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Are Denmark, Norway and Sweden an optimum currency area?

A study of economic covariation, real exchange rate, the relation between inflation and unemployment and the degree of openness

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1. Introduction

In 1873-1913 Denmark, Norway and Sweden were a currency area. Since then new currency areas have advanced around the world, and countries have become more open and integrated. The most recent formed currency area in Europe is the EMU, which Denmark, Norway, and Sweden have not joined. Because of the development in the world, and the Nordic cooperation, an interesting question is if it would be possible for Denmark, Norway and Sweden to form a currency area once again.

In this paper we analyze if Denmark, Norway and Sweden would be an optimum currency area. There are economical, historical, political, cultural, and other reasons for forming a currency area. We have chosen a few of the economical factors: the covariation in economic activities, the real exchange rate, the relation between inflation and unemployment, and the degree of openness. First we wanted to analyze how the three countries are affected by endogenous and exogenous shocks, therefor we chose to analyze the covariation in economic activities and the differences real exchange rate. Secondly, how the unemployment rate of the three countries are affected by a common inflation rate. Finally we wished to study the trade between the three countries, which is done though analyzing the degree of openness. These economical factors are just some of the important factors that should be analyzed before deciding to form a currency area.

The theoretical framework, which this paper is based on, comes from previous papers made by Mundell, Tavlas, Kenen, Jonung and Sjöholm, and others. These papers analyze the advantages and disadvantages of joining a currency area and the key factors that the members should fulfill. Statistical data is collected from reliable sources, such as the International Monetary Fund, the Nordic Cooperation and Eurostat. We have chosen to analyze data from 1971-2013 and 1990-2013, depending on which data that is available. Theories as the Phillips curve and purchasing power parity are also used to analyze the data.

The paper is organized as followed: the first section discusses the theories of optimum currency areas and the Phillips curve. The second section contains the economical background of the three countries and the forth section the empirical analysis. The fourth and final section contains the conclusions of this paper.

2. Theory

2.1. Definition of a currency area

A currency area, a monetary union and a currency union are the same thing. They refer to a geographical area that has the same currency, central bank and monetary policy. A currency area can be a country, such as Denmark, Norway or Sweden, but also many countries, such as the EMU. A currency area has a fixed exchange rate, which means that all the members of the area use the same currency and have the same exchange rate with the rest of the world (Fregert & Jonung, 2010).

2.2. Theories of optimum currency areas

There has been much research about optimum currency areas. Robert Mundell's theoretical foundation "The theory of optimum currency area" discusses the risks for asymmetric disturbances within the area and how these can be avoided. He also discusses when a country with an independent monetary policy should join a currency area and when they should not (1961). Since then, many researchers have extended and modified his work.[1] The main focuses of the literature are on the advantages and disadvantages of adopting a common currency and the characters of the potential members.

2.2.1. Advantages

The advantages of a common currency are seen at the microeconomic level. One advantage is that the transaction costs will go down. There will be no costs for exchanging currencies while trading inside the currency area (Tavlas, 1993). The elimination of transaction costs also has an indirect effect; it leads to greater price transparency. Consumers will be able to see the prices in the same currency and therefore compare prices between the countries, and competition should increase (de Grauwe, 2012, p. 55). This can also be described through the purchasing power parity (PPP). PPP states that ignoring transport costs, tax differentials and trade restrictions, homogenous goods and services should have the same price in two countries after converting the prices into a common currency. If the prices are different there will be an arbitrage opportunity, and adjustments will be made by the market to eliminate it. The absolute PPP[2] states that the real exchange rate is equal to 1, and because of that the theory usually fails. In the short run the deviation is significantly different from 1, but in the long run the deviation is slowly eliminated (Daniels & Van Hoose, 2014, pp. 49-51).

Another advantage is that the exchange risk is eliminated between the members of the area. It makes it possible for exporters and importers to be more certain about the price they will have to pay or receive on foreign goods and services (Tavlas, 1993).

[1] See for example McKinnon (1963), Kenen (1969) and Tavlas (1993).

[2] See appendix 1 for mathematical formula (1).

A final advantage is that a common currency will encourage trade within the currency area, and this will have a positive effect on output and consumption (Alesina & Barro, 2002). The integration on the goods, services, labor and capital market will improve, which will lead to economic growth (Fregert & Jonung, 2010).

2.2.2. Disadvantages

The disadvantages of joining a currency area are seen at the macroeconomic level. Each country will not be able to use their own monetary and exchange rate policies to absorb domestic and foreign disturbances; instead they will have a common monetary and exchange rate policy.

Another disadvantage is that the countries cannot use their floating exchange rate as protection against economic shocks. If the shocks are symmetric, they affect the countries of the area the same way. This means having the same currency will not be a problem because a common policy can solve the problems due to the shock. When an asymmetric shock occurs, it hits the countries differently, and with a common policy these shocks will be difficult to counter. The shocks can be endogenous, generated inside the country, and are generally caused by economic policies. They can also be exogenous, generated outside the country, and often due to political events[3] and international changes in the supply and demand for goods and production factors. These disturbances will lead to increased unemployment, inflation and stagnation in the economy (Jonung & Sjöholm, 1998; Mundell, 1961).

2.2.3. Characters of the members

It is important to observe the characters of the potential members closely to evaluate if a currency area will be successful or not. According to previous literature, the key factors that all potential members should fulfill, are: similar inflation rates, high factor mobility, high degree of openness, high degree of product diversification, covariation in economic activities, price and wage flexibility, similar industrial structures, similar economic policy preferences and political factors[4] (Jonung & Sjöholm, 1998; Mundell, 1961; Tavlas, 1993). These key factors can be divided into two groups: the country-specific criteria, which refer to a specific country, and the union-specific criteria, which refer to all the countries who want to join the currency area (Jonung & Sjöholm, 1998).

[3] For example the reunification of Germany or the collapse of Soviet Union
[4] The criteria are not listed in order of importance.

2.2.4. Country-specific criteria

Flexible prices and wages are important mechanisms, when it is not possible to use the exchange rate as an instrument. If the price and wage are flexible between and among the regions, the cost of abandoning the domestic currency is lower. Otherwise the adjustment between regions will lead to higher unemployment in one region and higher inflation in another (Jonung & Sjöholm, 1998; Tavlas, 1993).

Countries that have a high *degree of product diversification* are seen as better candidates for a currency area than countries with a low degree of product diversification, because they can handle demand and supply disturbances better. A country that has many different products to export will handle a disturbance, due to changes in demand or technology, better than a country that only exports one or few goods. A country that is less diversified, and has one of its few sectors hit by a disturbance, would probably have a larger total effect in the economy than if it had many production sectors. The economic stability will become even better if the labor force is able to reabsorb the labor and capital that is made idle by the shocks (Kenen, 1969).

2.2.5. Union-specific criteria

High *factor mobility* is an important mechanism that works as a substitute for a flexible exchange rate. When economic disturbances occur, the migration of labor and capital between the countries works as the adjustment process and prevents the unemployment and inflation to increase (Mundell, 1961).

Countries that have a *similar industrial structure* are affected in a similar way by shocks and therefore no adjustment in the exchange rate is necessary. Consequently countries with similar industrial structures are better candidates than countries which have different industrial structures (Mundell, 1961).

A high *covariation in economic activities* between the countries is important. It indicates that they are subject to common economic shocks and respond to them the same way, which will reduce the significance of exchange rate adjustment (Jonung & Sjöholm, 1998). Research also suggest, that countries that are more financially integrated and have a high inter-regional trade pattern, display more correlated business cycles and consequently the need for using exchange rate adjustments will be reduced (Imbs, 2004). Research made by Frankel and Rose also show that countries are better candidates to join a currency area after entering than before (1996). A way to measure the covariation in economic activities is to measure the correlation between output growths in the different countries. There have been a number of studies that have been focusing on the relation between trade and production growth. Some say that an economic integration leads to a higher correlation, and some say that it does not (Schiavo, 2008).

Similar inflation rates indicates that the countries conduct their economic policies the same way, and also that there is not a difference in the structure of the economies. In a currency area the inflation rate will be similar for the members. Consequently countries that have the same historical inflation patterns may experience a convergence to a similar inflation rate as a relativity easy change. For countries with different historical inflation, the convergence can be expected to be more difficult (Jonung & Sjöholm, 1998).

An agreement *about preferences in political economy*, as unemployment and inflation, is desirable since a currency area demands a convergence in stabilization policies. If the countries already are following similar economic policies, it indicates that joining the currency area will be easier than if they are following different economic policies (Kenen, 1969).

A country that has a high degree of *openness* will experience an easier transition when joining a currency area, because the higher the degree of openness, the less effective the nominal exchange rate is as a policy instrument for adjustment (McKinnon, 1963). When the economic integration increases, the countries become more open, and the advantages of a fixed exchange rate and a currency area increase. If a country's trade is a large part of its economy, then the exchange rate uncertainty is larger. When capital mobility, labor mobility, or similar economic behavior are integrated, the need to maintain a flexible exchange rate as a policy instrument declines for countries with high degree of openness (Frankel & Rose, 1996). Alesina and Barro (2002) have investigated the relationship between currency areas and trade flows. They found that countries that trade more with each other would benefit more from entering a currency area.

Political factors, or the political will to form a currency area, may be seen as the most important criteria for forming a currency area (Tavlas, 1993). The support from the public is generated from factors as geographical nearness of member countries and cultural, religious, social and language similarities (Cohen, 1993).

2.3. The Phillips curve

In 1958 William Phillips launched the theory of a negative relationship between unemployment and nominal changes in wages. He looked at wage inflation and unemployment in the United Kingdom in 1861-1957. This theory, named after him, is called the Phillips curve. Phillips found that when unemployment is low wages will rise due to the lack of labor supply, which will lead to an increase in wage inflation. Theoretically it works the other way around, when unemployment is high wages will decrease due to the large labor supply, and therefore wage inflation will decrease. In reality, it is more difficult to decrease wages than increase them, due to restrictions from unions, minimum wages etc. (Fregert & Jonung, 2010, p. 365; Phillips, 1958).

In 1960 Paul Samuelson and Robert Solow found a similar result for the US. Instead of changes in wages, they studied general price level inflation. Samuelson and Solow also introduced productivity as an important factor in the Phillips curve. They made the conclusion that the inflation rate equals the wage inflation rate excluding growth rate of labor productivity. This means that when productivity is higher than the country's

wages, prices will decrease. Samuelson and Solow made the Phillips curve relevant to policymakers by presenting it as a trade-off between inflation and unemployment. Governments have to choose between low inflation and low unemployment (Fregert & Jonung, 2010, p. 365; Samuleson & Solow, 1960). When forming a currency area it is important that the different governments have the same political goals and make the same priorities when it comes to the trade-off between inflation and unemployment (Hansson, 2008, pp. 212-214).

Milton Friedman and Edmund Phelps independently of each other, both reached the conclusion that there is no relation between unemployment and inflation in the long run. They argued that the models that Phillips, and Samuelson and Solow created are short run models. In the long run, expectations on inflation have to be taken into account. They also argue that it takes time for unemployment to adapt to inflation, as it takes time for the new inflation rate to be observed and wages to adapt to it. When the inflation is higher than expected, real wages will be lower and consequently the labor cheaper. The cheaper labor force leads to higher productivity, which in its turn leads to lower unemployment. According to Friedman and Phelps unemployment rates and inflation rates will adapt to its original level, natural unemployment, once the expectations on inflation has reached the new value of the inflation. The conclusion they reached is that the model Phillips created could be used in the short run, but does not work in the long run, since the unemployment rate will return the natural rate of unemployment (Fregert & Jonung, 2010, pp. 369-378; Friedman, 1968; Phelps, 1968).

In 1973 oil prices increased drastically due to an embargo by the OPEC-countries. The increasing oil prices lead to a general increase in prices, inflation, and at the same time unemployment increased. When both unemployment and inflation increase at the same time it is called stagflation. The original Phillips curve could not explain stagflation, but supply chocks can. If a negative supply chock occurs, for example by increasing oil prices, the cost of production increases for the companies. That will decrease the GDP, which will increase unemployment (Fregert & Jonung, 2010, pp. 378-380).

2.4. Nominal and real exchange rate

The nominal exchange rate is the price of money in terms of another currency, for example 9SEK/€. The real exchange rate measures purchasing power of one currency compared to another currency's purchasing power.[5] It is measured through the nominal exchange rate adjusted for price levels at home and abroad. Usually consumer price index (CPI) is used as price level comparison tool (Burda & Wyplosz, 2013, pp. 145-149).

[5] See appendix 1 for mathematical formula (2)

3. Economic background

3.1. The Nordic cooperation

In 1952 the Nordic Council was formed and 1971 the Nordic Council of Ministers. The members are Denmark, Finland, Iceland, Norway, Sweden and the three autonomous territories Greenland, the Faroe Islands and Åland. The Nordic Council is a collaboration between the Nordic members of the parliament, and the Nordic Council of Ministers is a collaboration of the Nordic governments. The areas of cooperation are economy, labor, law, research, education, environment and culture (Norden, n.d.-b).[6]

In 1962 the Helsinki Agreement was signed and it is an agreement that the countries' labor markets should be integrated and that the citizens of the Nordic countries are allowed to move and work in another of the member countries. The goal is a balanced regional development, both for the individual countries and the cooperation. The labor movement between the countries should not cause disturbance on the labor market, instead it should lead to economic and social development. The Nordic Labor Market Committee task is to study the Nordic labor market trends and discuss labor market policies, in order to ensure full employment (Norden, n.d.-a).

3.2. General information about the countries

3.2.1. Denmark

Denmark is the smallest country of the three, and is located south of Sweden and Norway. With a population of 5,6[7] million and an area of 44 thousand square kilometers, it is the most densely populated country of the three. The most important sources of income are oil and other forms of energy, agricultural production, medical industry, shipping, and IT services. In 1949 they became members of NATO and 1973 of the EU (Nordic Council of Ministers, 2013). Their national currency is the Danish krone (DKK) and in 1999 they pegged it to the Euro (Danmarks Nationalbank, 2009).

3.2.2. Norway

Norway is over three times as big as Denmark, and located to the west of Sweden and north of Denmark. Norway is the least densely populated country of the three, with a population of 5.1[7] million and an area of 324 thousands square kilometers. The most important sources of income are oil and natural gas, and also metal industry, shipping and tourism. In the 1970s Norway began to extract oil, which led to an increase in economic growth (FN-förbundet, n.d.). In 1949 Norway became a member of NATO. They are not a member of the EU (Nordic Council of Ministers, 2013a). The national currency is the Norwegian krone (NOK), which is floating since 1992 (Norges Bank, 2010).

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[6] n.d means that the quoted document is not dated.

[7] Data from 2013-01-01

3.2.3. Sweden

Sweden is the largest country of the three, with a population of 9,6[7] million and an area of 447 thousand square kilometers. Sweden's location is east of Norway and north of Denmark. Their most important sources of income is the production of electronics and cars, and the paper, iron and steel production. In 1995 Sweden joined the EU (Nordic Council of Ministers, 2013a). They have their own currency, the Swedish krona (SEK), and since 1992 they use a floating exchange rate instead of a fixed (Sveriges Riksbank, 2011).

4. Empirical analysis

The empirical analysis studies four of the important factors, which should be fulfilled in order to form an optimum currency area[8]. We have chosen to analyze if the countries have an economic covariance, the difference in real exchange, the inflation and unemployment rates, and the degree of openness.

4.1. Covariation in economic activities

To evaluate if the three countries' economic activities covariate, we analyze their GDP growth over time. We have done this through analyzing the correlation and convergence of GDP growth between the countries numerically and graphically.

The correlation coefficient indicates the strength and relationship between the countries GDP growth. The correlation between 1971-2013 is displayed in table 1 and shows that between Sweden and Norway the correlation is low. Between Sweden and Denmark, and Norway and Denmark it is higher.

The correlation between 1990-2013 is higher for Sweden and Norway than the correlation between 1971-2013, but it is still low. For Sweden and Denmark, and Denmark and Norway, the correlation is higher between 1990-2013 than between 1971-2013.

When the correlation for 2000-2013 is analyzed, the correlation between Norway and Sweden is higher compared to the previous years. The correlation between Denmark and Sweden is very high, and for Denmark and Norway it is the same as the years 1990-2013.

Table 1: Correlation of GDP growth 1971-2013, 1990-2013, and 2000-2013.

		Denmark	Norway	Sweden
1971-2013	**Denmark**	1		
	Norway	0.60	1	
	Sweden	0.50	0.23	1
1990-2013	**Denmark**	1		
	Norway	0.78	1	
	Sweden	0.73	0.32	1
2000-2013	**Denmark**	1		
	Norway	0.78	1	
	Sweden	0.90	0.63	1

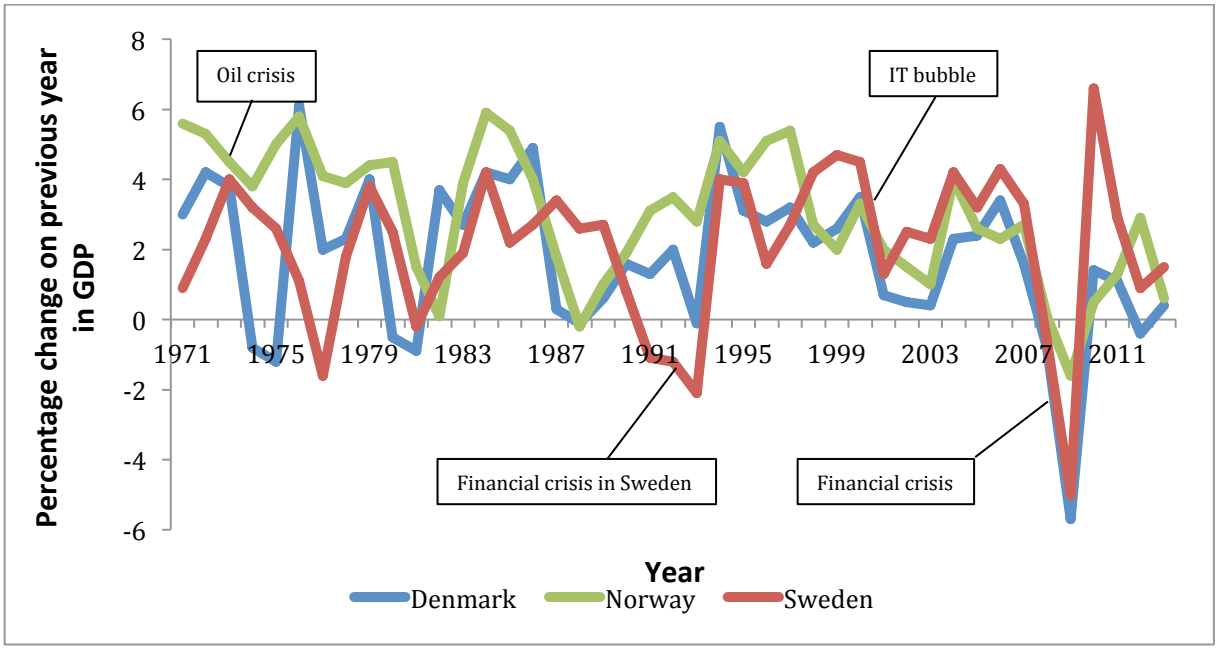
Source: Eurostat and authors' own calculation.

[8] We assume that each country is an optimal currency area when conducting the empirical analysis.

The length of the time periods in table 1 are not the same, therefore we calculated the GDP growth correlation for time periods with the same length (see table 8 in appendix 2). We wanted to make sure that the correlation is not higher in the more recent years because of the smaller sample size. The analyze shows that the correlation is much higher between 2000-2013 than 1971-1984 and 1985-1999, which shows that the higher correlation in 2000-2013 is not due to smaller sample size.

The covariation for the three countries is low when the data from 1971-2013 is analyzed and high from 2000-2013 (see graph 1). In 1971-1993 Sweden and Norway's GDP growth does not covariate often, which is also indicated by the correlation coefficient. Denmark seems to either covariate with Sweden or Norway, which also is indicated by the correlation coefficient. After 1993, the GDP growth of the three countries seems to covariate more than before, also indicated by the correlation coefficient.

Graph 1: Percentage GDP change on previous year 1971-2013.



Source: Eurostat

In the longer run, the correlation coefficient and the graph suggests that Denmark's economic activities covariate with Sweden and Norway's. This indicates that they could form a currency area with either of them. Sweden and Norway's economic activities do not seem to covariate, and consequently they probably should not form a currency area. When the correlation coefficient and graph is analyzed for the shorter time period, it still suggests that Denmark economic activities covariate with the other two's. However it also shows that Sweden and Norway's economic cycles covariate, which indicates that all three countries can form a currency area. So the short and long run correlation coefficient indicate different outcomes.

Through analyzing the countries' GDP growth over time, it is possible to analyze how they are affected by shocks. As previously mentioned the increases in oil prices in 1973 led to recession in many countries. Denmark and Sweden was struck hard and went into recession. Norway is also affected by this event, but not as hard, possibly because Norway is an oil exporting country.

In 1990 Germany was reunited and conducted a tight monetary policy, which led to an increase in the interest rate in the European Monetary cooperation. This led to a lower willingness to invest. At the same time the credibility of a fixed exchange rate policy decreased, because e.g. Finland devalued their currency after losing a large part of their export to Soviet when it fell. Sweden was struck hard by the raise in interest rate, because they already were in a recession (Hultkrantz & Tson Söderström, 2013, pp. 39-41). Denmark and Norway were however not affected by this event.

In 2000 the IT bubble, which had been built up by too high expectations on the results of new technology intensive companies, burst. The value of stocks in these businesses had been overvalued and when the results did not match people's expectations, the values of the stocks dropped drastically (Hultkrantz & Tson Söderström, 2013, pp.42). This shock set all three countries into recession and from 2000-2001 GDP growth decreased in all countries. However Norway and Denmark were in recession until 2003, while Sweden went into a boom already in 2001.

In 2008-2010 all three countries were affected by the financial crisis that struck the world. The graph indicates that the countries are all affected by the shock, and that they respond the same way to the crisis. Norway is the least affected. This is the expected effect, since Norway has the lowest standard deviation (see diagram 1). A possible reason for Norway's lower standard deviation might be their oil supply. Since there is a constant demand for oil, Norway is not affected as much as the other countries. After the turning point in 2009 Sweden has a much higher GDP growth than the other countries. The difference in GDP growth rate in 2010 is 6.1 percentage between Sweden and Denmark, and 5.2 percentage between Sweden and Norway. The fact that the countries all went into recession when the shock occurred indicates that they could form a currency area.

In graph 2 the moving averages[9] are displayed, to show the cyclical changes of the GDP growth. From 1990-2013, the moving averages mostly follow each other. Denmark and Norway seems to follow the same cyclical changes more than Sweden does with the others. For example in 1997-1999 Sweden shows a positive cyclical change, while Denmark and Norway show negative cyclical changes. Sweden also deviates from the others' cyclical changes after the financial crisis, since Sweden went into a boom before Denmark and Norway did.

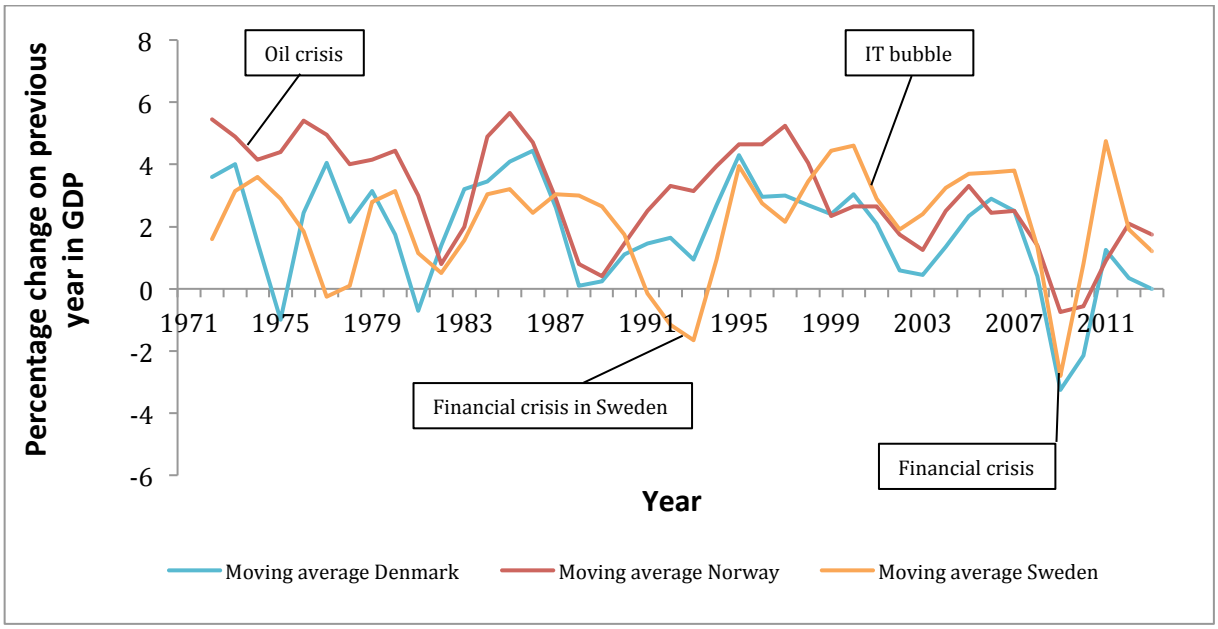
To analyze if the GDP growth of the countries' have the same trend and direction, we measure the convergence between the countries. The differences in standard deviation[10] are a way to measure the convergence. Diagram 1 shows the standard deviation per four-year intervals. We have chosen to use four-year intervals because that is approximate half of a cycle. According to Kindleberger (2000) a cycle can be considered seven to eight years long. The three countries' standard deviation mostly follows each other, but some deviations exist. In the first three periods Denmark has a higher standard deviation than Sweden and Norway. In 1991-1994 Norway has an almost 2 percentage points lower standard deviation than Sweden, and almost 1.5 percentage

[9] A two-year period is used. See appendix 1 for mathematical formula (3)

[10] See appendix 1 for mathematical formula (4).

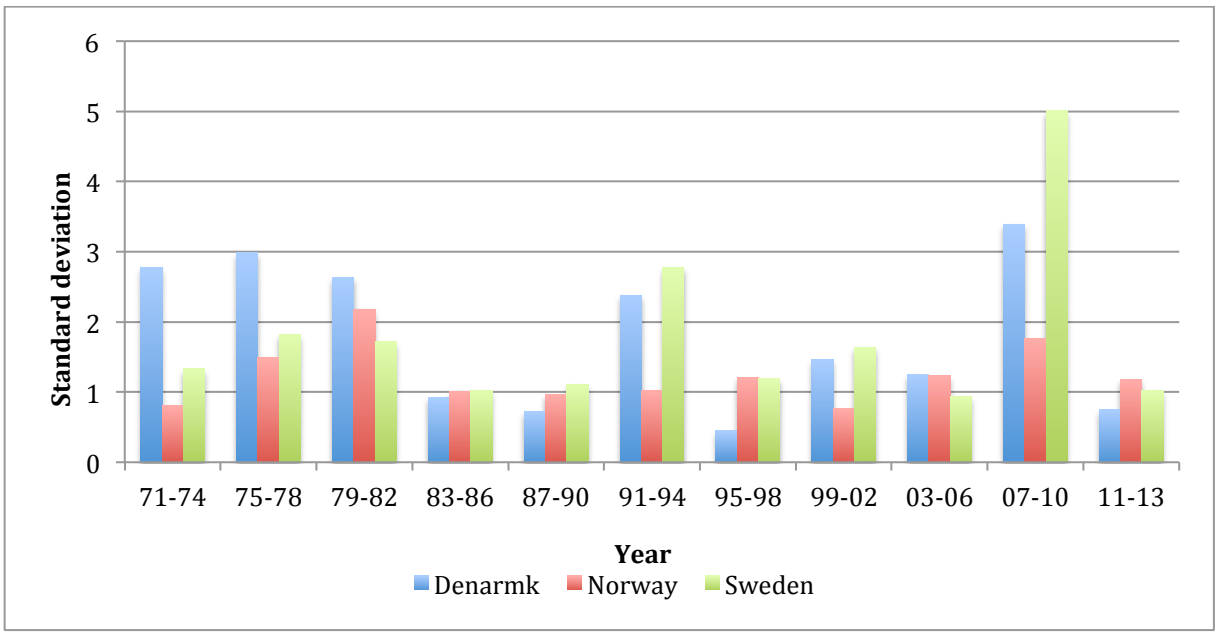
points lower than Denmark. In 2007-2010 all three countries have high standard deviations. The reason for this may be the financial crisis in 2008, which affected their GDP negatively and made them deviate from their trend GDP. Except for the period 2007-2010 the countries seem to converge to similar rates of standard deviation, which indicates a currency area might be possible.

Graph 2: Moving average of percentage GDP change on previous year, 1971-2013.



Source: Eurostat and authors' own calculation.

Diagram 1: Standard deviation per four-year intervals, 1971-2013.



Source: Eurostat and authors' own calculation.

4.2. Real exchange rate

If Denmark, Norway and Sweden would form a currency area, they would have to convert their currency into a common one.[11] A way to evaluate if a common currency would be successful is to analyze the differences in real exchange rate[12]. This is done through comparing the standard deviation of the countries, their mean real exchange rate [13], and how they are affected by crises.

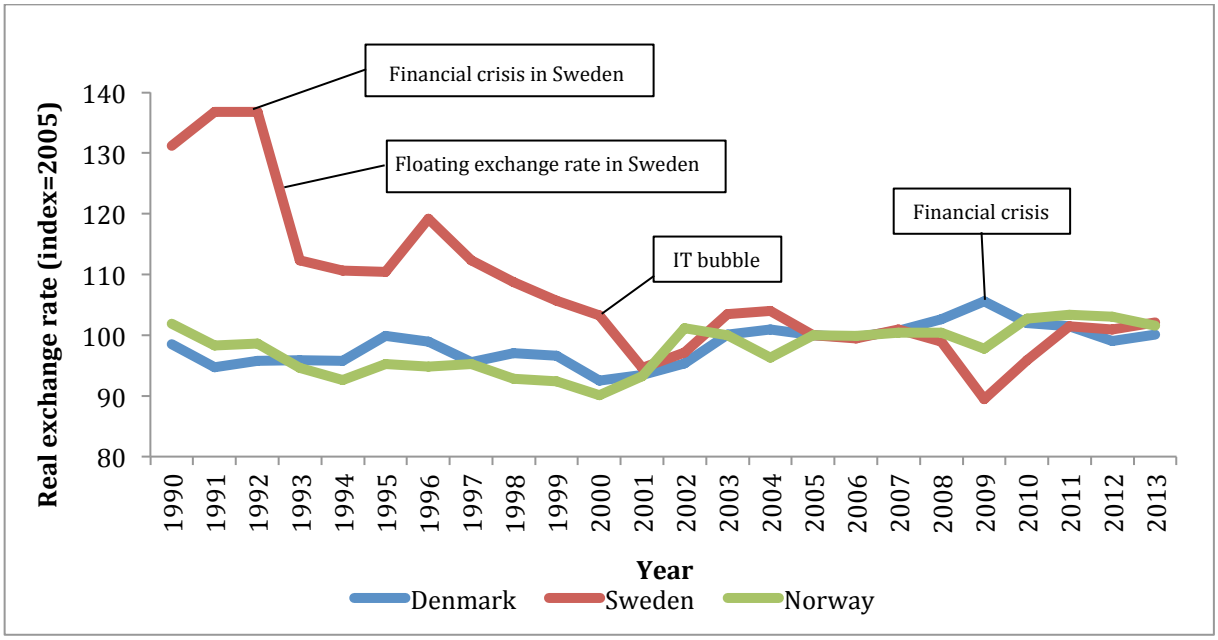
The standard deviation of the three countries' indicates how volatile their exchange rates are (see table 2). As can be seen in graph 3, Sweden's real exchange rate in the 1990s greatly differs from Denmark and Norway's. During this time period Sweden has a higher standard deviation than the other two countries, which indicates that Sweden's real exchange rate is more volatile. The greatest difference is in 1992 when there is a difference of 41 percentages between Sweden and Norway. An explanation for the difference may be due to Sweden's financial crisis in 1990. The major change in Sweden's real exchange rate in 1992-1993, is caused by the change from a fixed to floating nominal exchange of the Swedish currency.

After the burst of the IT bubble in 2000 the three countries' real exchange rate is more synchronized. They are the same in 2005 because it is the base year, but the real exchange rates are also very similar during 2006-2007. In 2008 the financial crisis spread from the US and affects all the three countries differently. Norway has a positive cyclical change and Denmark and Sweden a negative. Sweden seems to be affected the most and has a greater change in real exchange rate than the other two countries. The difference in real exchange rate between the countries is 3-4 percentages from 2000, except in 2009 during the financial crises when it is almost 8 percentages.

Comparing the 1990s, when Sweden is hit by a crisis, to the 2008, when all the three countries are hit by a crisis, we can see that the countries are affected differenlty. During these years there is a greater difference between the countries real exchange rate (49 and 8 percentages) than during the more similar times (3-4 percentages difference). This indicates that during a crises the countries are hit differently and with a different strenght. They will therefore probably need different policies, not a common one, to be able to manage the problems due to the crisis. This is not possible if they enter a currency area, which speaks against the forming of one.

[11] Either they use an anchor currency or create a new one.
[12] The real exchange rate data is retrieved from IMF, which uses consumer price index (CPI) as a measurement of the price level.
[13] See appendix 1 for mathematical formula (5).

Graph 3: Annual real exchange rate in percent 1990-2013.



Source: International Monetary Fund

To analyze how the countries real exchange rate varies and differs over time, we have analyzed their mean real exchange rate and standard deviation. These are displayed in table 2. The results illustrate that in the long run Denmark and Norway have a similar mean and Sweden a higher one. Sweden also has a higher standard deviation than Denmark and Norway.

If we analyze their real exchange rate for a shorter time period, the results are different. For the time period 1990-1999 the results are similar to the long run's results, but for the period 2000-2013 the results are different from the long run results. Denmark's and Norway's mean real exchange rates and standard deviation are still similar, but for Sweden there is a great difference. Both Sweden's mean real exchange rate and standard deviation is lower, and in the same range as Denmark's and Norway's.

When the mean real exchange rate and standard deviation between 1990-2013 and 1990-1999 is anlayzed, it suggests that Norway and Denmark are more suitable to form a currency area. But when the most recent data is analyzed, 2000-2013, it suggest that all three countries are suitable to form a currency area. These obesrvations are also supported by the absolute PPP because the real exchange rate standard deviation is decreasing in the long run for Sweden and has about the same value for Denmark and Norway.

Table 2: Mean real exchange rate and standard deviation between 1990-2013, 1999-1999 and 2000-2013.

		Standard deviation	Mean real exchange rate
1990-2013	**Denmark**	3.18	98.43
	Norway	3.90	97.77
	Sweden	12.52	107.32
1990-1999	**Denmark**	3.79	96.87
	Norway	3.08	95.66
	Sweden	11.98	118.40
2000-2013	**Denmark**	3.56	99.55
	Norway	3.79	99.29
	Sweden	4.01	99.41

Source: International Monetary Fund and authors' own calculation.

4.3 Inflation and unemployment

If Denmark, Norway and Sweden would form a currency area, it is important that their inflation rate and unemployment rate are not too different, because that will cause tension between them. We use Solow and Samuelson's short and long run Phillips curve to analyze which effects a common inflation rate will have on the unemployment rate. The flexibility of the labor force is also analyzed, to see if it is flexible enough to ease the potential tension caused by a common inflation rate.

When the countries join a currency area, they have to agree on a common inflation rate. The goal inflation rate that is chosen depends on the economic strength of the three countries: the country with the highest economic strength will have the largest influence over which goal that is set. When calculating a possible common goal inflation rate for the currency area, we have taken the weighted mean of the countries' goal inflation rate. The countries' weights depend on their economic strength, which is calculated from their GDP over the last 4 years; Sweden has the highest and Denmark the lowest. Their individual goal inflation rate is very similar: Sweden and Denmark have 2% and Norway 2.5% (Danmarks Nationalbank, 2009; Norges Bank, 2010; Sveriges Riksbank, 2011). The calculated common goal inflation rate that we will use when analyzing the effects on the unemployment is 2.15 percent.[14]

The countries actual inflation, which is used as comparison to the common goal inflation rate, is the mean inflation rate of the three countries since 1995. Denmark and Norway have a similar inflation rate, and Sweden has a lower (see table 3). A study made by Froot and Rogoff (1991) on the transition of the EMU countries, shows that their inflation rates differs more than Denmark, Norway and Sweden's does. This may indicate that the difference in inflation rate may not be a problem if they wanted to form a currency area.

[14] See appendix 1 for calculation (6).

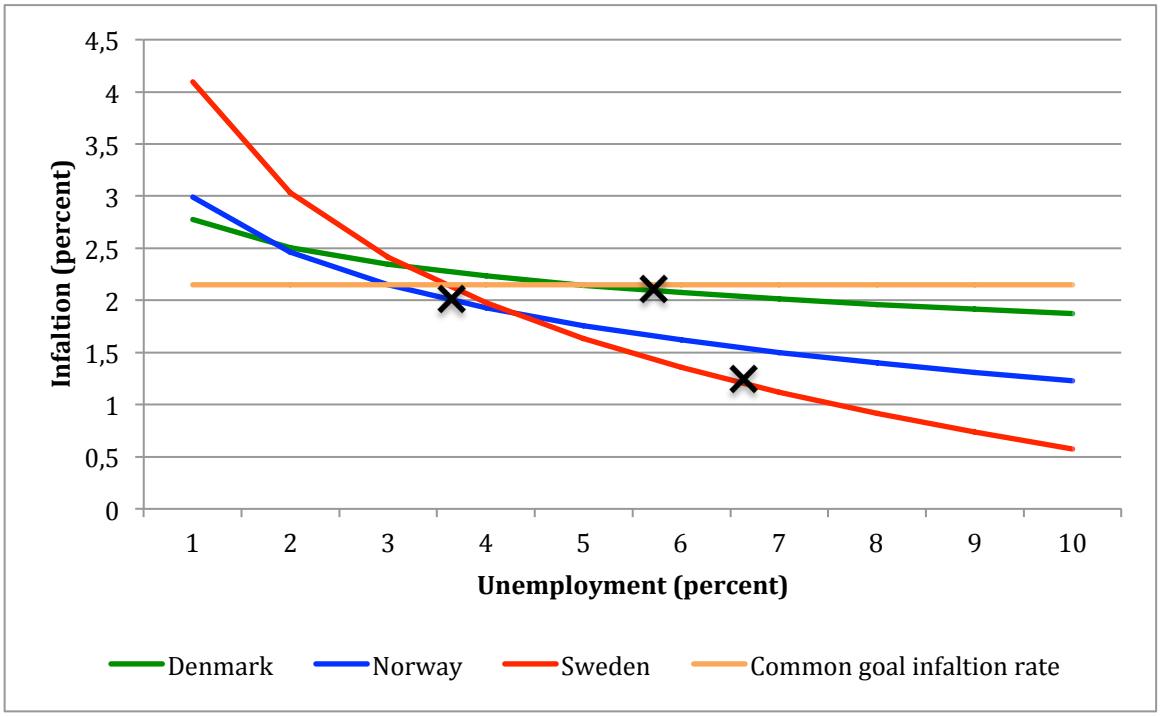
Table 3: Mean inflation from 1995-2013.

	Mean inflation
Denmark	2.11
Norway	2.01
Sweden	1.25

Source: International Monetary Fund and authors' own calculation.

In order to measure the effects of a common inflation rate on the unemployment in the short run, we have analyzed the short run Phillips curve for the three countries. They are displayed in graphs 4-6. For Denmark and Norway the common goal inflation rate at 2.15 percent does not lead to a big change in inflation since their mean inflation rate since 1995 is 2.12 and 2.01 percent. Both Denmark and Norway's unemployment rate will decrease with less than 1 percentage, this can be seen in table 4. Sweden's inflation rate has to increase with 1.02 percentages, which is a greater change than what Denmark and Norway have to go through. The unemployment rate in Sweden will decrease with 3.06 percentages, which is a greater decrease than the other two countries'. Sweden has to go through a larger change, in both inflation and unemployment rate, than the other two countries when using the calculated common goal inflation rate. This can be seen in graph 4, which shows all the countries' short run Phillip curve with the common inflation goal. The x shows the countries individual actual inflation rate, and the distance to the common goal inflation rate shows how large the changes are that they have to make.

Graph 4: Denmark, Norway and Sweden's individual short run Phillips curves with the common goal inflation rate and individual mean inflation rate (x).



Source: International Monetary Fund and authors' own calculation.

Table 4: Natural rate of unemployment and short run unemployment rate at the common goal inflation rate

	Natural unemployment rate	Short run unemployment rate
Denmark	5.72	4.98
Norway	3.65	3.02
Sweden	6.64	3.58

Source: International Monetary Fund and authors' own calculation

Because the countries have different levels of unemployment, but will have a common inflation rate if they enter a currency area, we also analyze how flexible their labor force is. A flexible labor force will ease the tension within the currency area that is due to a shock or the common inflation rate. All the three countries are members of the Nordic cooperation and they have an agreement that all the citizens of the member countries can work in other member countries without a working permit and that their labor market should be integrated. Consequently we assume that the labor force movement today will be similar to how it may look like if they form a currency area. The analysis is only based on the amount of commuters between the countries, because of low data availability. Therefore our analysis does not completely describe the flexibility of the labor force, but it gives an indication.

Table 9 and 10 in appendix 2 show the amount of commuters between the three countries for the years 2001, 2006 and 2009. Sweden has the highest amount of commuters in percentages and absolute numbers, and also a positive trend. Norway and Denmark have a lower amount of commuters and a negative trend. A reason that Sweden has more commuters than the other countries may be because they are geographically closer to both Norway and Denmark, while Norway and Denmark are not as closely located. Sweden also has a higher natural unemployment rate.

Since Sweden's labor force is larger than Norway and Denmark's, we have also calculated the numbers of commuters as a part of the labor force. The result, displayed in table 5, shows that the there is a small part of all the countries' labor force that is flexible. Sweden's numbers are although a little higher than the other two countries', and they also have a higher amount of unemployed citizens.

In the long run people will adapt their inflation rate expectations and the unemployment rate will return to the natural rate of unemployment, but with the new inflation rate on 2.15. Hence, in the short run there will be a change in the unemployment rate that will affect the countries differently. Since the differences are not that big, large problems will not occur, and in the long run these potential problems will disappear.

Table 5: Percentage amount of commuters as a part of the individual country's labor force.

		2001	2006	2008	Total change 2001-2009
Denmark to	Norway	0.12%	0.09%	0.11%	-0,01
	Sweden	0.05%	0.07%	0.04%	-0,010
	Total	0.17%	0.16%	0.15%	-0,021
Norway to	Denmark	0.03%	0.02%	0.01%	0,000
	Sweden	0.06%	0.08%	0.03%	-0,021
	Total	0.08%	0.10%	0.045%	-0,023
Sweden to	Denmark	0.11%	0.30%	0.41%	-0,044
	Norway	0.30%	0.33%	0.57%	0,000
	Total	0.41%	0.63%	0.98%	0,306

Source: International Monetary Fund; Nordic Council of Ministers, 2013, and authors' own calculation.

4.4 Degrees of openness

In order to evaluate the degree of openness we analyzed the trade between Denmark, Norway and Sweden, and also how high their total trade is as a part of their GDP.

Sweden is Denmark's second most important trade partner and Norway their fifth. Comparing the mean export and import rate between 1990-1994 to the mean import and export rate between 2008-2012 (see table 6) Denmark's trade with Sweden has a positive trend. Also, Denmark's export to Norway has a positive trend and the import a negative. In total Denmark's export and import with Sweden and Norway is about 20 percent of their total export and import (International Monetary Fund, n.d.-a).

Denmark is Norway's fourth largest import partner and seventh largest export partner. The trend of the trading is negative, both for the export and import sector. Sweden is Norway's fourth largest export partner and their largest import partner. The trend is negative for both the import and export sector. In total their export to Sweden and Demark is about 10 percent of their total export, and the import about 20 percent (International Monetary Fund, n.d.-b)(International Monetary Fund, n.d.-c).

Norway is Sweden's largest export partner and third largest import partner, and has a positive trend. Denmark is their fifth largest export partner, with a negative trend, and second largest import partner, with a positive trend. Their export to Denmark and Norway is about 16 percent of their total export and 17 percent of their total import (International Monetary Fund, n.d.-c).

These results indicate that all the countries are important export and import partners to each other, and that they would benefit from forming a currency area, so that the exchange rate uncertainty would decline.

Table 6: Mean export and import as a share of total export and import between Denmark, Norway and Sweden.

			1990-1994	2008-2012	Change
Denmark	**Export to**	Norway	6.26%	6.07%	-0.187
		Sweden	11.08%	13.31%	2.234
	Import from	Norway	5.09%	6.39%	1.299
		Sweden	10.93%	13.39%	2.451
Norway	**Export to**	Denmark	5.01%	3.62%	-1.384
		Sweden	9.90%	6.44%	-3.460
	Import from	Denmark	7.25%	6.48%	-0.767
		Sweden	15.11%	13.80%	-1.305
Sweden	**Export to**	Denmark	6.91%	6.77%	-0.146
		Norway	8.30%	9.98%	1.677
	Import from	Denmark	7.46%	8.62%	1.165
		Norway	6.98%	8.52%	1.54%

Source: Norden, n.d.-c, n.d.-d and authors' own calculation.

To evaluate how open the countries are, we calculated their trade as share of GDP (see table 7). The trade as a share of GDP in Denmark is higher than it is in Sweden and Norway. Norway has the lowest share of trade. This means Denmark is the most open economy, Sweden is the second most open and Norway the least open. One possible reason for Norway having the lowest share of trade might be because they are not an EU member.

Table 7: Trade as a share of GDP (percent) in 2008-2012.

	2008	2009	2010	2011	2012
Denmark	106.30%	91.38%	95.34%	102.09%	104.52%
Sweden	100.31%	89.43%	92.78%	94.14%	91.24%
Norway	76.27%	67.76%	69.03%	70.24%	68.47%

Source: The World Bank, n.d.

All three countries have high shares of trade, because they are small, open economies. In diagram 2 in appendix 2, Denmark, Sweden and Norway are compared to some other countries. In the top of the diagram there are small, open economies such as Ireland, Belgium, Netherlands and Iceland. In the bottom there are Russia, Japan and the US, which all are large countries, with much trade within their own country. We therefore draw the conclusion that Denmark, Sweden and Norway all are small, open economies, also compared to other countries.

5. Conclusion

Our study shows that there are advantages and disadvantages for Sweden, Denmark and Norway to form a currency area. The economic covariation analysis shows that the trend of the GDP correlation is positive, and since 2000 the correlation is high. However the shocks have affected the countries differently. Comparing the oil crisis in the 1970s to the IT bubble burst in 2000 and financial crisis in 2008, the countries are affected more similar to recent shocks than older. Norway's dependence on oil may be a problem for the currency area. As seen during the oil crisis in 1973, they reacted differently than Sweden and Denmark, and if another oil crisis occurs in the future it may cause tension between the countries.

Analyzing the real exchange rates indicates that the countries are affected differently by crises. This will cause tension between the member countries if they form a currency area. However the trend is that the real exchange rates are becoming more similar in the long run, according to the theory of absolute purchasing power parity. The countries' Phillips curves show that inflation and natural unemployment rates are similar. When forming a currency area this will probably not cause much tension between the countries. A problem though, is the low amount of commuters between the countries, which indicates a low flexibility of countries' labor forces. If an asymmetric shock occurs the labor force may not be flexible enough to ease the tension.

The degrees of openness study shows that interregional trade is high. The countries therefore would gain from forming a currency area, because the exchange rate uncertainty risk will disappear. All three countries are depending on their export, and have a high degree of openness to the rest of the world.

The conclusion we can draw is that they have a high degree of openness and similar inflation and unemployment rate. The potential problems are that there are differences when shocks occur and that the rates of commuters are low. The trend shows however, that their economic covariation and reactions to economic shocks are becoming more similar. Research also suggests that countries are better candidates to join a currency area after entering than before.[15]. Based on these results, our study indicates that it might be possible for Denmark, Norway and Sweden to form an optimum currency area. However, there are more criteria, which need to be analyzed before drawing a conclusion regarding the possibility for the countries to form an optimum currency area.

[15] See part 2.2.5.

Appendix 1

Mathematical formula 1: absolute purchasing power parity

$$P = S \times P^*$$

$$S \times \left(\frac{P}{P^*}\right) = \left(\frac{P}{P^*}\right) \times \left(\frac{P^*}{P}\right) = 1$$

where S is the spot exchange rate, P the domestic price level and P^* the foreign domestic price level (Daniels & Van Hoose, 2014, pp. 145-149).

Mathematical formula 2: real exchange rate

$$R = \frac{SP^*}{P}$$

where R is the real exchange rate, where S is the spot exchange rate, P the domestic price level and P^* the foreign domestic price level (Fregert & Jonung, 2010, p. 353).

Mathematical formula 3: moving average

$$x_t^* = \frac{x_t + x_{t+1}}{2}$$

where x_t is the observation and x_{t+1} is the observation for the following year.

Mathematical formula 4: standard deviation

$$s = \sqrt{s^2} = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$

where s is the standard deviation, x_i the observation, n is the number of observations, and $\bar{x}$ the mean value.

Mathematical formula 5: mean value

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

where $\bar{x}$ is the mean value and n is the sample size (Newbold, Carlson, & Thorne, 2010, pp. 66, 77).

Mathematical formula 6: calculated common inflation goal

$$\pi_G = \frac{\pi_D * (GDP_D/GDP_T) + \pi_N * (GDP_N/GDP_T) + \pi_S * (GDP_s/GDP_T)}{100}$$

where π_G is the common inflation goal, π is the inflation, D stands for Denmark, N for Norway, S for Sweden, and T for total. The GDP for each country and the total GDP for all the three countries is the mean GDP for the last 4 years.

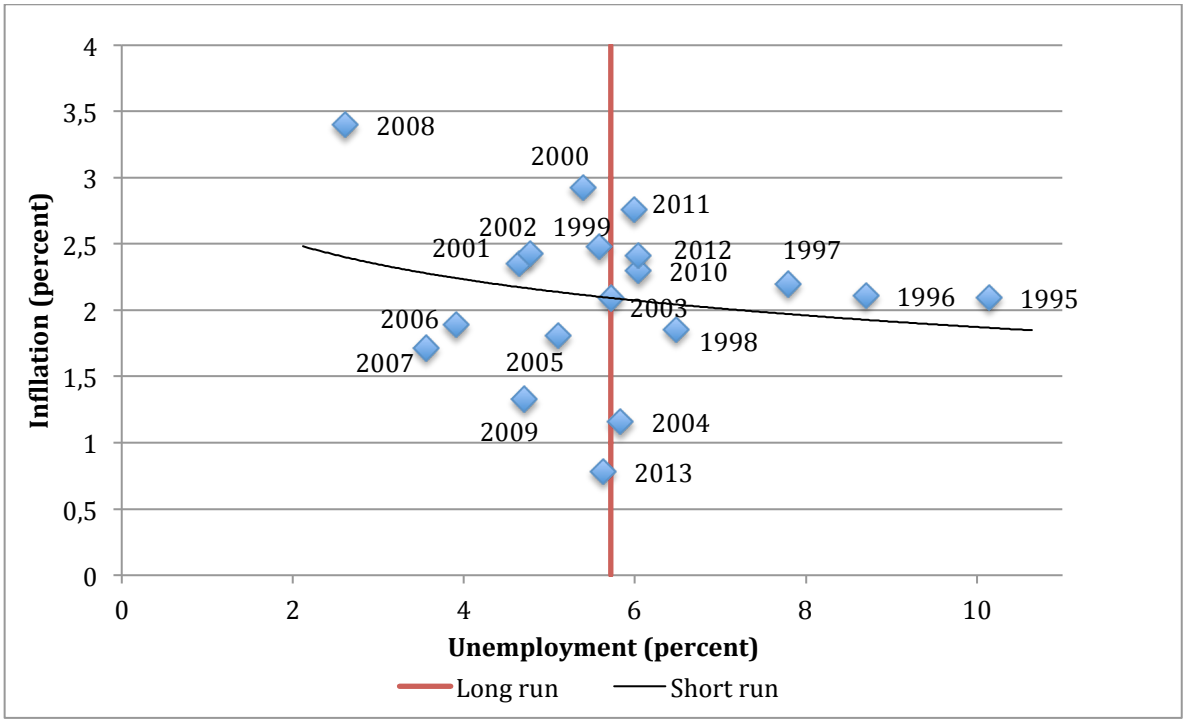
Appendix 2

Table 8: Correlation of GDP growth 1971-1984, 1985-1999, and 2000-2013.

		Denmark	Norway	Sweden
1971-1984	Denmark	1		
	Norway	0.33	1	
	Sweden	0.07	0.35	1
1985-1999	Denmark	1		
	Norway	0.78	1	
	Sweden	0.40	0.003	1
2000-2013	Denmark	1		
	Norway	0.78	1	
	Sweden	0.90	0.63	1

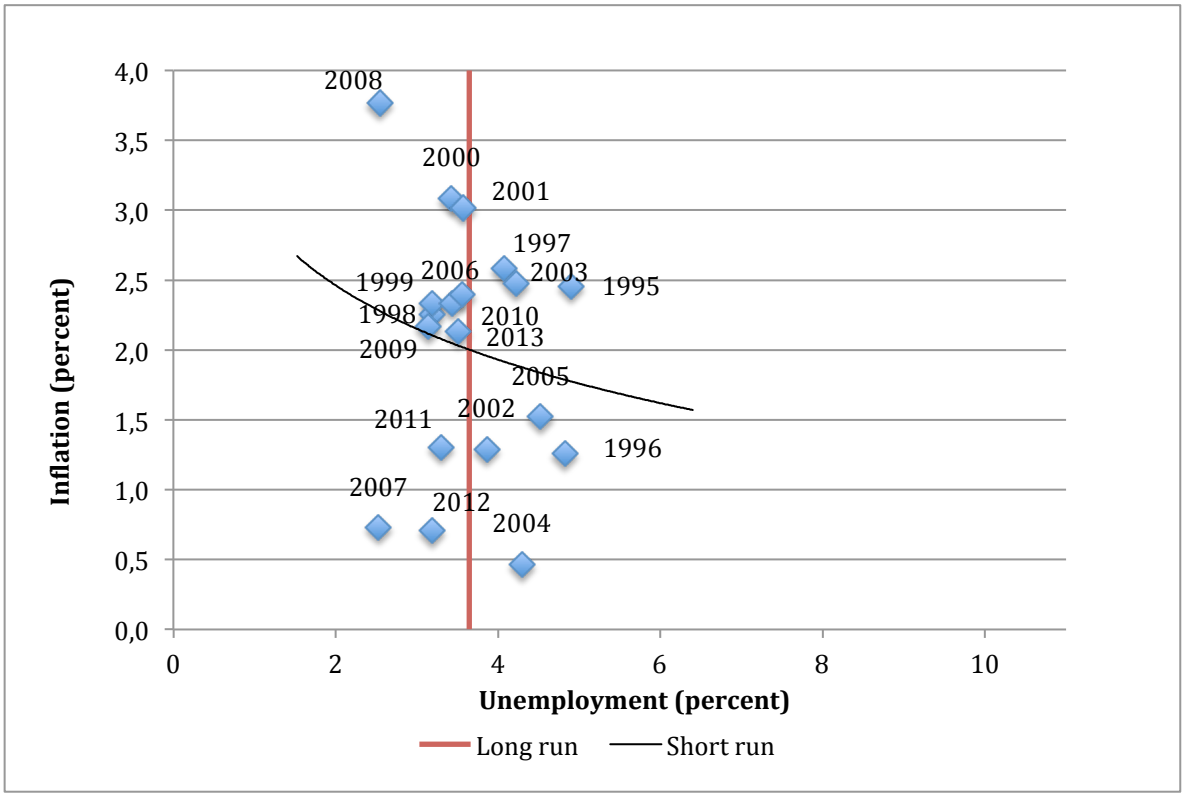
Source: Eurostat and authers' own calculation

Graph 4: Denmark's Phillips curve 1995-2013.



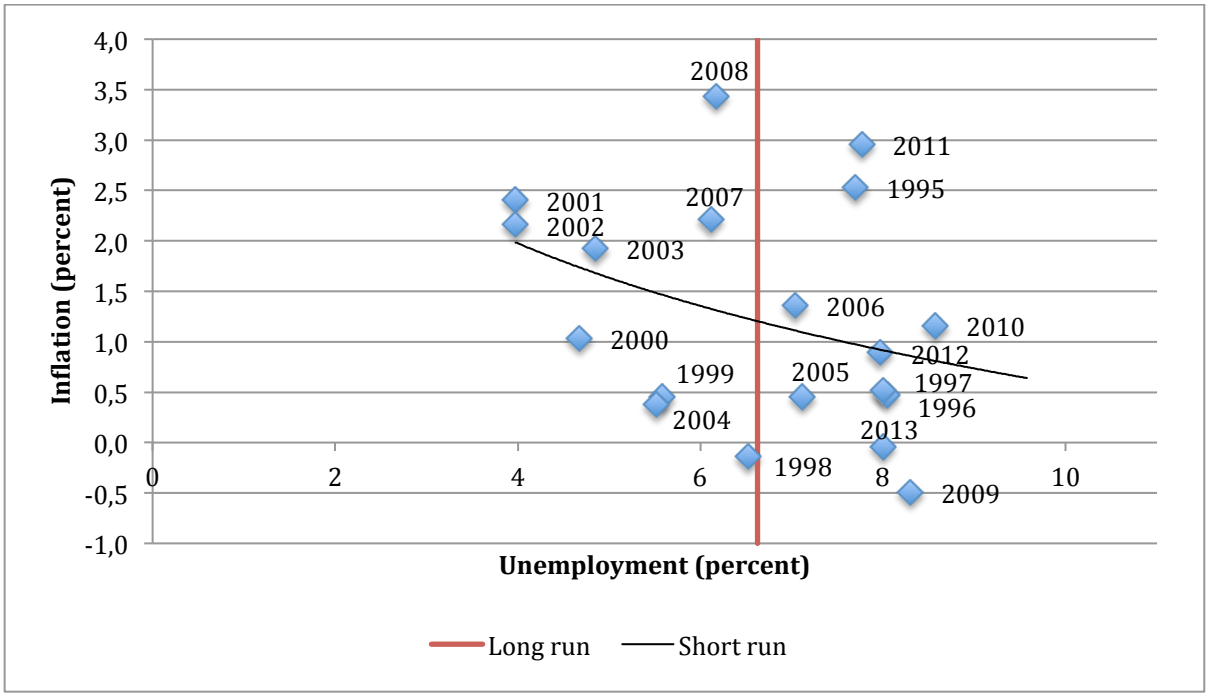
Source: International Moneatary Fund and authors' own calculation

Graph 5: Norway's Phillips curve 1995-2013.



Source: International Moneatary Fund and authors' own calculation

Graph 6: Sweden's Phillips curve 1995-2013.



Source: International Moneatary Fund and authors' own calcualtion

Table 9: Commuters as actual numbers, in percentage and in total change.

		2001	2006	2009	Total change 2001-2009
Denmark to	Norway	3 369	2 251	3 132	-237
		-	-24.28%	22.78%	-7.04%
	Sweden	1 410	1 980	1 129	-281
		-	40.43%	-42.98%	-19.93%
	Total	4 779	4 531	4 261	-518
		-	-5.19%	-5.96%	-10.84%
Norway to	Denmark	798	546	325	-473
		-	-31.58%	-40.48%	-59.27%
	Sweden	1 300	1 961	833	-467
		-	50.85%	-57.52%	-35.92%
	Total	2 098	2 508	1 158	-940
		-	19.54%	-53.83%	-44.81%
Sweden to	Denmark	4 636	14 225	20 189	15 553
		-	206.82%	41.94%	355.48%
	Norway	13 336	30 143	48 220	14 805
		-	19.37%	76.78%	111.02%
	Total	17 972	30 143	48 220	30 248
		-	67.71%	59.97%	168.31%

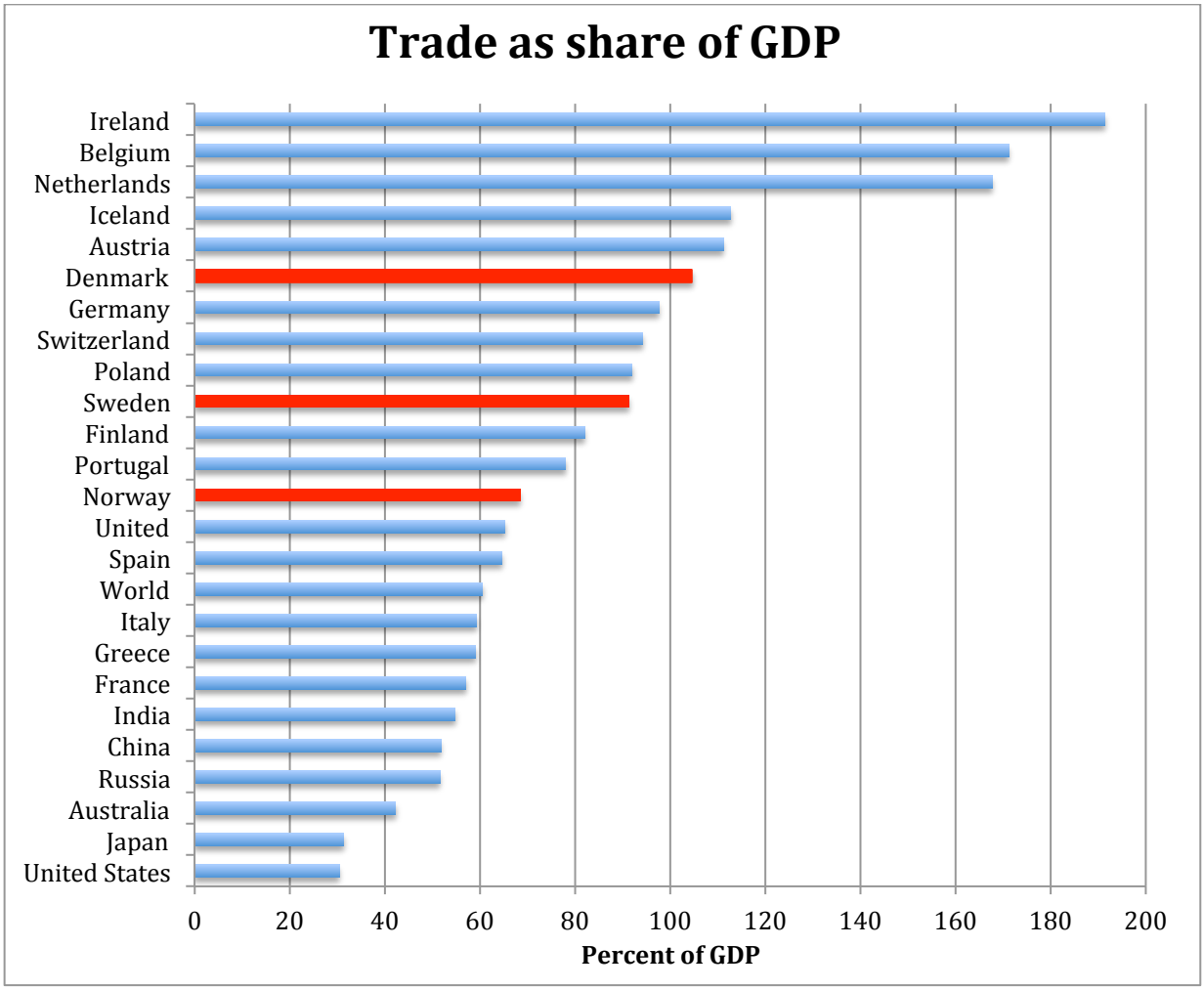
Source: Nordic Council of Ministers, 2013, and authors' own calculation

Table 10: Export and import as percent of total trade in 2008-2012.

			2008	2009	2010	2011	2012
Denmark	**Export to**	Norway	5.74%	5.97%	6.02%	6.09%	6.52%
		Sweden	14.42%	12.79%	13.40%	12.70%	14.43%
		Total	20.17%	18.75%	19.42%	18.80%	19.75%
	Import from	Norway	6.36%	6.99%	5.81%	6.17%	6.62%
		Sweden	13.90%	13.11%	13.33%	13.34%	13.25%
		Total	20.26%	20.10%	19.15%	19.50%	19.87%
Norway	**Export to**	Denmark	3.28%	3.95%	3.22%	3.53%	4.13%
		Sweden	6.32%	5.87%	7.02%	6.66%	6.34%
		Total	9.60%	9.81%	10.24%	10.19%	10.47%
	Import from	Denmark	6.89%	6.74%	6.21%	6.33%	6.22%
		Sweden	14.35%	13.76%	13.98%	13.39%	13.54%
		Total	21.24%	20.50%	20.19%	19.72%	19.75%
Sweden	**Export to**	Denmark	7.39%	7.32%	6.56%	6.18%	6.38%
		Norway	9.50%	10.64%	9.96%	9.47%	10.31%
		Total	16.89%	17.96%	16.52%	15.65%	16.68%
	Import from	Denmark	9.35%	8.96%	8.27%	8.13%	8.42%
		Norway	8.56%	8.66%	8.74%	8.01%	8.66%
		Total	17.92%	17.62%	17.00%	16.13%	17.07%

Source: Norden, n.d.-c, n.d.-e and authors' own calculation.

Diagram 2: Trade as a share of GDP (percent) for some countries in 2012.



Source: The World Bank

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