The Performance of the ’Interest Rate-Weapon’

A Study on the Long-Run Relationship between STIBOR T/N and the Inflation in Sweden

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ABSTRACT
This study uses an ARDL(p, q)-model to express a long-run relationship between ‘Stockholm Interbank Offered Rate Tomorrow/Next’ and the inflation in Sweden between 2007 and 2016 to see how efficient the ‘interest rate-weapon’ as a monetary policy-tool have been in affecting the inflation. The study shows that no such relationship can be expressed – hence the conclusion that the expectations of inflation are the most important variable affecting the inflation, and that the agents in the Swedish economy have rational expectations and a trust in the central bank of Sweden to reach its target of a 2 percent inflation rate.

Keywords: inflation, official interest rate, STIBOR, expectations, transmission channels
ACKNOWLEDGEMENTS

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1. INTRODUCTION

1.1 Background
Ever since the financial crisis of 2007-08 shocked the Global economy central banks all over the western world have struggled to avoid deflation and keep inflation at a desired level. Sweden is no exception. The conventional method of increasing the inflation in an economy has for many years being done by simply lower the interest rate offered by central banks on their respective interbank market. So did the Federal Reserve – the central bank of the United States – during the early 00’s and so did many central banks in 2008 and 2009.

The Riksbank – the central bank of Sweden – cut their interest rate from 4.25 percent in the middle of October 2008 to just 1.00 percent in the beginning of February 2009. And since then the Swedish Riksbank has decreased their offered interest rate even more, and as of today it is even below zero, at -0.50. But during this period of cutting the interest rate record low the inflation hasn’t increased to a level that has satisfied the Riksbank. Since 1992, when Sweden made a transition from a fixed exchange rate to a flexible exchange rate, the Riksbank’s financial policy was changed from defending the fixed exchange rate to targeting the inflation, keeping it around 2 percent.

Between 1992 and 2007 the Swedish Riksbank managed to control the inflation fairly good, with an average yearly inflation never below zero except during 1998 and with an average yearly inflation never higher than 3 percent except during 1993. But during the aftermath of the financial crisis the Swedish Riksbank have had problems increasing the inflation, with an average yearly inflation below zero for three years in a row, between 2013 and 2015. And in February 2012 Sweden had the lowest inflation rate of all countries in the European Union.

These problems have raised the question if the Riksbank’s ‘interest rate-weapon’ is sufficient enough to keep the inflation at a desired level. Some central banks, such as the European Central Bank, the Federal Reserve and the Bank of England have, during the aftermath of the

3 https://www.scb.se/sv_/Hitta-statistik/Artiklar/Svensk-inflation-lagst-i-EU/
financial crisis, used an unconventional monetary policy known as ‘quantitative easing’ where they have targeted long-term interest rates by increasing the money supply and their balance sheets by buying government and corporate bonds. The Riksbank has also used that method and since 2015 they have bought government bonds during certain periods\(^4\). But still the interest rate-weapon is the most common tool for conducting monetary policy when targeting the inflation.

Therefore this study will look at the connection between the rate of STIBOR T/N and the Swedish inflation to see how much the interest rate-weapon have affected the Swedish inflation during the last ten years – between 2007 and 2016. How has it performed?

1.2 Study objective
This study will examine the theoretical part of the assumptions behind how a change in the official interest rate decided by central banks ultimately will affect the level of inflation as well as trying to express the long-run relationship between the official interest rate set by the central bank in Sweden and the Swedish inflation.

1.3 Problem statement
This study will try to answer the following two questions: (1) how does a change in the official interest rate decided by the Riksbank affect the Swedish inflation and (2) what is the long-run relationship between that official interest rate and the inflation?

1.4 Methodology
This study will use an autoregressive distributed lag model (ARDL) to try to express the long-run relationship between the official interest rate decided by the Riksbank and the Swedish inflation. That is, this study will measure how much an increase of 1 unit in the official interest rate would affect the inflation in terms of \(x\) units in the long-run with the help of an ARDL\((p, q)\)-model as described by Pesaran, Shin & Smith (2001). The ARDL\((p, q)\)-model is chosen since it is the most widely used model to establish such a dynamic causal effect\(^5\).

\(^4\) http://www.riksbank.se/sv/Press-och-publicerat/Nyheter/2015/Riksbankens-kop-av-statsobligationer--hur-fungerar-de/
\(^5\) https://pdfs.semanticscholar.org/f123/9170d645e754ecb1210fb214cbd02255a8b0.pdf
The variables that will be used are the monthly Swedish inflation between 2007 and 2016, taken from the Statistiska Centralbyrån’s (Statistics Sweden) consumer price index, and the monthly averaged Stockholm Interbank Offered Rate Tomorrow/Next (STIBOR T/N) between 2007 and 2016, taken from the Riksbank. The reason why STIBOR T/N is chosen and not the Riksbank’s official interest rate will be discussed later.

1.5 The structure of the thesis
This study will begin by explaining how the ‘interest rate-weapon’ is used in practice as well as explaining the structure of the Swedish interbank market. Then the existing theories on the subject will be presented, starting with the transmission channels in which a change in the official interest rate becomes a change in the inflation, continuing with the IS/MP-model and finishing with the Phillips-curve and a discussion about expectations and the credibility and trust of central banks. After that the empirical analysis is presented, which concludes that it isn’t possible to express a long-run relationship according to the chosen ARDL(1, 1)-model. Finally a finishing conclusion will be presented along with references.
2. THE PRACTICAL USE OF THE ‘INTEREST RATE-WEAPON’

All banks that operate in Sweden are either a full-user of RIX or in collaboration with a full-user of RIX. RIX is an electronic payment system controlled by the Riksbank and all electronic payments and transfers between banks or between the banks’ customers runs through RIX. If a payment or transfer occurs between two customers within the same bank, that bank can easily adjust their customers’ accounts by debiting one account and crediting the other. But if a payment or transfer occurs between two customers with different banks, that debiting and crediting is done in RIX, between the banks’ accounts in the Riksbank. So if Customer A with Bank A transfers money to Customer B with Bank B, Bank A will transfer liquidity from their account in the Riksbank to Bank B’s account in the Riksbank. During one day several billion SEK is transferred between accounts in RIX and at the end of the day some banks will have a surplus on their accounts and some banks will have a deficit, by daily operations made by the Riksbank, the total deficit often equals the total surplus. The Riksbank forces all accounts to be in balance at the end of the day, so those banks with a surplus on their accounts must lend it out, and those banks with a deficit on their accounts must borrow that amount in order to be in balance.

Now they can do that directly with the Riksbank. The interest rate the Riksbank offer for lending out liquidity, against collateral, is their official interest rate plus 0.75 percentage points. So as of today banks can borrow from the Riksbank at a 0.25 percent interest rate. The interest rate the Riksbank offer for receiving any liquidity surplus is their official interest rate minus 0.75 percentage points. So today banks with a liquidity surplus can place their surplus in the Riksbank at an interest rate of -1.25 percent. But instead of doing this via the Riksbank the banks can do it between themselves, where a bank with a surplus can lend to a bank with a deficit. The lending bank will lend at a lower cost than 0.25 percent – benefitting the borrowing bank – and at the same time benefitting themselves since they can place their money and receive a higher interest rate than -1.25 percent. By setting an official interest rate, the Riksbank is actually setting a bottom and a top on the fluctuation of the interest rates between banks on the interbank market because the interest rates will never be higher than

what is offered by the Riksbank and never lower than what is offered by the Riksbank simply because the banks would, if that occurred, lend out or borrow liquidity directly from the Riksbank. And since the borrowing bank would like to borrow at the lowest cost, and the lending bank would like to lend at the highest possible interest rate, the negotiated interest rates between banks on the interbank market are usually near the official interest rate decided by the Riksbank⁷.

These daily negotiated interbank interest rates are the real interest rates that affect the interest rates in the broader economy through the transmission channels, for example the interest rates that the banks are offering for lending money to households and corporations, which affect the cost of borrowing and eventually the aggregated demand that in turn affect the inflation. Therefore this study will use the STIBOR T/N rate instead of the actual fixed interest rate when looking at how well the interest rate-weapon affects the inflation.

STIBOR is short for *Stockholm Interbank Offered Rate* and is the average interest rate based on the interest rates that certain banks within the Swedish interbank market offer to each other for lending out liquidity without collateral at different maturities⁸. T/N is short for *Tomorrow/Next* and is the shortest average interest rate banks offer each other for overnight loans that has to be repaid the next bank day⁹.

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⁹ [http://www.riksbank.se/sv/Penningpolitiik/Att-styra-rantan/](http://www.riksbank.se/sv/Penningpolitiik/Att-styra-rantan/)
3. THEORY

The most fundamental assumption behind the monetary policies of many countries – including Sweden – is the negative relationship between inflation and the decided interest rate offered by the central banks, in Figure 1 represented by a straight negative line between the Swedish inflation and STIBOR T/N. When STIBOR T/N increases, the inflation will decrease, and vice versa. According to the Riksbank, this is possible through the transmission channels in which a change in STIBOR T/N eventually affects the inflation\(^\text{10}\).

3.1 The transmission channels

\[\text{http://www.riksbank.se/sv/Penningpolitik/Prognoser-och-rantebeslut/Hur-paverkar-penningpolitiken-inflationen/}\]
Figure 2 is a translated schematic picture of how the Riksbank’s offered interest rate is intended to affect the inflation through STIBOR T/N and the transmission channels, in this example how an increase in the Riksbank’s offered interest rate, and thereby an increase of STIBOR, decreases the inflation through three different transmission channels\(^{11}\).

Today the Riksbank is not targeting the inflation to decrease it, but to increase it. Therefore the reversed scenario in Figure 2 is relevant, i.e. how a decrease in STIBOR increases the inflation rate through the three different transmission channels.

### 3.1.1 The connection between STIBOR and the market interest rates

As discussed in the background, a change in the official interest rate offered by the Riksbank immediately changes the STIBOR T/N rate. But how is STIBOR T/N related to the interest rates on the market? As seen in Figure 2, an increase of STIBOR leads to an increase in market interest rates, so a decrease of STIBOR leads to a decrease in market interest rates. But which mechanisms make the market interest rates follow the same direction as STIBOR?

First of all it is valid to assume that banks wouldn’t want their profits to decrease just because STIBOR is increasing. Banks’ profits on loans are the differences between the interest rate they pay for liquidity and the interest rate they receive on their loans – their net interest. If STIBOR increases, then banks with a liquidity deficit on the interbank market have to borrow liquidity at a higher cost than before. So if they want to keep the same profit on loans as before – the same net interest – they must increase the interest rates they receive on their loans. By doing so, the market interest rates have increased.

If STIBOR is decreasing, then the banks’ profits on loans will increase. They can leave it there but due to competition banks can now decrease the interest rates on their loans and still have the same profit on loans as before, and by offering lower interest rates than other competitors, take new market shares. To avoid losing market shares other banks will also decrease their interest rates, hence making the market interest rates decrease.

Another mechanism could be the demand for government bonds. If STIBOR is increasing, banks might want to lend out their liquidity surplus on the interbank market to other banks or placing it in the Riksbank instead of buying government bonds with a lower interest rate. This might decrease the demand for government bonds and thereby increase the interest rates received from government bonds, hence increasing market interest rates. If STIBOR is decreasing, banks might want to buy government bonds with higher interest rates than they receive if they lend out liquidity on the interbank market or placing it in the Riksbank. This will increase the demand for government bonds and hence decrease its interest rates, making the market interest rates decrease.

3.1.2 The credit channel

As seen in Figure 2, an increase in market interest rates or an expected increase in market interest rates leads to a lower expected profitability in businesses, and reversed a decrease in market interest rates leads to a higher expected profitability in businesses. That is because the price of household and company debt is changing due to the market interest rates. A higher interest rate means a higher price for debts and thereby a lower amount of money to consume for, and vice versa. This will also affect the availability of credit for companies. If people have a lower amount of money to spend on consumption, it wouldn’t be lucrative to invest in businesses, hence investments will decrease, and increase if people have more money to spend.

Another reason for companies to have harder or easier access to credit with more or less investments – if the market interest rates are changing – is something a fourth transmission channel might explain. Ugai (2007) talks about the “portfolio balance channel”, a transmission channel where investors, in order to keep the same return on their portfolios as before, have to rebalance them whenever there is a change in market interest rates. So if there is a decrease in market interest rates, investors with a large portfolio of government bonds now receive a lower return on their total portfolio unless they rebalance it, for example, with corporate bonds. This should increase the demand for corporate bonds, hence making it easier for businesses to get access to credit and investments. However, Ugai (2007) also states that investors could be indifferent between liquidity and assets, meaning that they will just hold their amount of previous government bonds in cash rather than buying corporate bonds.

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making the portfolio balance channel not a reliable assumption. Thornton (2014) couldn’t find any evidence suggesting the “portfolio balance channel” worked when the Federal Reserve purchased assets in order to reduce long-term interest rates on bonds, i.e. the investors didn’t rebalanced their portfolios as the portfolio balance channel suggests.

Mishkin (1996) also mentions the “bank lending channel”, which is a theory based on IS/LM where the central banks increase or decrease the money supply in order to conduct monetary policy by targeting $Y$, i.e. the GDP level. The basics of the bank lending channel is that when a central bank increases the money supply, the bank deposits will increase and thereby the amount of loanable funds will increase, which will decrease the interest rates and increase bank loans and thereby give credit to companies.

However this theory could be valid even when not based on the IS/LM-model where central banks target $Y$ by changing the money supply. In an ordinary demand- and supply curve there will always be a new equilibrium with a higher amount of $X$ no matter if one increases the supply or decreases the price. If $X$ are to be considered the amount of given credit, $X$ will increase either by increasing the supply (expansive monetary policy in the IS/LM-model) or by decreasing the price (expansive monetary policy when targeting the inflation by changing the interest rates offered by central banks). Hence a decrease in STIBOR T/N should lead to an increase of credit because of a new equilibrium on the money market with a decreased price on money. And this is something we have seen in Sweden during the past years where the amounts of credit to households and companies have expanded rapidly.

### 3.1.3 The interest rate channel
As seen in Figure 2, an increase in market interest rates or an expected increase in market interest rates leads to a lower consumption and a decrease in investments which in turn decrease the aggregated demand that will pull down the inflation. That is also something that is based on the IS/LM-model since the IS/LM-model says that investments will decrease or increase, dependent on the level of the interest rates. If the interest rates increase, the IS/LM-model says that investments will decrease because it is then more profitable to save the money, but if the interest rates decrease, investments will increase because it is then not more profitable to just save the money. According to Mishkin (1996) housing and consumer durable spending could be seen as investment decisions, therefore spending on consumption
will also decrease if market interest rates increase. And if the market interest rates are decreasing, investments – in both businesses and consumptions – will increase.

Mishkin (1996) also states the importance of the “expectations hypothesis of the term structure”, which is an hypothesis that the short-term nominal interest rates that are manipulated by the central banks affect not just only the real short-term interest rates but also the real long-term interest rates because the real long-term interest rates are said to be an average of the expected future short-term interest rates. Investments and consumptions are thought to be dependent on the real long-term interest rate, hence the importance of this expectations hypothesis. This is, according to Mishkin (1996), the reason why a central bank still can reduce real long-term interest rates even if the nominal short-term interest rate has reached its bottom of zero.

3.1.4 The exchange rate channel

As seen in Figure 2, an increase in market interest rates increases the exchange rate, meaning that foreign currency will be cheaper relative to domestic currency. This channel is yet again derived from the IS/LM framework, more specifically the Mundell-Fleming model with a Foreign Exchange-curve into the IS/LM-model. This model states that if the market interest rates in a small open economy like Sweden increases above the equilibrium on which the foreign interest rates are at, foreign investors will place their capital in financial assets linked to the Swedish interest rate. Hence they will buy Swedish currency and sell foreign currency, which will increase the price on the Swedish currency, making the foreign currencies cheaper. This will decrease the real price of import and increase the real price of export. A decrease in real import prices decreases the inflation, and according to the IS/LM-model a decrease in the net exports of a country decreases its aggregated demand, which in turn further decreases the inflation.

3.2 The IS/MP-model

So far this study have been referring to the IS/LM-model when describing the transmission channels but as stated before, the assumption of the IS/LM-model is that central banks are targeting the money supply by buying or selling government bonds and other treasuries when conducting monetary policies. In most countries, including Sweden, the central banks do not normally target the money supply – unless they for example are conducting a ‘quantitative
easing'-program – when trying to influence the inflation but rather just setting an offered interest rate, with the aim of manipulating the short-term interest rates between banks on the interbank market. Therefore Romer (2000) has developed another model derived from the IS/LM-model but without the LM-curve. Instead he introduces the Monetary Policy-curve, calling it the IS/MP-model. He assumes central banks do not target the money supply but instead follow a real interest rate rule. The result is a model that, according to Romer (2000), is better on showing the relationship between the aggregate demand, output and inflation.

![Figure 3](image)

In Figure 3 we can see a straight horizontal MP-curve, indicating that a central bank controls the real interest rate in an economy and that the real interest rate is a function of the inflation. The inflation determines the outcome of the real interest rate which in turn is the outcome of the monetary policy. The output in the economy will then be the intersection between the real interest rate and the IS-curve.
So if the Swedish economy was in point A before the bankruptcy of the investment bank Lehman Brothers and the great outburst of the financial crisis, the economy went down to point B after the financial crisis, where there was a drop in inflation, and hence a drop in the real interest rate as a result of the Swedish Riksbank’s monetary policy in reducing their official interest rate. In point B, the aggregate demand has risen due to the decrease in prices and the Riksbank’s monetary policy have decreased the real interest rate and hence made the economy move down the IS-curve, reaching a higher level of output, with the assumption that the immediate impact of an increase in aggregate demand affect the output.

Assuming that the Swedish economy was in a long-run equilibrium at point A, where output was at its trend level, the output in the Swedish economy would then be above its trend level in point B. Romer (2000) then introduces another straight horizontal line which intersects with the AD-curve and calls it the Inflation Adjustment-curve, representing the aggregate supply. The reason it is horizontal is because of the assumption that inflation is given at any point in time. The intersection between the aggregate demand and the IA-curve is in point B, where output is above its trend level. According to Taylor (1993), inflation should rise when output is above its trend level, so at point B, the inflation increases and the producers in the production of the economy adjusts to that, hence shifting up the IA-curve and making the economy move upwards the aggregate demand-curve, reducing output back to its trend level at point A with the same inflation rate as before.

### 3.3 The Phillips Curve

Another important variable when it comes to affecting the inflation is, as can be seen in Figure 2, expectations of inflation. The Phillips Curve shows the negative relationship between inflation and unemployment in the short-run. In Figure 4 we can see the equilibrium between aggregate demand (AD) as a function of prices and short-run aggregate supply (SRAS) at a specific price level. Assuming now that the equilibrium is where GDP is at its potential level – at point A in Figure 4 – a change in inflation would either shift the AD-curve up or down, intersecting with the SRAS-curve either below or above the potential GDP-level (Fregert & Jonung, 2005).

If the inflation would go down, the AD-curve would shift down to point B in Figure 4 and real wages would go up, increasing the real cost of labor that would force companies to discharge
workers which would lower production and increase unemployment; turning GDP below its potential level. If the expectations of inflation also would go down, the Short-Run Phillips Curve (SRPC) wouldn’t shift up as easily as it would if the expectations of inflation were unchanged when a central bank responded to the decrease in inflation by an expansive monetary policy. As seen in Figure 5, a shift upwards to an inflation rate at the targeted level of 2 percent would take much longer – reducing the inflation even more – if the expectations of inflation were changed due to the drop in inflation; therefore it is so important that the expectations of inflation are at the targeted level of 2 percent. These expectations will only correspond to the targeted level of 2 percent if the central bank has the credibility and trust of the people that it could stabilize the inflation around 2 percent (Fregert & Jonung, 2005).

![Figure 4](image1.png) ![Figure 5](image2.png)
This study uses two sets of data, a data set with the measured monthly change in the inflation on a yearly basis – taken from SCB’s Consumer Price Index between 2007 and 2016\(^{13}\) – and a time-averaging data set with a monthly averaged STIBOR T/N rate aggregated from daily data between 2007 and 2016\(^{14}\).

The aim of this study is to measure the effect of STIBOR T/N on the inflation rate to see how efficient the ‘interest rate-weapon’ is at keeping the inflation at the targeted level of 2 percent. Because these two variables are time series – meaning that the data are collected for each entity over time – a cross-sectional data analysis would be insufficient (Stock & Watson, 2015). Instead this study will use an autoregressive distributed lag model (ARDL) to express the long-run relationship between the average STIBOR T/N-rate and the inflation. That is, this study will measure how much an increase of 1 unit in STIBOR T/N would affect the inflation in terms of x units in the long-run. In other words, how much the inflation in the long-run would be affected by a 1-unit change in STIBOR T/N. The ARDL-model is the most widely used model to establish such a dynamic causal effect of one variable onto another variable and is used in a variety of studies and theses. Therefore it will also be used in this study.

When dealing with time series data trying to express a dynamic causal effect it is very important to adjust for seasonality. For example, the prices – and thereby the inflation – should rise just before Christmas and dip right after Christmas Eve. That is normal and has nothing to do with the overall trend in the inflation and must therefore be adjusted for. Unfortunately the student version of Eviews that this study is using does not support the function for adjusting the data with respect to seasonality. Instead two regressions are ran, first with inflation as the dependent variable and then STIBOR T/N as the dependent variable, along with twelve dummies – representing every month – as the independent variables using the following command: “ls VARIABLENNAME @expand(@monthly)”. The residuals from every observation in these two variables are then to be seen as the de-seasonal data.


When plotting these two new de-seasonal data variables one can see that there are no over-all trends in either of them. Hence it won’t be necessary adding a trend-variable when running the ARDL-model in Eviews so the following function is used:

\[ \Delta \text{Inflation}_t = \alpha_0 + b_0 \text{Inflation}_{t-1} + b_1 \text{STIBOR}_{t-1} + \sum_{i=1}^{i_{\text{max}}} c_i \Delta \text{Inflation}_{t-i} + \sum_{j=0}^{j_{\text{max}}} d_j \Delta \text{STIBOR}_{t-j} + \epsilon_t \]

Now the first thing to look at is whether or not these variables are stationary. If a time series is not stationary, that is, if the mean and variance for a series is not constant over time, the regularly OLS estimators are wrong (Stock & Watson, 2015). The long-run relationship between two variables that are non-stationary in their levels could also be spurious unless they are cointegrated, that is, unless the two variables together with their coefficients \(aX + bY\) are stationary in their levels (Engle & Granger, 1987).

Non-stationarity will occur if a series has some kind of trend, either deterministic or stochastic. A deterministic trend is a nonrandom function of time and its future outcomes are based on previous time periods. A stochastic trend is a trend that varies over time, either by a period of increase or by a period of decrease, and its outcome could sometimes be random (Stock & Watson, 2015). However, according to Pesaran & Shin (1997), it is possible to have non-stationarity and still run an ARDL-model if the non-stationarity is not in the first-difference of the series, i.e. that the series are either I(0) or I(1), meaning that the order of integration has to be at least 1. That is, it is still possible to run an ARDL-model if the
minimum number of differences in order for the variable to be stationary are 1. If a series is I(2), i.e. the minimum number of differences is two, the results will be inadequate.

If a series has a trend, a unit root test for trend has to be conducted. To test if there is a unit root with trend in the levels of these two series, a hypothesis test using the augmented Dickey-Fuller test for a unit autoregressive root with the following hypotheses will be used:

\[
    H_0: \text{Has a unit root} \\
    H_1: \text{Has no unit root}
\]

When testing for a unit root with trend in the levels of the series one gets the following results in Eviews:

**Inflation:**

<table>
<thead>
<tr>
<th>Null Hypothesis: INFLATION has a unit root</th>
<th>Exogenous: Constant Linear Trend</th>
<th>Lag Length: 0 (Automatic - based on SIC, maxlag=12)</th>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>-1.520275</td>
<td></td>
<td>0.173</td>
<td></td>
</tr>
<tr>
<td>Test critical values:</td>
<td>1% level</td>
<td>-4.030983</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5% level</td>
<td>-3.448021</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10% level</td>
<td>-3.149135</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


**STIBOR:**

<table>
<thead>
<tr>
<th>Null Hypothesis: STIBOR has a unit root</th>
<th>Exogenous: Constant, Linear Trend</th>
<th>Lag Length: 2 (Automatic - based on SIC, maxlag=12)</th>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>-2.413879</td>
<td></td>
<td>0.3705</td>
<td></td>
</tr>
<tr>
<td>Test critical values:</td>
<td>1% level</td>
<td>-4.038365</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5% level</td>
<td>-3.448881</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10% level</td>
<td>-3.146521</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


The augmented Dickey-Fuller test statistic is smaller in absolute terms than the test critical value at the 10% significance level for both variables; hence one cannot reject the null
hypothesis that the series has a unit root with trend. This could be problematic unless the series are cointegrated, which will be tested later.

When testing for a unit root with trend in the first-differences of the series one gets the following results in Eviews:

**Inflation:**

Null Hypothesis: D(INFLATION) has a unit root  
Exogenous: Constant, Linear Trend  
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

<table>
<thead>
<tr>
<th></th>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>-5.654848</td>
<td>0.0000</td>
</tr>
<tr>
<td>Test critical values:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1% level</td>
<td>-4.038365</td>
<td></td>
</tr>
<tr>
<td>5% level</td>
<td>-3.448081</td>
<td></td>
</tr>
<tr>
<td>10% level</td>
<td>-3.149521</td>
<td></td>
</tr>
</tbody>
</table>


**STIBOR:**

Null Hypothesis: D(STIBOR) has a unit root  
Exogenous: Constant, Linear Trend  
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

<table>
<thead>
<tr>
<th></th>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>-4.963264</td>
<td>0.0004</td>
</tr>
<tr>
<td>Test critical values:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1% level</td>
<td>-4.038365</td>
<td></td>
</tr>
<tr>
<td>5% level</td>
<td>-3.448081</td>
<td></td>
</tr>
<tr>
<td>10% level</td>
<td>-3.149521</td>
<td></td>
</tr>
</tbody>
</table>


Here the augmented Dickey-Fuller test statistic is larger in absolute terms than the test critical value at the 1% significance level for both variables; hence one can reject the null hypothesis and conclude that these series are stationary with no trends in their first-differences, that is, these series are I(1) and we can then continue to estimate the ARDL-model.

To avoid heteroscedasticity, i.e. that the error term ($\varepsilon_t$) varies over time, heteroscedasticity- and autocorrelation-consistent standard errors (HAC) will be used. The most common way is to use the Newey-West variance estimator when estimating the HAC-standard errors so therefore that estimator will be used in the function. The number of lags on both the dependent and the independent variable will be decided using the Akaike information
criterion (AIC). Running that regression in Eviews with HAC-standard errors gets the following result:

```
Dependent Variable: INFLATION
Method: ARDL
Date: 02/01/18  Time: 18:22
Sample (adjusted): 2007M04 2016M12
Included observations: 117 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors: (4 lags, automatic): STIBOR
Fixed regressors: C
Number of models evaluated: 20
Selected Model: ARDL(3, 1)
```

The next thing to look for is autocorrelation to see if the variables are dependent of its own values in its previous periods. The Breusch-Godfrey Serial Correlation LM test in Eviews has the following hypotheses:

\[ H_0: \text{No serial correlation} \]

\[ H_1: \text{Serial correlation} \]

When performing that test in Eviews with a maximum lags of 2 included one get the following result:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>INFLATION(-1)</td>
<td>0.855873</td>
<td>0.079382</td>
<td>10.90769</td>
<td>0.0000</td>
</tr>
<tr>
<td>INFLATION(-2)</td>
<td>0.220473</td>
<td>0.129161</td>
<td>1.706700</td>
<td>0.0907</td>
</tr>
<tr>
<td>INFLATION(-3)</td>
<td>-0.155102</td>
<td>0.126745</td>
<td>-1.302632</td>
<td>0.1954</td>
</tr>
<tr>
<td>STIBOR</td>
<td>0.832857</td>
<td>0.231866</td>
<td>3.506760</td>
<td>0.0002</td>
</tr>
<tr>
<td>STIBOR(-1)</td>
<td>-0.853839</td>
<td>0.235305</td>
<td>-3.827255</td>
<td>0.0004</td>
</tr>
<tr>
<td>C</td>
<td>0.025977</td>
<td>0.030480</td>
<td>0.852253</td>
<td>0.3959</td>
</tr>
</tbody>
</table>

*Note: p-values and any subsequent tests do not account for model selection.
The probability that the null hypothesis is true is very large (51.90 percent), hence one cannot reject the null hypothesis and therefore the conclusion is that there are no serial correlations in the variables.

To test if the model is mis-specified – and that a non-linear combination of the explanatory variable is better off explaining the dependent variable – a Ramsey Regression Equation Specification Error Test (RESET) is used with the following hypotheses:

\[ H_0: \text{No mis-specified} \]
\[ H_1: \text{Mis-specified} \]

When performing that test in Eviews with 2 numbers of fitted terms one get the following result:

Once again we can’t reject the null hypothesis since the F-statistic (0.699064) is larger than 0.05. The conclusion is therefore that there are no mis-specifications in the model.

To look for any large changes in the mean level of the time series, a cumulative sum control chart (CUSUM) is used. When performing the CUSUM-test in Eviews one gets the following result:
The mean of the series is within the 5% significance level which is what is required for it to be statistically significant.

To see if there are any structural breaks in the series, that is to see if there are any huge changes in the variables that might affect the estimated relationship, a CUSUM-squared test is also conducted. When performing the CUSUM-squared test in Eviews one gets the following result:
The CUSUM-squared test shows us that there in fact is a structural break since some of the observations are outside of the 5% significance level. To avoid this break a dummy variable can be included into the function to divide the sample into two different subsamples, one before the break and one after. In that way the estimated relationship won’t be wrong since the estimation won’t combine the two subsamples (Stock & Watson, 2015). When creating that binary variable, a date at the beginning of the break is used, hence the dummy equals 1 at 2010M02, i.e. February of 2010.

Adding that dummy (called dummy1) into the function gives us the following ARDL-model in Eviews with HAC-standard errors, a lag length based on AIC and with no trend:

![Eviews ARDL model output](image)

Repeating the tests of serial correlations and mis-specifications the F-statistics shows us that we cannot reject the null hypotheses that there are no serial correlations and no mis-
specifications – hence the conclusion that we still don’t have any correlations or mis-specifications. The CUSUM-test shows us that the mean are still in the 5% significance level.

When performing the new CUSUM-squared test one get the following results:

![CUSUM-test graph](image)

Now it looks much better and we can finally try to measure the long-run relationship between the inflation and STIBOR T/N. First however, we will test if the variables are cointegrated since they both were non-stationary in their levels. This will be done by using an hypothesis test developed by Pesaran, Shin & Smith (2001) with the following hypotheses:

\[ H_0: \text{No co-integration} \]

\[ H_1: \text{Co-integration} \]

This hypothesis test – a so-called “bounds test” – will test if it’s possible to express a long-run relationship between these two variables and it is done by running a conditional Error Correction Model (ECM) testing the hypothesis based on the F-statistic. According to
Pesaran, Shin & Smith (2001) a conditional ECM-model may be interpreted as an ARDL(p, q)-model without affecting the results.

When introducing the dummy the AIC chooses an ARDL(1, 1)-model, so based on that we calculate the long-run relationship and test the null hypothesis under the bounds test by running a conditional ECM-model.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>STIBOR</td>
<td>0.343756</td>
<td>0.313396</td>
<td>1.096875</td>
<td>0.2750</td>
</tr>
<tr>
<td>DUMMY1</td>
<td>8.924357</td>
<td>5.179977</td>
<td>1.723189</td>
<td>0.0676</td>
</tr>
<tr>
<td>C</td>
<td>0.290177</td>
<td>0.439998</td>
<td>0.659496</td>
<td>0.5109</td>
</tr>
</tbody>
</table>

EC = INFLATION - (0.3438*STIBOR + 8.9244*DUMMY1 + 0.2902 )

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>Value</th>
<th>Signif.</th>
<th>l(0)</th>
<th>l(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-statistic</td>
<td>2.255781</td>
<td>10%</td>
<td>2.63</td>
<td>3.35</td>
</tr>
<tr>
<td>k</td>
<td>2</td>
<td>5%</td>
<td>3.1</td>
<td>3.87</td>
</tr>
<tr>
<td></td>
<td>2.5%</td>
<td>3.55</td>
<td>4.38</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1%</td>
<td>4.13</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Based on the F-statistic we cannot reject the null hypothesis even at a 10% significance level, hence one can make the conclusion that there is no possibility to express a long-run relationship between STIBOR T/N and the inflation, i.e. no co-integration.
5. CONCLUSIONS

This study came to the conclusion that no long-run relationship can be expressed between STIBOR T/N and the Swedish inflation. But what does that mean? Does it mean that there is no long-run relationship at all? No, it doesn’t, because even though one cannot reject the null hypothesis that there are no cointegration, one cannot state that it is true – so there might still be a long-run relationship. But the fact that we cannot express how that relationship looks like could indicate that the ‘interest rate-weapon’ in itself isn’t that sufficient in affecting the inflation. One could even argue that it has performed badly during the past ten years. Does this then further indicate that the transmission channels don’t work? Maybe. But one cannot state that.

The fact that one cannot express a long-run relationship could be because the expectations of inflation are the most important variable, as is shown in the Phillips Curve. If all the agents in the economy expect the inflation to be lower than 2 percent – they will make decisions and act according to that forecast, and the inflation would then become lower than 2 percent – making it a self-fulfilling prophecy. So the reason why the ‘interest rate-weapon’ have performed poorly during the past ten years could be because the expectations of inflation was lower than 2 percent after the 2008 financial crisis. The agents in the Swedish economy might have thought that the Riksbank wouldn’t be able to reach its target – hence making economic decisions based on that – with a self-fulfilling prophecy of a low inflation becoming real.

But the fact that one cannot state a long-run relationship could also indicate that the trust in the Riksbank’s ability to reach its target of 2 percent is high, and that the agents in the Swedish economy have rational expectations. If the expectations of inflation are at 2 percent – and the agents trust that the Riksbank will reach that level – the expectations wouldn’t change if the Riksbank changed the official interest rate. But if there was an expressed long-run relationship between STIBOR T/N and the inflation, it could indicate that the expectations of inflation would change whenever the Riksbank changes the official interest rate, meaning that the agents in the economy would not trust the Riksbank’s ability to reach its target of 2 percent and instead form adaptive expectations, based only on the inflation in the past period. The agents in the economy would just adjust their expectations of inflation and economic
decisions based on the latest move from the Riksbank, changing the inflation by \(x\) units every time the Riksbank changes their official interest rate by \(y\) units.

So if the expectations of inflation are the most important variable – why bother about the transmission channels? Why not just target the expectations? First of all, it is very hard to measure the expectations of inflation and conduct monetary policy based on that. Second, according to Svensson (2007), most central banks are already doing that by having an announced numerical inflation target with implementations that gives the expectations a major role. By just having that monetary-policy strategy – and a transparency and credibility in reaching that target – it becomes an ‘inflation-forecast targeting’. This indicates somehow that in a perfect world were people’s expectations of inflation never changes, it doesn’t matter what the Riksbank are doing – the inflation will always be at 2 percent. So it is only a matter of trust and belief. Which is exactly what is printed on the dollar notes – ‘In God We Trust’.
6. REFERENCES


Websites


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