How does a financial crash affect the Phillips curve?

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Abstract

This study investigates if there is a significant Phillips curve correlation and if the tradeoff changed during the financial crisis of 2008 in countries such as Sweden, Austria and Belgium. It tries to find the evidence for a change in the tradeoff using a time series regression model. The study will first go through the different modifications that has been done to the Phillips curve and how the theory has evolved since it was originally theorized. After that the data that was used in the regression is examined and evaluated.

The regression on the Phillips curve that follows is done in two ways, first on a Phillips curve with backward-looking inflation expectations and then a regression with anchored inflation expectations. The results are ambiguous since the regression only found significance for a tradeoff in the Phillips curve with the anchored inflation expectations and not for the backward-looking inflation expectations model which is the more conventional model to use. If we follow the model with the anchored expectations we can see that the tradeoff does exist and that it was strengthened by the financial crash of 2008 in Belgium and Austria. In Sweden however, the only results the regression provided is that a significant Phillips curve correlation is present in the economy.
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1. Introduction

1.1 Background to the Study

Most of the western economies are running a zero or negative interest rate that the central banks are pushing to stimulate inflation. This can be regarded as a macroeconomic experiment, since it has not been done previously to this extent. (Christiano, Eichenbaum & Trabandt, 2014). The US had the same policies with a very low interest rate in the beginning of 2000 after the dot-com\(^1\) crash which inadvertently helped to stimulate and inflate the housing prices that eventually lead to the crash of 2008 (Verick & Islam, 2010). The crash started in the US and spread to Europe shortly after. The phenomenon that occurred with moderately unchanged inflation and high unemployment was a direct consequence of the crash of 2008 and is contradictory to the Phillips curve (Christiano, et al, 2014).

The Phillips curve is among the more prevailing theories when it comes to inflation. The Phillips curve states that there is a negative correlation between unemployment and inflation and because of this the central bank should be able to change its monetary policies to accommodate for the inflation target. This is however only true in the short run since the Phillips curve is assumed to be vertical in the long run (Carlin & Soskice 2006, p.67). To help and stimulate the economy most central banks resorted to low interest rates. The central bank of Sweden adopted a zero-bound interest rate in 2014 but had previously had a very low interest rate since the crash of 2008. The central banks want to avoid deflation and therefor the current inflation target is around 2\% in most countries in the EU area. This is what the central banks aim for with their low interest rate.

There are however different schools of economic science that has split views on the best solutions to help the economy get back on its feet and to prevent a new crisis. The Phillips curve is more prominent in the Keynesian view but is not very accepted within the Austrian view. The solutions and actions vary between the different schools of thought and so conclusions on how the economy should be managed is important to prevent economic crisis in the future. The purpose for this study is therefore to shed some more light on how the Phillips curve behave in the economy. Previous studies show that the trade-off between

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\(^{1}\) Dot-com bubble also known as the tech bubble which burst in 2000 and affected the financial markets in US but also in other countries.
inflation and unemployment is significant during some periods but it also breaks down and disappear completely sometimes (Stock & Watson, 1999; Friedman, 1975). Since monetary policy is based on this correlation, it is important to understand it completely (Ball & Mankiw, 2002). This study also aims to improve the theoretical framework for the given countries in this study, Sweden, Belgium and Austria. Since recent papers such as Ball & Mazumder (2014) shows that inflation expectations have changed recently and therefore the Phillips curve’s model must also be altered accordingly.

1.2 Study objective

This thesis aims to investigate the existence of the Phillips curves’ tradeoff between inflation and unemployment and spot if any change occurs because of the financial crash of 2008. The paper will focus on the Swedish economy but includes two more countries’ in the hope of giving a better perspective on the results, these are Austria and Belgium. These two countries were picked because their economies are similar to the Swedish economy in many ways. All three countries have a tax burden above 40%, labor unions are quite strong, trade is very important for all countries and they have a small but wealthy population (Heritage, n.d). The Belgium economy do however consume more oil than Sweden and Austria and hence is more sensitive to changes in the oil price which could affect inflation (CIA, n.d). The time periods have deliberately been chosen to 10 years before and 10 years after the crash of 2008, this way we should be able to capture a change in the tradeoff if it occurred. This will be done through a linear time-series regression analysis using the Phillips curves’ as a model for the regression. It will try to show the Phillips curve significance as well as provide statistical affirmation for a change between the periods.

1.3 Limitations

Limitations has been done due to time constraints and therefore the study will only use backward-looking- and anchored inflation expectation models for the Phillips curve. This is the change Ball & Mazumder (2014) noticed in the US, that expectations have changed from backward-looking to gravitate towards being anchored at the inflation target of the Central bank in the US. This neglects the fact that inflation expectations might be forward-looking.
1.4 Problem statement

Is the Phillips curve significant for Sweden, Austria and Belgium?
How is the Phillips curves’ tradeoff affected by the financial crisis of 2008?

1.5 Methodology

An econometric time series regression analysis will be used in this study to examine the Phillips curves’ tradeoff. Inflation will act as the dependent variable and unemployment will be our independent variable, we will also use a dummy variable to split the two periods. Another dummy variable is included for the slope in the regression to statistically test if a change occurs in the tradeoff between the two periods, if it exists. All the data in this study is based on monthly numbers and is taken from Eurostat which is the statistical office for the European Union.

1.6 Thesis structure

The first section, Previous studies should provide some more insight into the research on this topic. The Phillips curve is widely debated and the results can vary depending on what model that is used. It includes both research from before and after the 2008 financial crash. The Theoretical discussion is presented next. This section begins with how the Phillips curve developed from the original theory to the model that is used today. After that, important concepts for the long and the short run model are described and then how the Phillips curve model can differ between countries. This section ends with some critique for the Phillips curve and how the business cycle evolves from a “normal state” to a financial crisis. The next part is The empirical model where the regression model is presented. The explanation for each part of the model is also found here as well as a discussion for what lag the model should use.

The Regression analysis is where the different tests for possible errors in the data is showed. After that the data is presented in diagrams followed by comments for each country. The section ends with the results from the both regressions and a discussion of the findings.
In the Analysis we make sense of the findings from the regression with the theoretical framework that was presented in the theoretical discussion.

The Conclusion is where the final results are presented which will answer the problem statements for this paper.
All significant tables and figures associated with the study will be found in the text, but some less important tables are placed in the *Appendix*, to which references are given wherever relevant in the study.

## 2. Previous studies

Since the crash of 2008 many of the central banks in the western world are running the experiment with a zero or even negative interest rate. The economy has previously never really experienced this so the outcome is unknown at this moment. The macroeconomic theories that reinforce the current situation is, among others, the Phillips curve. (Verick & Islam, 2010). The Phillips curve have often come under criticism which has sprung up anew since the crash of 2008, the debate is whether the Phillips curve hold any significance in modern society. This concern stems from the fact that most western economies had a rapid increase in unemployment and economic weakness but still inflation remained relatively modest. (Christiano, et al, 2014)

### 2.1 Studies before the 2008 financial crash

There has been a lot of studies on unemployment and inflation using the Phillips curve, most of them were done on the US economy. The conclusion by Stock & Watson (1999) is that the Phillips curve is significant during their observation years (1970-1996). One of the interesting findings is that there are no benefits from including money supply measures, commodity prices or interest rates and its spread in their VAR\(^2\) models. They also state that it would be possible to improve the traditional Phillips curve and use alternative economic indicators. They conclude that the Phillips curve can play a useful role in forecasting inflation but to rely on it and exclude other forecasts would be a mistake.

There are conflicting results in how to calculate the inflation and whether to put emphasis on the unemployment as a major factor. King & Watson (1994) brings up the two views that has dominated the discussion of the Phillips curve, it is the Keynesians which believes in a significant correlation and the neoclassical/Austrian view which says that it does not work. The Austrian view states that the Phillips curve stopped showing significant evidence after the

\(^2\) VAR model stands for “vector autoregression” and is used to measure multiple time series in a regression.
inflation pattern changed between 1960-1970. However, in their investigation they found a negative correlation between inflation and unemployment in their sample. Their finding was highly dependent on whether they looked at low frequencies (trend, behaviors), intermediate frequencies (business-cycle behavior), or high frequencies (irregular behavior). Frequencies in this respect refers to time tables where low frequencies are more than 8 years, intermediate are 8 months to 8 years and high frequencies are less than 18 months. There is a clear negative correlation in the business-cycle frequencies, but the lower frequency co-movement of inflation and unemployment display links that are unstable across time.

In Staiger, Stock and Watson (1997) tries to answer question of how well the NARIU (non-accelerating inflation rate of unemployment) can be predicted since a lot of different economic institutions have varying results. Their conclusion is that NAIRU is very hard to predict. Their prediction lies between 4.3% and 7.3% which is to large of an interval to use when predicting inflation forecasts. They want to shed some light on this fact and inform policy makers of the difficulty of predicting the NAIRU. They also test unemployment and 69 other business cycle indicators to predict inflation. The results showed that unemployment was estimated on importance ranking at a 7th, between 1975-84, and at 10th, in the 1985-1993 period, out of 71 different measurements and the most important factor to use when calculating the inflation was suggested to be a measure of real activity - the rate of capacity utilization. It is therefore a certainty that there are more factors that influence the inflation rate even though we do not cover them in this paper.

2.2 Studies after the 2008 financial crash

Earlier studies on the OECD countries show that countries have different levels of correlation between unemployment and inflation. As Bhattarai (2016) proves in his thesis, counties like Denmark, Italy, France, Australia, Netherlands, Spain, New Zealand, the UK and the US had a higher significant tradeoff between inflation and unemployment. These results are quite interesting since they differ from countries that is on par in economic development like Austria, Norway, Israel and Germany. He also concludes that the unemployment for countries that have more liberal markets, hence less rigidities, has a lower natural rate of unemployment than other OECD countries.
Another interesting study comes from Kanellopoulos & Koutroulis (2016). Their thesis was inspired by the idea that inflation persistence might not be symmetric across different states of inflation. Hence, they wanted to check for an existence of non-linearity in the responsiveness of current inflation to its own lag\(^3\) for the EURO countries. They concluded that the inflation persistence is non-linear and that deflationary periods are possible but not very likely. They also showed that the negative correlation between unemployment and inflation exist, except in Germany and Luxenburg, and that it is highly significant. They could also see as stated earlier by Bhattachari (2016) that there is a significant difference between the correlation across different countries, Ireland had a -0.748 while Austria had a correlation coefficient of -0.256.

The last study which might be crucial to the findings of this paper is Ball & Mazumder (2014) study on the phenomenon of the “missing deflation” in recent years. They point to the fact that the high unemployment rates and the weak recovery that occurred during, and after the financial crisis of 2008 should have pushed inflation below zero into a deflationary state. This did however not happen. The reasons behind the “missing deflation”, as they call it, is still debated but they concluded two things that could improve further studies on this matter. The first one is that unemployment should be measured differently. They say that using short-term unemployment, which is defined as “the percentage of the labor force unemployed for less than 26 weeks”, should give a more accurate calculation of the Phillips curve correlation. The other conclusion is that expectations on inflation seem to be anchored from 2000 onward. The reasoning behind this phenomenon is that the central banks level of expectation, at 2%, keeps inflation anchored. This is not to say that it will always remain anchored at that level, it may vary if the central banks become less influential or they simply change their inflation target.

There are not a lot of studies done on the Phillips curve with simple time series regression like the one that will be used in this paper. All but one, Bhattarai (2016), uses the VAR regression model which is a bit different from the model that will be used here. The VAR model takes more variables into consideration than just inflation and unemployment and gives a more extensive look on the Phillips curves’ tradeoffs. They find that there are more components that can be used instead of unemployment to predict inflation. This is interesting but it is beyond the scope of this paper. The Phillips curve model that will be investigated in this

\(^3\) A lag is when something in the past explains or affect something in the present, there is a lag between the infection and the symptom
paper will only focus on unemployment and inflation. Some information and argumentation given in these studies to provide a base for this paper, like the findings of Bhattarai (2016) that finds which countries have a better negative correlation between inflation and unemployment than others.

3. Theoretical discussion

The central banks in many of the western economies have adopted a Keynesian theory of expansionary monetary policy during recessions, this is what we see in the western world today with nearly zero or negative interest rates. A unique environment based on theories like the Phillips curve. The stimuli from the monetary policies work in theory because the low interest rates incentivize investments in the short run. The money that enters the economy is used to produce and buy more goods, the goods that are produced requires more workers and hence the unemployment will decrease (Pissarides, 2013). Presented below is the theories surrounding the Phillips curve and then an alternative view that is stated by the Austrian school of economics.

3.1 The Phillips curve

The Phillips curve is an economic relationship between inflation rate and unemployment rate. It was first theorized in 1958 by William Phillips in his paper titled “The Relation between Unemployment and the Rate of Change of Money Wage rates in the United Kingdom, 1861-1957”.

$$\pi_t = (m + z) - \alpha u_t$$ (1)

This is the original Phillips curve which states that there is a negative correlation between inflation and unemployment. Where $\pi_t$ is the inflation rate in period t, m is called the markup and captures the firms power to set prices. z represents many different factors that affect wage setting – like unemployment benefits. $\alpha$ captures the strength of the effect that unemployment has on inflation and $u_t$ is unemployment in period t. The Phillips curve show that we can have a reduction in unemployment by increasing inflation, like moving from point A to point B on the graph below. (Blanchard, Melino & Johnson, 2003)
Figure 1 Shows the standard Phillips curve (Economics.org, n.d.)

The relationship between inflation and unemployment was considered stable and therefore policy makers could choose between different levels of unemployment and inflation, low unemployment would mean high inflation and vice versa. This was a great discovery but it was not fully accepted. The biggest concern that was presented early by Milton Friedman (1968) and Edmond Phelps (1967) which criticized the fact that it did not capture the workers’ expectations for future inflation levels.

3.2 The expectations-augmented Phillips curve

The most accepted theory today is not the original Phillips curve but an expectation-augmented Phillips curve that takes expected inflation into account, this extension of the Phillips curve was proposed by Milton Friedman and further simplified by Robert Gordon (Gordon, 1977, equation 13). It is also the conventional model to use in regressions today.

\[
\pi_t = \pi^e_t + \alpha(u_t - u_n) \tag{2}
\]

\[
u_n = \frac{(m+z)}{\alpha} \tag{3}
\]
In this model, $\pi_t$ is inflation period $t$, $\pi^e_t$ is the expected inflation. $m$ is still the markup which captures the firms’ power to set prices. $z$ is also the same and represents different factors that affect wages. $\alpha$ captures the strength of the effect that unemployment has on inflation and in this model, these are included as the variable $u_t$ (3) which represent the NAIRU (Non-inflationary accelerating inflationary rate of unemployment). $u_t$ is still unemployment in period $t$. This model suggests that the change in inflation depends on the difference between the actual and the natural rate of unemployment. If we have an actual unemployment higher than the natural rate then the inflation will increase, and decrease if the opposite is true. This would mean that if we have the actual rate of unemployment at the same level as the natural rate we would have a constant level for inflation, and therefore the term non-accelerating rate of inflation (NAIRU). (Blanchard et al, 2003) Which can be illustrated as model 2 can be rewritten as:

$$\pi_t - \pi^e_t = \alpha(u_t - u_n)$$

(4)

Where we will have a constant rate of inflation ($\pi_t = \pi^e_t$) if the unemployment rate is equal to the NAIRU at $u_t = u_n$ i.e. both side of the equation is zero.

3.3 The natural rate of unemployment

The natural rate of unemployment or NAIRU is a concept in macroeconomic theory that can be viewed as the point of unemployment that keeps inflation rate constant. The NAIRU is a common view of the labor market in the long run, it leads to a neutrality of fiscal and monetary policy – i.e. the policies have no effect in the long run on unemployment. The relevance of the short- and the long run version is stated by the Calvo-price setting model. Market participants have an incomplete formation of expectations in the short run because of real and nominal rigidities. Their adjustment of expectations will not immediately lead to a correction of prices and wages because of the rational behavior of the market participants. The rigidities that affect expectations only have a short run effect, in the long run they lose their influence which leads to the natural rate of unemployment in the long run (Calvo, 1983).

In practice, it is the level of unemployment where the wage setter does not have to increase wages for workers to stay (when unemployment is high) and cannot depress wages because the unemployment is too low (Staiger, et al, 1997). Inflation is constant when wage and price setter are in equilibrium, where both parties are satisfied with their position. Bell &
Blanchflower (2018) looked at the wage growth in the UK and US and found that the NAIRU has decreased since the Great recession in most western economies. The biggest reason for this decrease in the NAIRU was because of a change in workers’ perception of the employers’ willingness to keep them employed. They were frightened to ask for a higher wage because of the possibility of their jobs being outsourced. Ball & Mankiw (2002) stated that the NAIRU is hard to measure because it changes a lot over time. Their reasoning was that not only changes in the labor force affected the NAIRU but also broader changes in the economy. Different factors that would make the NAIRU change was: better job matching which would reduce frictional unemployment, and greater openness to trade because more products on the market would create greater competition between firms hence put a downward pressure on prices. A lower natural rate than before would mean that unemployment exerts less upward pressure on inflation and hence it would increase more slowly and stay at lower levels longer than before.

3.4 Rigidities in the labor market

Alternatives to the natural rate of unemployment there are theories which states that there is friction, or rigidities in the labor markets. The “hysteresis hypothesis” states that temporary shocks affect unemployment rate permanently. The theory is based on that workers have a strategic advantage in wage negotiations and can prevent cuts in the nominal wages. This will lead to a higher wage pressure if inflation is low (Holden 2004). Also, unionization creates rigidities when they favor the ones already employed and makes it harder for non-union workers to enter the labor force. Unionization results in keeping wages high even during recession and impede the non-union workers the ability to compete for the job. After prolonged layoffs, the employed union workers might find it hard to moderate their wage demand to promote the rehiring of unemployed workers. (Kevin D. Hoover, 2008)

There is however another component to this. Akerlof, Dickens & Perry (2000) states it as a concept of ‘near rationality’ that would reduce the rigidity in less liberal labor markets. The concept is based on the fact that not all workers will be able to distinguish between a real wage increase and a nominal wage increase. When workers are non-rational, higher inflation would reduce the real wage without necessarily reducing the nominal wage. This would serve as a stabilization mechanism in the less liberal markets and reduce the rigidity effect. The rigidity in the labor market is hence more salient with low inflation rather than with high inflation. The rigidities in the economy can also change the tradeoff between inflation and
unemployment, any additional friction would decrease this tradeoff in the Phillips curve but also changes in the NAIRU would have an impact (Ball & Mankiw, 2002).

3.5 Different modifications to the Phillips curve model

There has been a lot of different modifications to the model of the Phillips curve. Some of the modifications are described by Ball & Mazumder (2014, p.18) a bit comically as follows:

*Unfortunately, researchers have repeatedly needed to modify the Phillips curve to fit new data. Friedman added expected inflation to the Samuelson-Solow specification. Subsequent authors have added supply shocks (Gordon, 1982), time-variation in the Phillips-curve slope (Ball et al., 1988), and time-variation in the natural rate of unemployment (Staiger et al., 1997). Each modification helped explain past data, but, as Stock and Watson (2010) observe, the history of the Phillips curve “is one of apparently stable relationships falling apart upon publication.” Ball and Mazumder (2011) is a poignant example.*

The expectations-augmented Phillips curve considers that people are aware of the inflation levels and will incorporate it into their wages and prices. However, since we cannot predict the future, the expected inflation ($\pi^e_t$) that we use can differ depending on the way the market constructs their expectations. What economist mean with inflation expectations is the expectations of those who are directly involved in setting prices and wages, we will call them agents. The Phillips curve model should be calculated differently depending on how a market is forming their expectations for future inflation. There are however, differences of expectations depending on what socioeconomic group one is classified as but mainly there are two commonly used approaches in forming expectations; backward looking - and anchored inflation expectations (Blanchflower & Mac, 2009).

**Backward-looking inflation expectations**

The backward-looking inflation expectation can be applied to agents who based on their observations of past behavior for the variables infer a model for future occurrence.

$$\pi_t = \pi_{t-1} + \alpha(u_t - u_n)$$ (5)

Agents think that last periods inflation ($\pi_{t-1}$) is representative for the future inflation rate. In this model, we have that unemployment affects the *change* in inflation rate ($\pi_t - \pi_{t-1}$). This is
the more common view of a market and is included in one of the regressions that will be conducted in this thesis.

**Anchored inflation expectations**
The anchored inflation expectations can be applied to agents who are insensitive to new data, or believe in a stable inflation rate. Justification for this belief is that they base their assumptions on what the central bank is aiming at. (Eyvind, 2015)

\[
\pi_t = \pi^{CB} + \alpha(u_t - u_n) 
\]

\(\pi^{CB}\) in this model represents the anchored expectations and is the other regression that we will conduct in this study. A trend towards more anchored inflation expectations seem to be rising in the west and studies believe that one of the reasons is that central banks are more credible, i.e. the agents believe in the central banks’ ability to control inflation (Simon, Matheson, & Damiano, 2013; Ball & Mazumder, 2014). As Ball & Mazumder, (2014) found that this trend is visible in the US where expectations being anchored at the level of the Federal Reserve’s commitment which is that they want to keep inflation rate at a 2% level. Properly anchored inflation expectations with a credible central bank policy will also reduce the chance that core inflation should be affected by a sharp rise in the more volatile energy prices (Binder, 2018). The expectations formation should not be seen as a perpetual state and may change depending on the economic conditions for the country.

3.6 Alternative view - contrary to the Phillips curve

The critique for the Phillips curve has increased since the contradictory evidence that can be seen during the crash of 2008 with high unemployment but modest variations in inflation. Kotios & Galanos (2012) states that the main factors behind the economic crash are still debated between the different schools of economic science. The inability of a uniform interpretation has led to confusion among public opinion and with decision-makers today. With the confusion around the origin of the crash, the solutions and the recommendations to address the consequences are varying widely. Decision-makers apply measures that they deem necessary depending on their ideologies or political interests. The Austrian school of economics is one of the different ideologies that exist within the economic science that is opposing the Keynesian view.
The Austrian view of inflation is different from the Keynesians. According to them the main driver of inflation is the money creation itself and not due to higher productivity which is a part of what the Phillips curve is based upon. Horwitz (2014) states that the Austrian believe that money should be created but, based on the monetary equilibrium theory, only to the extent that it matches the demand to hold it given the current set of prices. In creating this equilibrium, the structure of capital is sustainable and borrowers can rely on interest rates to guide their consumption habits in the future. According to the Austrian theory an economy is experiencing abnormal rise in inflation during booming periods of the economy. In fact, inflation should not increase during booms since it should be met with a deflationary pressure or as Horwitz calls it “benign productivity-induced price deflations”. Which can be explained with higher outputs and higher revenue due to economies of scale.

The Austrian business cycle theory is a common way of expressing what happens before and after a crash. Salerno (2012) states that the Austrian view believe that the reasons behind the crash is because of malinvestment and overconsumption which are the essential features of an inflationary boom. The artificially low interest rates incentivize businesses to invest in projects they would not, with “normal” interest rates, invest in. The same goes for the households which overestimates their real income and net worth and exercises overconsumption – which is directly correlated with the wealth effect.

The economy is booming at this state, low unemployment and an ever-increasing stock market. The overconsumption is called “capital consumption” because money that might otherwise be spent on capital investment or savings is now used to consume products in the market. Salerno (2012) continues to describe the slump that follows a boom in the economy as a disintegration of production because of the capital consumption and the malinvestment that occurred. In the Austrian view a recession is seen as a cleansing mechanism that the economy exerts to restore the natural state of the economy. In fact, monetary manipulations or fiscal stimuli is viewed as a derailing or impediment for the recession-adjustment process.

The consequences of an economic crash are apparent in many parts of the economy. As shown in Morlino & Piana (2014), unemployment increases, GDP growth declines, investment decreases and government effectiveness is reduced.

During the 1970, the US experienced a stagflation period that crippled the economy and the Austrian school got more influential because it was the only one who could explain the
phenomenon sufficiently. (Jesús, 2003, p.100) The Keynesians thought it impossible since that would mean that the Phillips curve would break down completely because stagflation is identified with two key conditions: increasing inflation rates and output that is stagnant i.e. rise in unemployment. The term stagflation was coined by Iain Macleod in a speech to Parliament in 1965 and is a combination of inflation and stagnation. Stagflation creates very high inflation rates coupled with high unemployment rates.

The central bank can stimulate the economy with their monetary policy and choose between unemployment or inflation in the short run. That is not possible if the economy is experiencing stagflation since if unemployment is stimulated to decrease, inflation will in turn increase even more because of the expansionary spending that must be committed. When stagflation occurs in an economy the Phillips curve will not hold any significance since the correlation no longer exists. (Li & Lin 2016) The best countermeasure that countries can apply to provide protection from a stagflation crisis is to remove the threat of a drifting inflation target. This is done through limiting monetary policy uncertainty with a fixed and credible inflation target. (Khan & IIKnotek, 2015)

4. Research Design

The regression will use the monthly data on inflation and unemployment as a basis for the empirical study. The data is taken from Eurostat and the regression will investigate the trade-offs between inflation and unemployment in Sweden as our main focus but does also include Belgium and Austria to give us some perspective on the results. The data starts in the first month of 1998 and ends in 2018. The numbers of observations differ a little between countries because some have reported their 2018 numbers and some has not, this is negligible since it is only the last months missing with a maximum of 2 months.

4.1 The Regression Model

The regression models that are used in this study are based on the Phillips curve. A time-series model with monthly data is used to provide statistical results from the inflation and unemployment data. Two periods have been chosen, these are 1998-2008 and 2009-2018. The model includes two dummies, one to differentiate between the different periods and one for the possible change in the “slope” – which should be viewed as evidence for a change in the
tradeoff between unemployment and inflation. Since there is a debate on what kind of Phillips curve that is currently the best one to run we will use two different regression models, one with anchored inflation expectations and one with backward-looking. The regression models that are used will look like this:

Backward-looking inflation expectations:
\[ \pi_t - \pi_{t-1} = \beta_0 + \beta_1 D + \beta_2 U_t + \beta_3 DU_t + e_t \] (7)

Anchored inflation expectations:
\[ \pi_t - \pi^{CB} = \beta_0 + \beta_1 D + \beta_2 U_t + \beta_3 DU_t + e_t \] (8)

4.2 Variable definition

\( \pi_t \) = Is the inflation rate in period t and this is the dependent variable
\( \pi^{CB} \) = This variable captures the anchored inflation expectations
\( \pi_{t-1} \) = This variable captures the backward-looking inflation expectations
\( U_t \) = Is the unemployment rate in the period and is the independent variable
\( D \) = Dummy variable that will be 0 for first period and 1 for second period
\( DU_t \) = We incorporate this variable to provide evidence for any change in the slope between the two time-periods.
\( e_t \) = Error term

Table 1: Variable prediction

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Source</th>
<th>Expected outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \pi )</td>
<td>Inflation rate</td>
<td>Eurostat</td>
<td>--</td>
</tr>
<tr>
<td>( U )</td>
<td>Unemployment rate</td>
<td>Eurostat</td>
<td>Negative</td>
</tr>
<tr>
<td>( D )</td>
<td>Dummy variable</td>
<td></td>
<td>Negative or positive</td>
</tr>
<tr>
<td>( DU )</td>
<td>Slope Dummy</td>
<td></td>
<td>Negative or positive</td>
</tr>
</tbody>
</table>
4.3 Variable specification

Price Inflation
The brief explanation of inflation is the rate at which the purchasing power of the currency is falling, or put another way, the rate at which the price of general goods is increasing. The common consensus is that the inflation rate should preferably equal 2% in the long run to have the economy running smoothly. If there is too much inflation, it will erode the savings of the population and people will try to spend it as quickly as possible. This is problematic in a lot of ways since savings is what makes investment possible which increases our productivity in the future. (Blanchard et al, 2003)

Price Inflation is calculated based on the consumer price index and is the price change of some selected products and services that has been deemed worthy of explaining the price changes in our economy. This is often stated as a basket of goods that the consumer can buy, if the inflation increases you would be able to buy less of the given basket with the same amount of money. Sometimes the price of a good increases/decrease which has nothing to do with the nominal increase of the money base. This is not called inflation and can be explained with other factors such as too much demand for too few products or developments that incur less production cost. Hence, the basket will contain a lot of products to give an unbiased result. The inflation rate will be our dependent variable.

To clarify what the real difference between the two models are, the main difference is the inflation data that is used. When we conduct the anchored expectations model (π_t - π^{CB}) the inflation data is the inflation rate. In the model with backward-looking inflation expectations (π_t - π_{t-1}), we use the data for the change in inflation expectations. In both cases the inflation expectations are incorporated in the data.

Unemployment Rate
As an independent variable in this time-series model we use unemployment rate. Unemployment show the number of people with officially unemployed status. The most common definition of unemployment is ‘an unemployed person who is seeking paid employment’. If you are unemployed but not looking for work you are not considered in the unemployment rate for your country. The data that we will use is the unemployment rates which is calculated as the people who are unemployed divided by the people in the labor
force, shown as a percentage. It is however important to note that there is not a one for one relationship between employment rate and unemployment rate. The population of the people who can work can be divided into three groups: unemployed, employed and inactive. Therefore, unemployment rate can decrease without employment rate increasing which can be viewed as people withdrawing and leaving the labor force altogether. However this will show up in the statistics as unemployment rate going down which is viewed as something positive, but in reality the situation is not better – people are giving up on the labor market. (Blanchard, Melino & Johanson 2003)

**Dummy Variable**

We use a dummy variable to separate the two periods, 0 will be our first period of 1998-2008 and 1 is the second period, 2009-2018. The value for this variable would indicate that a shift occurred in the intercept of the Phillips curve between the two periods.

**Slope Dummy Variable**

The slope variable is used to spot the change in inflation and unemployment tradeoff between the two periods. This is incorporated to get a statistically valid argument that there is a move in the inflation and unemployment rate correlation between the two time-periods.

**Error Term**

An error term is always included in regression models and will count for everything that separates the model from actual reality. It will reflect unpredictable effects, measurements errors and nonlinearity.

4.4 Lagged variable

It is unlikely that this month’s unemployment affect inflation immediately the same month. Therefore a lag will be included in the regression but how big of a lag is a harder question. Most of the previous studies such as Bhattari (2016) has quarterly data and include a lag of 2 quarters, which would be a lag of 6 months for this regression. Kitov, Kitov & Dolinskaya, (2007) noticed a lag for 4,5 years in their data between inflation and unemployment. The lag should make a better fit for the data and give more accurate result on the regressions. It is also reasonable to think that unemployment has a faster impact on inflation in some countries and slower in others, this would make it possible for a different lag in each country. There is also
a discrepancy between the causality of unemployment and inflation. Is it unemployment that moves first to cause a change in inflation or is it the other way around? We will go with the more common view, as Friedman (1975) also states it, that unemployment cause inflation to move.

5. Regression analysis

The main focus of this paper is on the Swedish economy but does include two more countries to give a better perspective of the Phillips curves’ tradeoff. These countries are Belgium and Austria and according to Bhattarai (2016) they had different levels of correlation between inflation and unemployment which found that Belgium had a greater negative correlation between inflation and unemployment than Sweden and Austria had a lesser correlation.

Before the regression results can be provided, some tests must be conducted on the data set. Firstly, a non-stationarity test called the augmented Dicky-fuller test is done on the data. The data should be stationary to provide acceptable results in the regression. Stationarity is achieved when the mean and the variance for the data is constant over time (Gujarati & Porter, 2009).

<table>
<thead>
<tr>
<th></th>
<th>Test statistic</th>
<th>1% Critical value</th>
<th>5% Critical value</th>
<th>10% Critical value</th>
<th>Z(t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweden</td>
<td>-3.07</td>
<td>-3.461</td>
<td>-2.88</td>
<td>-2.57</td>
<td>0.028</td>
</tr>
<tr>
<td>Austria</td>
<td>-2.91</td>
<td>-3.461</td>
<td>-2.88</td>
<td>-2.57</td>
<td>0.043</td>
</tr>
<tr>
<td>Belgium</td>
<td>-3.15</td>
<td>-3.461</td>
<td>-2.88</td>
<td>-2.57</td>
<td>0.023</td>
</tr>
</tbody>
</table>

Table 3: Augmented Dicky-fuller test for unemployment

<table>
<thead>
<tr>
<th></th>
<th>Test statistic</th>
<th>1% Critical value</th>
<th>5% Critical value</th>
<th>10% Critical value</th>
<th>Z(t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweden</td>
<td>-5.383</td>
<td>-3.461</td>
<td>-2.88</td>
<td>-2.57</td>
<td>0.00</td>
</tr>
<tr>
<td>Austria</td>
<td>-4.547</td>
<td>-3.461</td>
<td>-2.88</td>
<td>-2.57</td>
<td>0.00</td>
</tr>
<tr>
<td>Belgium</td>
<td>-3.090</td>
<td>-3.461</td>
<td>-2.88</td>
<td>-2.57</td>
<td>0.027</td>
</tr>
</tbody>
</table>

With the results above inflation for all countries is stationary with a 95% certainty and unemployment is stationary at 99% certainty for all countries but for Belgium which is at
95% certainty. With these results, we can prove that the data does not have any problems with non-stationary variables and should be viable to run in the regression.

As stated earlier the regression should also use a lag in inflation to give more appropriate results. The test for the optimal lag can be found in the appendix at section 9.4, and shows that the most optimal lag for Sweden is 9, for Austria it is 12 and for Belgium it is 7. This result is higher than expected since previous studies such as Bhattari (2016) and Kitov, et al (2007) used a lag of 6 and 4.5 respectively. It is also a common practice today to always use the robust standard error when running a regression, therefore it will also be used here to avoid heteroscedasticity.

5.1 Descriptive statistic

The following tables are a summary of the data that was gathered and show the numbers of observations, the mean of each variable, the standard deviation, minimum and maximum values that the data provided. The standard deviation is the total range (negative and positive values) that the data deviated from the mean. High deviation means more volatility and vice versa. The same tables for the whole period for each country can be found in the appendix with a scatterplot of the data.

Sweden

Table 4: Descriptive statistics for Sweden; 1998-2008

<table>
<thead>
<tr>
<th>Variables</th>
<th>Nr. obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
</table>

Figure 2 Graph of inflation (bottom line) and unemployment (upper line) in Sweden between 1998-2018
Inflation | 131 | 1.651 | 0.953 | -0.1 | 4.2
Unemployment | 131 | 6.658 | 1.024 | 4.6 | 9.5

Table 5: Descriptive statistics for Sweden; 2009-2018

<table>
<thead>
<tr>
<th>Variables</th>
<th>Nr. obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation</td>
<td>112</td>
<td>1.190</td>
<td>0.686</td>
<td>-0.3</td>
<td>2.8</td>
</tr>
<tr>
<td>Unemployment</td>
<td>112</td>
<td>7.688</td>
<td>0.917</td>
<td>5.8</td>
<td>9.8</td>
</tr>
</tbody>
</table>

The Swedish economy have a stable unemployment in the 20 years’ period, it peaked at 9.8% but the mean is around 7% judging by the two periods. The spread of the mean is shown in the standard deviation number and in Sweden’s case it does not show a lot of volatility in either inflation nor unemployment. Sweden peaked in inflation with 4.2% but were closer to 1.6 during the whole period.

**Austria**

![Graph of inflation (bottom line) and unemployment (upper line) in Austria between 1998-2018](image)

Table 6: Descriptive statistics for Austria; 1998-2008

<table>
<thead>
<tr>
<th>Variables</th>
<th>Nr. obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min %</th>
<th>Max %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation</td>
<td>131</td>
<td>1.797</td>
<td>0.814</td>
<td>0.1</td>
<td>4</td>
</tr>
<tr>
<td>Unemployment</td>
<td>131</td>
<td>4.666</td>
<td>0.813</td>
<td>3</td>
<td>6.2</td>
</tr>
</tbody>
</table>

Table 7: Descriptive statistics for Austria; 2009-2018

<table>
<thead>
<tr>
<th>Variables</th>
<th>Nr. obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min %</th>
<th>Max %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation</td>
<td>111</td>
<td>1.777</td>
<td>0.950</td>
<td>-0.4</td>
<td>3.9</td>
</tr>
<tr>
<td>Unemployment</td>
<td>110</td>
<td>5.294</td>
<td>0.562</td>
<td>3.9</td>
<td>6.5</td>
</tr>
</tbody>
</table>
Austria was one of the countries that showed less significance in the correlation between unemployment and inflation in previous studies (Bhattarai, 2016). Their unemployment rate has a lower mean than Sweden and it is more stable, it fluctuated 3 percentage points in the first period. It seems like inflation had a deflationary tendency in the second period, with a negative min value for inflation but that is also true for Sweden and Belgium. Both periods are quite stable for Austria in all categories and judging by this data they seem to have managed the crash quite well although they experienced a 1% higher unemployment after the crash to the same inflation.

Belgium

![Graph of inflation (bottom line) and unemployment (upper line) in Belgium between 1998-2018](image)

**Table 8: Descriptive statistics for Belgium; 1998-2008**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Nr. obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min %</th>
<th>Max %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation</td>
<td>131</td>
<td>2.115</td>
<td>1.105</td>
<td>0.3</td>
<td>5.9</td>
</tr>
<tr>
<td>Unemployment</td>
<td>131</td>
<td>7.866</td>
<td>0.909</td>
<td>6</td>
<td>9.9</td>
</tr>
</tbody>
</table>

**Table 9: Descriptive statistics for Belgium; 2009-2018**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Nr. obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min %</th>
<th>Max %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation</td>
<td>112</td>
<td>1.669</td>
<td>1.118</td>
<td>-1.7</td>
<td>4</td>
</tr>
<tr>
<td>Unemployment</td>
<td>111</td>
<td>7.810</td>
<td>0.761</td>
<td>6</td>
<td>8.8</td>
</tr>
</tbody>
</table>

Belgium is a small economy much like Sweden. The data show that Belgium have a higher mean in both inflation and unemployment than Sweden. When looking at the minimum
inflation that Belgium has experienced, it is obvious that the worst deflationary period of the three countries can be found in Belgium, with -1.7 in inflation. The volatility in inflation and unemployment is quite even between all three countries in this study, although Belgium has a higher mean in unemployment than the other countries. All three countries have good data without any outstanding anomaly.

5.2 Regression results

Two regression have been conducted and the results are shown below. The first regression is based on the backward-looking inflation expectations and the second is done on the anchored inflation expectations model.

Backward-looking inflation expectations:

$$\pi_t - \pi_{t-1} = \beta_0 + \beta_1 D + \beta_2 U_t + \beta_3 DU_t + e_t \quad (7)$$

<table>
<thead>
<tr>
<th>Table 10: Backward-looking inflation expectation regression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable: Change in inflation ($\Delta \pi_t$)</td>
</tr>
<tr>
<td>Independent Variables:</td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>Constant:</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Unemployment:</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Dummy:</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Slope Dummy:</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>R-squared:</td>
</tr>
<tr>
<td>F-prob:</td>
</tr>
<tr>
<td>Observations:</td>
</tr>
</tbody>
</table>

Standard error in parentheses | ***p<0.01, **p<0.05, *p<0.1
As can be seen above, the regression (7) does not prove a lot for any of the three countries, albeit the Belgium unemployment variable shows some significant. Some earlier studies like Bhattarai (2016) found that this model could be applied to the given countries but used the first difference for unemployment since their unemployment data was non-stationary. Since the unemployment data in this study had no problem with non-stationarity, and because the theoretical model does not call for such an action, we cannot justify using first difference in unemployment. The next regression is the Phillips curve with anchored inflation expectations.

\[
\pi_t - \pi^{CB} = \beta_0 + \beta_1 D + \beta_2 U_t + \beta_3 DU_t + e_t
\]  

(8)

<table>
<thead>
<tr>
<th>Table 11: Anchored inflation expectation regression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable: Inflation ((\pi_t))</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Independent Variables:</th>
<th>Sweden</th>
<th>Austria</th>
<th>Belgium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant:</td>
<td>4,346*** (0,353)</td>
<td>1,331*** (0,337)</td>
<td>5,043*** (0,726)</td>
</tr>
<tr>
<td>Unemployment:</td>
<td>-0,398*** (0,049)</td>
<td>-0,118* (0,069)</td>
<td>-0,361*** (0,087)</td>
</tr>
<tr>
<td>Dummy:</td>
<td>-0,624 (0,602)</td>
<td>5,421*** (0,133)</td>
<td>3,53*** (0,985)</td>
</tr>
<tr>
<td>Slope Dummy:</td>
<td>0,0697 (0,091)</td>
<td>-1,331*** (0,337)</td>
<td>-0,519*** (0,123)</td>
</tr>
<tr>
<td>R-squared</td>
<td>0,273</td>
<td>0,216</td>
<td>0,2067</td>
</tr>
<tr>
<td>F-prob</td>
<td>0,00</td>
<td>0,00</td>
<td>0,00</td>
</tr>
<tr>
<td>Observations</td>
<td>242</td>
<td>240</td>
<td>241</td>
</tr>
</tbody>
</table>

This regression (8) seem to be consistent albeit quite low R-squared values was generated. The low R-squared values is something that also showed up in previous studies for Bhattari (2016). That being said, even though the low value of R-squared is something to be mindful of there are other statistics like the F-prob, which proves a significance in the regression.
Another useful statistic when deciding the reliance of the regression is the P-value which showed significance for all variables except for both Swedish dummies.

5.3 Findings

The first regression (7) is the more conventional regression to run when testing the Phillips curve correlation but does not provide a lot of useful information. The unemployment for Belgium is significant at the 95% level but low R-square values shows that the dependent variables does not prove a lot of movement in the independent variable. Therefore, it is hard to make any concluding remarks on the results from this regression (7) for any of the countries. Recent studies on this matter like Ball & Mazumder, (2014) shows that a deviation from conventional regression (7) may be warranted since people’s expectations may have changed since about the year 2000. This is still a theory in development but the second regression (8) would confirm this theory. The anchored Phillips curve model (8), show significant results in all three countries, albeit the unemployment variable for Austria is only significant at the 90% level.

Starting by looking at Sweden’s regression (8), the unemployment variable, that proves an existing negative correlation, is the only variable with significant p-value. Both dummy variables are not significant even though there are significant statistics validating the regression, like F-prob and R-squared. For Austria, there is also a significant negative Phillips curve correlation, albeit only at the 90% level. The dummy show that the Austrian Phillips curve moved upward operating with a higher inflation in the second period, all else being equal. The slope dummy is negative meaning that the tradeoff between the two variables has increased. According to the regression (8), the crisis of 2008 was more impactful on the Austrian economy compared with Belgium.

Looking at the regression (8) for Belgium, the Phillips curve correlation is significant and quite strong. The negative correlation between inflation and unemployment is high and so is the R-square number. The crash of 2008 seem to have had similar effect to the Phillips curve correlation as in Austria with a higher inflation, given the same unemployment, and an increased negative correlation. The R-square value is not very impressive but do still contain some information. A useful term associated with the R-square value is “the power of explanation” and means to what extent the dependent variables affect the independent
variable, i.e. how much unemployment affects the inflation rate (Rosenthal & Rubin 1982). The R-square tells us that unemployment affect 20% of inflations moves in Belgium, about the same for all three countries. This is in line with what was expected since Bhattarai (2016) got about the same values.

6. Analysis

The regressions that was made show some evidence contrary to each other. The results from the Phillips curve with backward-looking expectations (7) was unable to provide any strong evidence of a correlation between inflation and unemployment. This would give credit to the Austrian view of the economy and the correlation would be non-existing at least in Sweden and Austria. However, if the expectations have changed as Ball & Mazumder, (2014) proposes, then the anchored inflation expectation model is more appropriate for these countries. The regression results confirm this claim since we got significant results from the Phillips curve with anchored inflation expectations (8) which shows that it is still useful given the current conditions in Sweden, Austria and Belgium. The results point to the fact that the Phillips curve is still present in all these countries today, despite the turbulence during the crash of 2008.

Judging from the anchored inflation expectations model (8) for Sweden, the negative correlation is present but both the dummy variables are insignificant. This means that we are unable to make any good conclusion on how Sweden was affected by the financial crisis of 2008. In Austria and Belgium however, there is a negative correlation present, and both dummy variables show significant values. The slope dummy for Belgium is negative meaning that the correlation increased after the crash. The dummy for the intercept was also affected, but positively. A higher intercept would mean that the economy operates with a higher inflation, given the relative same unemployment, after the crash. It is also in line with the descriptive statistics that was given in table 9 and 10 for Belgium where the mean for inflation increased between the two periods but unemployment remained the same. The results for Austria show the least correlation in this study, it was expected since Bhattarai (2016) got similar results. The tradeoff in Austria is low despite the fact that the correlation increased after the crash, according to the slope dummy.
Some ending remarks on the first model with backward-looking inflation expectations (7) should be addressed since this is the conventional way to investigate the Phillips curve. We cannot reject it completely since “bad results” are results nonetheless. From this regression (7) there is no sign of a strong negative correlation present in Sweden nor Austria and low values in the dummy variable was generated. This would mean that the Phillips curve is not present in the Swedish nor Austrian economy at all. There is no tradeoff between inflation and unemployment, at least not during the given period and given the assumptions that was made.

An explanation for an absent Phillips curve in these countries can be a sign of the rigidities in the labor market that Holden (2004) suggested. The more liberal labor markets should have a greater negative correlation between inflation and unemployment. The unions might have created a more ridged labor market where a layoff is harder to propose. During the crash the unions might have prevented a lot of labor turnover and thereby reducing the impact the crisis posed on the unemployment rate. This would mean that the tradeoff would get reduced since unemployment would be exposed to more friction. Inflation rate in Sweden was also low during the given periods that we looked at and could also be a contributing factor since low inflation cannot take advantage of the concept of ‘near rationality’ stated by Akerlof et al (2000).

Another case can be the excessive monetary policy that the central banks in Sweden and Austria were running, as Salerno (2012) and the Austrian Business cycle theory would suggest that inflation would increase more rapidly with the low interest rates after the crash. The unemployment rate would also increase because of the cleansing mechanism that would abolish all the malinvestment, leading to a stagflationary condition which would dissolve the correlation. It can however be the case that the assumption about how inflation expectations are formed is not backward-looking instead they are anchored in Sweden and Austria and that this is the reason why no negative correlation was found.

The results from the regression with backward-looking inflation expectations (7) would also be in line with what the NAIRU is proposing where the correlation disappears in the long run. The regression is however not estimated for catching a long run trend and it is very unlikely the case. Nevertheless, the low rates of inflation in Sweden, Austria and Belgium during the whole period could indicate that the NAIRU is very low. Since a lower natural rate of unemployment would mean that unemployment exerts less upward pressure on inflation and hence inflation would increase more slowly and stay lower for a longer time.
7. Conclusion

This study wanted to investigate if there is a significant Phillips curve present in Sweden, Austria and Belgium and if the crash of 2008 affected the tradeoff. The results show that the Phillips curve is absent in the Swedish economy when assuming backward-looking inflation expectations (7). This is however not the case for the anchored inflation expectations model (8), where the correlation is quite strong. This is however all information the regression provided for Sweden, so no conclusion can be made on how a crash affects the Phillips curve, instead we turn to Belgium and Austria for further information. For Austria and Belgium, which found a significant Phillips curve when using the anchored inflation expectations model, the negative correlation between inflation and unemployment seem to have strengthened during the crash, i.e. the Phillips curve is more prominent after the crash than before. Also, the crash increased the intercept for the Phillips curve in both Belgium and Austria which means that inflation rate is higher after the crash than before, ceteris paribus. The findings, for all countries, are however in line with what Ball & Mazumder (2014) also found that agents’ inflation expectations are becoming more anchored, at least for Sweden, Austria and Belgium.

For future studies, it could be relevant to change the unemployment variable for a short-term unemployment which would give a more accurate description of the labor force because the long term unemployed (more than 26 weeks) are less attractive to employers and hence exerts less influence on prices. It could also be relevant to fully explore which of the inflation expectation that are the most accurate for the given economy and maybe add the forward-looking inflation expectation. Also, since the results are different between each country, studies should be made on more countries to find a more unanimous conclusion for how a crash affects the Phillips curve.
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8.1 Electronic sources


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Heritage (n.d) Austria https://www.heritage.org/index/country/austria (20190105)
Heritage (n.d) Belgium https://www.heritage.org/index/country/belgium (20190105)

Heritage (n.d) Sweden https://www.heritage.org/index/country/sweden (20190105)


The Statistical data that was used was found on: Eurostat – the statistical office of the European Union http://ec.europa.eu/eurostat
9. Appendix

9.1 Sweden

Table 12: Inflation and unemployment for Sweden; 1998-2018

<table>
<thead>
<tr>
<th>Variables</th>
<th>Observations</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation</td>
<td>243</td>
<td>1.438</td>
<td>0.870</td>
<td>-0.3</td>
<td>4.2</td>
</tr>
<tr>
<td>Unemployment</td>
<td>243</td>
<td>7.132</td>
<td>1.101</td>
<td>4.6</td>
<td>9.8</td>
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</tbody>
</table>

Figure 5 Scatterplot Sweden (Data for the Phillips curve with anchored inflation expectations)

Inflation on Y-axis
Unemployment on X-axis
Figure 6 Scatterplot Sweden (Data for the Phillips curve with backward-looking inflation expectations)

Inflation on Y-axis
Unemployment on X-axis

9.2 Austria

Table 13: Inflation and unemployment for Austria; 1998-2018

<table>
<thead>
<tr>
<th>Variables</th>
<th>Observations</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min %</th>
<th>Max %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation</td>
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<td>1.787</td>
<td>0.879</td>
<td>-0.4</td>
<td>4</td>
</tr>
<tr>
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<td>241</td>
<td>4.961</td>
<td>0.771</td>
<td>3</td>
<td>6.5</td>
</tr>
</tbody>
</table>

Figure 7 Scatterplot Austria (Data for the Phillips curve with anchored inflation expectations)
Inflation on Y-axis
Unemployment on X-axis

Figure 8 Scatterplot Austria (Data for the Phillips curve with backward-looking inflation expectations)
Unemployment on X-axis

9.3 Belgium

Table 14: Inflation and unemployment for Belgium; 1998-2018

<table>
<thead>
<tr>
<th>Variables</th>
<th>Observations</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min %</th>
<th>Max %</th>
</tr>
</thead>
<tbody>
<tr>
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<td>-1.7</td>
<td>5.9</td>
</tr>
<tr>
<td>Unemployment</td>
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<td>7.839</td>
<td>0.841</td>
<td>6</td>
<td>9.9</td>
</tr>
</tbody>
</table>

Figure 9 Scatterplot for Belgium (Data for the Phillips curve with anchored inflation expectations)

Inflation on Y-axis
Unemployment on X-axis
9.4 Estimating the optimal lag

Choosing the optimal lag for each country should make a better fit for the results of the regression. Common practice when determining the optimal lag is to follow FPE (final prediction error) and AIC (Akaike’s information criterion) when the sample size is small, i.e. less than 100 units’, and use HQIC (Hannan and Quinn information criterion) when the sample size is greater than that. In determining the maximum number of lag that the test should work with is commonly set to 1 for annual data, 4 for quarterly and 12 for monthly data. (Liew, 2004) Since there is no confliction results from the tables below, the optimal lag will be chosen for each country as the tables shows.
### Table 15: Estimating optimal lag for Sweden

<table>
<thead>
<tr>
<th>LL</th>
<th>LR</th>
<th>Lag</th>
<th>DF</th>
<th>p</th>
<th>FPE</th>
<th>AIC</th>
<th>HQIC</th>
<th>SBIC</th>
</tr>
</thead>
<tbody>
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<td>4</td>
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<td>5,416</td>
<td>5,433</td>
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<td>0,046</td>
<td>2,617</td>
<td>2,653</td>
<td>2,705*</td>
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<tr>
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<td>4</td>
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<td>0,045</td>
<td>2,581</td>
<td>2,54</td>
<td>2,728</td>
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<td>4</td>
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<tr>
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<td>4</td>
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<td>0,047</td>
<td>2,583</td>
<td>2,689</td>
<td>2,847</td>
</tr>
<tr>
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<td>5</td>
<td>4</td>
<td>0,76</td>
<td>0,042</td>
<td>2,609</td>
<td>2,739</td>
<td>2,931</td>
</tr>
<tr>
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<td>4</td>
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<td>0,041</td>
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<td>2,772</td>
<td>2,999</td>
</tr>
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<td>2,699</td>
<td>2,962</td>
</tr>
<tr>
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<td>8</td>
<td>4</td>
<td>0,01</td>
<td>0,041</td>
<td>2,500</td>
<td>2,701</td>
<td>2,999</td>
</tr>
<tr>
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<td>4</td>
<td>0</td>
<td>0,039*</td>
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<tr>
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<td>3,073</td>
</tr>
</tbody>
</table>

### Table 16: Estimating optimal lag for Austria

<table>
<thead>
<tr>
<th>LL</th>
<th>LR</th>
<th>Lag</th>
<th>DF</th>
<th>p</th>
<th>FPE</th>
<th>AIC</th>
<th>HQIC</th>
<th>SBIC</th>
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</thead>
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<td>4</td>
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<td>0,0146</td>
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</table>
Table 17: Estimating optimal lag for Belgium

<table>
<thead>
<tr>
<th>LL</th>
<th>LR</th>
<th>Lag</th>
<th>DF</th>
<th>p</th>
<th>FPE</th>
<th>AIC</th>
<th>HQIC</th>
<th>SBIC</th>
</tr>
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</tr>
</tbody>
</table>

LL = Log likelihood  
LR = Likelihood ratio  
DF = Degrees of freedom  
FPE = Final prediction error  
AIC = Akaike’s information criterion  
SBIC = Schwarz’s Bayesian information criterion  
HQIC = Hannan and Quinn information criterion