Okun's law in the Nordics

A time series analysis based on Okun's law

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Table of content

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Abstract:
In this thesis we examined the validity of Okun's law across four Nordic countries (Sweden, Norway, Finland and Denmark) using the gap version of Okun's law. Our method for analyzing the Okun's law for Nordic countries in this study is time series. We performed an Augmented-Dickey fuller test in order to test for stationarity, to which the result yielded all variables stationary. Our result, after running the regression of the gap version of Okun's law, confirms the existence of a negative relationship between unemployment rate and economic growth. However, the outcome indicates different Okun coefficients for the four Nordic countries within the time period of 1989-2018. In conclusion we can affirm that according to our result, the basic assumptions made by Okun regarding a negative correlation between unemployment rate and output still holds true today for Nordic countries, with the exception that the percentage decrease in unemployment rate when output increases by one percent varies across Nordic countries.

Abstrakt:
I denna uppsats undersökte vi validiteten av Okuns lag för fyra nordiska länder (Sverige, Norge, Finland och Danmark) hjälp av Okuns lag gap modellen. Vår metod för att analysera Okuns lag för de nordiska länderna i denna studie är tidsserier. Vi testade stationariteten i våra resultat från tidsserie regressionen via ett Augmented-Dickey fuller test, vilket indikerade att alla variabler var stationära. Vårt resultat, efter att ha utfört regressionen av gap versionen av Okuns lag, bekräftar förekomsten av ett negativt samband mellan arbetslöshet och ekonomisk tillväxt. Utfallet indikerar dock olika Okun-koefficienter för de fyra nordiska länderna inom tidsperioden 1989-2018. Sammanfattningsvis kan vi konstatera att enligt vårt resultat gäller de fundamentala antagandena för Okuns lag fortfarande idag för de nordiska länderna, med undantaget att den procentuella minskningen av arbetslösheten när produktionen ökar med en procent varierar mellan de nordiska länderna.

LIST OF ACRONYMS

GDP	Gross domestic product
NAIRU	Non-accelerating inflation rate of unemployment
NRU	Natural rate of unemployment
u	Unemployment rate
u*	Natural rate of unemployment
Y	Output
Y*	Potential Output

1. Introduction

This paper will investigate whether Okun's law is still relevant in more recent times and if its fundamental assumptions still hold true across four Nordic countries (Sweden, Norway, Finland and Denmark). The reason for writing about this subject is predominantly due to unemployment and economic growth being two major subjects of macroeconomics, Hall and Papell (2005). The research area in this study is Nordic countries' macroeconomy, more specifically how the unemployment rate is affected by the level of output within the Nordic economies.

Regarding earlier literature, there is an adequate amount of studies that have been done concerning unemployment rate and economic growth. The main reason being the importance of these subjects and its close relation to various macroeconomic topics. Ball and Loungani (2013) in their study “Okun's law: fit at fifty” The analyzed Okun’s law in 20 advanced economies, utilizing the Hodrick prescott filter for estimating the potential GDP and the natural rate of unemployment. The previous research made by Ball and Loungani (2013) will also contribute to the result and conclusion made from this paper with the difference being that the natural rate of unemployment will be obtained through the regression that this paper will use in order to calculate the level of sensitivity output will have on unemployment rate in the Nordic countries.

Another study done by Mutascu and Sokic (2021) has a different approach to Okun’s law and examines the interaction between the cyclical components of unemployment rate and the level of output in the USA. Mendonça and de Oliveira (2019) and Bräuninger and Markus (2002) also analyzed Okun’s law on OECD countries, focusing heavily on investigating the unemployment rate. A detailed explanation of the previous studies can be found in chapter three. The vast majority of the research regarding the natural rate of unemployment and Okun’s law has been done concerning either OECD countries or greater economies such as the USA. A common result that is indicated by most of the previous studies is the existence of a negative relationship between economic growth and unemployment rate. Due to the lack of research done specifically on Nordic countries, this study will aim to fill this void by

analyzing the relationship between unemployment rate and economic growth using the Okun's law.

It's noteworthy to mention that analyzing short run and long run time periods are also of great interest, because it will give further insights to better comprehend this subject Charles (2021). For this reason, both the short and long run periods will be analyzed. Economic models that are included in this study consist of Okun’s law and the Keynesian unemployment theory in order to give a broader perspective on the subject, however only Okun's law will be used in order to produce a single result for this paper.

This paper seeks to contribute and complement earlier studies conducted on unemployment rate and economic growth. The aim of the outcome for this research is to provide beneficial insights and deepen the perception of the relation between unemployment rate and economic growth for the Nordic countries.

The gap version of Okun's law will be this study’s main theory for examining this subject. The reason for applying Okun’s law as the main theory is because it describes the negative relationship between unemployment rate and economic growth thoroughly, and it also has been used as a rule of thumb in macroeconomic context since it was invented, Knotek (2007). The gap model also allows for the natural rate of unemployment to be estimated since this is a non-observable variable. Another feature that makes Okun’s law efficient is that it has three different models (Dynamic model, Gap model and the First difference model), which serves different purposes, thus utilizing this theory will enable a more elaborate and detailed examination of economic growth and unemployment Rahman and Mustafa (2017). This paper also aims to provide an initiative for further research and studies on Nordic countries' economies. Regarding the empirical method in this study, a time series method will be applied and data will be collected from the NASDAQ’s and OECD’s databases.

1.2 Background

According to Capehart (2019) the definition of natural rate of unemployment (NRU) , and non-accelerating inflation rate of unemployment (NAIR) are rather ambiguous among

academics. Economists such as Friedman (1967) were among the pioneers who tried to define the concept of NRU. Friedman argued that NRU is the rate of unemployment which is consistent with the existing real conditions in the labor market. NRU has also been defined as ‘equilibrium’, ‘steady state ’, ‘frictional ’ and ‘long run ’ Rogerson (1997). In today's world the definition of NRU is stated as the level of unemployment rate around which the actual unemployment fluctuates Levernier and Yang (2011).

When the American economist Arthur Okun presented the infamous equation, the main idea was to explain the changes in output denoted as GDP. In 1962 Okun’s article presented two equations which simply connected the rate of unemployment to real output. This paper made by Okun in 1962 has been used since then as a rule of thumb for macroeconomic analysis. Few years after the publication of Okun's law, the federal reserve stated that Okun’s law describes the decreasing rate of GDP when the unemployment rate is above its natural rate. The equation has been modified and changed multiple times by other economists within different fields in order for it to be applicable and fit to other theoretical areas as well, Knotek (2007). There have been a lot of critics on Okun's law since its creation. Mostly due to some arguments stating that the Okun’s coefficient is not stable and has been varying over time Knotek (2007) and Owyang and Sekhposan (2012). One of the main reasons for this claim is the 2008 financial crisis. Owyang and sekhposyan (2012) and Meyer and Tasci (2012) have criticized Okun’s law due to its simplicity and the lack of accounting for different economical factors like productivity and technology.

1.3 Research question

Does Okun's law still hold true in the Nordic countries?

1.4 Purpose

The aim of this thesis is to study and analyze the relationship between unemployment rate and output, measured in gross domestic product (GDP), across four Nordic countries (Sweden, Norway, Denmark and Finland). The method used in this paper will be the Okun's law, the gap model, which also allows an investigation on the relevance of the Okun's law

within the Nordics to be done in modern time. This study will analyze Okun's law during a thirty year time period between 1989-2018.

1.5 Delimitation

This paper is delimited on both countries and the time period. We are examining the four Nordic countries (Sweden, Finland, Norway and Denmark). The main objective for choosing Nordic countries is due to the lack of research conducted on these countries specifically to which this study would contribute to further studies. The reason for not including Iceland in this research is due to the lack of relevant data. The time period is between 1989-2018, the reason for choosing this specific time period is due to scarcity of reliable data on some of the countries.

1.6 Disposition

This thesis is organized as follows, in the first chapter an introduction of the research topic is presented, followed by a brief background of Okun's law, and then earlier studies that have been done about this research topic. The second chapter will explain the theories that will be utilized throughout this thesis, proceeding with a description of unemployment rate and growth. In the third chapter the previous studies will be presented and explained in depth their relevancy and use for this thesis. The fourth chapter is about the methodology, where descriptive statistics are provided for a better understanding of the variables used, as well as the conduction of an OLS estimation. The fourth chapter further explains the concept of stationarity as well as applying a Dickey-Fuller test. Chapter five is devoted to our results which is acquired from the OLS regression. In the sixth chapter the results are analyzed and a final conclusion is made from the study in chapter seven.

2. Theoretical framework

In this section the theoretical part of the study is presented. Implication of economic models and theories that are perfectly suitable and coordinated with our research topic is of great importance. Not only for the better understanding of the subject, but also for providing

different points of views on the topic. Firstly, Okun's law is introduced which consists of the relationship between a country's unemployment rate and economic growth. Understanding the relation between a country's unemployment rate and economic growth will help to better comprehend the concept of the natural rate of unemployment. Discussing this topic can also help for a better understanding of the relationship between unemployment rate and growth from different scenarios. The Keynesian unemployment theory will also be included in the theoretical framework for the main reason of giving a better understanding about unemployment and how it is affected by aggregate demand.

2.1 Okun's Law

This theory was constructed and created by the former economist and Yale professor Arthur Okun (1960) where the outcome of his studies displayed that when the unemployment rate decreases by one percent the country's GDP increases by three percent Edward and Knotek (2007), Mendonça and Oliveira (2019).

Okun's equation is a simple law with a straightforward idea to it. It will show how much of a country's output (GDP) will decrease when the unemployment rate exceeds its natural level. The theory proves that there is a correlation between the country's level of production and the level of active labor workers, the correlation is negative according to Okun's law meaning that when there is an increasing rate of unemployment, there will be less contribution to the economy's output thus leading to a decrease in output Prachowny (1993), Mendonça and Oliveira (2019).

As previously stated, Okun's law is a great theory to utilize when analyzing the fluctuations within a country's economy. However, there are in fact three different models of Okun's law when interpreting and measuring the relationship between unemployment rate and economic growth. Following will discuss and interpret the difference between the three models for the estimations of the Okun coefficient. The reason for explaining different versions of the Okun's law in this chapter, is to enhance and provide a thorough and detailed insight of the model, following those specifications of which model to use in this study will be explained.

2.1.1 The first difference model

By using a linear regression model, the first difference model will estimate the Okun's coefficient by denoting the rate of change in unemployment from the previously observed period as the dependent variable and the rate of change of output, or GDP as it is commonly used as the measurement of output, from the previous period as the independent variable Ball (2013) and Prachowny (1993). The model will be displayed as shown below by equation (1). Δ will operate as the differentiator and the $\beta 0$ will be the intercept term for which it will show the mean rate of growth. $\beta 1$ is the Okun coefficient, Y is the output, U is the unemployment, ε is the random error term and lastly t is the period observed Ball (2013) and Prachowny (1993).

$$\Delta Ut = \beta 0 + \beta 1 \Delta Yt + \varepsilon t \quad (1)$$

The first difference model is one of the most commonly used models when measuring the association between unemployment and economic growth through the Okun coefficient. This model will show the effect that the independent variable (output) has on the dependent variable (unemployment) during the same time period however this can come to be known as a dilemma as bias could occur due to simultaneous causality between unemployment and output.

2.1.3 The Gap version

The second model created by Okun takes a different approach on how to find the relationship between unemployment and economic growth. It estimates Okun's law based on the gap between the actual output and the potential level of output as well as the gap between actual unemployment rate and the natural rate of unemployment, equation (2) is as follows Ball (2013) and Prachowny (1993).

$$(\mathrm{u}t - \mathrm{u}t^*) = \beta 0 - \beta 1(\mathrm{Y}t - \mathrm{Y}t^*) + \varepsilon t \quad (2)$$

$\beta 0$ is the intercept, Y is the natural logarithm of GDP and $\mathrm{Y}t^*$ is the potential level of output in the time period t which means that $\mathrm{Y}t - \mathrm{Y}t^*$ = output gap. $\mathrm{u}t^*$ represents the natural rate

of unemployment in time period t which means that ut - ut* = the cyclical rate of unemployment, also known as the unemployment gap.

Economists such as Lee 2000 approached Okun's law differently, Lee set the output as a dependent variable for calculating the coefficient, which doesn't match with the original Okun equation. Lee meant that shocks do not affect unemployment, as it only affects the output. Chamberlin (2011) claims that potential output can be defined as "an equilibrium level of output where the economy can grow without experiencing inflationary or deflationary pressure". According to Ball (2013) inflation mechanism can explain the relationship of the underlying variables in the gap model. Ball also argues that shifts in the domestic demand have a negative effect on the competitiveness of the domestic goods. The cause for the shift in domestic demand happens though an accelerating inflation. When Domestic demands change, it will lead to a fluctuation in the output. This will force firms to react to such movements and start to hire and fire their workers. Since this model is based on the estimation of the variables potential output and the natural rate of unemployment, it means that some might interpret and measure these variables differently which could lead to different resulting coefficients.

In the gap version of Okun's law the attempt is toward finding the level of production to which the economy is fully employed Zeeshan (2010). The definition of full employment according to Okun is, the lowest rate of unemployment that can maximize economic growth. This level occurs at approximately four percent Okun (1962). This paper shall apply the gap model of Okun's law as the method to investigate the relevance of Okun's law. Due to the availability data regarding output gap, it is possible to estimate the Okun coefficient using the gap model. Usually, Potential output and the natural rate of unemployment is estimated using the Hodrick Prescott (HP) filter, which is to exclude cyclical components of the unemployment rate and remove the trend of inflation from actual GDP, this is also called smoothing the data Cogley and Nason (1995) and Cornett, Marcus, Saunders and Tehranian (2007).

2.1.4 The dynamic model

The third and last model is called the dynamic model which analyzes the previous level of output on the unemployment rate and corrects for omitted effects. It assumes that the currently observed level of change in output is affected by the previous as well as other periods of output in combination with previous periods of unemployment Knotek (2007). However, this model is not as easy to interpret as previous ones, although showing a more vigorous result it is not as commonly used as the Gap version or the First Difference model since it requires multiple lags of output and unemployment rate. The model is displayed as shown by equation (3).

$$\Delta u_t = \beta 0 + \beta 1 \Delta Y_t + \beta 2 \Delta Y_{t-1} + \beta 3 \Delta Y_{t-2} + \beta 4 \Delta u_{t-1} + \beta 5 \Delta u_{t-2} + \varepsilon_t \quad (3)$$

Δu_t represents the change in unemployment rate, $\beta 0$ is the intercept, $\beta 1 \Delta Y_t$ is the change in output and $\beta 2 \Delta Y_{t-1}$ as well as $\beta 3 \Delta Y_{t-2}$ are the first and second lagged rates of the total output growth. $\beta 4 \Delta u_{t-1}$ is the first lag of change in unemployment rate and $\beta 5 \Delta u_{t-2}$ is the second lag of change in unemployment rate. The lagged attribute of this model can provide a better explanatory power for the model.

2.1.5 Comparison of the models

To summarize these models, there are both pros and cons when estimating the Okun coefficient. The First Difference model shows its pros by displaying its simple lucidity which will give a result to interpret with ease, which explains why it is one of the most commonly used models. The con with the First Difference model is the fact that other models such as the Dynamic one will observe more of the contrast displayed by the unemployment rate over time, which is obviously a positive when using the dynamic model. The gap model usually requires output gap and unemployment rate to be estimated, it implies a big risk of a misinterpretation which could lead to invalid results and also a difficulty when discussing the result with previous studies however, the data for output gap is available for this study through Nasdaq's database which enables this study to estimate the natural rate of

unemployment thus making the gap model a better fit for this study and will be applied for every country.

2.2 Unemployment rate

In this part different types of unemployment will be explained (Frictional, structural, cyclical, and the non-accelerating inflation rate of unemployment (NAIRU)). Due to the fact that this study will be examining the relationship between unemployment rate and output, explaining different types of unemployment can help to better comprehend the interaction between the concept of economic growth and unemployment. Among economists, cyclical unemployment is the most commonly used which is defined as the cyclical change in output that causes the cyclical effect in unemployment Weber (1995). The cyclical unemployment will describe how it will increase during a recession or decrease during a boom.

The transitional state in the society occurs when perhaps the demand of supply decreases which will lead to a lower demand in labor, some workers might need to find a new job but might not be able to do so immediately. This is called frictional unemployment Reder (1969), which can be seen as both negative and positive. The negativities with frictional unemployment is obviously that unemployment rate increases, which would lead to lower output in society, and based on what the reasons were for the occurrence of the frictional unemployment it could lead to other negativities as well. But there are also some positive aspects, such as the opportunity of finding the right workers with the correct competence to better suit the job presenting itself García and Sorolla (2017) and Reder (1969).

Frictional unemployment is only one factor affecting the natural rate of unemployment, another factor that affects the natural rate of unemployment is something called structural unemployment Diamond (2013) and Kahn (2015). This is represented by the amount of workers that do not qualify for the job that the society demands labor for, these are workers who do not fulfill the amount of expertise required for the job. This could be the cause of a number of things, perhaps society do not require the skill that these people have, thus leading to lower demand in the work they pursue which leads to them seeking different jobs to which society has put a higher demand upon, and if they lack the expertise in those jobs they will be

put in a structural unemployment Diamond (2013) and Kahn (2015). Many believe that this ongoing problem of structural unemployment is enhanced by the developing technology, since people with a lower skill set have been put in structural unemployment because the demand for higher educated workers increases. A problem solver for this seems to be education which will decrease the rate of structural unemployment in the long run Diamond (2013) and Kahn (2015).

According to Claar (2006) Non-Accelerating inflation rate of unemployment (NAIRU), and natural rate of unemployment are not interchangeable. Grant (2002) conducted a study on NAIRU to which it concluded that NAIRU is an empirical macroeconomic relationship estimated by the Phillips curve. Grant also argued that the natural rate of unemployment is an equilibrium condition in the labor market, which reflects the microeconomic features of the market. NAIRU means that the unemployment rate is at a certain rate which doesn't lead to an increase in inflation Douglas, Stock and Watson (1997). This also indicates that if the rate of unemployment is at NAIRU, the rate of inflation is constant. A downside that is worth mentioning in the NAIRU model is that it doesn't consider other factors that affect the unemployment rate besides inflation. According to Heimberger, Kapeller, and Schütz (2017) and Watson (1997), there is no formula for calculating NAIRU level, thus the federal reserve uses statistical models and estimates that the NAIRU level is approximately between 5 to 6 percent for the US.

2.3 Relation between unemployment rate and growth

As mentioned earlier, Okun's law will be the central and major concept for explaining the relation between unemployment rate and economic growth. According to Chen and Semmler (2018), before Okun, classical economists such as Ricardo have already mentioned the relation between economic growth and unemployment rate. Ricardo asked whether the technical progress may impact employment positively or negatively. After publication of the Okun's law (1962) several authors such as Klador (1985), Tobin (1993) and Blanchard (1997), have been involved in the discussion of productivity and unemployment as well. Tobin (1993) points out that in the short run perspective, employment and output are driven by aggregated demand. In the long run, Tobin states that when the unemployed eventually

find a job their capital and skills have a persistent impact on output and long run economic growth. Kaldor (1985) argues that in the short run employment growth will be detached from output growth. Blanchard (1997) mentions that the time variation of the labor market participation rate has to be considered when analyzing the relation between unemployment and productivity.

According to Clemente, Lanaspa and Montañés (2005) and Levine (2012), in order to analyze the relationship between unemployment and growth, both short and long run periods must be considered. In the short run unemployment rate and growth usually have an unsteady relation and the unemployment rate may illustrate sustained decline Levine (2012). The reason for this is when the economy recovers from a recession some firms may underutilize their workers on their payrolls.

Researchers like Pissarides (1990), Aghion and Howit (1994) and Mortensen (1998) have been working on the effect of technological progress on economic growth and unemployment rate. They argued that the type of technological progress can determine the direction of a change in unemployment rate, while its impact on economic growth is rather straightforward. The research made by Pissarides introduced a negative relation between economic growth and unemployment rate, which later was called the capitalization effect. Bean and Pissarides (1993), also mentions another concept which is called the pool of saving effects. This concept simply implies that unemployment adversely affects capital accumulation by reducing the amount of savings, which leads to a slowdown in economic growth. Creative destruction effect is another interpretation that was introduced by two economists Aghion and Howitt (1994). They mean that innovation leads to labor force allocation, this is caused by an increased cost of human capital. Determination of the impact of economic growth on unemployment rate has mainly two factors. Firstly a direct creative destruction effect, leading to an increased unemployment rate under economic growth conditions and secondly, an indirect creative destruction effect which leads to decreased number of job vacancies. This is equivalent to an increase in the unemployment rate.

According to Dixon and Shepherd (2000), the unemployment rate is mainly dependent on the relative growth rates of labor force and employment. They also mention that the level of

production is a factor that the amount of employment that has been produced across the economy. In the article written by Dixon and Shepherd, they conclude that the movements in the unemployment rate reflect a rather complicated set of macroeconomic forces that indicates its difficulty to explain the movements. That is to say, increasing and decreasing rates of unemployment with only one single source such as economic growth. further Dixon and Shepherd describe that the analysis illustrates that the correlation between economic growth and unemployment rate is highly variable. The outcome is correlated to several factors such as labor productivity, labor force and employment.

2.4 Keynesian unemployment theory

The Keynesian unemployment theory, often referred to as the cyclical unemployment theory, was created by John Maynard Keynes and relies on the premise of this theory on the assumption that unemployment increases as the country's aggregated demand is decreasing. This is explained as when the aggregated demand for goods and services decreases there will be a lower level of incentive to produce those goods and services which will lead to less active labor workers Palley (2019).

The reason this theory is often referred to as a cyclical theory is in view of the fact that a country's economic situation will always fluctuate, it will enter different phases that are characterized by different levels of unemployment, inflation and so on. When a country enters a ´´boom´´ phase it will reach a higher level of employment due to a higher level of aggregate demand, and vice versa when entering a recession Palley (2019). Keynes's conclusion to this occurring problem of cyclistical behavior on the labor market is to involve the government through fiscal policies that will stabilize the transitional phase between a recession and an increase of aggregate demand and employment.

To summarize this section, starting with a background of the relationship between unemployment rate and economic growth as well as explaining the Okun's law and establishing the gap model applicable method for this paper. Then explained the unemployment rate and economic growth relation in the short-run and long-run. Afterwards, the impact of technology on economic growth, continuing with a discussion about the factors

that affect the movements of the unemployment rate (capitalization effect and pool of saving effect), as well as the introduction of the Keynesian unemployment theory. The purpose of introducing different viewpoints to the research topic in this chapter was, to provide an extensive explanation of the relationship between economic growth and unemployment rate, which will give a more comprehensive background to our research subject. Due to the different approaches to the relationship between unemployment rate and economic growth, it is not easy to find a general definition which is agreed upon by all economists. But one point that is clear and is agreed among most economists, is the basic idea of the Okun's law, which is the existence of a negative relation between unemployment rate and economic growth.

3. Previous studies

This chapter will consist of the literature and previous studies that this paper will take inspiration from. Explanations as to why and how these papers will help this study in completing the research will also be included. Six papers have been selected that will provide this study with insights and guidance. Five of the literatures concern the Okun's law Ferreirade Mendonça and Oliveira (2019), Mutascu and Sokic (2021), Fernández, Prieto, Sáez (2018), Rahman and Mustafa (2015) and Ball and Loungani (2017). The remaining one by Bräuninger and Pannenberg (2002) describes and focuses mostly on unemployment rate and economic growth. The main reason for selecting these specific studies are because of their relevancy of the content, and the efficient yet simple way of explaining and approaching our research topic.

Okun's law and its importance in the economic world has attracted lots of attention from economists. There are an incredible amount of studies that have been done, which covers this subject from different angles. One study regarding Okun's law that takes a deep and detailed approach on this subject is "Firm's confidence and Okun's law in OECD countries" by Mendonça and Oliveira (2019). In this study the main objective is to analyze three basic concepts. Firstly, what does the relationship between firm's confidence and Okun's law look like, secondly, the effects the update of firm's confidence has on the Okun's coefficient. Thirdly, the link change that occurs by updating the firm's confidence between unemployment rate and output growth. For the methodology part the authors choose panel

quarterly data, and the time period is from 2001-2016. The result of the study indicates that the link between economic growth and unemployment rate changes, due to the updates of firms' confidence both on medium-term and persistent-term.

Among several studies that this thesis will take inspiration from, one that stands out slightly is unemployment and productivity growth, an empirical analysis within an augmented Solow model by Bräuninger, Pannenberg (2002). This paper attempts to understand whether a country's level of unemployment affects the long run growth rate or not? To answer this question, they apply the generalized Solow type growth model, and also use the neoclassical framework for analyzing the subject. The reason for this is that the traditional Solow model does not illustrate any long run influence on economic growth rate and productivity. Through application of panel data and utilizing the results from 13 OECD countries, they demonstrate an increase in unemployment rate down the long-run level of productivity. The main factors that cause the negative effect of an increase in unemployment rate are reduced savings, capital accumulation and learning by doing.

Since the invention of the Okun's it has been examined from different views, an interesting approach which concerns the validity of Okun's law for 13 different countries has been done by Rahman and Mustafa (2015). The study concerns the time between 1970-2013 and tests the cointegrating relationship between unemployment and GDP growth. They apply two

different tests in this study: the first one is the λ max and λ trace test which tests the cointegrating relationship between unemployment rate and GDP growth and the second one is a dynamic OLS. The result of the sound test however illustrates a different picture. That is when they apply the error-correction model (ECM) it demonstrates that Okun's law is valid only for two countries, USA and South Korea. The author's suggestions regarding policy implications for different countries are also quite interesting. The suggestion for the USA and South Korea according to the study is that mitigating unemployment by intensifying real GDP growth through expansionary fiscal policy will lead to economic success. For Germany on the other hand the suggestion is to make its labor market more flexible. Other countries will not witness development by applying the same policies due to their inflexible markets. Those countries should concentrate on promoting structural changes and invest in improving

and rehabilitating the labor market. This could be done by greater wage flexibility and an increase in employers' freedom to hire and fire workers. This study has been a valuable resource and guide for this thesis due to its helpful usage of theory and methods. Also, the description of the results on the empirical part was quite insightful which deepened our understanding of the Okun's law.

Another study concerning Okun's law has been done by three economists from Spain named Fernández, Prieto and Pascual (2018). This paper analyzes Okun's law and considers the effect of age and gender. The main methodological approach used in this study is Panel data, and the time period was considered from 2005-2017. While examining the relation between unemployment and growth it appears from the result of the study that, there is a clear difference when it comes to unemployment rates in the southern Europe area. The unemployment rate is usually higher in these areas, and the reason for the high unemployment rate is thought to be the higher impact of the economic crisis in these areas. It has also been clear from hypothesis results that there is an inverse relationship between unemployment and GDP. Also, they found that developed European countries experience smaller output loss while having higher unemployment rate. The suggested solution for the unemployment problem in this study is that different policies from policy makers are needed in each country in order to minimize the level of unemployment rate. That is designing several ways to increase employment opportunities for different groups.

In the literature world lots of economists have been working on the correlation between Okun's law with different economical topics. One study that stands out, and this thesis will be relying on when writing this paper is called, Okun's law in the US: New insights in time and frequency by Mutascu and Sokic (2021). Their focus on this work is mainly on analyzing the interaction between the cyclical components of unemployment and output in the US, through usage of the wavelet tool. Wavelet tool has the advantage of illustrating the relationship between economic variables in the-time frequency space. The time period that this study is considered is from 1948-2020. Result of this paper illustrates a new direction and duration of co-movement between the cyclical components of output and unemployment. They analyze the effect of Okun's law in different periods including short run, medium-term and long run. In the short run it appears that only under socio economic shocks Okun's effect

is valid. In the medium-term, GDP negatively drives unemployment at the business cycle which proves the existence of cyclical unemployment. In the long-term unemployment negatively runs GDP, that is proposing the existence of classical unemployment.

Suggested solution about policy application according to this study is that US policy makers should adapt their interventions. In the short run the suggestion is expansionary fiscal-policy and avoiding monetary policy. This will stimulate aggregate demand and production which leads to a decrease of temporary unemployment. In the medium-term the policy should be based on aggregate demand. That is during recessions applying expansionary policy and vice versa during a booming economy. In the long-term the suggestions are no intervention at all, because the US economy has demonstrated a strong self-corrective behavior.

In the paper published by Ball and Loungani (2017) they analyze the Okun's relation in the USA and 20 advanced countries. They utilize the Hodrick-Prescott filter to estimate the natural rate of unemployment and the potential GDP. The result of their study indicates that the Okun's relationship is true in most of the countries. Their result also illustrates that the Okun's coefficient change rate of one percent in output on unemployment differs between countries. This change, they argue, could be explained by distinctive features of the national labor market.

To summarize this chapter, six studies have been introduced and explained regarding Okun's law and the relation between unemployment and growth. The studies concerning Okun's law provide different approaches and methods which improved our comprehension of the topic, and the studies regarding unemployment and growth introduced and explained the impacts of the important factors on unemployment and growth. As mentioned in the introduction part, this thesis will follow the same principle of approaching Okun's law as Ball and Loungani (2017), with the difference being that in this thesis the natural rate of unemployment will be calculated instead of using the HP filter to estimate potential GDP and the natural rate of unemployment.

Table 1: Summary of previous studies

Author	Subject	Result
Ferreirade Mendonça and Diego S.P.de Oliveira (2019)	Okun's law in OECD countries	link between growth and unemployment changes, due to the updates of firm's confidence both on medium-term and persistent-term..
Bräuninger & Pannenberg (2002)	Whether a country's level of unemployment affects the long run growth rate or not?	The main factors that cause the negative effect of an increase in unemployment rate are, reduced savings, capital accumulation and learning by doing.
Matiur Rahman and Muhammad Mustafa (2015)	Validity of Okun's law for 13 different countries.	Okun's law is valid only for two countries, the USA and South Korea.

Fernández, Cantarero-Prieto, Pascual-Sáez (2018)	Okun’s law and effect of age and gender.	Existence of an inverse relationship between unemployment and GDP, and that European countries experience smaller output loss while having higher unemployment rate
Mutascu & Sokic (2021)	Okun's law in the US	Result of this paper illustrates a new direction and duration of co-movement between the cyclical components of output and unemployment
Ball and Loungani (2017)	Okun’s relation in the USA and 20 advanced countries, using the HP filter.	The result of their study indicates that the Okun’s relationship is true in most of the countries. Their result also illustrates that the Okun’s coefficient change rate of one percent in output on unemployment differs between countries.

4. Methodology

In this section the choice of econometric model and methodology will be explained in greater detail and present the analytical choice of the empirical data as well as the sources that this study will use for gathering our data.

According to Scott and Hayes (2021) time series could be defined as a sequence of datasets that occur in successive order over time. The attribute of time series is that it allows us to see what factors affect certain variables from one period to another. The time-series method has been used widely among economists such as Silvapulle, P. Moosa and Silvapulle. In a paper published by Silvapulle, Moosa and J. Silvapulle (2004) they explain the concept of structural

time series, which basically means extracting the cyclical components of output and unemployment. This method is also called Harvey's (1989) structural time series. Based on these studies, the choice of method will be of a quantitative type which will consist of time series data that takes an individual, in this case a country, and observes it over *t* amount of time. Since this type of data observation lets us study this analytical problem over a longer period of time it is of greater interest to use time series data instead of cross sectional data. The same goes for not using panel data as the choice of method to analyze our gathered data as it is not a fitting method when only comparing four countries, such small sample testing is not suited for panel data thus leaving us with time series data as the more optimal choice.

The four different countries that will be observed in this study are Sweden, Norway, Finland and Denmark. The program Excel will be used in order to gather the statistical information from the chosen databases that are OECD's and Nasdaq's data platform. For the econometric regression analysis, the software programme R-studio will be used as the tool to create a time-series regression for each country, the regression will then provide necessary data to apply into the Okun equation. This method will be applied for all four Nordic countries, and the results will be compared between all countries in the discussion part of the study, where the previous studies will be taken into account when comparing the results. Annual data will be used and gathered from previously mentioned databases to compile the result, annual data will be chosen as this was the only available data.

As previously mentioned, Okun's law is the main theory for this research in investigating the relationship between unemployment rate and output where the gap model of Okun's law will be applied for each country. The difference between this research paper and the one made by Okun (1962) is that the variables needed for the equation were not observable at the time and thus needed to be estimated. However, the data for output gap is now an observable variable that dates back to 1989 for each country related to this study. This alludes to using a modified equation of the one originally made by Okun for the gap model which is stated as equation (4), where the independent variable is the output gap gathered from Nasdaq's database and the dependent variable is unemployment rate gathered from OECD's database. The result collected from running the regression will imply that the value of $\beta 0$ will be equal to the natural rate of unemployment for the observed country, and the result gathered from $\beta 1$ will

be equal to the Okun coefficient which will show the sensitivity of output gap in relation to unemployment rate.

$$ut=\beta 0 - \beta 1(\text{OutputGap}) + \varepsilon t \quad (4)$$

4.1 Variables

Since the data for the variables unemployment rate and output gap will be collected from OECD's and Nasdaq's databases, the definition of these macroeconomic terms will be presented in accordance with the chosen databases' statistical concepts.

4.1.1 Output gap

Output gap will be the independent variable for equation (4) and represents the difference between the actual output an economy produces and the potential output. The output gap is calculated as actual GDP less potential GDP as a percent of potential GDP. In order to comprehend what the value of output gap captures, we will break it down into the two components that make up for the variable output gap. The data for the estimated output gap for each country will be gathered from Nasdaq's database and will be used in order to measure the remaining variable, natural rate of unemployment (u*), as well as measure the sensitivity of how output affects the unemployment rate. The explanation of this variable will be in accordance with the definition made by Nasdaq.

4.1.1.1 GDP

As previously mentioned, there are different ways of measuring the concept of output. According to Nasdaq's database, the most common approach is by denoting it as GDP (gross domestic product) as it is one of the standardized measurements of the value added that is assembled through the production of all goods and services in a country during a chosen time period and as such it will take into account the income earned from that production. According to Nasdaq's database, this indicator is based on nominal GDP which measures the GDP at current prices, the currency chosen to measure GDP in this study will be in MUSD (Million USD). The chosen countries for this study have all compiled their data in accordance with the 2008 system of national accounts.

4.1.1.2 Potential GDP

Potential GDP is the total level of output that a country will attain when the inflation is stagnated and remains at a non-accelerating rate. The level of potential output and the output gap is an estimated trend that will determine the medium-term pace of which growth will remain sustainable for an economy, as well as the short term benchmark for which inflationary pressure is needed.

4.1.2 Unemployment rate

Unemployment rate will be the dependent variable for the regression model, the data will be gathered from OECD's database and will help with estimating the value of u*. The definition of unemployment rate according to OECD's database are the people within a country that are if working age but are out of the labor market i.e. Without employment but are still available for work and are in the process of finding work. The application of this definition will result in some estimates of unemployment rate that are more suitable for comparisons internationally. The indicator of unemployment rate is measured in numbers of unemployed people as a percentage of the total labor force, which is the total number of unemployed people combined with those already in employment, within the country and it is seasonally adjusted data.

4.1.3 Natural rate of unemployment

Natural rate of unemployment is defined as the minimum rate of unemployment that is a result of real or voluntary economic forces Capehart (2019). Natural rate of unemployment reflects the amount of the labor force that are unemployed because of the structure of the labor force. For example, workers that are laid off due to lack of skills, or those whose job has been replaced by technology Cogley and Nason (1995). According to Blanchard and Katz (1997) natural rate of unemployment could also be defined as the movement of labor force in and out of unemployment that could be voluntary or mandatory, when demand and supply for labor force is at equilibrium the lowest unemployment rate that occurs could be defined as the natural rate of unemployment. The natural rate of unemployment explains the reason why

there is never a level of unemployment at 0 %. The concept of the natural level of unemployment is explained by the simultaneous existence of social, political and economic factors while the economy is not in a recession or in a booming phase.

Since u* is an non-observable variable due to no accessibility of data, the natural rate of unemployment will be drafted from equation (4) by plotting the output gap against the unemployment rate. The intercept that will be $\beta 0$, will give us the natural rate of unemployment which will be a constant value and a non-time varying variable.

4.2 Descriptive statistics

Descriptive statistics will include number of observations, minimum value, maximum value, the mean and the standard deviation of each variable used in the equation for each country and will be presented in table 2 as shown below. The time period for the data gathered is between 1989-2018. Due to the u* not being an observable variable and needs to be estimated through the regression itself, the statistics for u* will be presented in chapter five where the regression results are presented.

Table 2: Descriptive statistics

Variable	Obs	Min	Max	Mean.	StdDev
u Sweden	30	1.55833	9.89167	7.01056	2.04634
Output gap Sweden	30	-5.62	4.886	-0.05603	2.46093
u Norway	30	2.71667	5.95	4.17556	0.88568
Output gap Norway	30	-2.181	2.63	-0.18363	1.2428

u Denmark	30	3.70833	9.55	6.12722	1.5231
Output gap Denmark	30	-3.576	3.628	-0.13157	1.7042
u Finland	30	3.10833	16.5833	9.3725	3.22611
Output gap Finland	30	-6.998	6.864	-0.37103	3.39924

4.3 OLS

To estimate the models so that the result can be reliable and consistent, an ordinary least squares method will be applied (OLS), and by minimizing the sum of squares in the residuals the regression can therefore estimate the relationship between our dependent and independent variable. The equation that will be used for the OLS estimator model is the equation for the gap model (equation (2)), which will be applied to all four Nordic countries individually over a Thirty-year time period, this choice of method is a quantitative type which will consist of time series data. Since this type of data observation enables us to study the analytical problem over a longer period of time, it is of greater interest to use time series data instead of cross sectional or panel data, since panel data would be a better fitting method when the total number of countries observed is of a larger magnitude.

4.4 Stationarity

Since the chosen method of data is time series it will be of the utmost importance to test our variables for stationarity. When dealing with time-series data there is a basic condition which states that it is stationary and in order to test this stationarity we will perform a test called the Augmented Dickey-Fuller test to then see if our dataset is of valid use for this study or not, if our variables are shown to be non-stationary we will have a invalid set of data since the variables will be a trend of time Stock & Watson (2015). The testing of a Dickey-fuller test is

through a hypothesis testing with an alternative hypothesis, where the time-series is stationary, and a null hypothesis where the time-series is non-stationary. The test will be applied for all the variables used in the linear regression. If the p-value conducted from the Dickey-Fuller test is above 5% we will fail to reject the null hypothesis and the tested variable is deemed as non-stationary at the first difference level. If the p-value is below 5% we can reject the null hypothesis and the variable is stationary. As shown by the results in table 3 we will perform the Augmented Dickey-Fuller test on our variables GDP gap and unemployment rate in order to see if they are stationary for all four Nordic countries.

$H0$: The variables are non-stationary.

$H1$: The variables are stationary.

Table: 3 Augmented Dickey-Fuller test

Country	**GDP GAP P-value**	**Unemployment rate P-value**
Sweden	>0.01	>0.01
Norway	>0.01	>0.01
Denmark	0.014	0.039
Finland	0.037	0.043

Since all the variables received a P-value below 5% for the Dickey-Fuller test, we can therefore reject the null hypothesis because all the variables are stationary thus leading the time series to not be a function of time for all countries

To summarize this chapter, we initiated this section by demonstrating the descriptive statistics table, furthermore we went through the ordinary least squares (OLS) method, following that we also described a concept of which is related to the research subject through

a Dickey-Fuller test which was made in order to test for stationarity amongst the variables used for the equation.

5. Results

In this section of the study the results of the regression will be compiled and presented. The following table will display the regression result for each country and will exhibit the intercept, their Okun's coefficient, their t-value, their standard error and the goodness of fit (R squared adjusted).

5.1 Regression result

The regression results are presented in table (4) and were obtained by running a simple time-series regression individually for each country in order to measure the sensitivity between unemployment rate and output as well as the natural rate of unemployment. As stated before we will use the modified version of the gap model of Okun's law which uses the gap between actual unemployment and potential unemployment, as well as actual GDP and potential GDP to estimate the relationship between the two variables. Presented below is the equation applied to create the regression results shown in table 5.

$$ut=\beta 0 - \beta 1(\text{OutputGap}) + \varepsilon t \qquad (4)$$

Table: 4 Regression results

Country	**Intercept**	**t-value**	**Std. Error**	**Okun Coefficient**	**t-value**	**Std. Error**	**R2 Adjusted**
Sweden	6.978***	25.175	0.2772	-0.569***	-4.971	0.114	0.5
Norway	4.059***	35.132	0.11619	-0.521 ***	-5.725	0.091	0.532
Denmark	5.990***	40.625	0.14836	-0.689***	-6.263	0.110	0.717

Finland	9.137***	20.356	0.4489	-0.633***	-4.749	0.133	0.531

*Note: Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*

Table 4 shows the regression results of all four Nordic countries between the time period 1989-2018, the intercept displays the natural rate of unemployment for each country and the Okun coefficient represents the sensitivity of the relation between output gap and unemployment rate. The adjusted R2 will show a more precise review of the correlation between the variables.

6. Analysis

By conducting the results from the regression presented in the previous part of the study we can identify the correlation and relationship between unemployment rate and economic growth, and by taking a look at the intercept we are able to compare the natural rate of unemployment between each country, as well as looking at $\beta 1$ we can assess the result for the Okun coefficient. The result gathered shows a negative correlation between unemployment rate and economic growth for all four of the Nordic countries during the period 1989-2018, and a natural rate of unemployment that differs between the countries. Although a negative and a significant correlation between the variables was shown, and therefore corresponds to the results from (Fernandez et al. 2018), the value of the Okun coefficient varies greatly between the countries which could lead to uncertainty when drawing a conclusion from this result.

6.1 Sweden

Sweden's Okun coefficient shows that there is a negative relationship between unemployment and GDP that displays from 1989 to 2018. As shown in table 4 the Okun coefficient indicates that for a one percent increase in output gap we will see a decrease in unemployment rate by approximately 0.569%. When we take a look at the adjusted R2 we can see that it received a value of 0.5 which indicates that the variation of the dependent

variable unemployment rate can be explained by our independent variable output gap at a 50% level. These values are, in comparison to the other countries, relatively low and would therefore suggests that the Swedish economy does not have a great impact on the labor market or that the goodness of fit for this equation is not strong enough and more independent variables need to be added in order to get a better understanding of what actually causes the variation in unemployment rate for Sweden.

6.2 Norway

The Okun Coefficient for Norway yielded a fully significant value of -0.521 which indicates that a 1% increase in output gap leads to a 0.521% decrease in unemployment rate. The adjusted R2 was 0.532 which tells us that the variation in unemployment rate can be explained by the output from the economy at a 53.2% level. Norway's regression results were the lowest out of the four countries, this would stipulate a labor market that is insensitive to when the output is deviating from its potential levels.

6.3 Denmark

Denmark’s Okun coefficient was the highest out of all the Nordic countries at a value of -0.689 which designates that for every 1% increase in output gap, the unemployment rate will decrease by approximately 0.689%. Denmark’s labor market is the most sensitive to change in economic output out of all four Nordic countries. Their adjusted R2 level was also the highest out of the four Nordic countries, which tells us that the gap between the potential level of GDP and the actual level of GDP can explain approximately 71.7% of their change in unemployment rate.

6.4 Finland

Finland had one of the highest Okun coefficients with a value of -0.633 which means that unemployment rate reduces by 0.633 % for every 1% increase in output gap, this would also indicate that the Finnish labor market is quite sensitive to inflation or deflation in their economy. They also yielded a R2 value of 0.531 which indicates that the output gap would

explain for 53.1% of the increase or decrease in unemployment rate during the time period 1989-2018.

6.5 Comparison between the countries and previous studies

When comparing all four countries, we will have to take into consideration all the relevant variables that the regression model was built of. Beginning with the intercept which was, as mentioned before, the rate of unemployment when inflation is constant (Capehart. 2019) and is therefore a non-time varying variable that is constant. The intercept from each country is the natural rate of unemployment in percent and yielded a result of which was quite varying between the countries. The lowest being Norway with 4.059 displaying a natural rate of unemployment of 4.059%, and the highest being Finland with 9.137, displaying a natural rate of unemployment of 9.137%. The remaining two countries, Sweden and Denmark, yielded a result of 6.978 respectively 5.990 which would result in a value for natural rate of unemployment of 6.978% as well as 5.990%.

When analyzing these results we can see a correlation between the level of actual unemployment and the natural rate of unemployment. Norway having the smallest intercept out of all countries also had the lowest level of mean value as well as the lowest level of standard deviation for their actual unemployment as shown in table 2. What also can be seen is Finland with the biggest intercept simultaneously having the highest mean value as well as the highest standard deviation for unemployment. Sweden and Denmark shared a more similar level of u* and concurrently their data for unemployment rate was also more alike when compared to Norway and Finland, as seen in table 2.

Table 4 displays the results for the relationship between unemployment rate and output gap which varies between the Nordic countries, and the statement regarding the fact that for every 3% increase in GDP we would see a 1% decrease in unemployment made by Edward and Knotek (2007), does not hold true for the Nordic countries. However, the original statement made by Arthur Okun (1962) and a statement that was later on proven to be true again with more recent data by Mutascu & Sokic (2021), shows that there is a negative correlation

between the unemployment rate and output. This holds true for every country observed in this study and also goes in align with previous research made from Ball et al. (2013), Bräuninger & Pannenberg (2002), Fernández et al. (2018), Matiur.R & Muhammad.M (2015).

The Okun coefficients for all countries were all statistically significant at a higher level than all the previous studies have shown which would therefore indicate that the results from this paper is to be deemed as more robust in comparison to the previous studies made on this topic. The results from this study have also shown that the Okun coefficient is larger for all four countries when compared to what has been studied in previous research. However, what should not be excluded when analyzing these results and comparing to previous studies is the slight difference in the method used as well as the time period of which the study was based. This study did not use the likes of HP-filter as a method for conducting the values of natural rate of unemployment and the potential level of output, instead the data for output gap was available on Nasdaq's database and the data for u* was conducted from the intercept when running the time-series regression. This could possibly play a big difference as to why the results from this study yielded a larger absolute value for the Okun coefficient when compared to previous studies such as one made by Ball and Loungani (2017).

In the study made by Ball and Loungani (2017) they received an average value for adjusted R2 at 0.62 which is, compared to this study's average adjusted R2 of 0.57, larger and would then suggest that the fit for this equation for these countries are not as precise as it could be. The study made by Ball and Loungani (2017) also came to a conclusion that the countries with larger adjusted R2 result in higher coefficients, to which this study cannot come to the same conclusion as the results in table 4 show that Norway whose coefficient was the lowest out of the four but received a value for adjusted R2 which was the second highest. This should also be considered when assessing the conclusion of the robustness and validation of the regression results.

7. Conclusion and limitations

The purpose of this study was to examine the macroeconomic correlation between output and unemployment rate within the Nordic countries. This study used the methodology of Okun's

law in order to formulate a time-series regression that then would present the sensitivity between output gap and unemployment rate to which this study also has compared between the Nordic countries, as well as with previous studies. This study used unemployment rate as the dependent variable and the output gap as the independent variable in order to measure the relationship between economic growth and unemployment rate through Okun's law.

The conclusion that can be made by the results from study is that the fundamentals and the basic assumptions from Okun's law about the relationship between unemployment rate and output is still relevant in today's economy for the Nordic countries Okun (1962), the coefficient for each country produced a fully significant result and proved the negative correlation between the dependent and independent variables to be true. However, one assumption that we can not ascertain to be true in today's economy for the Nordic countries is that for each percentage increase in output the unemployment should decrease by three percent, since this does not hold true for any country in this study.

A limitation in this thesis needs to be considered. The estimated natural rate of unemployment proved to be different for each country with the results quite widely spread. However, the natural rate of unemployment was not investigated as the relation between unemployment rate and output was. This limits any robust conclusion regarding the natural rate of unemployment to be made through this thesis.

Even though all the coefficients were highly significant, the validity of the results could still be evaluated as not fully trustworthy due to the adjusted R2 is in comparison to previous research not being as high which could indicate that the fit for the regression model is not as adequate as previous studies would suggest. Further studies would therefore need to be made considering the Okun's law in order to assure the fact of what more potential variables could affect the unemployment rate.

Furthermore, what needs to be taken into account is the fact that this study did not use the same methodology in estimating the variables for the regression as previous studies have. This study used the estimated variable of output gap gathered from Nasdaq's database as the independent variable, whereas all of the previous studies used a HP-filter to estimate the

remaining unobservable variables natural rate of unemployment and output gap. This also affects the validity when comparing the results of this thesis to the previous studies.

As a final conclusion to this study, the overall result and the main research question have proven to be true in today's Nordic countries however, to further assure the validity of Okun's law, more in depth studies need to be done in order to receive a more detailed and valid explanation for what actually causes the natural rate of unemployment to differ between the countries as well as comparing the different versions of Okun's law to further assure the validity of this theory.

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