Master's Thesis

Swiss Monetary Policy since the Recent Financial Crisis

An Analysis of Unconventional Instruments

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Abstract

Since the recent financial crisis a surge in safe haven currency investments leads to a sharp Swiss franc appreciation. The main focus of this thesis is to discuss the unconventional monetary policy instruments, adopted by the Swiss National Bank in order to tackle the appreciation pressure on the Swiss franc. These include unsterilized foreign exchange interventions and negative interest rates. The effect of the foreign exchange interventions throughout the crisis is analysed by considering the evolution of the SNB's balance sheet, followed by a discussion about the implied balance sheet risks. The consideration of negative interest rates contains the analysis of their impact on financial markets and a discussion about their potential side effects.

Contents

1 Introduction **1**

2 Conventional versus Unconventional Monetary Policy **3**

2.1 Conventional Monetary Policy 3

2.2 Unconventional Monetary Policy 5

2.2.1 Credit Easing 5

2.2.2 Quantitative Easing 6

2.2.3 Forward Guidance 10

2.2.4 Unsterilized Foreign Exchange Interventions 11

2.2.5 Negative Interest Rates 13

3 Unconventional Monetary Policy during the Recent Financial Crisis **15**

3.1 A Chronological Overview for Switzerland 15

4 Analysis of Swiss Unconventional Instruments **22**

4.1 Balance Sheet Considerations of the SNB 22

4.1.1 The Evolution of SNB's Balance sheet 22

4.1.2 Balance Sheet Risks and the Significance of Negative Capital . 27

4.2 Implication of Negative Interest Rates 32

4.2.1 Technical Implementation 33

4.2.2 Impact on the Swiss Financial Market 33

4.2.3 Risks and Side effects 39

5 Discussion **44**

6 Conclusion **46**

References **i**

List of Figures

1 QE and Portfolio Balance Effect 7

2 Transmission of QE to the Macro Economy 10

3 Sterilized and Unsterilized FX Intervention 13

4 SNB Policy Announcements in August and September 2011 18

5 Swiss Franc Appreciation since the Recent Financial Crisis 21

6 Swiss Franc Development since the Introduction of NIR 21

7 Simplified Swiss National Bank Balance Sheet: Assets 24

8 Simplified Swiss National Bank Balance Sheet: Liabilities 26

9 Volatility Increase of SNB's Financial Positions 28

10 Transmission: From Negative Interest Rates on Sight Deposits to Libor 34

11 Transmission: From Libor to Money Market Rates 35

12 Low for Long: 3M Libor Futures Contracts 36

13 Transmission: From Money Market to Capital Market Rates 37

14 Decrease of Yield Curves 38

15 Increase in Yield Spread 39

16 Increase in Mortgage Rates due to Increased Refinancing Costs 40

17 Refinancing of Mortgages 42

1 Introduction

In the wake of the financial crisis in 2007/2008, central banks around the globe were confronted with a new challenging environment concerning their strategy of monetary policy. The bankruptcy of Lehman Brothers on September 15, 2008, turned into a financial panic. By January 2009, the global industrial output has decreased by more than 10%, global trade by almost 20% and the global stock market has lost about half of its value. In order to stimulate the economy, central banks began to lower interest rates. After having decreased policy rates to the zero lower bound, they reached the natural limit at which conventional monetary policy - the steering of the economy via short-term interest rates - becomes powerless. At the same time, many governments entered the crisis with a high debt burden and were restrained by their budgets to spend more. Central banks found themselves as the only ones left to support the economy. In order to provide further monetary stimulus, the introduction of unconventional instruments was inevitable (Danthine, 2014, p. 3).

A number of major central banks created large excess reserves via large-scale asset purchases, also referred to as quantitative easing (QE). The aim of such purchases may differ slightly across countries, but usually involves the reduction of long-term interest rates to subsequently stimulate the overall economy through this channel (Christensen and Krogstrup, 2014, p. 1). In the case of Switzerland, large amounts of foreign currency denominated assets have been purchased, mainly in order to tackle the tremendous appreciation pressure on the Swiss franc. Already at the onset of the financial crisis in August 2007, a surge of safe haven flows lead to an appreciation of the Swiss franc, which in 2011 reached its peak. The rapid and dramatic appreciation of the Swiss franc carried the risk of deflationary developments, as for a small and open economy such as Switzerland the exchange rate is the major driver of the price level. On September 6, 2011, the Swiss National Bank (SNB) announced that it would no longer tolerate a euro/Swiss franc exchange rate below 1.20, and it would enforce the minimum exchange rate through unlimited foreign currency purchases (Jordan, 2013, p. 2). The minimum exchange rate was enforced for more than three years, but changes in fundamental international conditions forced the SNB to abandon the peg. The discontinuation of the minimum exchange rate meant that interest rate steering once again took on an important

role. In December 2014, the SNB announced the introduction of negative interest rates on banks' and other financial market participants' sight deposits held at the SNB. Making it significantly more expensive to hold Swiss francs, the introduction of negative interest rates intends to mitigate the upward pressure on the Swiss franc (Zurbrügg, 2015, p. 2-4).

The development of Switzerland's economy is highly dependent on the global economic environment, and specifically on the one of the euro area. If the economic situation in the euro area does not improve in the near future and the European Central Bank (ECB) eases its monetary conditions further, the appreciation of the Swiss franc will remain a concern. Therefore, it is important to understand what kind of instruments are available to the SNB in order to ease monetary conditions, since conventional monetary stimulus is exhausted.

The aim of this thesis is to provide an overview of the unconventional instruments that were applied by the SNB since the recent financial crisis and to discuss their effects. As we will see in this thesis, among the widely used unconventional instruments, there are two instruments that are at SNB's disposal in order to ease monetary conditions: unsterilized foreign exchange interventions and negative interest rates. The thesis explains the functioning of the two instruments, shows their impacts and discusses their risks. For this purpose, we will analyse the SNB's balance sheet, in order to quantify the effects of the foreign exchange interventions and get an insight about its risks. The consideration of negative interest rates contains the analysis of their impact on financial markets, followed by a discussion about their potential side effects.

The thesis proceeds as follows: Section 2 shows the difference between conventional and unconventional monetary policies and introduces major unconventional instruments. Section 3 gives a chronological overview of the recent financial crisis that shows against which background the implementation of unconventional instruments in Switzerland was necessary. Section 4 analyses the two unconventional instruments applied by the SNB. Section 5 discusses the findings of the analysis of the two unconventional instruments. Section 6 concludes.

2 Conventional versus Unconventional Monetary Policy

Prior to the recent financial crisis, the aim of monetary policy was inflation targeting, which was achieved through short-term interest rates, at which the central bank provided funds to the banking system. The impact of this official short-term interest rate on market rates as well as on the overall economy was reliably quantified. This is what constitutes conventional monetary policy. The financial crisis of 2007/2008 however, posed a number of challenges that made the use of conventional policies ineffective and unconventional instruments were required. These challenges include the emergence of asset market bubbles, the zero lower bound on nominal interest rates, and the breakdown of the interbank market because the solvency of banks and borrowers was called into question (Joyce et al., 2012, p. F272-F273). As it is important for the further reading of this thesis to understand the difference between the two policies, this section gives a brief explanation of conventional and unconventional monetary policy.

2.1 Conventional Monetary Policy

In a world with pure "fiat" money - money that is not backed by any physical commodity - the value of it depends widely on the policies of the particular central bank. Therefore, it is crucial that central banks commit themselves to an explicit objective, guaranteeing monetary and financial stability. Nowadays, a very common objective is the mandate of price stability. The way in which this mandate is to be reached is often described in more detail by specifying a rule, such as a specific inflation target (Woodford, 2003, p. 2,21). For example, in the case of Switzerland the SNB's mandate is to ensure price stability, with an explicit inflation target of less than 2% (SNB, 2015e).

In normal times, and specifically prior to the recent financial crisis, the specified inflation target is pursued by conventional monetary policy, which means via short-term interest rates. In order to determine these interest rates, the best known rule, which is the benchmark for many policymakers in assessing the current stance of monetary policy, is the one proposed by John Taylor (1993), the so-called Taylor

rule. It prescribes setting an interest rate operating target as a linear function of measures of the current inflation rate and the current gap between real and potential output (Woodford, 2003, p. 39).

With an equilibrium real interest rate of 1%, an inflation target of 2%, and equal weights of 0.5 on inflation and output deviations, the rule takes the following form:

$$i = 1 + p + 0.5(p - 2) + 0.5(y - y^*)$$

where i is the nominal interest rate, p is the current inflation rate, $(p - 2)$ is the inflation deviation, and $(y - y^*)$ is the output gap (Evan F. Koenig et al., 2012, p. 64). The basic idea behind the equation is that nominal interest rates should be increased when inflation is above its target and employment is above the full employment levels, and decreased in the opposite situation. More specifically, it says that nominal interest rates should be adjusted by more than one-for-one with an increase in inflation above its target. This can be seen by rearranging the equation to the following form (Evan F. Koenig et al., 2012, p. 69):

$$i = 1.5p + 0.5(y - y^*)$$

One of the most important monetary policy instruments that the SNB uses to influence short-term interest rates is the repo (repurchase agreement). In order to decrease interest rates, the SNB increases the money supply by buying securities from a commercial bank. At the same time, there is an agreement that the commercial bank repurchases the securities from the SNB at a later date. Therefore, the repo looks like a collateralized loan in the sense that the commercial bank receives a short-term Swiss franc loan from the National Bank, for which it pays the repo rate, and the National bank receives the securities by way of collateral. Thus, in "normal" times monetary policy is determined by setting the price of central bank reserves (SNB, 2015h).

In an environment with deep recession, Taylor rules recommend negative nominal

interest rates. We can see this from the above mentioned equations. If we consider a very low current inflation rate p, let us say close to zero or even some deflation, and a negative output gap, the nominal interest rate becomes negative. Since agent's can choose to hold non-interest bearing cash, nominal interest rates are bounded by zero. This is where we reach the problem of the zero lower bound[a] on nominal interest rates, where the Taylor rule cannot be applied anymore and unconventional policies need to be considered (Joyce et al., 2012, p. F272).

2.2 Unconventional Monetary Policy

Once the possibility of further conventional monetary stimulus was exhausted, central banks adopted alternatives that depart from their usual practice, which are therefore called "unconventional" instruments. Typically, these include measures that expand the size of the balance sheet, operations that change the composition of the central bank's balance sheet, and actions that try to guide long-term interest rate expectations. Often, the latter is considered as forward guidance, while the former two describe what is called quantitative easing and credit easing respectively (Peersman, 2011, p. 5). In addition to these major unconventional instruments, there are two, in this from unprecedented instruments, which were particularly applied by the Swiss National Bank. They are unsterilized foreign exchange (FX) interventions on a large scale and the introduction of negative interest rates. The functioning of these unconventional instruments is described below.

2.2.1 Credit Easing

The goal of credit easing is primarily to ease credit conditions for the non-financial private sector, i.e. small and medium sized businesses as well as households, after policy rates were decreased towards zero (ECB, 2015, p. 5-6). One major problem that occurred in the recent financial crisis was the perceived increase of the riskiness of the banking sector which lead to a sharp increase on bank debt spreads. The increased bank funding costs subsequently resulted in increased borrowing costs

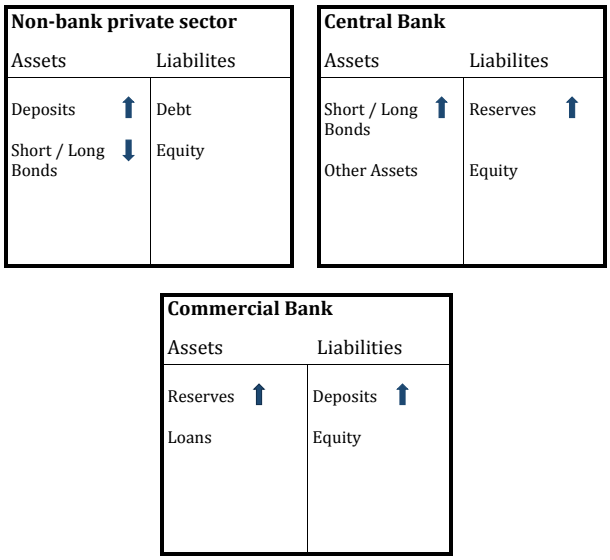
[a]Later in the thesis in section 4, it will be shown that the zero lower bound can be broken. Nominal interest rates are not bounded by zero, as holding cash is not free of frictions, but accompanied with costs (Rogoff, 2014).

for households and firms. As a reaction, central banks implemented credit easing measures. A typical example for credit easing is the ECB's long-term refinancing operation program (LTRO) (Bowdler and Radia, 2012, p. 618). With LTROs the ECB lengthened the maturity of liquidity provisions and eased collateral requirements. Subsequently, the LTRO program lowered bank funding costs and spreads and resulted into looser financing conditions for final borrowers (Claeys, 2014, p. 6).

2.2.2 Quantitative Easing

Simply easing credit conditions for the private sector may not be enough to achieve the required degree of accommodation the central bank needs in order to fulfil its mandate of price stability. In order to pursue an even more expansive monetary policy, central banks started to intervene in capital markets, by implementing quantitative easing (abbreviated QE in the following). QE involves purchasing assets on a large scale and injecting broad money into the economy. In contrast to conventional monetary policy, QE tries to directly affect long-term interest rates. QE actively involves changing the size of the balance sheet, where not only the one from the central bank but also the balance sheets of the non-bank private sector and the banking sector are affected. The mechanism behind QE is best understood graphically, shown in Figure 1. Typically a central bank buys assets, such as long-term government bonds, from the non-bank private sector, for example insurance companies or pension funds. Since the private sector sells these bonds to the central bank, the private sector's holdings of bonds fall and the assets of the central bank increase. In order to pay for the purchased bonds, the central bank credits the corresponding amount on the bank account of the private sector, which increases its deposits. The central bank finances its purchases by issuing base money in the form of reserves that are held at the central bank and expands its balance sheet. The private sector's deposits are held at the banking sector. Hence, also the balance sheet of the banking sector expands, as the increased holdings of deposits of the private sector are matched against the newly created central bank reserves (Bowdler and Radia, 2012, p. 606-607). The transmission of QE to capital markets can be explained through different transmission channels, i.e. the portfolio-balance channel and the signalling channel, that are described below.

Figure 1: QE and Portfolio Balance Effect



Source: Adapted from Bowdler and Radia (2012)

Portfolio Balance Channel

The portfolio balance channel explains changes in financial market prices due to generated liquidity through purchases of assets, that is used by investors to reallocate their portfolios. In order to explain the portfolio rebalancing process we take again a look at Figure 1, where the central bank has purchased bonds, and the non-bank private sector's balance sheet is left with increased liquidity in the form of deposits, rather than bonds (Bowdler and Radia, 2012, p. 609).

First, we assume the purchased bonds to be short-termed. Hence, they can be seen as near-perfect substitutes for deposits or reserves, since all of the three items carry near zero interest rates (Christensen and Krogstrup, 2015, p. 8). Under this assumption the private sector is indifferent between holding short-term bonds and deposits. Therefore, no portfolio rebalancing is needed and one could assume the process would end here. Woodford, M. (2012) describes such kind of purchases as "pure QE" and claims that such attempts of expansionary monetary policy have no impact on the economy, since the economy is in a liquidity trap (Bowdler and Radia,

2012, p. 609). However, as we have seen in Figure 1, the size of the balance sheet of the banking sector has increased, as the increased deposits of the private sector are held at the bank and are matched against the newly created reserves. Assuming that the bank considered its asset allocation and portfolio duration optimal before, it is unlikely that it considers the asset allocation after the balance sheet expansion still as optimal. After the expansion, the bank's portfolio is more heavily tilted towards safe, liquid and low-yielding reserves and also the duration of the asset side has declined. Hence, the bank will try to diversify the excess reserves into longer-term and higher yielding assets, i.e. long-term bonds, in order to reobtain its previous risk and duration structure of the portfolio. Consequently, the demand of these long-term bonds increases, pushing the price of the bonds up. As the price of bonds increases, the yield decreases. This shows that QE can affect long-term interest rates and asset prices even when the central bank does not purchase long-term assets. This is the so-called *reserve-induced portfolio channel*, since it describes the transmission of QE only due to increased reserves in the banking system (Christensen and Krogstrup, 2015, p. 8-9).

On the other hand, if we assume that the assets the central bank purchased are long-term assets, the transmission mechanism is more direct. Again we can look at Figure 1, where we now assume that the central bank buys long-term bonds and therefore credits the private sector's deposits in order to pay for the purchase. This will directly induce a portfolio rebalancing effect, since the long-term bonds are not perfect substitutes anymore, as they are higher yielding and have a longer duration than deposits. Hence, the private sector will seek to invest its deposits in alternative but similar long-term assets, as were the bonds it sold to the central bank. This increases the demand for those alternative long-term assets and lowers their yield (Bowdler and Radia, 2012, p. 609-610). Also, when a central bank buys long-term bonds on a large scale it reduces their availability on the market, so that also the bonds' prices increase and yields decrease (Christensen and Krogstrup, 2015, p. 5). Since long-term bonds are now more expensive, investors will look for alternatives and likely invest in slightly riskier assets that are now relatively cheaper in comparison to long-term government bonds, such as high-quality corporate bonds that will eventually also experience an increase in price and a decrease in yields. Finally, the process ends when all long-term asset prices are adjusted. This mechanism is called the *supply-induced portfolio channel*, because asset prices and yields are af-

fected due to a restriction in the overall supply of bonds (Bowdler and Radia, 2012, p. 610). Finally, when a central bank buys long-term bonds in exchange of newly issued reserves both of the channels, the supply- and the reserve-induced channel, are active.

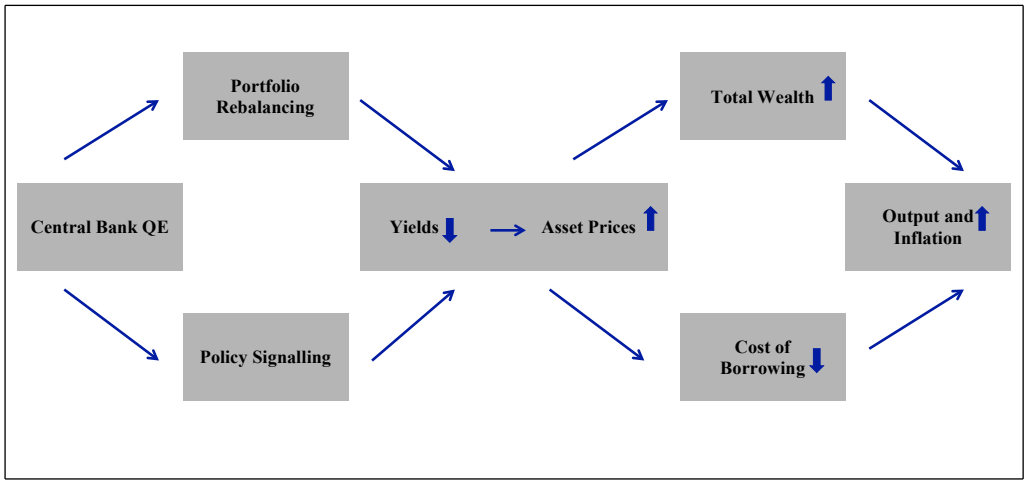
Signalling Channel

The second transmission channel of QE is the signalling channel. When a central bank announces to purchase assets on a large scale, it provides a signal for the monetary policy stance in the future. By purchasing a large quantity of long-term assets the central bank gives a credible commitment to keep interest rates low in the future, because if the central bank raises interest rates later on, it will suffer significant losses on the assets it purchased under its QE program. Because of this commitment that QE contains, the central bank creates expectations for lower interest rates in the future, leading to decreasing long-term interest rates today and subsequently increasing inflation expectations (ECB, 2015, p. 8-10).

Transmission of QE to the Macro Economy

As we have seen, the overall result of the different types of transmission channels of QE is an increase in long-term asset prices and a decrease in long-term interest rates. In theory, this should transmit to the macro economy through a reduction of costs of capital and an increase in wealth. Lower yields mean that costs of debt issuance for banks decrease, enabling banks to reduce the prices of loans to households and firms. This should stimulate consumption and investment. Since QE is mostly conducted in times where the banking sector is damaged, this transmission channel could be debatable. Still, since we have seen that the portfolio rebalancing also goes towards corporate bonds, their yields decrease as well. Hence, also the borrowing costs for companies with access to capital markets decrease. When small firms are connected to large firms through a supply chain they can indirectly benefit from either an increased demand, or improved trade credit conditions. Furthermore, the increase in asset prices represents an increase in wealth for their holders, which should boost spending as well (Bowdler and Radia, 2012, p. 612-613). The transmission of QE to the macro economy is graphically explained in Fugure 2 (Christensen and Krogstrup, 2015, p. 9).

Figure 2: Transmission of QE to the Macro Economy



Source: Adapted from Bowdler and Radia (2012)

2.2.3 Forward Guidance

Another popular unconventional policy tool besides QE is forward guidance. In addition to the central bank's usual announcements about its current policy actions, the central bank gives an explicit statement about the outlook for future policy. Compared to past, conventional statements about future policy, the unconventional component that forward guidance contains is that forward guidance is much more precise and quantitative and refers to policy decisions much further in the future (Woodford, 2012, p. 3). The explicit commitment to a future path of loose monetary policy intends to influence interest rate expectations, and according to the expectation hypothesis[b], this should lead to lower long-term interest rates. According to Krugman (1998) the initial idea of forward guidance is to convince the public that the central bank will pursue a more expansive policy than previously expected, even after the economy recovers. This should result in an increase in inflation expecta-

[b]According to the expectation hypothesis, long-term interest rates are purely determined by market expectations of short-term interest rates over the holding period of the long-term assets, plus a risk premium. This means that investing in a sequence of short-term bonds results in the same return as investing in a long-term bond (Guidolin and Thornton, 2008).

tions, which should have a decreasing effect on real long-term interest rates today and boost investment and consumption (Claeys, 2014, p. 9).

The major problem of implementing forward guidance is that it is time-inconsistent. Once the economy begins to recover and inflation expectations increase, there is no incentive for the central bank to hold on its promise of further keeping its expansionary monetary policy. The promise is not credible because, if the central bank maintained the policy stance as promised, inflation would increase up to an unintended level (Bowdler and Radia, 2012, p. 615-616). According to Woodford (2012), the only way to make the commitment credible is to publicly state the commitment, such that it is sufficiently unambiguous and that it would make it embarrassing for policymakers to renege on it when making decisions at a later time.

2.2.4 Unsterilized Foreign Exchange Interventions

In a small and open economy, such as Switzerland, the exchange rate is one of the major drivers of the price level. The financial crisis evoked a flight in safe currencies, which lead to a sharp appreciation of the Swiss franc. The appreciation lead to a tightening of monetary conditions and induced deflationary threat (Jordan, 2013, p. 3-5). The above mentioned classical QE has a depreciating effect on exchange rates, since it boosts the supply of the currency. Therefore, it represents a viable measure in order to ease monetary conditions when the zero lower bound is reached (Financial Times, 2015). However, the bond market in Switzerland is very limited, so that bond purchases on a large scale are not feasible. Consequently, the SNB applied QE through the purchase of foreign exchange. There are two ways, in which interventions in the foreign exchange market can be conducted: sterilized and unsterilized interventions.

Sterilized interventions contain a combination of two transactions. First, the SNB buys foreign currency denominated assets against Swiss francs. Thus, it increases the money supply. This is followed by a second transaction, where the SNB sells Swiss franc denominated assets. With the second transaction the monetary base is reduced again. This is what is called sterilization. Hence, sterilized interventions do not change the monetary base and therefore do not change the monetary stance of a central bank. Sterilized interventions are therefore an attempt to influence exchange

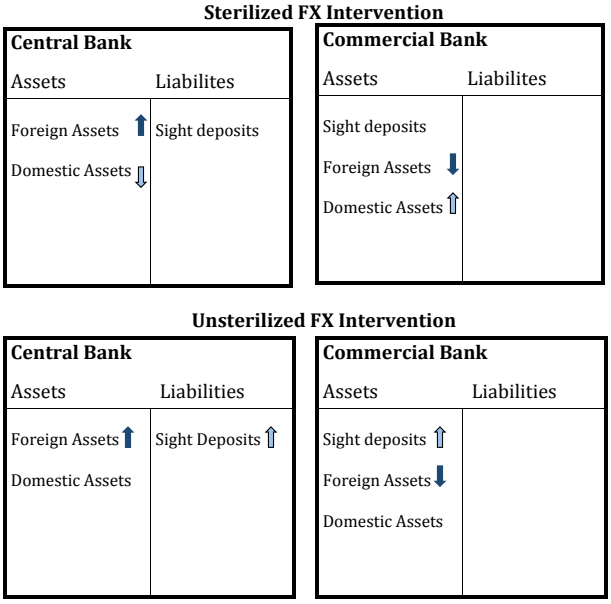
rates without interfering the domestic monetary policy stance (Humpage, 2013). Unsterilized interventions involve only the first transaction. This means that the SNB buys foreign currency denominated assets and prints money in order to do so, which increases the money supply. There, the monetary policy stance is affected, i.e. unsterilized interventions ease monetary conditions (Burkhard and Fischer, 2007, p. 3-11). Figure 3 shows the above described balance sheet effects of sterilized and unsterilized interventions graphically. As we can see, sterilized interventions only change the composition of the balance sheets (exchanging domestic assets with foreign assets), while unsterilized interventions expand the balance sheet of the central bank and increase the sight deposits of commercial banks and therefore expand the monetary base.

The effect of sterilized interventions on exchange rates is disputed, since it does not increase the monetary base and therefore does not ease monetary conditions.[c] On the other hand, the effect of unsterilized interventions is much more obvious. An intuitive explanation why unsterilized foreign exchange interventions lead to depreciation is the following: The supply of domestic currency increases. At the same time also demand for the foreign currency, by purchasing foreign currency denominated assets, increases. This mechanism has a depreciating effect on the currency (Isber and Petursson, 2003, p. 51-53). The depreciation of the Swiss franc should increase inflation through the exchange rate channel. On the one hand, thanks to a weaker franc, Swiss products become more affordable, increasing Switzerland's competitiveness and stimulating exports. On the other hand, prices for imported goods increase, leading to an imported inflation (Cevik and Teksoz, 2012, p. 6-7).

Since the recent financial crisis, the SNB has conducted unsterilized foreign exchange interventions to a large extent. In section 4, when analysing the SNB's balance sheet, the dimensions are going to be more clear.

[c]Theory suggests that sterilized intervention should affect exchange rates through the portfolio balance channel and the signalling channel. However, the portfolio balance channel only holds under the strong assumption that domestic currency and foreign currency are not substitutes. Furthermore, most empirical studies find that sterilized interventions have a very limited effect on exchange rates. A more detailed discussion can be found in (Isber and Petursson, 2003).

Figure 3: Sterilized and Unsterilized FX Intervention



Source: Adapted from Isber and Petursson (2003)

2.2.5 Negative Interest Rates

The exceptional developments of the recent financial crisis evoked, in addition to the above mentioned instruments, another fairly new and unfamiliar unconventional instrument - the introduction of negative interest rates. So far, only few central banks have made use of this unconventional measure, such as the European Central Bank, the Danish central bank, the Swedish Riksbank and the Swiss National Bank. Since Denmark and Sweden, just as Switzerland are considered to have safe and stable currencies, a surge in safe haven investments into these countries, since the recent crisis, causes sharp appreciation pressures. This is why, on December 18, 2014, the Swiss National Bank announced to charge negative interest rates on banks' and other financial market participants' sight deposits held at the SNB, that exceed a given exemption threshold. Furthermore, it moved the three-month Libor range for the first time into negative territory (Moser, 2015, p. 4-8). The main intention of

the implementation of negative interest rates, is to counter the enormous upward pressure on the Swiss franc, by making the Swiss franc less attractive compared to other currencies. By charging negative interest rates on Swiss francs, holding Swiss francs becomes more expensive compared to other foreign currencies, leading to incentives to get rid of them and lowering the demand. This in turn leads to a depreciation of the currency (Zurbrügg, 2015, p. 4-5).

Historically, Swiss interest rates have been lower than those of Switzerland's main trading partners, reflecting Switzerland's political and economical stability, its sound institutions and an outstanding financial sector. In the wake of the recent financial crisis, many advanced economies decreased their interest rates towards zero, so that the historical interest rate differential of Switzerland disappeared. This made Swiss franc investments more attractive compared to similar investments in other currencies. The final target of the implementation of negative interest rates is therefore to move this historical interest rate spread again towards more normal levels. This means that the goal of the measure is to transmit from negative interest rates on sight deposits to market rates throughout all the maturities, i.e. decreasing short-term as well as long-term interest rates, subsequently leading to a decrease of Switzerland's overall yield curve. A decline of Switzerland's yield curve means that the interest rate spread with other currencies increases again which eventually makes investments in Swiss francs less attractive. Market observations proved that after the introduction of negative interest rates, Switzerland's yield curve in fact declined (Maechler, 2015, p. 3). The transmission to the financial markets will be shown and explained in more detail in section 4.

So far, no considerable experiences could be gained with the new measure of negative interest rates. In particular, undesired side effects can appear that we are not aware of yet, which are worth a detailed analysis and discussion. This will be covered in section 4 as well.

3 Unconventional Monetary Policy during the Recent Financial Crisis

The attempt of major central banks around the globe, to stimulate the economy and escape the deflationary threat, evoked a number of various unconventional monetary instruments that have never been applied to this extent before. As already mentioned, the two main unconventional instruments that were applied by the SNB are unsterilized foreign exchange interventions and negative interest rates. This section gives an overview about the milestones of the recent financial crisis and shows the background that made the implementation of these two measures necessary.

3.1 A Chronological Overview for Switzerland

September 2008: Financial crisis in the US spreads to Europe

As of end of 2008, the international financial situation radically deteriorated. With the announcement of the bankruptcy of Lehman Brothers in September 2008, the financial crisis in the US spread to Europe. The advanced economies fell more or less simultaneously into a recession and further worsening in the growth rate of the US and Europe was expected. It was clear that the Swiss economy would be effected by these developments as well. The SNB assumed that due to the worsening of the global financial environment, growth rates for Switzerland could reach negative territory. The slowdown in economic activity, as well as the decline in the oil price, lead to decreasing inflation expectations. The Governing Board of the SNB decided to relax monetary policy and to bring market rates down close to zero. More precisely, the SNB lowered the three-month Libor target range to 0.0 - 1% during the last quarter of 2008 (SNB, 2015c).

March 2009: The beginning of unconventional monetary policy

Due to the global financial turmoil, sustained safe haven flows into the Swiss franc lead to a persistent strengthening of the currency. The Swiss franc appreciation created unfavourable conditions for the Swiss export, thereby amplifying the recession, and lead to a decline in import prices. Both effects together increased the risk of

deflation. After having lowered the Libor target range by another 25 basis points, to now 0.0 - 0.75%, the SNB decided to substantially increase the supply of liquidity, adopting a number of unconventional policy measures. Instruments that were introduced include foreign exchange swaps, repos with longer terms, purchases of Swiss franc bonds, issued by domestic private sector borrowers, and direct interventions in the foreign exchange market, in order to counter further appreciation of the Swiss franc (SNB, 2015d). The interventions have lead to a substantial expansion of the SNB's balance sheet.

2010: First global recovery and the introduction of SNB bills

In the third quarter of 2009, a first global recovery could be achieved which was supported by three main factors: cheap oil, the first round of quantitative easing conducted by the FED and a massive Chinese fiscal intervention (SNBCHF, 2015). Against this background, the SNB decided to tighten its monetary policy by closing most foreign exchange swap agreements and discontinuing the bond purchase program. Up to that point in time, the balance sheet has experienced a large increase in volume. In order to reduce the size of the balance sheet, the SNB began in 2010, to absorb a large part of reserves through reverse repo operations and the issuance of SNB bills[d] (Christensen and Krogstrup, 2014, p. 5-6). The global economic outlook remained positive until mid 2011, but concerns about the stability in the euro area led to renewed financial market tensions, weakening the euro and leading to sharp appreciation pressures on the Swiss franc (SNB, 2011a).

September 2011: The introduction of the minimum exchange rate

Between July and August 2011 the development of the Swiss franc exchange rate was exceptional in two ways. First, in 2011 doubts about the solvency of Spain and Italy increased, which lead to an escalation of the European sovereign debt crisis. The Swiss franc appreciation accelerated dramatically so that the currency has been left extremely overvalued. Second, the debt ceiling negotiations in the United States lead to a downgrade of the US by Standard and Poors and created further tensions.

[d]SNB bills are debt certificates issued by the SNB. They are purchased by commercial banks, which therefore reduces their holdings of reserves (Porta, 2011, p. 21).

Consequently, the Swiss franc appreciated against all the major currencies. The appreciation did not reflect fundamental factors but only reflected international developments that transformed the Swiss franc into a safe haven (Jordan, 2013, p. 3-5). Figure 5 shows the development of the euro/Swiss franc exchange rate since the beginning of the financial crisis. We can see that the Swiss franc appreciated gradually throughout the crisis, until it reached its peak in August 2011. In order to counter the appreciation pressure, the SNB aimed for a three-month Libor as close to zero as possible, reducing the target range from 0.0 - 0.75% to 0.0 - 0.25%. At the same time the SNB announced numerous unconventional measures in August and September, increasing sight deposits to a large extent. The interventions are listed in tabular form in Figure 4. By end of August 2011, total reserves amounted more than 200bn Swiss francs, which is close to a third of Switzerland's GDP (SNB, 2011b). Despite the enormous expansion of reserves, the appreciation of the Swiss franc resumed. In a small and open economy, such as Switzerland, the exchange rate is one of the major drivers of the price level. Lowering interest rates further was not possible since they were already close to zero. The purchase of domestic assets was not an option either, since the Swiss bond market is very small. In order to prevent deflation and fulfil its mandate of price stability, the only viable option was the introduction of a minimum exchange rate (Jordan, 2013, p. 3-5). In the press release of September 6, 2011, Thomas Jordan, Chairman of the Governing Board of the SNB, stated:

" With immediate effect, the SNB will no longer tolerate a euro/Swiss franc exchange rate below the minimum rate of 1.20 Swiss francs. The SNB will enforce this minimum rate with the utmost determination and is prepared to buy foreign currency in unlimited quantities." (SNB, 2011c)

2012: Continuation of the minimum exchange rate

In 2012 the European sovereign debt crisis reached its peak. Doubts about the solvency of Spain and Italy increased. Additionally, speculations about a Grexit, i.e. the withdrawal of Greece from the euro zone, intensified (Financial Times, 2012). The minimum exchange rate had to be defended through extensive foreign currency purchases. For the subsequent two years the SNB maintained the minimum exchange rate of 1.20 Swiss francs per euro unchanged (SNB, 2013a).

Figure 4: SNB Policy Announcements in August and September 2011

Date	Announcement description
August 3, 2011, 8:55 a.m.	Target range for three-month CHF LIBOR lowered to 0 to 25 basis points. In addition, banks' sight deposits at the SNB will be expanded from CHF 30 billion to CHF 80 billion.
August 10, 2011, 9:05 a.m.	Banks' sight deposits at the SNB will rapidly be expanded from CHF 80 billion to CHF 120 billion.
August 17, 2011, 8:55 a.m.	Banks' sight deposits at the SNB will immediately be expanded from CHF 120 billion to CHF 200 billion.
September 6, 2011, 10:00 a.m.	The SNB announces a minimum exchange rate for the Swiss franc to the euro of 1.20 francs per euro and is prepared to buy foreign currency in unlimited quantities to defend it.

Source: Christensen and Krogstrup (2014)

February 2013: Imbalances in the real estate market and the introduction of the countercyclical capital buffer

The environment of historically low interest rates resulted in strong growth in real estate prices as well as mortgage lending in Switzerland. There is a certain risk that a sharp correction in real estate prices as well as mortgage defaults could jeopardize financial stability. An increase in interest rates could counteract these developments but it would lead to an increase of the exchange rate, given the expansionary monetary policy stance in major advanced economies. Against this background, the Swiss Federal Council followed the proposal of the SNB and introduced the countercyclical capital buffer (CCB) in February 2013. The CCB is an unconventional measure applied by the SNB, that can be used to target specific market segments (Jordan, 2013, p. 4). It requires banks to temporarily build-up additional capital of up to

2.5% of total domestic risk-weighted assets. On the one hand, it aims to increase the banks' loss-absorbing capacity and to protect the banking sector from excessive credit growth. On the other hand, it aims to dampen mortgage lending due to increased capital requirements associated with residential mortgage loans (SNB, 2014a, p. 1,7).

January 2015: Discontinuation of the minimum exchange rate...

For more than three years, from September 6, 2011 until January 15, 2015, the minimum exchange rate was successfully kept and helped the Swiss economy to overcome severe deflationary pressures. Eventually, on January 15, 2015, the SNB concluded that the measure was not justified from a monetary policy perspective anymore and decided to discontinue the minimum exchange rate. But what was the reason behind it? First, there were expectations that the US Federal Reserve System would increase interest rates. At the same time, there were signs that the ECB would conduct further monetary policy easing from mid-year onwards. These developments weakened the euro significantly against the US dollar, which in turn affected the euro/Swiss franc exchange rate (Zurbrügg, 2015, p. 2-3). The Ukraine conflict, the fall in the price of oil, which was interpreted as a decline in demand, and re-emerging debt issues in Greece lead to an even stronger surge in safe haven investments and caused upward pressure on the Swiss franc. In order to support the exchange rate peg the SNB introduced a new monetary instrument. In December 2014 the central bank decided to charge negative interest rates of - 0.25% on banks' and other financial market participants' sight deposits held by the SNB as of January 22, 2015. Furthermore it lowered the Libor range for the first time into negative territory (Moser, 2015, p. 4). But the upward pressure on the Swiss franc was still too strong. Eventually, the fundamental changes of the global developments made a continuation of the minimum exchange rate infeasible. Only massive purchases of foreign currency would have allowed the SNB to hold the minimum exchange rate. Potentially an expansion of the balance sheet of up to a level several times higher than Swiss GDP would have been necessary to keep the minimum exchange rate. An expansion of such a dimension would have sharply increased the risk of the SNB's balance sheet and the SNB was not willing to take this risk.

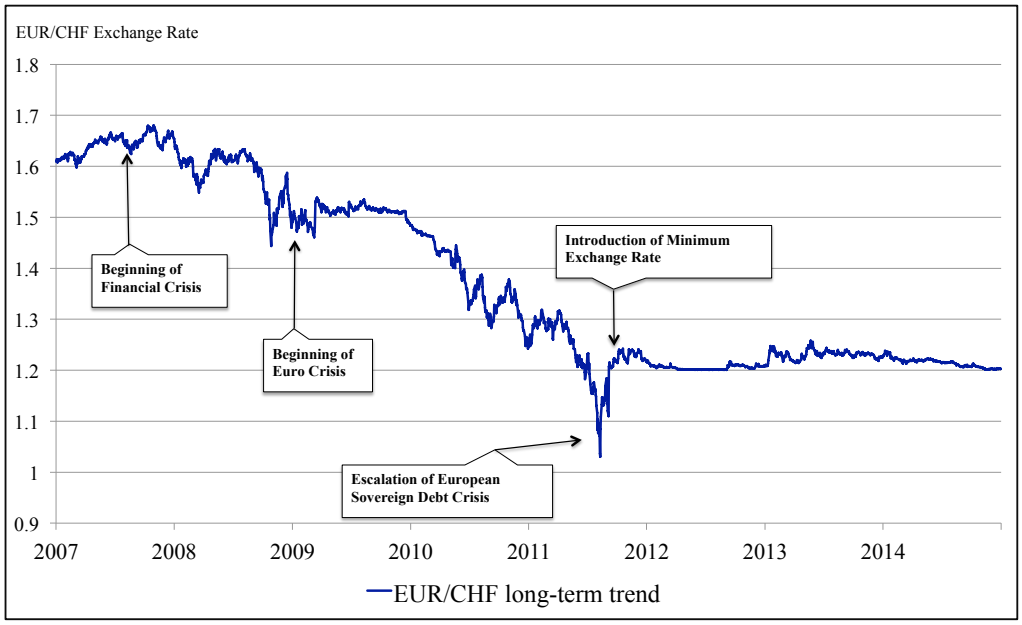
The announcement of the discontinuation was a big surprise to all of the financial

market participants, thus also the reactions on the foreign currency and equity markets were correspondingly strong. This can be seen in Figure 6, which shows the development in the euro/Swiss franc exchange rate after the discontinuation. Usually the SNB tries to avoid surprising the economy, by communicating its intentions credibly and transparently. But the discontinuation of the minimum exchange rate was an exception from this policy for a simple reason - speculation. An announcement, or even a little hint, about the intention to discontinue the peg would have triggered massive speculations against the SNB. Financial participants would have tried to buy Swiss francs for cheap before the discontinuation and sell them after the discontinuation, when the price of the Swiss franc increased. This would have put even more pressure on the Swiss franc and the SNB would have been forced to subsidize these speculations by purchasing even more foreign currency (Zurbrügg, 2015, p. 1-4).

... and the introduction of negative interest rates

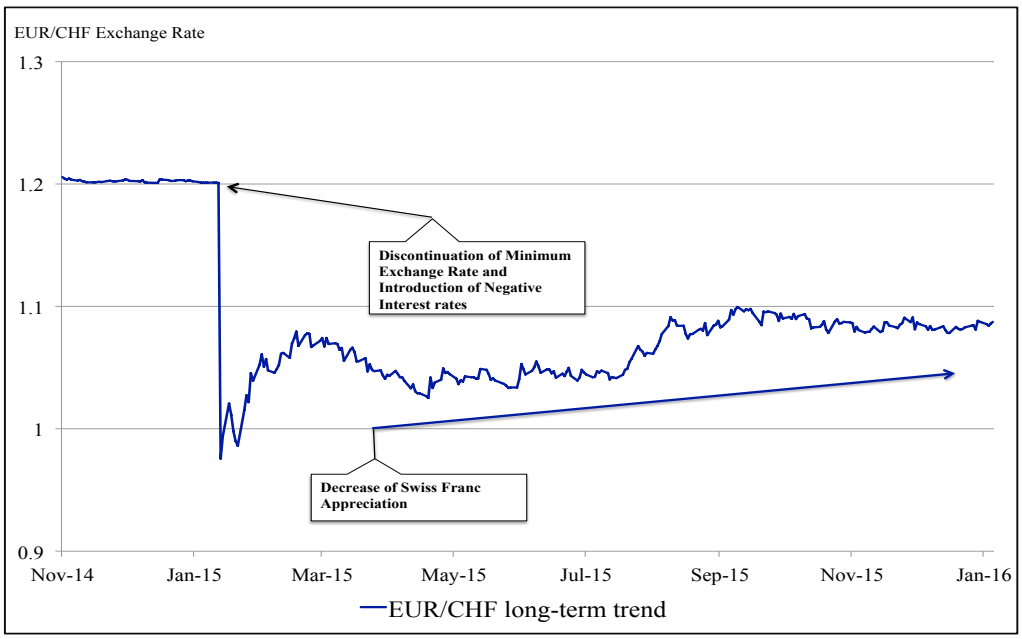
After the discontinuation of the minimum exchange rate, the SNB claimed it would still intervene in the foreign exchange market in order to control monetary conditions. Nevertheless, monetary policy through interest rate steering became again a more important tool (Zurbrügg, 2015, p. 4). On January 15, 2015, at the same time as the decision about the discontinuation was taken, the SNB decided to lower the interest rate on sight deposits by another 0.5%, to -0.75%. At the same time it was moving the Libor range further into negative territory to between -1.25% and -0.25% (Zurbrügg, 2015, p. 4). The main intention of negative interest rates is to make it less attractive to hold Swiss francs, thereby mitigating the upward pressure on the Swiss franc that accelerated since the discontinuation of the minimum exchange rate. In Figure 6 we can see that the appreciation of the Swiss franc has declined since the introduction of negative interest rates, moving away from the initial euro/Swiss franc parity and eventually stabilizing at around 1.1 Swiss francs per euro.

Figure 5: Swiss Franc Appreciation since the Recent Financial Crisis



Source: Bloomberg, adapted from Zurbrügg (2015)

Figure 6: Swiss Franc Development since the Introduction of Negative Interest Rates



Source: Bloomberg

4 Analysis of Swiss Unconventional Instruments

In section 3 we have seen that against the background of the recent financial crisis, the appreciation pressure on the Swiss franc accelerated dramatically so that the implementation of unconventional instruments in Switzerland was inevitable. In this section we will analyse the two main unconventional instruments that the SNB applied, i.e. foreign exchange interventions and negative interest rates.

4.1 Balance Sheet Considerations of the SNB

4.1.1 The Evolution of SNB's Balance sheet

In order to quantify the effects of the SNB's foreign exchange interventions, an analysis of the balance sheet is crucial. In this section we will consider the evolution of the SNB's balance sheet from the onset of the financial crisis in 2007/2008 until today. The consideration of the asset side leads to the following conclusions:

- Figure 7 illustrates the simplified asset side of the SNB's balance sheet. As can be seen from this figure, before the financial crisis impacted the Swiss economy, two items played a major role: repo transactions and foreign currency investments.
- In the first phase of the crisis, in October 2008, we can see a significant increase in repo transactions, as well as swap transactions[e] against Swiss francs, trying to provide the market with liquidity. Moreover, the SNB Stabilization Fund was created with the aim to purchase illiquid assets of the UBS, stabilizing UBS' financial position and thereby strengthening the Swiss financial system (SNB, 2013b).
- Already in 2009 the SNB started to apply outright purchases of assets denominated in foreign currency. During 2009 foreign currency investments increased

[e]A foreign exchange swap is an instrument, where the SNB purchases foreign exchange against Swiss francs with a promise to sell the foreign exchange back to the counterparty for Swiss francs, at a specified date in the future. It is a liquidity providing instrument, comparable to repos, with the difference that the collateral is foreign exchange (Humpage, 2013).

by 50bn Swiss francs and became the most important item on the asset side (Porta, 2011, p. 18-19).

- By 2010 we can see that repo transactions as well as FX swap agreements did not play a role anymore. This means that the SNB stopped providing the market with liquidity through these operations but let them expire. The reason was the first global recovery, mentioned in section 3. At the expiry of FX swap agreements, the commercial bank is obliged to repurchase the previously sold foreign currency from the SNB, which subsequently reduces its sight deposits. The same applies for repos.

- When looking at the balance sheet it is remarkable that since 2010, FX interventions increased sharply. In particular, three massive interventions attract attention:

  1. In May 2010 FX interventions increased by more than 100bn Swiss francs. This is of particular note since, as mentioned in section 3, the SNB was aiming to tighten its monetary policy due to the first global recovery at this time.

  2. In the third quarter of 2011 we can remark a sudden increase in FX investments amounting more than 110bn Swiss francs, evoked by renewed concerns in the euro area.

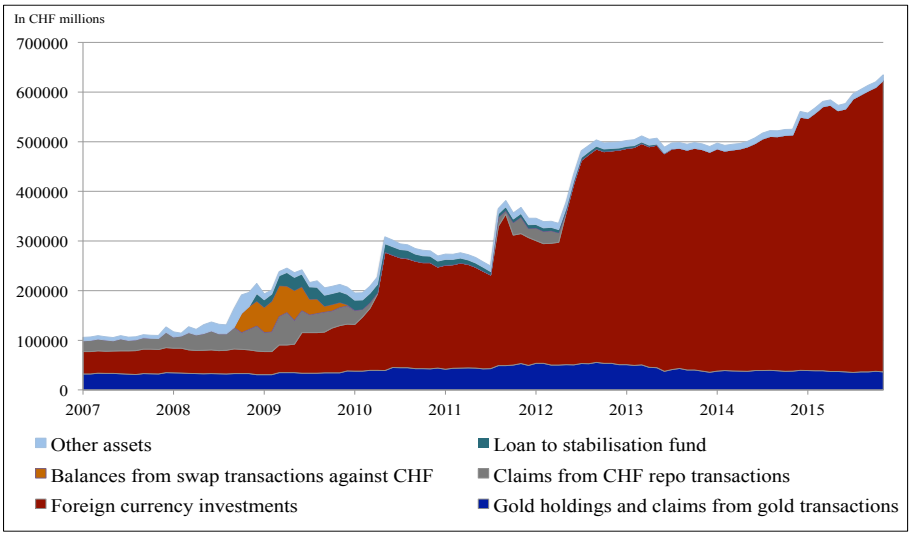
  3. At the peak of the crisis in 2012, we can see renewed FX interventions on a large scale. From May until August 2012, foreign currency investments increased by almost 175bn Swiss francs.

- An interesting observation is that on September 6, 2011, when the SNB introduced the minimum exchange rate, no further FX purchases had to be conducted. Up to this point, foreign currency investments have already been increased by large amounts, so that further monetary easing was not necessary.

- Throughout 2014 the euro/Swiss franc exchange rate remained stable at 1.20 and the SNB did not have to intervene much in the foreign exchange market. Still, in December 2014, we can see once more an increase in FX investments. This was when the ECB announced it may ease conditions further, which made the Swiss franc appreciate again.

- Since the discontinuation of the minimum exchange rate in January 2015, it can be seen that the SNB remained active in the foreign exchange market, however to a much smaller scale than before.
- Overall, since 2007 until end of 2015 foreign currency investments increased dramatically from 45bn Swiss francs up to 580bn Swiss francs.

Figure 7: Simplified Swiss National Bank Balance Sheet: Assets



Source: SNB Data

As we have seen, the SNB's balance sheet has experienced a tremendous increase, particularly due to FX purchases. In order to figure out how these purchases have been financed, we need to have a look at the liabilities side, illustrated in Figure 8.

- It is shown that banknotes in circulation have only slightly increased throughout the years. From end 2008 onwards the main increase in the liabilities side can be noticed in sight deposits of domestic banks. This implies that FX investments have mainly been financed through a creation of money that has been credited to the commercial banks' sight deposits held at the SNB. To verify this assumption, a more detailed look on the impact of the three large-scale FX purchases on sight deposits is needed.

- The consideration of the three large-scale FX interventions gives us the following conclusions:

  1. From mid 2010 onwards, sight deposits did not increase but they decreased to around 30bn Swiss francs and remained at this level until the third quarter of 2011. This means that the SNB sterilized part of its first round of large-scale FX interventions. In order to absorb liquidity it conducted reverse repo operations[f] (Liabilities from CHF Repo Transactions), as well as SNB bills[g] (SNB debt certificates) (Christensen and Krogstrup, 2014, p. 5-6). We can see that already during the short period from June 2010 until August 2010 sight deposits decreased by nearly 50bn Swiss francs. Hence, SNB bills proved to be a useful tool in order to absorb large amounts of liquidity within a short time (Porta, 2011, p. 19). A possible explanation why the SNB sterilized its FX purchases is that the global economic outlook was positive, but the Swiss franc was still overvalued. This is why the SNB was aiming to increase its FX investments, but at the same time wanted to avoid increasing sight deposits to prevent inflation (SNB, 2011a). Since the sterilization did not ease monetary conditions it did not have a significant effect on the Swiss franc (Humpage, 2013). The Swiss franc continuously depreciated from 1.50 Swiss francs per euro in May 2010 to 1.08 in August 2011 (see Figure 5).

  2. Figure 8 shows that in August 2011 sight deposits increased sharply. This implies that the SNB changed its liquidity management and abandoned the sterilization. Therefore, it repurchased SNB bills and conducted unsterilized FX interventions. During August 2011 sight deposits increased by more than 170bn Swiss francs. The Swiss franc that almost reached parity at the beginning of August 2011, depreciated to a euro/Swiss franc exchange rate of 1.18 by end of August 2011 (see Figure 5). Hence, unlike sterilized FX interventions, unsterilized FX interventions proved to have a significant effect on the euro/Swiss franc exchange rate, which is in accordance with the theoretical assumption discussed in section 2.

[f] A reverse repo is a liquidity absorbing instrument, that works conversely as the repo. The SNB sells securities to the counterparty and debits the associated amount from the counterparty's sight deposits, with the agreement to buy the securities back at a later date (SNB, 2015f).

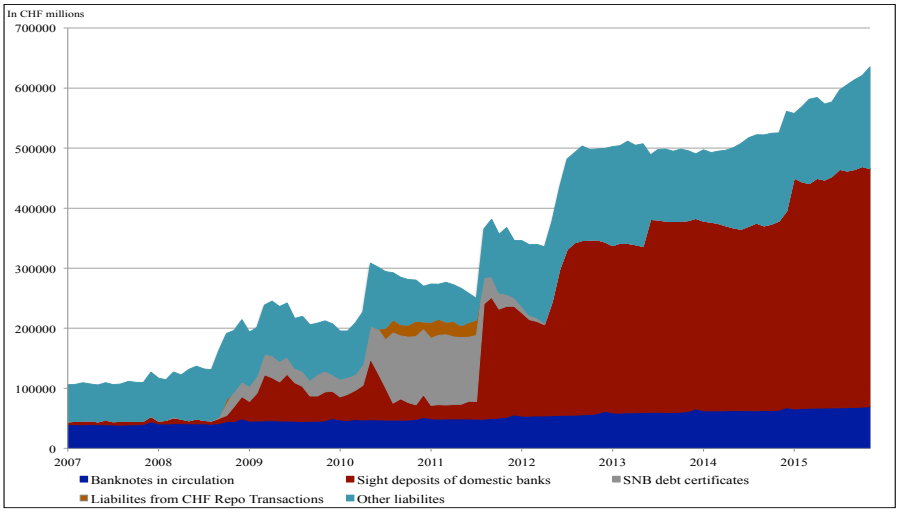
[g] SNB bills are debt certificates issued by the SNB. They are purchased by banks, which therefore reduces their holdings of reserves. They are a frequently discussed tool when considering exit strategies of the expansive monetary policy (Porta, 2011, p. 21).

3. Again in 2012, at the peak of the crisis, sight deposits increased abruptly. From April until August 2012 they increased by more than 135bn Swiss francs. Thanks to these interventions the Swiss franc stood stable at the precise exchange rate of 1.20 Swiss francs per euro, as shown in Figure 5.

- In December 2014, before the discontinuation of the minimum exchange rate in January 2015 was executed, the SNB increased sight deposits by another 60bn Swiss francs through FX purchases. Most likely the expansion was conducted due to the ECB's announcement of further monetary easing, but also as a preventive for the expected subsequent Swiss franc appreciation after the discontinuation of the minimum exchange rate.

- Since the onset of the recent financial crisis, the SNB's sight deposits increased by a hundredfold. Having stood at 4bn Swiss francs in 2007, sight deposits reached an amount of more than 400bn Swiss francs by end of 2015. The total increase of the SNB's balance sheet from 2007 until end of 2015, amounts more than 500bn Swiss francs and the size of the balance sheet exceeds 630bn Swiss francs, which is more than 90% of Switzerland's GDP.

Figure 8: Simplified Swiss National Bank Balance Sheet: Liabilities



Source: SNB Data

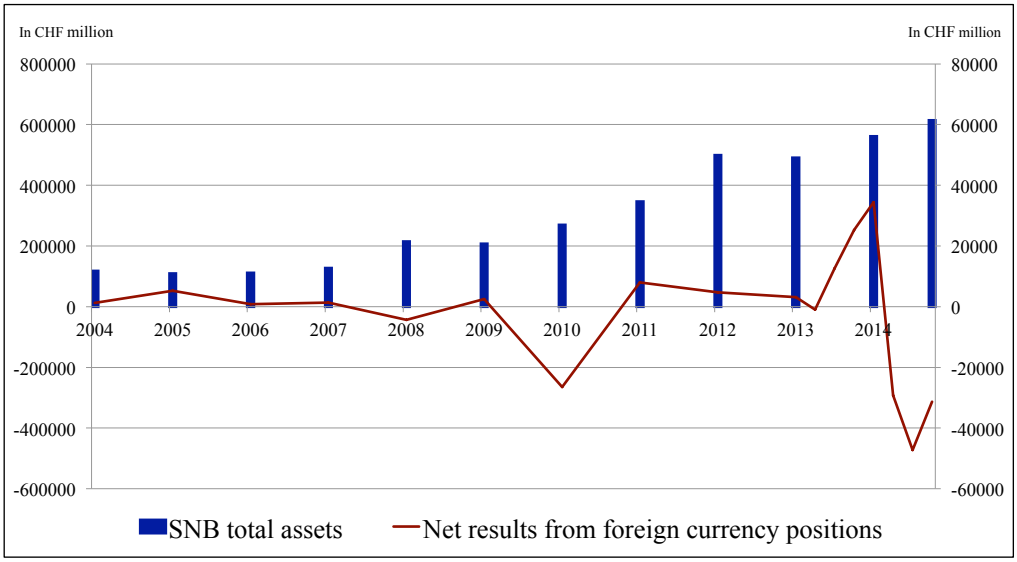
4.1.2 Balance Sheet Risks and the Significance of Negative Capital

We have seen that the SNB's unsterilized foreign exchange interventions were able to weaken the Swiss franc against the euro. Nevertheless, it was also shown that the SNB had to expand its balance sheet dramatically. This expansion changed the structure of the balance sheet and carries significant risks. The asset side of the SNB's balance sheet is mainly consisting of foreign exchange investments and gold reserves, stated at market value and in Swiss francs. Fluctuations in these values have a direct impact on SNB's result. More precisely, if the Swiss franc depreciates, the stated value of the foreign currency investments increases, leading to a profit in the SNB's balance sheet. If the Swiss franc appreciates, the stated value in foreign currency investments decreases, leading to a loss in the SNB's balance sheet. The larger the size of the balance sheet, the larger are also the absolute values of the fluctuations of the result (SNB, 2015g). Figure 9 shows that the SNB's results from foreign currency positions are more volatile (in absolute terms) as the balance sheet expands.

For the first half of 2015, the SNB incurred a provisional loss of 50.4bn Swiss francs. The loss was reported in the interim result as at June 30, 2015 and consisted of a loss on foreign currency positions of 47.2bn Swiss francs and a valuation loss of 3.2bn Swiss francs on gold holdings. The loss incurred due to the discontinuation of the minimum exchange rate which lead to a subsequent appreciation of the Swiss franc and resulted in exchange-rate related losses in foreign currency investments (SNB, 2015a). By the end of the year these losses could be partially compensated thanks to a weaker Swiss franc compared to the first half of the year. Still, the SNB announced an expected loss for 2015 of 23bn Swiss francs. Holding equity capital of 84.5bn Swiss francs, the capital buffer can compensate the loss but it diminishes significantly (SNB, 2015b).

Since the equity capital, which serves as a buffer to absorb potential losses, does not increase proportionally to the size of the balance sheet, there is a certain risk that accumulated losses eventually exceed the equity capital. Since such a situation forces commercial banks or private companies to go out of business, the question arises what negative capital for a central bank means.

Figure 9: Volatility Increase of SNB's Financial Positions



Source: SNB Data

No Liquidity or Solvency Problems

First of all, the main aim of a central bank is to create socially optimal outcomes and not to maximize profits, so that the SNB accepts potential losses. Second, even if from an accounting standpoint a central bank is identical to a commercial bank, holding equity in order to absorb potential losses, it cannot be compared to a commercial bank. The main difference is that a central bank cannot become illiquid. A central bank has a money-issuing privilege and will therefore always be able to meet its liabilities. Since a central bank never faces liquidity problems, even a situation where it suffered a loss that exhausts its capital (insolvency), would not stop it from operating. The creditors can be sure that the central bank will always be able to meet its obligations by printing new money, so that from their perspective it is irrelevant whether the central bank operates with negative capital, or whether it holds an adequate capital buffer in order to absorb losses.

Furthermore, the SNB's liabilities side differs from the one of a commercial bank. It consists mainly of banknotes and sight deposits of commercial banks and other

financial market participants. These positions are not comparable to usual borrowed capital of a commercial bank or private company. There is no interest paid on these positions, there is no determined maturity and the amount of the positions is defined by the SNB. This means that on the main positions of the liabilities side, the SNB has no repayment obligation. Still, there might be positions on a central bank's liabilities side that ask for remuneration, such as SNB bills, i.e. outstanding debt of the SNB. In order to redeem SNB bills, the SNB can simply print money, thanks to its money-issuing privilege, and pay any outstanding debt back by crediting the counterparty's sight deposits with the newly issued money (Jordan, 2011, p. 1-7).

Structural Profit Potential

The SNB has a so-called structural profit potential, meaning that over the long term it generates an income surplus. The SNB's assets are invested such that they generate a return, in the form of interest income and dividends. At the same time, financing these assets is made at very low costs. As already mentioned, the main positions on the SNB's liabilities side are banknotes and sight deposits of banks. Sight deposits are a form of financing that is free of costs, since there is no interest paid on them. Furthermore, the issuance of banknotes costs only a fraction of the nominal value of the created banknotes, which the SNB can invest. Hence, in the long run, the SNB generates profits, also known as seigniorage (SNB, 2015g). According to the National Bank Act, any profits the SNB generates are used to build up provisions, subsequently increasing equity capital or rebuilding equity capital after having suffered losses (Jordan, 2011, p. 8). Over the long term the SNB is therefore able to gradually compensate any incurred losses.

Loss of Credibility and Increase in Inflation

According to the above mentioned arguments, a central bank is able to fulfil its monetary policy tasks even with negative capital. It was shown that any incurred costs can be covered indefinitely thanks to the money issuing privilege. Furthermore, in the long run losses and negative capital can be compensated due to the structural profit potential (Bindseil et al., 2004, p. 23).

However, there are various studies, supported by empirical evidence, that show an inverse correlation between capital and inflation, meaning that with a worsening

capital inflation increases (Stella (1997),(2002); Ernhagen and Vesterlund (2002)). From a macroeconomic point of view, losses of a central bank are then a problem if they endanger the control of monetary targets. For example Stella (1997) argues that the privilege to issue base money does not guarantee long-run profitability and that the accumulated losses lead to inflation. This is explained as follows: In order to cover the incurred losses, the central bank will inject liquidity and expand excess reserves. If this injection is not consistent with the monetary policy it will induce inflation. The excess liquidity could be reduced by issuing debt certificates. Since debt certificates however create expenses, it would put even more pressure on the profitability, so that the bank will be forced to print even more money and the process could continue indefinitely. Stella (1997) concludes that a capital buffer is crucial in order to guarantee price stability.

However, the above reasoning is based on the assumption that the central bank has structural balance sheet problems, not being able to generate profits in the long run. Structural balance sheet weakness is characterized by valuation losses on the asset side, combined with remunerated debt issuance (SNB bills).[h] Hence, the income generated on the asset side diminishes while the expenses increase, so that the structural profit potential does not hold anymore. However, according to Jordan (2011) loosing the structural profit potential would require a significant gap between the income generated on the asset side and the expenses produced on the liabilities side, so that the emergence of such a scenario is very unlikely for the SNB. In 2007, the SNB published 100 years of income statements. The inspection of those statements proves that in normal times the SNB nearly always generates positive profits, so that we can conclude that only due to the exceptional events over the last few years losses incurred (SNB, 2007, p. 71-95). This implies that over the long run the SNB has a structural profit potential and will therefore be able to gradually cover its losses.

Moreover, Bindseil et al. (2004) argue that the empirical findings of an inverse relationship between the central bank's capital and the inflation rate lack an explanation of causality. They show that negative capital is not a concern as such, but leads to increased inflation only under the assumption that prolonged central bank losses

[h] Negative structural profits could be observed in many developing countries. However this fact does not allow us to make an overall conclusion for all central banks, since central banking is highly diverse in its finance. For more details see (Archer and Moser-Boehm, 2013).

lead to a credibility crisis.[i] After a series of capital losses, the public might expect a risk that the central bank might loose the right to work independently and therefore also loose its right to issue legal tender at some point in time. It is likely that the public does not fully trust the theoretical possibility that from an accounting point of view a central bank is able to successfully manage monetary policy while incurring repeated losses. This could undermine its reputation, induce increased inflation expectations, which become a self-fulfilling prophecy and lead to increased inflation today. Also, in order to mitigate the reputational damage as fast as possible, the financially weak central bank could be incentivised to restore its capital through increased inflation. This can be explained as follows: Seigniorage is generated by issuing non-interest bearing currency which can be invested for a positive return. With an increase in inflation, interest rates increase so that the central bank will be able to invest in more profitable assets, while the expenses on the liability side remain at a very low level. Hence, the central bank reaches positive income much faster, at the expense of temporarily higher inflation rates (Bindseil et al., 2004, p. 27-29).

In brief, the only concern of negative capital for the SNB is that its credibility could be questioned by the public, leading to increased inflation. It is key for a central bank to maintain its credibility in order to be able to ensure price stability. Since a capital buffer increases the public's confidence in the central bank to fulfil its mandate, positive capital is favourable, even if from an accounting perspective the SNB is able to conduct its monetary policy with negative capital. Nevertheless, given that nowadays, the main challenge that central banks, and particularly the SNB, face is deflationary threat, increased inflation is desirable. Notably, an increase in inflation would lead to a depreciation of the Swiss franc which would subsequently transmit to significant valuation gains in the balance sheet, compensating all of the incurred losses.[j]

[i] This means however, that there is no direct causal relationship between capital and inflation. I.e. credibility should be positively correlated with the level of capital, which means that the causal relationship exists between credibility and inflation (Bindseil et al., 2004, p. 8).

[j] This fact has implications for the structural profit potential, namely: Only if inflation expectations increase, the issuance of SNB bills will be required, increasing SNB's expenses. But then, the income on the asset side will increase thanks to valuation gains and higher interest rates, so that the SNB generates profits. This reconfirms that the SNB is not exposed to the risk of structural balance sheet problems.

Liquidity Surplus and Exit Strategies

Via huge amounts of foreign exchange purchases the SNB created large excess reserves and put the market in a liquidity surplus. The problem of a liquidity surplus is that the transmission mechanism of monetary policy becomes more difficult. Prior to the financial crisis, central banks provided just enough liquidity to the banking system so that minimum reserve requirements were fulfilled, meaning that reserves were scarce (Berensten et al., 2015, p. 20). If the market is short on liquidity, banks must go to the central bank and borrow on its terms. However, if there is a liquidity surplus, banks do not have to participate in central bank cooperation anymore. Thus, in a liquidity surplus the central bank has less control over interest rates (Gray, 2006, p. 8). When economic conditions improve and a tightening of monetary policy is required, the liquidity surplus causes a major challenge and simulations of different exit strategies are crucial (Rule, 2015, p. 24). In their paper about exit strategies Berensten et al. (2015) examined the question how a central bank can control interest rates in an environment with large excess reserves and what exit strategies can be used. They find that among the available instruments, central bank bills and reverse repos are the most cost-effective tools. Today, the global banking system is found in a structural liquidity surplus, so that further studies in this field are desirable in order to gain more detailed insights of how to overcome its risks.

4.2 Implication of Negative Interest Rates

As already mentioned in section 2, in December 2014, the Swiss National Bank decided to charge negative interest rates on banks' and other financial market participants' sight deposits held at the SNB, and lowered the Libor range into negative territory. In this subsection we will have a look on the implementation of the measure, its transmission mechanism to the financial markets and analyse its potential consequences and side effects.

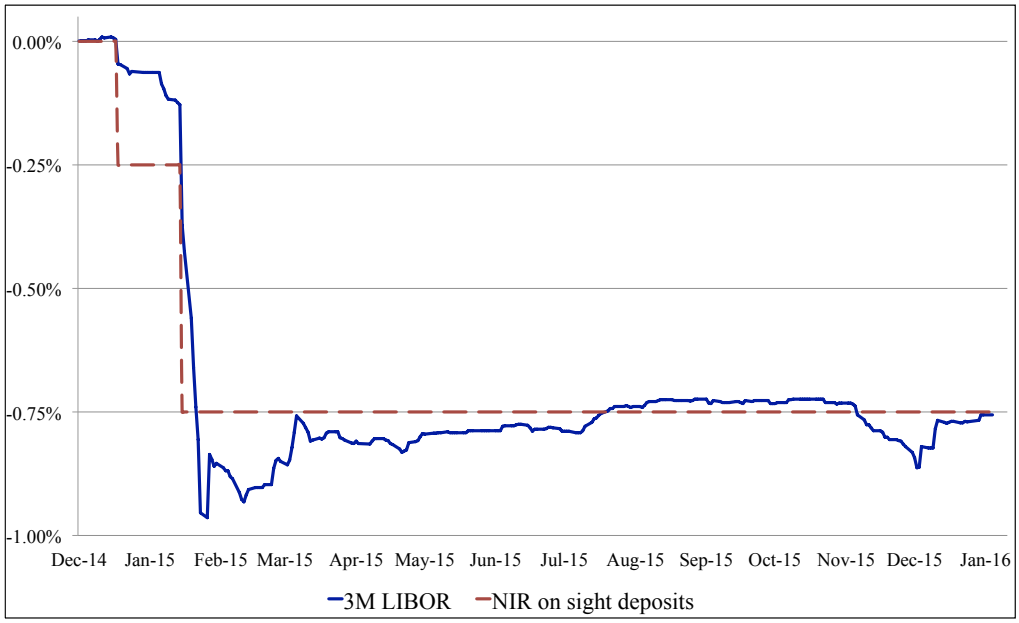
4.2.1 Technical Implementation

In order to produce the desired effect of SNB's monetary policy, negative interest rates are charged on basically all banks' and other financial market participants' sight deposits held at the SNB, following the principle of equal treatment. The SNB defined an exemption threshold, meaning that negative interest rates are charged only on the portion of sight deposits that exceeds this threshold (Moser, 2015, p. 7-8). There are two methods of calculating the exemption threshold. The first method refers to minimum reserve requirements and prescribes an exemption threshold that corresponds to 20 times the minimum reserve requirements. The second method is related to account holders that are not subject to minimum reserve requirements. There, the SNB sets a fixed threshold. Furthermore, no matter what method is applied, there is a minimum exemption threshold, amounting 10mn Swiss francs (SNB, 2014b). Taking into account the enormous expansion of sight deposits within the last few years, the SNB decided to set a large exemption threshold. Another reason why such a large threshold was set, is that negative interest rates should primarily affect newly created Swiss franc liquidity, reflecting the idea of marginal costs of negative interest rates (Moser, 2015, p. 7-8).

4.2.2 Impact on the Swiss Financial Market

The negative interest rate charged on sight deposits eventually transmitted to the Swiss financial markets. As shown in Figure 10, it had an immediate effect on the three-month Libor. Since the first announcement of negative interest rates of -0.25% on December 18, 2014, we can see that within few days the Libor was moving into negative territory. On January 15, 2015, when the SNB decreased the interest rate further to -0.75%, the Libor was also moving further downwards towards this level. This transmission can be explained as follows: Since a commercial bank is charged for holding liquidity at the SNB, it is willing to lend this money out to another bank, even for a negative interest rate. This means that a bank is willing to pay when giving out a loan to another bank, as in any case it is charged for holding liquidity. This moves the Libor into a negative range (Quora, 2015).

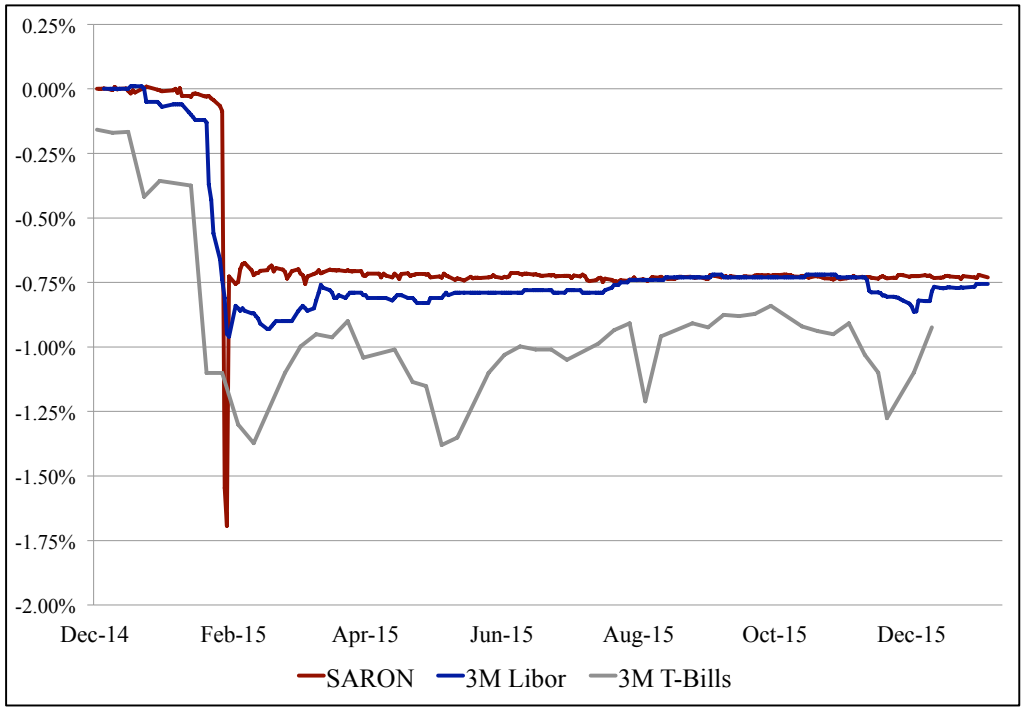
Figure 10: Transmission: From Negative Interest Rates on Sight Deposits to Libor



Source: Bloomberg

Eventually, the measure did not only affect the Libor, but also had an impact on other money market interest rates in Switzerland. As shown in Figure 11, the SARON, which is the base for the Swiss franc yield curve, as well as the three-month T-Bills, i.e. money market debt instruments of the Swiss Confederation, follow the Libor into negative territory. The intuition behind this is the following: Negative interest rates on sight deposits should give banks an incentive to invest their money in alternative assets. Since short-term Swiss government bonds are considered safe and liquid assets, they can be seen as a substitute for the banks' sight deposits. If banks start buying these short-term bonds, the demand increases, which puts some upward pressure on the prices of these bonds and leads to decreasing yields. Also, negative policy rates, i.e. the Libor, are a benchmark for short-term borrowing costs throughout the economy, so that short-term market rates on government bonds should follow negative policy rates (Worldbank, 2015, p. 5).

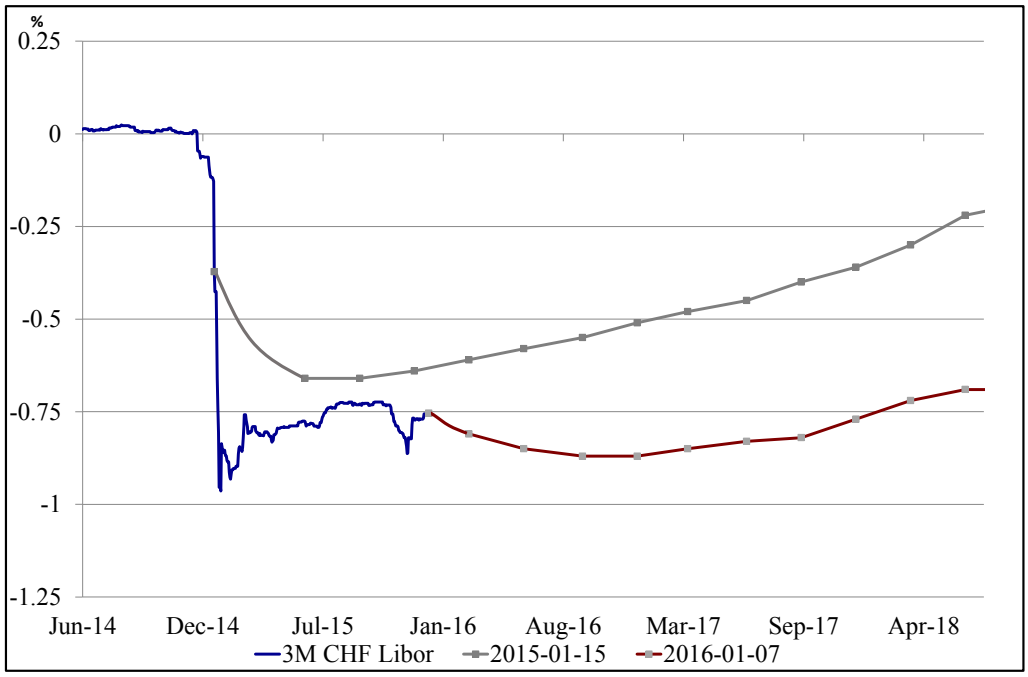
Figure 11: Transmission: From Libor to Money Market Rates



Source: Bloomberg

After the introduction of negative interest rates, market expectations about the SNB's future monetary policy stance changed. This can be interpreted from the futures contracts of the three-month Libor, shown in Figure 12. On January 15, 2015, when the negative interest rate was lowered to -0.75%, the market expected the Libor to remain persistently well below zero. One year later, on January 7, 2016, the curve of the 3-month Libor futures contracts reaches even more negative fields. Hence, the market expects the Libor to get even more negative. The expectations of ongoing lower interest rates finally transmit to long-term interest rates, showed in Figure 13.

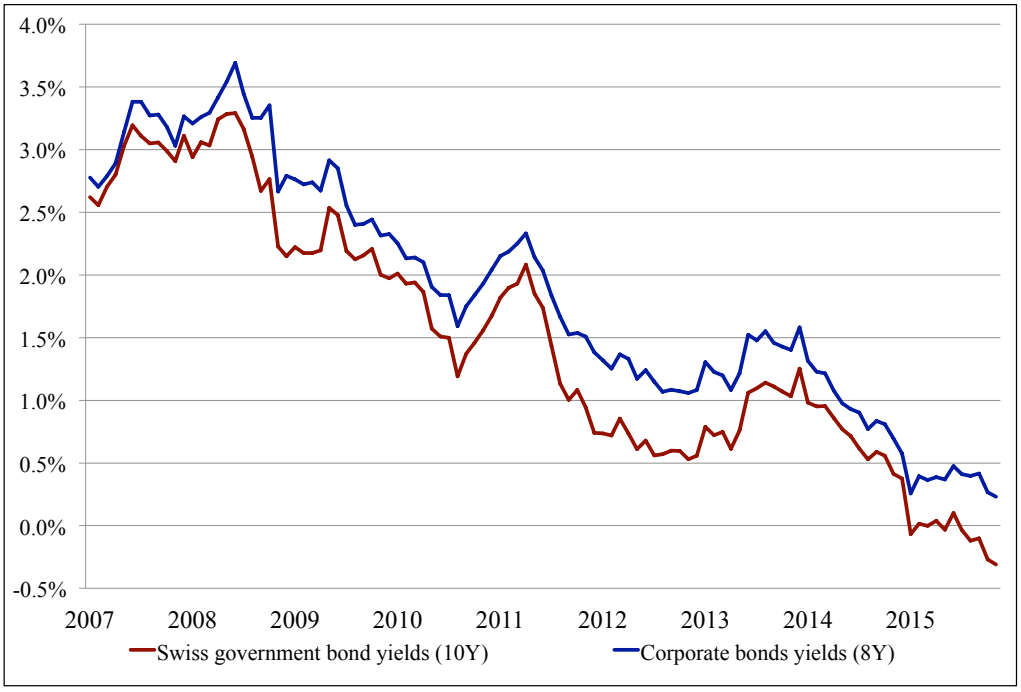
Figure 12: Low for Long: 3M Libor Futures Contracts



Source: SNB Data

Figure 13 shows the decrease of capital market rates in Switzerland. More specifically, we can see that 10-year Swiss government bond yields reached negative territory by 2015. Also, interest rates for long-term corporate bonds declined significantly, but not by as much as government bonds, reflecting the greater substitution opportunities for corporate bond investors (Maechler, 2015, p. 5). Negative yields in Switzerland can be seen as an expression that investors are ready to pay in order to hold the safe and stable Swiss currency. The ECB's extended asset purchase program in January 2015 increased doubts in the euro area once more and caused another surge of investments into low-risk fixed income assets, increasing the demand for Swiss government bonds and lowering yields below zero (Worldbank, 2015, p. 5-6).

Figure 13: Transmission: From Money Market to Capital Market Rates

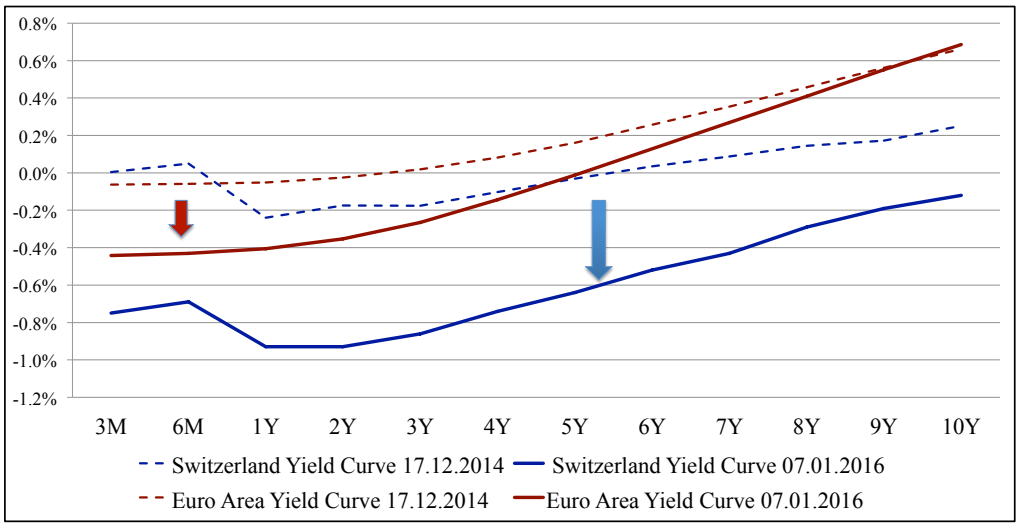


Source: SNB Data

Finally, it was shown that negative interest rates do not only have an impact on short-term but also on long-term interest rates, leading to an overall downward shift of Switzerland's yield curve. Figure 14 shows the two yield curves of Switzerland and the euro area as of December 17, 2014, hence just before the announcement of negative interest rates, and a year later as of January 7, 2016. We can see that not only the yield curve in Switzerland, but also the yield curve in the euro area declined, since also the ECB introduced negative interest rates. Nevertheless, the decline of the yield curve in Switzerland is much larger than the one in the euro area. This means that the interest rate spreads - the difference between the Swiss yield curve and the yield curve of the euro area - increased, making it less attractive to hold Swiss francs throughout all maturities, and eventually counteracting the upward

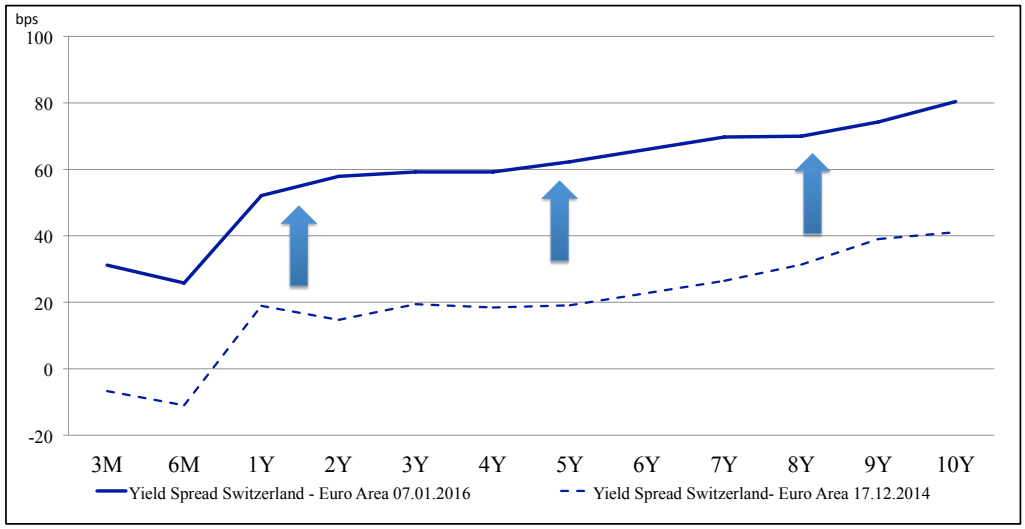
pressure on the Swiss franc (see Figure 15). Previously in the thesis in Figure 6, we could see that the negative interest rate was able to mitigate the upward pressure on the Swiss franc. The euro/Swiss franc exchange rate moved away from its initial parity right after the discontinuation of the minimum exchange rate and stabilized today at 1.1 Swiss francs per euro. Nevertheless, the Swiss franc is still significantly overvalued. According to Maechler (2015) its real effective exchange rate, i.e. the Swiss franc's exchange rate against a basket of currencies of Switzerland's main trading partners, is still 15% above its long-term average. Compared to 2014, when the exchange rate peg was still implemented, the real effective exchange rate was above its long-term average by only less than 10%.

Figure 14: Decrease of Yield Curves



Source: Bloomberg

Figure 15: Increase in Yield Spread



Source: Bloomberg

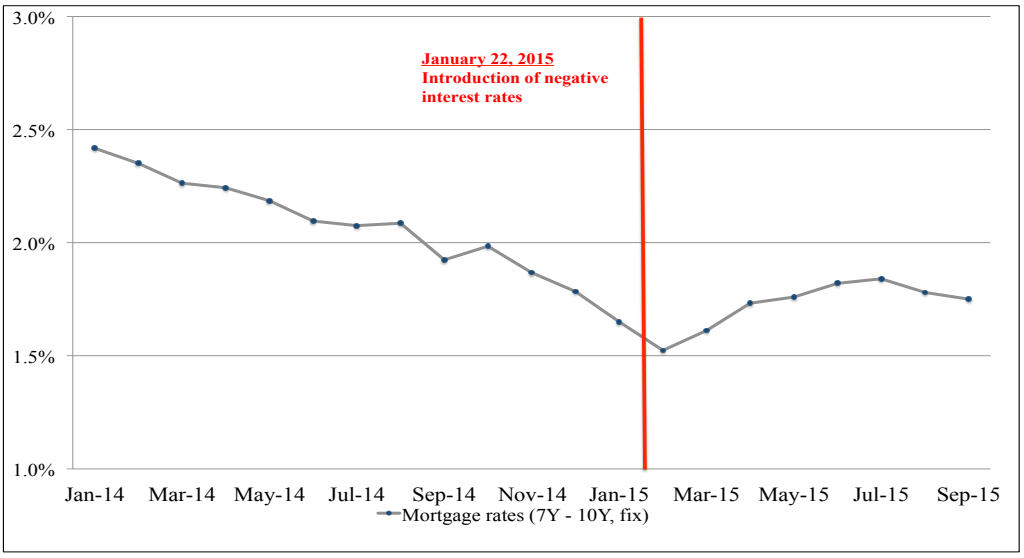
4.2.3 Risks and Side effects

As we could see from the transmission mechanism, negative interest rates lead to an increase of Switzerland's interest rate differential with other countries, mitigating the appreciation pressure on the Swiss franc. However, negative interest rates cause several side effects that need to be considered.

Increased Refinancing Costs and Margin Pressure in the Banking Sector
Since the measure was new to most of the financial market participants, it initially lead to confusion in many treasury departments. Right after the announcement of the introduction of negative interest rates in December 2014, a widely held believe was that mortgage rates need to decrease if the Libor rate decreases. This believe was put into practice and mortgage rates declined. But from February 2015 on, the development changed. As we can see in Figure 16, from February 2015 on,

mortgage rates did not decrease as could have been expected, but they started to increase (NZZ, 2015b). The reason is that, as the Libor gets negative, refinancing costs for banks increase. The explanation is as follows:

Figure 16: Increase in Mortgage Rates due to Increased Refinancing Costs



Source: SNB Data

Due to the historically low interest rate environment, banks today mainly sell long-term mortgages which are financed with short-term deposits. Once interest rates start to rise, the expenses on deposits could exceed the income generated by mortgages. This is what constitutes the interest-change risk that a bank carries. In order to hedge this risk, banks use so-called swap transactions. A swap transaction implies swapping the fixed interest rate on mortgages against a variable interest rate, so that in times when interest rates rise, not only the bank's expenses but also its income increases.

For a better understanding let us consider Figure 17, an example that was published in the NZZ (2015a). Let us start with the swap transaction, i.e. the exchange of a fixed interest rate for a variable interest rate. In this example, the swap transaction

is the agreement to pay a fixed payment of 0.64% (swap rate[k]) and in return, to receive a variable payment of 0.05% (Libor rate) for 10 subsequent years. If the bank sets the base interest rate for the mortgage equal to the swap rate, the base rate and the swap rate neutralize each other. Furthermore, the obtained Libor rate usually moves in line with the interest rate on deposits that needs to be remunerated, so that the deposit rate and the Libor rate cancel out as well. The only remaining component is the margin that the bank adds to the base interest rate on mortgages, so that the interest-change risk is fully hedged.

However, in times of negative interest rates this swap transaction does not work in the same way anymore. As explained above, the swap transaction involves paying the fixed swap rate and in return receiving the variable Libor rate. If the Libor is negative, the commercial bank needs to pay the Libor instead of receiving it. In this example the Libor rate is set at -0.76% and the corresponding swap rate is -0.01%. The costs for the swap transaction therefore amount 0.75%[l]. How to deal with these costs? The bank is unwilling to pass the costs on deposits, to avoid a loss of customers. Thus, the only alternative left for the bank is to pass the costs on mortgages, increasing their base interest rate to 0.75%.

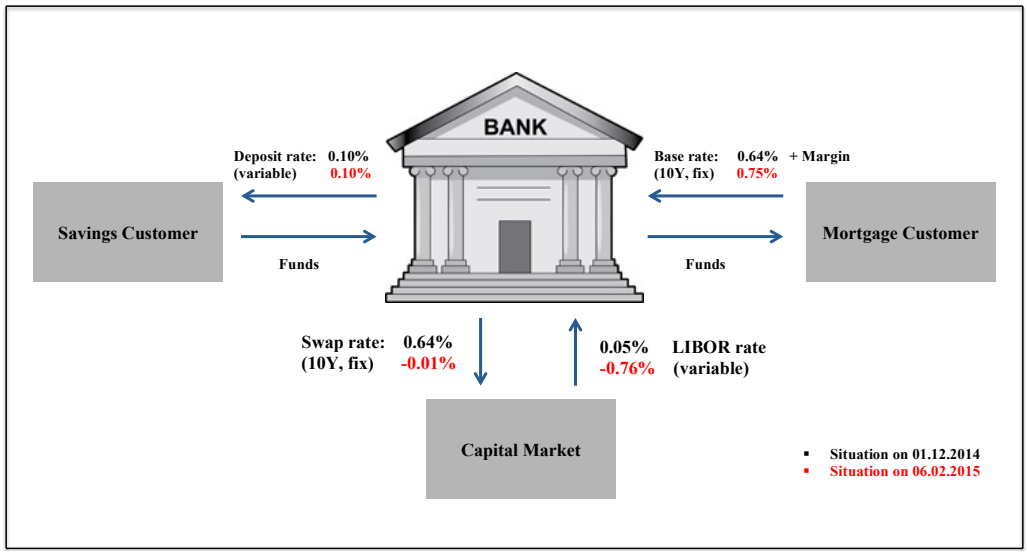
From this simplified example we can see that refinancing costs of a bank and the Libor do not, as could be expected, always move in line. As long as the Libor is above zero, refinancing costs increase when the Libor increases, and they decrease when the Libor decreases. This implies that mortgage rates move in the same direction as the Libor. But as soon as the Libor gets negative, refinancing costs increase again, so that mortgage rates increase as well. Finally, the increased refinancing costs do not only affect newly concluded mortgages but also those who have already been sold before negative interest rates were applied. In many cases the higher refinancing costs diminish the margins on the previously concluded mortgages and cause margin pressure in the banking sector (NZZ, 2015a). If negative interest rates remain over a long period and profitability comes under sufficient pressure it can not be ruled

[k]The swap rate is the rate that is fixed over a defined amount of years (here 10 years) which needs to be paid for the subsequent 10 years, in order to receive the variable three-month Libor for the subsequent 10 years. Therefore it can be interpreted as the corresponding expected "long-term Libor rate" (MATLAB, 2015).

[l]In comparison, the costs for the swap transaction in the situation with a positive Libor rate amounted 0.59% (0.05% Libor that is received subtracted by 0.64%, the swap rate that needs to be paid).

out that banks will try to restore their profitability by allowing deposit rates to fall below zero.

Figure 17: Refinancing of Mortgages



Source: NZZ (2015a)

Cash Holdings

The margin pressure on the banking sector implies that if negative interest rates on sight deposits remain over a long period and continue to decrease even more in the future, banks will increasingly be incentivised to pass the costs on their customers. The customers may be encouraged to hold their savings in cash in order to avoid the charge. If cash withdrawals occurred at a rapid rate, it poses significant risks for the financial system (Bean, 2013). Furthermore, the SNB's monetary policy intentions could not be achieved if investors bypassed negative interest rates with cash holdings (Moser, 2015, p. 9).

However, security, transaction and storage costs act prohibitive for large cash holdings. Several approaches have been studied in order to increase the costs of holding money. The most feasible in the case of Switzerland is the one discussed by Rogoff

(2014), which suggests smaller denominations of a currency. This implies abandoning the issuance of one thousand franc notes. People would need much more notes in order to hold the same amount of money, if the highest face value of banknotes was restricted to, let us say, a 200 Swiss franc note, increasing security and storage costs. Since holding cash is not free of frictions but accompanied with costs, the zero lower bound can be broken. The question is, up to which point interest rates can get negative so that costs of holding cash still exceed the costs of negative interest rates (Riksbank, 2015).

Searching for Returns

Several private and commercial banks in Switzerland already started to pass negative interest rates on large investors, such as pension funds. The direct cost burden from negative interest rates that pension funds need to carry is limited, since the share of liquidity in a pension fund amounts only 5% on average. The main challenge that negative interest rates induce, is that it became much more difficult to find interest-bearing safe investments (Moser, 2015, p. 8). In Switzerland, pension funds are obliged by the Swiss Federal Council to pay a certain interest on the accumulated capital. Negative interest rates make this obligation much more difficult and cause significant pressure, considering that a pension fund's portfolio consists by more than 40% of interest-bearing safe investments.

Despite these negative consequences that affect pension funds, it needs to be mentioned that the supply on fixed-interest assets has always been very limited in Switzerland, so that pension funds have always been forced to invest abroad, no matter what the interest rate in Switzerland was. This implies that, not the measure of negative interest rates as such creates the main difficulty of finding investments that generate a positive return, but the globally low interest rate environment causes the challenge (Swisscanto, 2015, p. 14-19).

Excessive Risk Taking

In the search for positive returns bank and non-bank investors may have an incentive to take excessive risks in their investments. Several studies have shown a negative relation between short-term interest rates and bank risk taking (Altunbas et al. (2010); Dell'Ariccia et al. (2013)). Eventually, greater risk taking could contribute

to the formation of bubbles in asset prices.

5 Discussion

As we have seen, the SNB's toolkit of unconventional instruments, which it can apply in order to tackle the appreciation pressure on the Swiss franc, consists mainly of two instruments: unsterilized foreign exchange interventions and negative interest rates.

It was shown that the interventions in the foreign exchange market have been effective in order to counter the enormous appreciation pressure on the Swiss franc. At the peak of the crisis, the SNB was able to achieve the targeted euro/Swiss franc exchange rate of 1.20 and to hold it for more than three years, by purchasing foreign currency denominated assets on a large scale. Nevertheless, the benefits of these FX interventions were accompanied by an enormous expansion of the SNB's balance sheet. The expansion caused large fluctuations of the SNB's result and the potential losses could reach an amount that exhausts its equity capital. However, we have shown that negative capital is not a concern for the SNB. First, the SNB cannot become illiquid thanks to its money-issuing privilege and will therefore be able to indefinitely cover any incurred costs. Second, the SNB has a structural profit potential that guarantees long-run profitability, so that any losses can be compensated over the long term. One reason why a capital buffer still might be favourable is that it increases public confidence in a central bank to work independently and ensure price stability. A long period of negative capital could undermine SNB's credibility to operate efficiently and induce inflation. However, today's circumstances seek for higher inflation. Moreover, if inflation increases the Swiss franc is likely to depreciate which will lead to significant valuation gains in the SNB's balance sheet. In general it is to say that, once the economy recovers and inflation starts to rise, the Swiss franc will depreciate and the SNB will generate significant profits due to the revaluation of the foreign assets in the balance sheet, so that any incurred losses will be compensated.

Risks from occurring losses in the balance sheet are therefore manageable. The only remaining risk that interventions in the FX market entail is the creation of

surplus liquidity in the market. In a liquidity surplus, central banks have less control over interest rates. Especially when economic conditions improve and interest rates should be increased this causes a major challenge. Currently, a lot of research is being conducted in this field (Berensten et al. (2015) etc.) and central banks around the globe are searching for their optimal exit strategy when monetary tightening becomes required.

The second unconventional instrument which the SNB introduced are negative interest rates, charged on banks' and other financial market participants' sight deposits, held at the SNB. The measure transmitted from short-term to long-term interest rates and proved to decrease Switzerland's yield curve and increase the interest rate differential with other currencies. It helped to mitigate the upward pressure on the Swiss franc to some extent. However, its effects have not been strong enough to offset the existing deflationary threat and the Swiss franc remained significantly overvalued. Therefore, negative interest rates are not a stand-alone measure, but should only be considered as a support for FX interventions.

Furthermore, negative interest rates cause numerous side effects, that need to be considered. First, refinancing costs for the banking sector increase, which results in higher mortgage rates. In the present circumstances however, this effect is rather positive, since it mitigates the strong growth of mortgage lending in Switzerland. Nevertheless, the higher refinancing costs cause margin pressure in the banking sector. If negative interest rates remain over a long period there is a risk that more and more banks will start to restore their profitability by passing the cost burden on their customers and allowing deposit rates to fall below zero. This could imply increased cash holdings if negative interest rates exceed the costs of holding money, imposing negative effects for the financial system if the cash withdrawals occurred at a rapid rate. Also, the SNB's monetary policy intentions could not be achieved, if investors bypass negative interest rates with cash holdings. Furthermore, in the search for positive returns investors may have an incentive to take excessive risk, contributing to the formation of bubbles.

This shows that even if so far, negative interest rates helped to mitigate the Swiss franc appreciation, in the long term its side effects could outweigh its benefits. There are limitations to which extent and over which period negative interest rates can be held without inducing significant substitutions into cash, leading to risks for the

financial system and excessive risk taking. Therefore, it is not a measure that should be held over a long period.

To sum up, the SNB has two measures at its disposal in order to tackle the appreciation pressure. FX interventions proved to be an effective tool and achieved any targeted euro/Swiss franc exchange rate, helping to stabilize Switzerland's economy. But the associated creation of a liquidity surplus in the market created a challenge. However, this could be mitigated by the introduction of negative interest rates that was introduced as a supportive tool and achieved to ease the upward pressure on the Swiss franc, so that the creation of liquidity could be kept within a limit. Thus, so far the interaction of the two measures was a good attempt in order to ease the pressure on the Swiss franc. Nevertheless, negative interest rates are accompanied by significant side effects if they persist over a long period or decrease even more in the future. The risk imposed by FX interventions on the other hand, is likely to be controllable, since a lot of research is conducted to find reliable and efficient strategies to exit the liquidity surplus. Hence, since FX interventions proved to be more effective to tackle the upward pressure on the Swiss franc and carry less risks than negative interest rates, when having to ease monetary conditions further in the future, intensified FX interventions should be preferred over a decrease of negative interest rates.

6 Conclusion

The aim of this thesis is to provide an overview about SNB's unconventional monetary policy and to discuss their effects. We have seen that SNB's unconventional toolkit mainly consists of two instruments: unsterilized foreign exchange interventions and negative interest rates.

It was shown that the interventions in the foreign exchange market have been effective in order to counter the enormous appreciation pressure on the Swiss franc and helped to stabilize Switzerland's economy. The benefits of these FX interventions were accompanied by an enormous expansion of the SNB's balance sheet, that caused increased risks, namely: the potential risk of negative capital and a liquidity surplus. While it could be shown that negative capital is not a concern for the

SNB, the major issue associated with FX interventions, is the creation of a liquidity surplus in the market. Currently, a lot of research to find optimal exit strategies is conducted which could potentially mitigate this risk. Moreover, negative interest rates have been a supportive tool to mitigate the appreciation pressure on the Swiss franc, so that foreign exchange purchases could be kept limited and the risk of the creation of a liquidity surplus could be better kept under control. So far, the interaction of the two instruments was therefore a good attempt to tackle the appreciation pressure on the Swiss franc.

Nevertheless, negative interest rates cause numerous side effects that might impose severe risks if they remain over a long period and get even more negative. That means: There are limitations to which extent and over which period negative interest rates can be held without inducing significant substitutions into cash, leading to risks for the financial system and excessive risk taking. Thus, the insights of this thesis have shown that, when considering future strategies of the SNB to ease monetary conditions, further FX purchases are more effective and carry lower risks than a further decrease of negative interest rates.

To pursue the subject of this thesis further, it would be interesting to analyse alternative approaches the SNB could apply in order to ease monetary conditions. One could consider IMF's (International Monetary Fund) suggestion of foreign currency QE, that prescribes a pre-announced asset purchase program, and analyse its advantages to the past and current FX interventions of the SNB. Also, since SNB's monetary policy clearly targets the valuation of the Swiss franc, it would be interesting to consider an exchange rate target for the SNB, instead of an interest-rate target and compare the two approaches for the Swiss case.

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Plagiatserklärung

Ich bezeuge mit meiner Unterschrift, dass meine Angaben über die bei der Abfassung meiner Arbeit benutzten Hilfsmittel sowie über die mir zuteil gewordene Hilfe in jeder Hinsicht der Wahrheit entsprechen und vollständig sind.
Ich habe das Merkblatt zu Plagiat und Betrug vom 22. Februar 2011 gelesen und bin mir der Konsequenzen eines solchen Handelns bewusst.

Datum: Unterschrift: