2.8 we looked at the structure of interest rates. When decomposing the nominal uncollateralized money market interest rate we are left with the following 3 components\(^82\) when the real rate and expected inflation is equal to the nominal interest rate.

1) Term structure
2) Liquidity risk
3) Credit risk

\(^81\)Damodar N. Gujarati and Dawn C. Porter Basic (2009). Basic Econometrics - page 71
\(^82\)Niels Blomquist, Niels Arne Dam and Morten Spange (2011). Monetary-Policy Strategies at the Zero Lower Bound on Interest Rates Danmarks Nationalbank’s - page 86
Since the term structure component, see section 2.8, can be viewed as the uncertainty of changes in the real interest rate over time it will be relatively larger in interest rates with long maturities than in interest rates with short maturities. Figure 10 shows how the standard deviations from the expected real rate increase over time.

**Figure 10**

Source: Own Creation

The total risk component in the money market interest rate will consist of a systematic-/market and a bank specific component. Both systematic and bank specific credit and liquidity risk can be reduced by the loaner providing collateral.

### 5.4.2 Dependent Variable Y

The dependent variable Y will be a proxy for the risk premium in the money market. Using a money market spread that eliminates the real rate, inflation and the term structure, cf. 5.4.1, will leave us with the risk components liquidity and credit risk. The risk of holding an asset over time should be insignificant if not eliminated from the risk premium and by taking the spread of two short-term interest rates with the same maturity the term structure component should not be present in the spread. Inflation will also be eliminated from the equation if the expected inflation is the same for the two interest rates.

Looking at similar econometric models used to measure the same effect on money market interest rates in other countries we find a proxy for a spread that leaves only the risk components

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83 Based on the theory of interest presented in section 2.8
or risk premium. They argue that the best proxy is the spread between 3 months Overnight Interest Swap (OIS) and the 3 months uncollateralized money market interest rate LIBOR. To be able to measure the effect on the Danish money market we will have to find a similar spread that holds the same properties as OIS and LIBOR spread. CIBOR can be used as the Danish uncollateralized money market interest rate as it reflects the same as the LIBOR. The Cita-swap can be used instead of the OIS as they both are swap agreements of the average overnight interest rate over a period. It will not be used in this model as data on the Danish Cita-swap is not available before October 2008\textsuperscript{84}. Instead we use the 3 month collateralized money market interest rate which is a repo-transaction of secure assets. Although this is more “noisy” it is a better proxy for a credit and liquidity risk free asset\textsuperscript{85} than the OIS.

The chosen dependent variable for risk premium will be the spread between the Cibor 3-month interest rate and the money market 3-month collateralized interest rate.

Risk Premium = Cibor – Collateralized

Since we are interested in the changes in the spread between the short term non-collateralized and collateralized interest rate we take the natural logarithm to the first difference of the spread.

\[ \Delta \ln(\text{risk premium}_t) = \ln(\text{Risk Premium}_t) - \ln(\text{Risk Premium}_{t-1}) \]

5.4.3 The Intercept \( \alpha \)

The intercept \( \alpha \) is a constant. Since the money market interest rate is an average of multiple interbank interest rates the bank specific credit and liquidity risk will be assumed to be constant and the systematic credit and liquidity risk the independent variables. In other words the model will seek to measure the systematic risk of the risk premium and the intercept will be a constant that measures the unsystematic risk in the risk premium.

A priori I argue that the unsystematic risk should not be significant in the model and an insignificant intercept is therefore expected. In section 5.5.2 the model will check for differential intercepts to make sure that the effect of the bank specific risk does not change due to structural breaks. Two dummy variables and the intercept that SAS enterprise guide generates will cover the whole period to make sure the model does not fall into a dummy variable trap.

\textsuperscript{84} http://www.finansraadet.dk/tal-fakta/satser/swap/historiske-satser.aspx#  
5.4.4 The Independent Variable X1

The first independent variable X1 will be a proxy for systematic liquidity risk. Liquidity risk can as described in section 2.7.2 cause solvency problems in the market and it can therefore be difficult to distinguish between the liquidity and the credit risk. We are looking for a proxy that measures the systematic liquidity risk in the money market and not a bank specific risk.

The authors of Danmarks Nationalbank’s quarterly survey from 2011 2nd quarter, present different proxies for liquidity risk that can be used in our model, i.e. the relationship between the bid ask spread on 2 year government security and the amount of transactions of it. Using a proxy like the bid ask spread to measure the liquidity risk can be difficult and will therefore not be used. Instead we will use an implied volatility index that seems to avoid the above mentioned issues and is generally used to measure the market liquidity risk but since both market and balance sheet liquidity risk is closely correlated, cf. section 2.7.2, the implied volatility index of S&P500 will be used in the model. It is calculated using prices on call and put options on the S&P500 and depicts the expected volatility in the next 30 days86.

I argue that Denmark is a small open economy that is likely to be affected by the economic shocks from larger economies and the volatility in the Danish stock market will therefore be similar.

Like the dependent variable we are only interested in the change from the previous period and to get this we take the natural logarithm of the first difference.

\[
\Delta Ln(VIX_t) = Ln(VIX_t) - Ln(VIX_{t-1})
\]

As liquidity demand will have a direct influence on the money market so will the liquidity risk and it can therefore be argued that the variable should be set at time t. The relationship between the VIX-index and the dependent variable is expected to be positive as increased volatility will reduce liquidity supply in the market causing the spread to increase87. An increase in volatility will therefore be regarded as an increase in the liquidity risk which will increase the money market spread.

86 http://www.investopedia.com/terms/v/vix.asp/#axzz1uvSbR
5.4.5 The Independent Variable X2
The second independent variable X2 should include information about the changes in the systematic credit risk in the money market. The problem of distinguishing between the two risk-components still applies so to avoid high multicollinarity between the variables we will have to find a proxy for “pure” credit risk. One way to do this could be to construct a model using aggregated bank specific data of the Danish banks. The troubles of getting the correct data on all banks and constructing a correct model are far greater than the possible benefits of obtaining a proxy for credit risk this way. Instead we wish to find a single variable, preferably a credit-derivative, that is a good proxy for the systematic risk on the money market.

A common proxy that has been used in other models is the premium on 5 year Credit Default Swaps (CDS) and it is used in all the models mentioned above. A CDS is a derivative that guaranties a premium if the payment on a loan or obligation is not met. It can therefore be used as a hedge against credit risk by the buyer of the CDS as the buyer buys protection against default in a specific period of time. The higher the risk of default the higher the premium which means that the level of the premium depicts the level of the credit-risk. By choosing the CDS premium on banks, we will get the credit risk of the financial sector, which are the actors on the money market.

Only CDS’s on a few Danish companies are traded and only two of these are Danish banks (Danske Bank and FIH Erhversbank). Since we are only interested in the systematic credit risk on banks and using data on two banks will not remove the unsystematic or bank specific credit risk we will have to look for prices on a group of banks instead. Again we look outside Denmark and find CDS on Senior Financial 5 year which is a CDS of European banks. I argue that European banks will have similar credit risk and the derivative will therefore serve as a good proxy for the systematic credit risk in the Danish money market as well.

As with the two other variables we also take the natural logarithm of the first difference of the CDS premium to make sure the data is stationary and to depict the change in the premium.

$$\Delta Ln(CDS_t) = Ln(CDS_t) - Ln(CDS_{t-1})$$

---

A positive relationship between the credit risk and the risk premium is expected as actors on the money market will demand a higher premium as systematic risk increases. Unlike liquidity risk, the relationship between the dependent variable and credit risk seems graphically to be lagged one period when comparing it to the two other variables. This could be because it takes a little longer for credit risk on European banks to have an effect on the Danish money market. I have therefore decided to lag the CDS one period. This means that the effect of the credit risk of this month will not have an immediate effect on the spread but will be present in the next month instead.

5.4.6 Error Term

$u$ is the random component of the changes in the spread between the two money market interest rates chosen in section 5.4.2 where the independent variables and the error term is uncorrelated, $\text{cov}(u, x_i) = 0$. In section 5.7 tests of the error term will be performed.

5.4.7 Description of Data

The time series consist of data on different interest rates, the prices on a credit default swap (CDS) and the VIX-index during the period from March 2005 to December 2011. As we are not interested in the daily volatility of the variables but are looking for a trend and to get a balanced data set a monthly average of the interest rates and prices on CDS’ is calculated from the found daily observations. This gives us a total of 80 observations.

The data was found using the following two websites www.dst.dk, www.eurostat and on Datastream - Thomsen Reuters. Data on interest rates are recorded and published by public institutions and dataset going back 10-15 years can easily be found. Data on the price of CDSs and the VIX are more difficult to access, as they are only available through private companies that specialize in selling data.

The dependent variable is the spread between the CIBOR 3 month interest rate and the collateralized 3 months money market interest rate. The monthly average of both interest rates in the period March 2005 – December 2011 was found using www.dst.dk

As mentioned in section 5.4.4 liquidity risk is measured by using the implied volatility index. The dataset CBOEVIX or the Chicago Board Option Exchange volatility index on the S&P 500 is available on Datastream from March 2005 which should be more than enough to measure the
effect of the systematic liquidity effects on the money market interest rates just before, during and in the aftermath of the crisis.

CDS on European banks will be used to proxy the systematic credit risk effect on the risk premium as mentioned in section 5.4.5. The dataset ITRAXX, Senior Financial 5Years, CDS Premium - Mid spread from the same period as the other variables is found on Datastream will be used.

All the Calculated datasets on interest, CDS prices and VIX are attached appendix C

5.5 Econometric Test of the Independent and Dependent Variables in the Model
In this section the problems of using OLS-estimators in a time series analysis where the OLS-assumptions are not met will be presented. To make sure OLS-estimates can be used and are BLUE the following 3 criterions will be tested.

1. The data is stationary
2. No structural breaks
3. No or low multi-collinearity between the independent variables X1 and X2

5.5.1 Stationarity
“If a times series data is stationary, its mean, variance, and autocovariance (at various lags) remain the same no matter at what point we measure them; that is, they are time-invariant.”

The regression analysis is based on the assumption that the time series are stationary. Using non-stationary time series can result in autocorrelation that will be discussed in section 5.7.2. Furthermore since the t-test is based on the stationarity assumption regressing non-stationary time series on each other can make the relationship between the two seem significant although they are not (spurious regression).

To check for stationarity we can perform a trend and correlation analysis of the variables.

The correlogram of the autocorrelation function (ACF) on the left side of figure 9b in appendix B shows graphically how the spread between the 3m CIBOR and collateralized interest rates is non-stationary as there seems to be a downward-going trend in the spikes of the correlogram. The augmented Dickey-Fuller unit root test confirms our suspicion of a non-stationarity as we
cannot reject the null hypothesis of unit root. In section 5.4 the dependent variable has been transformed into natural logarithm of the first difference. We now look at the transformed dependent variable and perform the trend and correlation analysis again. This time no trend is present, see the right side of Figure 9b in Appendix B, and therefore the time series seems stationary. This is backed up by augmented Dickey-Fuller unit root test as the hypothesis of unit root can be rejected.

When performing a stationarity analysis of the dataset of independent variables, see Appendix B figure 10b and 11b, we find that they are stationary when the natural logarithm of the first difference is taken. This reduces the risk of the regression being spurious as co-integration will not be present. A co-integration test will therefore not be performed.

5.5.2 Structural Break
From section 4 we saw that the financial crisis started mid-2007 with the subprime crisis and was at its highest in the months around September 2008 where Lehmann Brothers collapsed. We also know that following a small recovery in the first quarter of 2009 the economy experienced an economic relapse where the fear of a double-dip increased. It is therefore possible that the data have experienced a structural change more than once during the period from 2005 to 2011.

Graphically this is supported in figure 11 where the log change of the dependent variable and the independent variables X1 and X2 is shown. The level of volatility in the change of all three variables seems to shift over time and can be divided into three periods.

![Graphical test of structural changes](graph.png)

Source: Calculated from data in Appendix C
From May 2005 – June 2007 the volatility in the changes in the risk premium seems relatively stable. This could indicate that the money market is not affected by the risk components. The volatility in the changes of the two independent variables is even more stable and there is no definite pattern between the variables.

In the second period from July 2007 – May 2009 the volatility of the changes increases in all three variables. The variables seem to have a higher degree of correlation in this period indicating that the two independent variables might have had an effect on the risk premium.

In the third period from June 2009 – December 2011 the volatility decreases especially in the changes of the risk premium. Opposite to the first period the changes in credit and liquidity risk seem relatively more volatile than the changes in the risk premium. As the global economy was still in a slump and it therefore can be argued that the financial crisis was not over in June 2009 the period will be referred to as “the aftermath of the financial crisis” in this thesis. This might in some way be misleading but what is meant is that the money market in this period is normalized significantly compared to the period before.

This could indicate that the data have structural breaks around June 2007 and April 2009. This can be due to a change in both the intercept and the slope. To test for a structural change in both slope and intercept we use three dummy variables representing the three periods. The dummy variables will be used in the multiplicative form with the independent variables and the additive form to conclude whether the structural changes have been due to changes in the intercept or the slopes.

5.5.3 Multicollinearity

High multi-collinearity between the independent variables can make estimation troublesome as high variances and covariances of OLS-estimators are some of the consequences. This will widen the confidence intervals making it more difficult for the t-statistic to be higher than the critical value and rejecting the null hypothesis.

Multi-collinearity should not be present at a high enough level for the above mentioned problems to be present. Intuitively the independent variables are different in the sense that there is no

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89 Damodar N. Gujarati and Dawn C. Porter Basic (2009). Basic Econometrics - page 287
90 Damodar N. Gujarati and Dawn C. Porter Basic (2009). Basic Econometrics - page 327
direct link between CDS prices on European banks and the VIX-index. Our intuition is substantiated in the correlation-matrix in figure 12 that shows the correlation between the independent variables \(X_1\) and \(X_2\). Perfect multi-collinearity is where the correlation between the independent variables = 1. The highest correlation between the independent variables in our model is between the CDS and the VIX in the first period where the correlation is 0.2.

**Figur 12**

| Source: Generated in SAS Enterprise Guide |

5.6 Econometric Model

5.6.1 Functional Form

As mentioned in section 5.4 the natural logarithm first difference of the variables in the model will be taken which gives us the log change in the variables from one period to the next. Running our regression as a log-log model will make it possible for us to use OLS-estimates where the parameters will show the elasticity between the dependent variable and the independent variables. In other words the parameters will show the percentage change in the dependent variable given a percentage change in the independent variables.

5.6.2 Model Used for Estimation

The following model will be used for estimation and the result will be presented in section 5.8 and analyzed and discussed in section 6 together with Danmarks Nationalbank’s monetary responses presented in section 4.

\[
\Delta \ln(\text{risk\_premium})_t = \beta_1 \ast (D1 \ast \Delta \ln(\text{VIX})_t) + \beta_2 \ast (D2 \ast \Delta \ln(\text{VIX})_t) + \beta_3 \ast (D3 \ast \Delta \ln(\text{VIX})_t) + \beta_4 \\
\ast (D1 \ast \Delta \ln(\text{CDS})_{t-1}) + \beta_5 \ast (D2 \ast \Delta \ln(\text{CDS})_{t-1}) + \beta_6 \ast (D3 \ast \Delta \ln(\text{CDS})_{t-1}) + D1 \\
+ D2 + D3 + u
\]
5.7 Error Term Tests and Model Misspecification

The first 3 tests in section 5.5 tested the data set and the variables in the model. In this section the error term and misspecification of the model will be tested to ensure that the OLS-estimates are BLUE.

1. The error term is normally distributed
2. No autocorrelation in the error term
3. No heteroscedasticity in the variance of the error term
4. No misspecification of model

5.7.1 Normality in the Residuals

Assuming that the residuals are normally distributed has two major advantages. The parameters will be normally distributed if the residuals are normally distributed making hypothesis testing easier. The other is that the sum of possible omitted variables that would have an effect on the
dependent variable will also be normally distributed\(^1\). The normality in the residuals assumption is important when there is only a small amount of observations. This is because the t-test is based on the normality assumption and with a small number of observations the t-test becomes less credible.

To test for this we can use the Jarque Bera test where the null hypothesis is normality in the error term. Graphically the histogram shows the distribution of the residual and although they do not seem to be perfectly normally distributed they do seem normally distributed, see figure XX.

Figure 2b in appendix B shows the result of the JB-test. We can see that Ho of normality in the residuals cannot be rejected with a probability of 0.59. It is therefore fairly safe to say that the t-statistics in our regression does not lose its validity.

5.7.2 Autocorrelation in the Residual
The assumption of no autocorrelation in the residuals in the Gauss-Markov theorem is vital for the OLS-estimates to be BLUE. If there is no sign of autocorrelation OLS-estimates can be used as autocorrelation in the residuals will cause consistent and unbiased but inefficient estimates making hypothesis testing troublesome.

The correlograms of the autocorrelation function (ACF) and Partial autocorrelation function (PACF) in figure 7b in Appendix B can be used as a graphical test of autocorrelation and to determine the type of AR(p) process that should be used to transform the data in the presence of autocorrelation.

Figure 3b in Appendix B shows the result of the Durbin-Watson test that checks for autocorrelation in the residuals. The d-value of the Durbin-Watson statistic test is 1.9924 and the

\(^1\) Damodar N. Gujarati and Dawn C. Porter Basic (2009). Basic Econometrics - page 99
probability of negative autocorrelation is therefore 0.36 and the probability of positive autocorrelation 0.63 which means we cannot reject the null-hypothesis of no autocorrelation. This is also confirmed graphically with the ACF and PACF in figure 7b despite of on spike that exceeds the grey area in the ACF graph around lag 3. To correct for this we transform the data using a AR(3) process found by choosing the lags (3) that minimizes Akaike Information Criterion (AIC) value which indicates a better fit\textsuperscript{92}. After the transformation no autocorrelation seems present and we are safe to use OLS-estimates, see Figure 8b in Appendix B.

5.7.3 Heteroscedasticity
The problem of a changing variance over time is called heteroscedasticity and the problems associated with it are the same as with autocorrelation. Although the estimats are still unbiased and they are not efficient as there is no longer the minimum variance among the estimators\textsuperscript{93}. Since we have transformed our model to a log-log model the risk of heteroscedasticity has been significantly reduced\textsuperscript{94} and heteroscedasticity should not be present in our model. Because of this only a graphical test will be performed, see figure 6b in Appendix B. Since the scatter-plot seems random distributed it graphically confirms our intuition of the variance being homoscedastic.

5.7.4 Misspecification
Misspecification can have severe consequences for our estimation especially if we have omitted a variable that should have been included. If this is the case the estimates will no longer be Best Linear Unbiased Estimators BLUE as the estimates will not be best or unbiased which means that hypothesis testing of the estimators are likely not to be true\textsuperscript{95}.

If the model on the other hand is overfitted the estimates will still be Linear Unbiased Estimates (LUE) as they are unbiased\textsuperscript{96}. Hypothesis-testing will therefore still be possible although the estimates are likely to be insignificant. The estimators can therefore be deemed insignificant although they might actually be significant.

The Ramsey test in figure 4b in Appendix B shows that the model can be misspecified as the tests are all significant. The test does not say what kind of specification error it is but as we have

\textsuperscript{92} Damodar N. Gujarati and Dawn C. Porter Basic (2009). Basic Econometrics - page 494
\textsuperscript{93} Damodar N. Gujarati and Dawn C. Porter Basic (2009). Basic Econometrics - page 413
\textsuperscript{94} Damodar N. Gujarati and Dawn C. Porter Basic (2009). Basic Econometrics - page 395
\textsuperscript{95} Damodar N. Gujarati and Dawn C. Porter Basic (2009). Basic Econometrics - page 471
\textsuperscript{96} Damodar N. Gujarati and Dawn C. Porter Basic (2009). Basic Econometrics - page 475
not found any autocorrelation in the residuals and the error term has been found normally distributed it is most likely not a omitted variable. This leaves us with either an overfitted model or a wrong functional form.

**5.8 Results and Criticism of Estimation**

**5.8.1 Results**

Although the model could be misspecified the OLS-estimates have been found to be Best Linear Unbiased Estimates (BLUE) and are presented in figure 2. There is no theoretical reason for changing the form of the model or add an independent variable and we therefore consider the model to be overfitted. As the estimates will then still be LUE we consider the result to be “good enough” for further analysis. The goodness of fit seems to be fairly good with a $R^2$ of 0.34, see table 2, which means that our independent variables can explain at least some of the changes in the risk premium in the money market.

The intercept in the first period is significant which could indicate that the changes in the systematic credit and liquidity risk do not alone explain the change in risk premium. The dummy variables for the intercept, D2 and D3, during and in the aftermath of the crisis are insignificant which means that the intercept does not change over time.

In table 2 the results of the model measures the elasticity of the independent variables on the risk premium before, during and in the aftermath of the crisis. When we look at the parameter estimates during and in the aftermath of the financial crisis we can see that our a priori assumptions on how the independent variables would affect the dependent variable were correct.

In the period before the financial crisis the credit risk effect on the money market spread was insignificant at a 10 % significance level, see table 2, which means it is also insignificant at a 5 % and 1 % significance level. This indicates that credit risk was not of major concern before the financial crisis hit. This is backed by the fact that the period before was characterized by high level of indifference to risk with an easy access to loans without collateral. The same goes for liquidity risk as the estimate is also insignificant at a 10 % significance level.

During the crisis the risk aversion grew and the increasing credit risk affected the money market spread. The estimate of 0.55 is highly significant at a 1 % significance level, see table 2, which means that an increase of 1 % in the credit risk increased the risk premium by 0.55%. In other
words the elasticity between credit risk and the spread was 0.55 during the crisis. Liquidity risk also seemed to have an effect on the risk premium during the crisis as the estimate of 0.36 is also highly significant at a 5% significance level, see table 2. The elasticity is not as high as with the credit risk indicating that credit risk has had a higher effect on the risk premium.

In the last period both the estimates of the credit and liquidity risk are insignificant at a 10% significance level, see table 2. The volatility in changes of both risk components and the money market risk premium fell, see figure 11. Especially the spread became more stable although the independent variables were not as stable as before the crisis. This could be interpreted as the money market did not fear liquidity and credit risk which could indicate that the monetary responses by the central bank had stabilized the money market. This will be discussed in section 6.

<table>
<thead>
<tr>
<th>Period/Variable</th>
<th>Before Crisis 2005 5m – 2007 6m</th>
<th>During Crisis 2007 7m – 2009 4m</th>
<th>Aftermath of Crisis 2009 5m – 2011 12m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.0665* (0.0354σ)</td>
<td>-0.817 (0.0526σ)</td>
<td>-0.0740 (0.0472σ)</td>
</tr>
<tr>
<td>Liquidity Risk</td>
<td>-0.1395 (0.2816σ)</td>
<td>0.3634** (0.1546σ)</td>
<td>0.2360 (0.1648σ)</td>
</tr>
<tr>
<td>(ΔLn(VIX)_t)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Credit Risk</td>
<td>-0.2186 (0.3534σ)</td>
<td>0.5513*** (0.1102σ)</td>
<td>0.0622 (0.2009σ)</td>
</tr>
<tr>
<td>(ΔLn(CDS)_{t-1})</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td></td>
<td>0.3412</td>
<td></td>
</tr>
</tbody>
</table>

Note: σ = standard deviation of the estimate, * is at a 10% significance level, ** is at a 5% significance level and *** is at a 1% significance level

Source: Own creation based on the data described in section 5.4.7 and generated in SAS enterprise Guide see appendix B

5.8.2 Criticism of Model
We have estimated and found results that correspond to our expectations given that our assumptions of the proxies and the general framework of the model hold.
It has been assumed that it is the trend that is important for further analysis as day to day observations will be noisier and other than macroeconomic factors can affect the risk premium in the short run. This means that some explanatory power of the independent variables on the risk premium will be lost and not be incorporated in the estimates. Furthermore the amount of observations will not be as high as if day to day observations were chosen, especially when the observations are divided in three to measure the effect before during and in the aftermath of the crisis. A low amount of observation decreases the credibility model and the estimates found.

The credit risk has been lagged one period as it is assumed that credit risk will not immediately affect the money market interest rate. This can be the reason why the model is mispecified and the significance of estimate for the credit risk can therefore be false. A misspecified model can give false estimates but it seems most likely that we have an overfitted model and we therefore continue our analysis.

5.9 Recapitulation
Section 5 gives an empirical analysis of the risk premium in the money market in the period 2005 – 2011. The period is characterized by a boom in the Danish economy up to mid 2007 followed by a recession in 2008 and 2009 due to the financial crisis and low economic growth in 2010, cf. figure 7.

The estimates have been found to be BLUE or at least LUE and in line with our a priori expectations which gives us the best possible background for interpreting the result.

The econometric analysis shows that the credit and liquidity risk changes during the financial crisis. The results can be interpreted to conclude that credit and liquidity risk during a “normal” economic cyclical, i.e. before the crisis, is insignificant for money market interest rate whereas in a financial crisis like the one we have seen they are both significant.

On the basis of the analysis it seems evident that alternative measures will have to be used by the central bank in order to reduce these risk components in order to make the money market and thus the monetary policy of the central bank efficient. This is due to the fact that the traditional monetary policy of lowering interest rates in an economy caught in a liquidity trap may not be efficient especially when the money market is inefficient. This will be discussed in section 6
6.0 Discussion

6.1 Purpose of Section
The purpose of this section is to discuss alternative monetary strategies when the monetary interest rate is at the zero-limit bound. Danmarks Nationalbank pursues a fixed exchange policy and the effects of the alternative strategies on the exchange rate will not be discussed. I assume that Danmarks Nationalbank will be able to conduct these strategies in coordination with the ECB and therefore will still be able to pursue its fixed-exchange rate policy.

6.2 Background
The traditional monetary strategy efficiency has been questioned by economists when the economy is caught in a liquidity trap, cf. 2.6. The Danish central bank’s strategy has for a long time been to achieve price stability through a fixed exchange rate regime, cf. section 3.2. Its main monetary instrument used to perform its monetary policy is the short term interest rate which influences the money market interest rate and the exchange rate between the Danish krone and the euro, cf. Section 3.3.3.2. An efficient money market is imperative for Danmarks Nationalbank to conduct its monetary policy but during the crisis the money market froze, cf. section 4. A high increase in the market risk can stop the transmission of the effects of a reduction in the monetary interest rate to the real economy. The results from chapter 5 show that the effect of the increase in liquidity risk has affected the risk premium during the crisis. To reduce the risk premium and address the issues associated with macroeconomic tendencies Danmarks Nationalbank has expanded its array of instruments, cf. section 3.3.4, and looked at alternative monetary policies. In this section the findings in sections 4 and 5 will be analyzed and discussed and four alternative strategies which could have been used will be presented.

6.2.1 Before the Financial Crisis
The results of section 5 show that before the start of the financial crisis the effects of the systematic credit and liquidity risk of the financial institutions were insignificant. The conducted monetary responses of Danmarks Nationalbank support this as its primary focus until late 2007 was the inflation level and the competitiveness of the Danish economy. The Danish economy was overheating although the monetary interest rate had increased in line with the European interest rate. This was partly due to an expansionary fiscal policy and as the fixed-exchange rate policy in this period denied Danmarks Nationalbank the opportunity of increasing the monetary interest
rate any further it could not be used to stabilize the economy. The central bank could instead have contributed by reducing the growth in lending by reducing the credit multiplier cf. section 2.3.1. It could also be argued that the government should have pursued a more contractive fiscal policy that would have dampened the economic boom and thus have reduced the effects of the financial crisis.

6.2.2 During the Financial Crisis
In mid 2007 we see a change in the significance of both the credit and the liquidity risk on the risk premium on the money market as the spread between the CIBOR and collateralized money market interest rate increased. The FED reacted promptly to the sub-prime crisis by lowering the monetary interest rate but the high level of inflation was considered a larger threat to the European economy and the ECB reacted by increasing its monetary interest rate and Danmarks Nationalbank followed. As the scale of the sub-prime crisis became evident Danmarks Nationalbank expanded its list of assets that can be used as collateral to ease the provision of liquidity to the financial sector to decrease the liquidity risk in the sector.

As the crisis escalated in 2008 so did the monetary responses of Danmarks Nationalbank. The Danish krone weakened and although the economic state cried out for an expansive monetary policy lowering the interest rates Danmarks Nationalbank had to increase the spread between its own and the monetary interest rates of the ECB. The credit risk increased and to prevent a bank run and reduce the credit risk the government introduced bank packages guaranteeing deposits up to a certain level with purpose of creating trust. The model in section 5 shows that an increase in the credit and liquidity risk-components of 1 % increased the risk premium by respectively 0.55 % and 0.36 % during this period. This relationship must have been clear to Danmarks Nationalbank as its monetary responses are focused on reducing both liquidity- and credit risk in the money market while trying to induce growth by lowering interest rates. Research on monetary- to retail interest rate pass-through by Danmarks Nationalbank shows that it took longer for the interest rate to pass through during the crisis. This indicates that the financial counterparties have used the expansive monetary policy as a way to regain their strength and it could be argued that Danmarks Nationalbank has indirectly subsidized the financial sector by having a lower lending rate than the retail rate.
6.2.3 The Aftermath of the Financial Crisis

Looking at the estimates in the econometric model after 2009 we see that the relationship once again becomes insignificant which could indicate that the responses meant to reduce credit and liquidity risk influence on the money market have worked as intended. Credit and liquidity risk was still present but it does not seem to influence the risk premium. Despite the fact that the credit and liquidity risk’s influences have already been reduced the central bank has continued to ease the access to liquidity by introducing 6-month and 3-year refinancing loans and accepting high rated loans as collateral. Despite the expansionary monetary policy, that since the start of the financial crisis have been pursued by the ECB and therefore also by Danmarks Nationalbank, the real economy is still affected by the crisis. The monetary policy seems inefficient in order to increase output through the transmission channels and the transmission channels in the Danish economy will therefore be discussed in the following section.

6.3 Liquidity Trap and Transmission Channels in the Danish Economy

Although interest rates were reduced significantly in 2008 and 2009 it does not seem to have had an immediate effect on the real economy. This can be due to a number of reasons but this discussion will look at how the inefficient transmission channels could have been a primary reason. The article found that the monetary interest rate potentially affects the Danish economy through the interest rate- and credit channel but there is only evidence that this is true in the interest rate channel. Although efficient, the article by Danmarks Nationalbank\(^7\) concludes and as mentioned in section 6.2.2 that the lag in time for the monetary interest rate to transmit to the retail interest rates became longer during the crisis which indicates a less efficient interest rate channel than before the crisis.

Through the credit channel a reduction in the monetary interest rate should according to the theory presented in section 2.5.2 have a positive effect on total lending and thus total investments in the economy. Instead as stated in an article published by the ECB in 2009\(^8\) the financial sector has hoarded liquidity and the authors present counterparty risk as one of the reasons why the money markets might have frozen up. This corresponds with the findings in section 5 as both liquidity and credit risks are considered counterparty risks and both are significant in our model.

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\(^7\) Peter Askjær, Marianne Clausager Koch, Morten Hedegaard Rasmussen, Morten Spange and Søren Vester Sørensen (2011). The Effects of Monetary Policy in Denmark.

\(^8\) Florian Heider, Marie Hoerova and Cornelia Holthausen (2009). Liquidity Hoarding and Interbank Market Spreads: The Role of Counterparty Risk
As we know the monetary interest rate might already be ineffective when an economy is caught in a liquidity trap, see section 2.6. Deciding to lower the interest rate immediately can therefore be costly as the interest rate approaches the zero-limit bound where it has little or no effect. Furthermore Woodford concludes in his article that the monetary interest rate especially when close to the zero-limit bound may not be effective enough in reducing the risk-premium in the money market99.

The increase in counterparty risk exemplified by an inefficient money market might have reduced the effects of a decrease in the monetary interest rate. Thus reducing the monetary interest rates in an inefficient money market might not have had the wished effect on commercial bank-lending as the counterparty risk made the credit channel ineffective.

I therefore argue that Danmarks Nationalbank should have looked at alternative monetary strategies which will be discussed in section 6.4 to reduce the risk premium on the money market and make it efficient. When the economy had stabilized, the full effect of a following decrease in the monetary interest rate would then be transmitted to the real economy.

A decrease in the monetary interest rate would also have increased the value of the asset on the financial institutions’ balance sheets. It can therefore be argued that all Danmarks Nationalbank’s monetary responses in combination have helped the financial counterparties reduce the asset side of the balance sheet to reduce credit risk and increase its solvency. Had these measures together with the government’s bank packages not been introduced there would have been a much higher risk of total economic panic.

### 6.4 Alternative Monetary Strategies

When the monetary interest cannot be lowered or the effects have little or no significant effect the following four alternative strategies can be used to pursue an even more expansionary monetary policy. All four strategies is based on the monetarist mechanism presented in section 2.6 that by increasing money supply the expected price level will increase leading to higher expected inflation and thus lower real interest rate.

- Communication strategy
- Quantative easing

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99 Michael Woodford (2010). Financial Intermediation and Macroeconomic Analysis - page40
- Credit easing
- Providing liquidity

6.4.1 Communication strategy
The effectiveness of the monetary policy can be increased if the market understands how the central bank will conduct its monetary policy, cf. section 2.5.3. Since the money market interest rate is a function of the monetary interest rate the money market interest rates can be lowered by signaling that the monetary interest rate will be held at a low level. The idea is that it will reduce uncertainty of the future interest rate and thus the term structure component, which is described in section 5.4.1, and flatten the horizontal interest rate structure, cf. section 2.8. Potentially it will lower the money market interest rates without lowering the monetary interest rate. This can be useful when the economy is caught in a liquidity trap where interest rates cannot be lowered any further. As this strategy does not seem to decrease the risk premium in the money market it does not address the issues discussed above.

6.4.2 Quantitative and credit easing
The fact that the central bank can print money means that it can increase the money supply by increasing its own balance sheet. In all three strategies, quantitative easing, credit easing and providing liquidity, the central bank increases its balance sheet but where quantitative and credit easing are active procedures where the central bank buys securities in the financial markets the providing liquidity procedure is more passive as the central bank does not actively buy securities. Credit and quantitative easing will therefore be presented together and providing liquidity in the next section.

Quantitative easing is performed by the central bank buying assets with long maturities to reduce the long term interest rates and flattening the horizontal interest rate structure. The reduction in the long term interest rate should have a positive influence on investments in the economy, i.e. in the real estate market. Securities with relative high risk premiums that do not reflect the real risk of the security due to inefficiency can be chosen to reduce the credit risk of the securities. Since the procedure is not sterilized by selling other securities the central bank also provides liquidity which means that the procedure potentially has three positive effects.
Credit easing is performed as the name also implies to reduce credit risk. In the same way as with quantitative easing the central bank buys securities that have irrational high risk premiums but as it sells other securities at the same time the liquidity effect is sterilized.

As both quantitative and credit easing are conducted to reduce the risk premium and are therefore relevant strategies for the central bank to use when it as in our situation wishes to reduce the risk premium in the money market. The FED has used both procedures where the Bank of England has performed quantitative easing and the ECB has used the credit easing procedure. The Security Market Programme (SMP) initiated by the ECB should also be seen as a way of addressing the sovereign debt crisis mentioned in section 4.2 through monetary policy.

6.4.3 Providing Liquidity
By expanding the lending facilities the central bank can provide liquidity and reduce the liquidity risk. When looking at the monetary responses by Danmarks Nationalbank we can see that it has used one out of the four alternative strategies. Since 2007 Danmarks Nationalbank have expanded its lending facilities either by expanding the list of assets that could be used as collateral or by increasing the maturity of the available loans.

The immediate effect of providing liquidity is that financial counterparties are able to refinance when the money market is frozen. As Danmarks Nationalbank can print money it can reduce the amount of assets on the financial sector’s balance sheet by lending against collateral. The reduction would under normal circumstances induce the financial sector to increase its lending but instead the liquidity injections in the form of extraordinary OMO’s etc. can have been used by the banks to reduce the spread between deposits and lending. This could explain why a lower monetary interest rate has not seemed to influence commercial bank-lending significantly. However over time it should, all else being equal, reduce the risk in the financial market and since Danmarks Nationalbank does not incur a higher risk due to hair-cuts, margin calls etc. there is no apparent reason why this procedure should not be used in a time of crisis.

Besides reducing the risk premium quantitative-, credit easing and provision of liquidity can also affect expectations in the market. This will reduce the expected interest rate, cf. section 6.4.,1 as the central bank is signaling that it will do whatever it can to pursue an expansionary monetary policy. Paul Krugman has questioned the effects that an increasing money supply will have on
the real economy as a central bank, that over the years have done all it could to convince the market that it would target low inflation, will have problems with convincing the market that it will create inflation. Furthermore the effects of the alternative measures are more uncertain than the traditional expansionary policy of lowering the interest rate and are therefore more risky. Therefore my suggestion of providing liquidity and waiting to see what happens might not have been sufficient and perhaps more risky. My point is, that lowering the monetary interest rate, when the money market is inefficient and the monetary interest rate is close to the zero-limit bound, will only remove a monetary instrument when the financial markets have normalized and growth is of the essence. Krugman mentions fiscal policy as the only potential mean of escaping a liquidity trap as it is more effective and the effects more transparent than the alternative procedures presented above. It could therefore have been interesting to look at fiscal policy efficiency but the scope of the thesis has meant that this is not possible in this thesis as explained in section 1.2.

6.5 Recapitulation
In this section the monetary responses by Danmarks Nationalbank before, during and in the aftermath of the financial crisis have been discussed. The central bank faces some challenges with the liquidity trap and 4 alternative procedures have been presented.

\[\text{References}\]
100 Paul Krugman (May 1998). Japan’s Trap
101 Paul Krugman (May 1998). Japan’s Trap
7.0 Conclusion
In the conclusion I will present a general evaluation of the monetary policy during a recession and point out the issues that it faces in the form of the liquidity trap. The purpose of the thesis was to obtain a profound understanding of the theory on monetary policy and since Danmarks Nationalbank bears the sole responsibility of performing the monetary policy Danmarks Nationalbank’s framework has been presented. Danmarks Nationalbank’s final target is clear-cut as it wishes to reach price-stability through a fixed exchange rate policy, maintaining secure transactions and stabilizing the financial sector.

Although the effects of a monetary policy are more indirect than fiscal policy the monetary policy has the advantage that it can be changed and implemented almost overnight. This is due to the fact that the central bank is independent of the political system. Despite of this other issues with the monetary policy have emerged since the start of the financial crisis.

The financial crisis did not only affect the Danish economy but was a global phenomenon although more severe in the USA and the Euro-area. To address the issues that caused the financial crisis Danmarks Nationalbank has performed a combination of the traditional monetary strategy of lowering interest rates and providing liquidity to the financial sector. An increased risk premium in the money market was found in section 5 to be the result of an increased liquidity- and credit risk. This was a potential threat to the efficiency of the traditional monetary policy. As a response to further reduce the risk-premium in the money market Danmarks Nationalbank expanded its lending facilities providing more liquidity to the financial sector.

The weakened financial sector during the crisis caused credit- and liquidity risk to become significant influences on the money market, cf. section 5. To stabilize the financial sector, induce growth and employment, and get an efficient money market actions both by the central bank (and the government in the form of banking packages) have been taken. Although independent the central bank has coordinated its responses to the monetary policy of the ECB. The ECB’s responses have therefore been significant for the strategy laid by Danmarks Nationalbank.

In the discussion I argue that the monetary responses have not been sufficient or performed in the wrong order as historical low monetary interest rates have not been transmitted to the real economy. Alternative monetary strategies (and fiscal policy) can therefore be looked at to help
make the transmission channels efficient when distressed and avoid the economy from falling into a liquidity trap by lowering monetary interest rates that are already close to the zero-limit bound. In conclusion the monetary responses, although comprehensive and necessary, have not been sufficient.
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http://ioa1.systime.dk/?id=p108

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Statistics and Data

Danmarks Statistikbank: www.dst.dk -> find statistik -> arbejdsmarked -> sæsonkorrigeret bruttoledighed -> AUS07:


Appendix A
Appendix A shows some of the data used in section 4. Danmarks Statistikbank has been the source of all the data used in the figures.

Figure 1a

Liquidity Position of Financial Counterparties

Source: Danmark Statistikbank

Figure 2a

HICP

Source: Danmarks Statistikbank
Appendix B

All figures in Appendix B have been generated in SAS Enterprise Guide

Figure 1b

Regression Analysis with Autoregressive Errors

The AUTOREG Procedure

Dependent Variable Ln(risk_premium)

Generated by the SAS System (Local, XE4_VSPRO) on 24. maj 2012 at 5:09:40 PM

---

Figure 2b

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Note: Pr<DW is the p-value for testing positive autocorrelation, and Pr>DW is the p-value for testing negative autocorrelation.
Figure 4b

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Figure 5b

| Variable | DF | Estimate | Standard Error | t Value | Approx Pr > |t| |
|----------|----|----------|----------------|---------|-------------|---|
| Intercept| 1  | 0.0665   | 0.0354         | 1.88    | 0.0646      |
| D1 * Ln(VIX_t) | 1 | -0.1395  | 0.2816         | -0.50   | 0.6218      |
| D2 * Ln(VIX_t) | 1 | 0.3634   | 0.1546         | 2.35    | 0.0216      |
| D3 * Ln(VIX_t) | 1 | 0.2360   | 0.1648         | 1.43    | 0.1565      |
| D1 * ln(CDS_t-1) | 1 | -0.2186  | 0.3334         | -0.62   | 0.5382      |
| D2 * ln(CDS_t-1) | 1 | 0.5513   | 0.1102         | 5.00    | <0.0001     |
| D3 * ln(CDS_t-1) | 1 | 0.0622   | 0.2019         | 0.31    | 0.7577      |
| D2     | 1  | -0.0817  | 0.0526         | -1.55   | 0.1252      |
| D3     | 1  | -0.0740  | 0.0472         | -1.57   | 0.1211      |

Figure 6b

Note: residuals Generated by SAS enterprise Guide
Figure 7b

Note: Before AR(3)

Figure 8b

Note: After AR(3)
Figure 9b

Trend and Correlation Analysis for \((3\text{m}_\text{OBOR} - 3\text{m}_\text{collateralized})\)

Trend and Correlation Analysis for \(\ln(\text{risk\_premium})\)

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Figure 10b

Trend and Correlation Analysis for in(CDS)t-1

Figures showing time series plots and correlograms.

Table 11b

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Figure 11b

Trend and Correlation Analysis for in(CDS)t-1

Figures showing time series plots and correlograms.
Appendix C

In appendix C all the Data used in the model will be compiled. The source of the data has been described in section 5.

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