Exchange rate misalignment and economic growth

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Abstract

This paper study the relation of RER misalignments for three southern countries and for three northern countries, obtaining the misalignments from a VEC model. Concluding that misalignments are bigger in the northern countries with one exception. The next step done is through a basic equation of economic growth do a similar VEC model, later with impulse response analyses the effect of misalignments in economy activity for each country. The result are positive effects in southern countries with the exception of Spain and negative for northern with the exception of Denmark. Finally mixing the two results the results are not clear because are contradictory results and is not possible say if undervalued exchange rate is good o bad. Anyways, concluding, the misalignments affect the economy activity and it is growth for each country so exchange rate becomes an important instrument to consider for the countries.

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1. Introduction

For centuries, the currencies of the world were backed by gold. This means, that a currency bill issued by a world government represented a real amount of gold that government kept in a vault. In the 30s, the US established the value of the dollar at a single and unalterable level: an ounce of gold was worth $ 35, the gold standard. After World War II, the countries signed the Bretton Woods pact, whereby the IMF was created. Through fixed exchange rates everyone knew how much gold was worth a US dollar, the value of any other currency against the dollar could be based on its value in gold. A currency whose value was twice the value in gold of a dollar, was worth, therefore, two dollars.

Unfortunately, the real world of economics overcame this system. The US dollar suffered inflation (its value relative to the goods it could buy decreased), while other currencies revalued and became more stable. In the end, the USA they could no longer pretend that the dollar was worth as much as it had been worth, so its value was officially reduced so that an ounce of gold would then have a value of $ 70. Finally, in 1971, the gold standard was over and countries applied a flexible exchange rate. This meant that the dollar no longer represented a real quantity of precious material, and change the model to one where supply and demand adjust the price, and in some cases with central banks keeping the price between some values. After 1971 the flexible exchange rate became the most used type of exchange rate.

Today, the US dollar continues to dominate many financial markets. In fact, interest rates are often expressed in US dollars. Currently, the US dollar and the euro account for approximately 50 percent of all the world's foreign exchange operations. Including British pounds, Canadian dollars, Australian dollars and Japanese yen, we have more than 80 percent of all currency changes.

On the other hand, the last years the importance of the exchange rate policies was fundamental for many countries, and has become a huge debate. Countries like China are the example of this policies, which are related with current account surpluses undervaluation his currencies for gain competitiveness. As other emerging countries that adapt the exchange rate policies to reach the developed countries. The Balassa-Samuelson effect relate the exchange rate and economic activity, where variation in exchange rates may have an important effect to economy.

In this paper, I study the relationship between real exchange rate misalignments and economic activity for three southern European countries (Spain, Italy and Greece) and three northern countries (Denmark, Sweden and Finland). The reason for choose these countries is compare two realities, during the financial crisis the difference between the north and the south has increased. In the north the standard of live is on the top comparing all the EU countries, while the south is on the bottom (with the exception of Spain that is in the middle), capital flight from the south to the north and the effect in unemployment was so much bigger in the south. Looking at the GDP per capita the difference is enormous, we see how Denmark leads the table of the northern countries with the highest values followed by Sweden and Finland. While in the south, Italy leads followed by Spain and Greece with the lowest values. Observing well the data we see how the distance is abysmal between these countries, where Finland has twice the GDP as Italy, where also Sweden and Denmark get high differences with Italy.

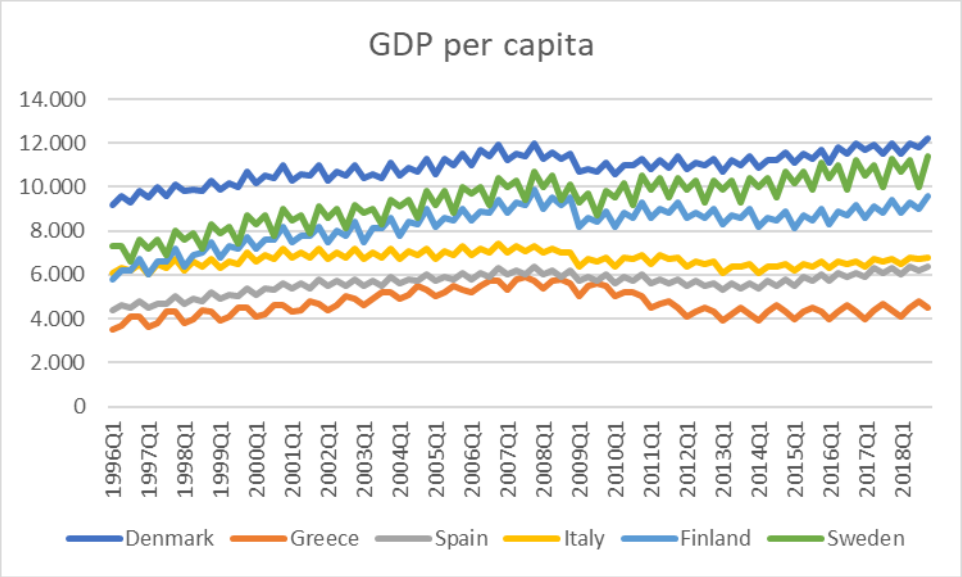

Figure 1. GDP per capita

The Human Development Index is other clear example between the differences in the north and the south. This index integrates life expectancy, education and per capita income to create a ranking of the countries. In the Figure 1, clearly, we can see the difference while the norther countries stay in the top with Sweden in the head followed by Denmark and Finland, the southern countries stay in the middle of a ranking with 58 countries. As Spain as in the head followed by Italy and Greece.

7	–	Sweden	0.933
11	▼ (1)	Denmark	0.929
15	–	Finland	0.920
26	–	Spain	0.891
28	–	Italy	0.880
31	▼ (1)	Greece	0.870

Figure 2. HDI

First, using the real exchange rates, in the Figure 1 are represented for the countries selected since 1995 until 2018 in quarters using the 2010 as base year (2010=100), I will predict the theoretical equilibrium for exchange rate and obtain the misalignments respect the original value. Point out that they are all countries of the European Union, but Sweden and Denmark have their own currencies.

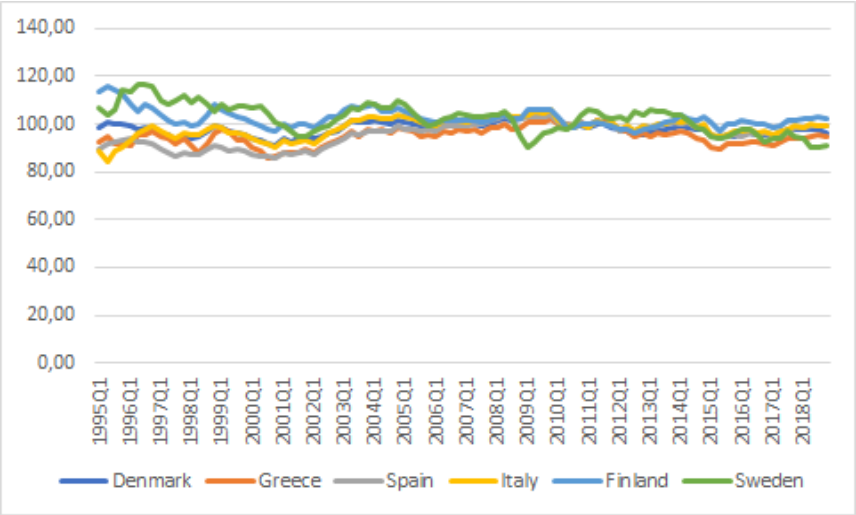

Figure 3. RER

Each country will be analysed individually using time series, the process of obtaining the misalignments will be explained in the corresponding section 3, when we see the variables used and the econometric process. Secondly, using the results previously obtained I will make an equation of growth including the misalignments calculated in the previous step to obtain the effect in the economic growth in each country. After through impulse reaction we will analyse the comportment of economic growth respect RER misalignments; concluding with a comparative between the north and the south.

Summarizing, the objective is to explain how misalignments in the exchange rate affect in the countries of the North and the South. On the other hand, see how the exchange

rates are important nowadays for the economic activity using countries of the European Union as the best example to describe this importance. Where the euro area (formed by nineteen countries) is the most important area in the European Union for maintain the stability, nowadays Spain, Greece, Italy and Finland are members of the eurozone. Denmark and Sweden, have they own currencies, but Denmark have linked his currency to the euro with the ERM II (European Exchange Rate Mechanisms II) where the exchange rate of a non-euro area Member State is fixed against the euro and is only allowed to fluctuate within set limits. On the other hand, Sweden still out of this mechanism because the population did not approve it by referendum.

The rest is organized first with a review of the literature used to the paper in section 2. In the section 3 we analyse the RER equilibrium equation analysing the components and the results of misalignments. The section 4 use the misalignments obtained in section 3 to create an equation of economic growth for later analyse the coefficient and do an impulse response, to know how growth respond to misalignments in each county. Following in the section 5 are the general conclusions and in section 6 and 7 appendix and data appendix.

2. Literature review

There are many studies that relate exchange rate misalignments (defined as deviations of the exchange rate from the equilibrium level) and economic growth, where the use of cointegration models are common. The most differences between the studies are the variables. One of the studies bases use the purchasing power parity from Rodrik (2008) where undervaluation have a good effect over the growth, but in the long-run this suppose does not hold.

Other group use the long-run relationship to obtain the misalignment using cointegration time series o panel data, based on a model for determining the exchange rate. Aguirre and Calderón (2006) is an example, the study of the effects of the misalignments in the real exchange rate (RER) for 60 countries during 1965-2003 using cointegration methods for time series and panel. Based on the model of Obstfeld and Rogoff´s (1995) where exchange rate equilibrium is productivity, net foreign assets, the terms of trade and government spending. Concluding that depreciation have a positive effect to the growth, like Rodrik (2008). Similar, Razin and Collins (1999) pose a different model concluding that overvalued currencies have a negative effect to the growth.

Other studies are based in the search of which variables include as fundamentals. Berg and Miao (2010) compare the results between the “Washington Consensus” who argues that RER misalignments imply imbalances and in consequence bad for the growth. Although, Rodrick (2008) relate the undervaluation relative to purchasing power parity is good for growth. This study concludes the theory of Rodrik but the viewpoint of WC is more difficult to confirm. Comunale (2017) obtain the same results with the analysis for the EU countries, in the same way Habib et al. (2017) for a large panel of almost 150 countries.

On the other hand, Schröder (2013) and Aguirre and Calderon (2005) conclude with an inverse result. The undervaluation is not positive for the economic growth of the countries in comparison with the other studies. Looking around the literature, we can see how misalignments affects growth, undervaluation stimulate growth in contrast than overvaluation that harm the economy. For this, the importance of search asymmetric effects gained importance due to policy. Rodrick (2008), Berg and Miao (2010), Comunale (2017) barely find asymmetries with undervaluation and overvaluation, but Aguirre and Calderon (2006) and Schröder (2013) concludes that both affect negatively to the economy growth where overvaluation with the strongest effect.

Other of the studies, Cuestas, Mourelle and Reges (2019) obtain the same results as Berg and Miao (2010), Schröder (2013), Comunale (2017) where overvalued exchange rate is bad for the economic activity for a group of CEE countries. Besides, overvaluation is much stronger than undervaluation.

3. RER Misalignments

First, as Cuestas, Mourelle and Reges (2019) do in their paper, to obtain the RER misalignments we selected a group of variables to create an equilibrium equation for the RER. The variables are GDP per capita (pibpc), balance of payments (bp), government expenditure (gov), investment (inv), bond yields (int) and consumer price index (pc). This variable is selected based to literature previously explained and data available, see the data appendix for a definition and the data sources of the variables.

Obtained the variables, the equilibrium equation is:

$$rer_t = \alpha 0 + \alpha 1\ pibpc_t + \alpha 2\ bp_t + \alpha 3\ gov_t + \alpha 4\ inv_t + \alpha 5\ int_t + \alpha 6\ pc_t \quad (1)$$

This equation is analysed for each country separately, as we know that Purchasing Power Parity does not hold. The RER is proposed as a cointegration relationship of the variables previously exposed to obtain the misalignment. Applying the cointegration test by Johansen (1988, 1991) for each equation the results show a clear relationship in the long-run, there is cointegration in the variables. To see the results of the test look at the appendix.

Next, applying the VEC model for cointegrated and non-stationary I obtain the coefficients of the cointegrated model for each country. There are values omitted due to difficult to find all the data for the specific country and year. The estimation in the Table 1 follows the strategy of estimate a long-run exchange rate for time series since 1995 until 2018 in quarters. The coefficient of exchange rate is normalized to 1 and the level of significance is indicated with *.

Analysing the Table 1 for each coefficient, first we can see that GDP per capita is significant in all countries but the sign is not the same, with four countries in positive and two in negative. In this case the results are ambiguous, the sign expected is the negative like Greece and Denmark because according to the Balassa-Samuelson effect when a country is more developed should have a more valued currency. This effect relates the differences into a country between tradable and non-tradable market, where the “Penn Effect” says that RER follow the same direction: If the incomes are high, the prices levels are high comparing to international average, and when are low the contrary.

According to Cuestas, Mourelle and Reges (2019): “The Balassa-Samuelson effect is the real appreciation generated by the increase in the relative price of non-tradable goods that follows an increase in productivity in the more competitive tradable market. This is driven by the upward pressure on wages in the non-tradable sector that arises because wages in the tradable sector are higher since productivity growth is faster in that sector than in the non-tradable sector”, so in the case of Spain, Italy, Sweden and Finland may be for the no increment in the relative price o and a lower incomes and price levels compared to international average.

The next coefficient to analyse it is only available for Spain, Sweden and Finland due to the lack of data in the other year in respective quarters. The balance of payments alone does not serve to explain fluctuations in the real exchange rate, it is composed of a

current account and capital account. The balance of payments registers all monetary transactions between a country and the rest of the world, the current account includes net transactions of goods and services, while capital account the inflows and outflows of capital. The sum of these two has to add cero, if current account has surplus the capital account has deficit and vice versa.

Continuing with the main part, if the current account has deficit during a long time the currency tends to depreciate. The sing of the coefficients is the expected in Spain and Finland where an improvement in the balance of payments tend to appreciate the currency but in Sweden the results are contradictory may be due to that historically Sweden always has surplus.

The government expenditure and investment are all significative in all the cases except the government expenditure in Italy. The interpretation of the signs depends the policy of each country, when a country spends more in non-tradable goods the sign is negative. As we can see Sweden and Finland have a negative sign because the specific policies where spend a lot of money in non-tradable goods. On the other hand, Spain, Greece and Denmark have spent more in tradable goods so for this the sign is positive. With the exception of Denmark that is a interesting difference between northern and southern countries.

The explanation for investment is similar, a positive sign indicates that the invest depends more on non-tradable goods and positive if depends more on tradable goods. In this case four countries have positive sign and two negatives, with the exception of Spain and Italy (due to government expenditure is not significative) is surprising that in the other countries government expenditure and investment goes to the same direction. To tradable goods in Greece and Denmark and non-tradable goods in Sweden and Finland.

Finally, the interpretation of the last two coefficients are confusing and depend of the characteristics of each country. The coefficients of bond yields are significance with the exception of Spain and oscillate between negative o positive depend the country. The consumer price index has a little significance and it is only significative in four countries, where the signs are positive for two countries and negative for two too.

	(1)	(2)	(3)	(4)	(5)	(6)
	Spain	Italy	Greece	Denmark	Sweden	Finland
RER	1.000	1.000	1.000	1.000	1.000	1.000
GDP PER CAPITA	0.073199*** (0.1548)	0.087405*** (0.00811)	-0.075936*** (0.01391)	-0.042398*** (0.0064)	0.030193*** (0.00347)	0.653995*** (0.07322)
BALANCE OF PAYMENTS	-0.001741*** (0.00054)				0.008075*** (0.00101)	-0.021979*** (0.01188)
GOVERMENT EXPENDITURE	0.001905*** (0.00076)	-0.000289 (0.00043)	0.017689*** (0.00392)	0.013123*** (0.00532)	-0.004324*** (0.00267)	-0.590943* (0.07737)
INVESTMENT	-0.003198*** (0.00081)	-0.002430*** (0.00027)	0.003660*** (0.00126)	0.009014*** (0.00163)	-0.005767*** (0.00079)	-0.197065*** (0.02442)
BOND YIELDS	-1.764546 (1.42934)	2.963008*** (0.65594)	-1.757599*** (0.39624)	-4.784149*** (1.41865)	8.324433*** (1.06342)	-66.22856*** (11.9472)
CONSUMER PRICE INDEX	-2.246807*** (0.56763)	-0.162827 (0.17303)	0.670559*** (0.20887)	-1.502561** (0.76785)	0.040461 (0.43755)	6.556983*
CONSTANT	-208.4823	-469.6298	-10.04652	199.7542	-466.2958	2383.366

*Table 1. VEC of RER. Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.*

Now using the coefficients of the equilibrium real exchange rate for calculate a theoretical equilibrium. The results obtained are in the figures were using a line graph are represented the theoretical equilibrium and the real exchange rate. Point out that the equilibrium calculated in some cases have a lot of fluctuations, because apart form the long-run component, there is a short-run component to provoke the fluctuations. There is a solution to solve this using the Hodrick-Prescott filter but in this analysis do not need do that for analyse the misalignments.

Starting with the first country, Spain. In this case there is a pattern of undervalued exchange rates, since 1995 until 2010 with a big increment of misalignments during the major years of expansion before the crisis. The trend changes completely after the start of the crisis, where the misalignments reduced. The next two year between 2011-2012 the misalignments adjusted a lot of to the real value, the following years the tendency was undervalued exchange rate, and in the last three years coinciding with the time of more growth before the crisis the tendency is overvalued.

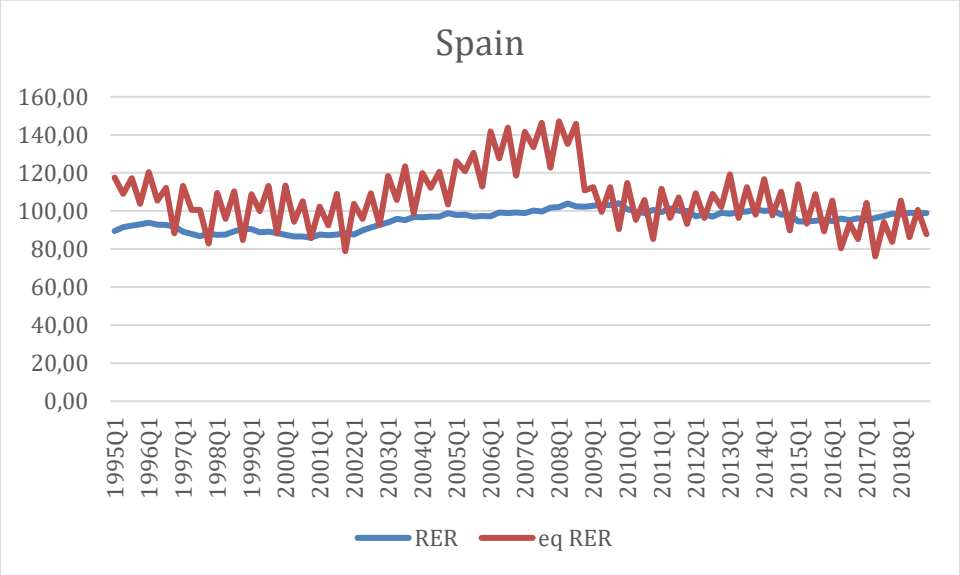

Figure 4. Spain eq RER

The next country of the south, Italy have an overvalued exchange rate during all the period analysed. The rate of misalignments is high as we can see in the figure, the comportment is similar since 1995 until 2010 but in the las years misalignments reduced a bit and are more stable. Probably because the measures applied after the crisis.

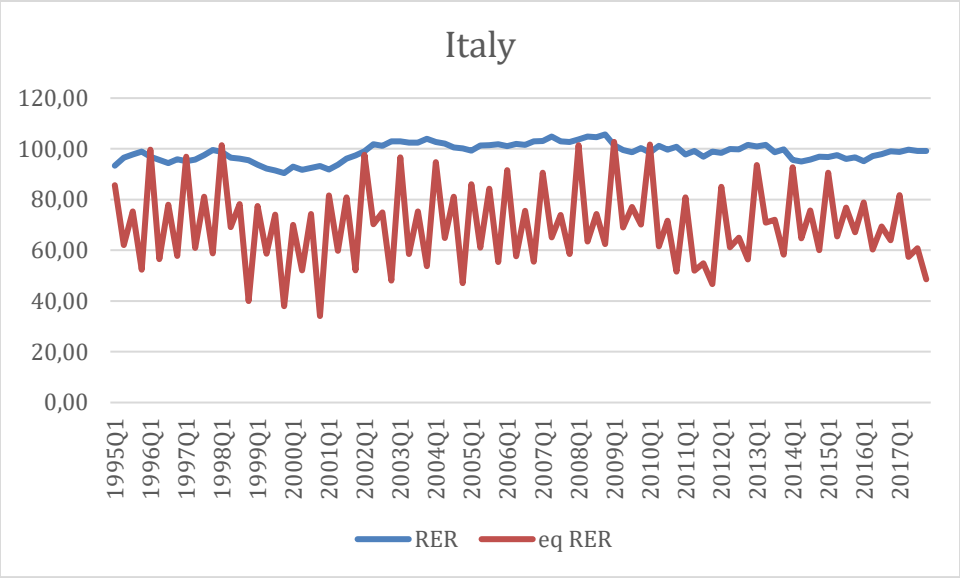

Figure 5. Italy eq RER

In the Greece case, is similar to Spain but with more oscillations. The first clear tendency is undervalued currency until the crisis start until 2009, after crisis start the exchange rate started to be overvalued but the last three-four year is starting to change to a more overvalued exchange rate, although still undervalued. Respect to the misalignments in this case are bigger than Spain and still similar to 1995.

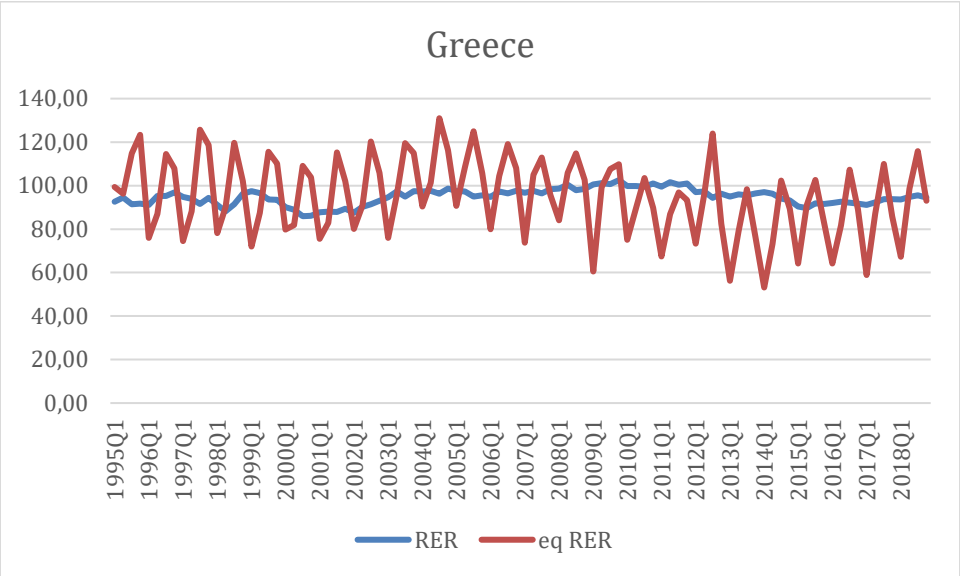

Figure 6. Greece eq RER

Changing to northern countries, looking Denmark the currency was undervalued since 1995 until 2000 were the more growth period starts. Since 2000 the tendency change to a more overvalued currency until 2015, although the years of crisis reduce the

misalignments a bit. After 2015 the currency still undervalued like the first period analysed. Respect the oscillation of misalignments, in this case are little compared to Greece o Italy due to that Denmark currency is linked to euro.

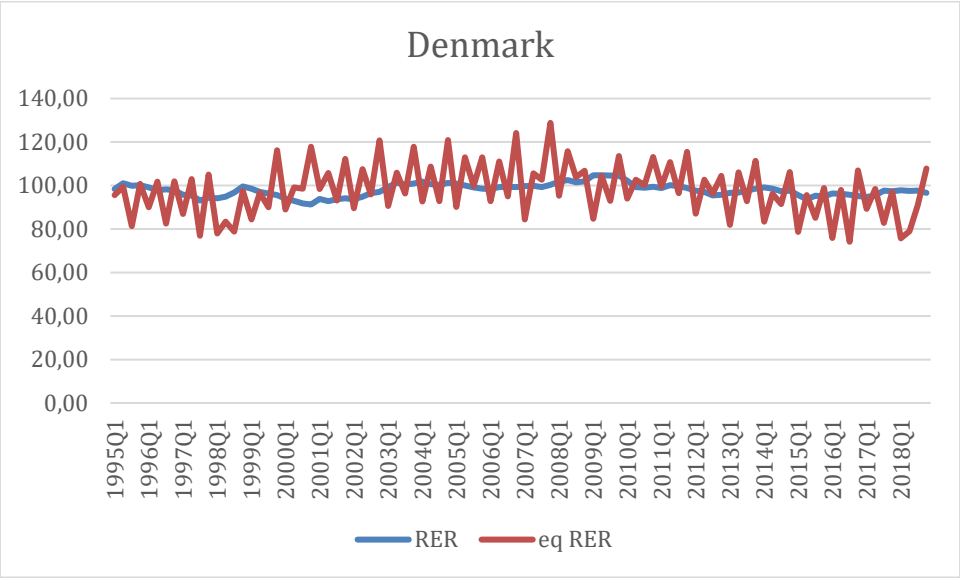

Figure 7. Denmark eq RER

The case of Sweden is curious, the currency still so stable during the period analysed without almost any effect of the crisis. The currency is undervalued during all the period with a high misalignment that increment lightly the last years. This would be caused by the special politics of Sweden for example with the government expenditure.

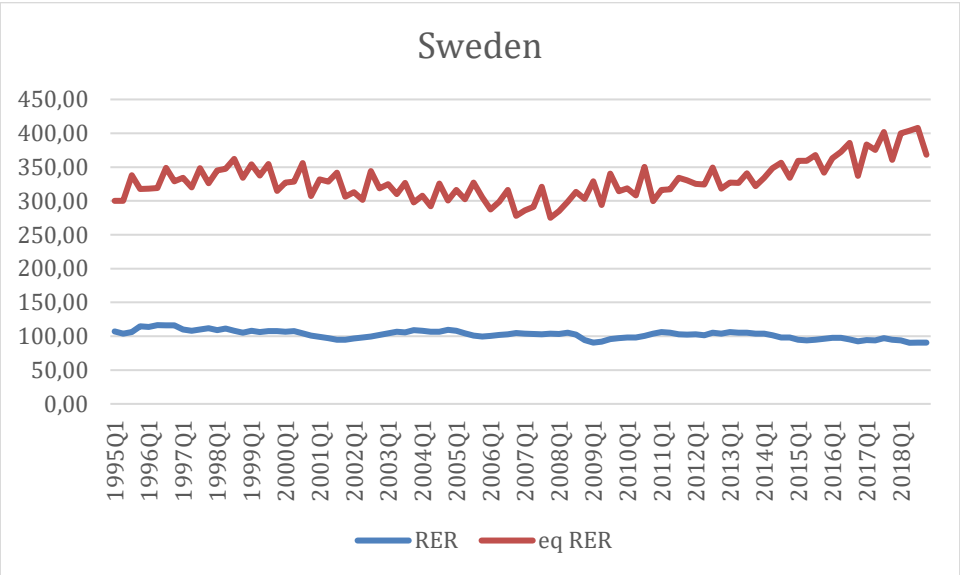

Figure 8. Sweden eq RER

Finland is really difficult to analyse; the misalignments are huge and the tendency of exchange rate is not clear with this big oscillation. In this case we can analyse nothing, only that is the country with the most misalignments of the six.

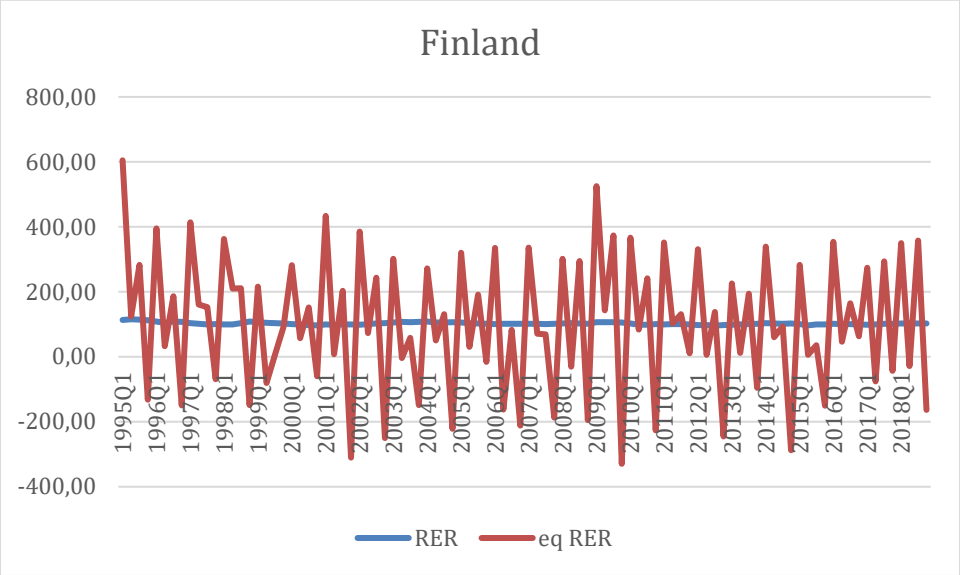

Figure 9. Finland eq RER

Summarizing, once misalignments are calculated we put it together in a figure. As we can se Finland and Sweden have a huge misalignment respect the other countries, this will be for the specifics policies that these countries apply. Respect the others Italy has the major misalignments followed by Greece, and Spain and Denmark are similar where Denmark has a bit less. Comparing north and south, the south has a lot less misalignments than the north, where the exception of Denmark, are huge. These estranges cases can be due to specific policies of the Scandinavians countries, although Denmark keeps stable the misalignments due to it is currency is linked to the euro. On the other hand, the southern countries were more affected by the crisis changing the tendency of real exchange rate.

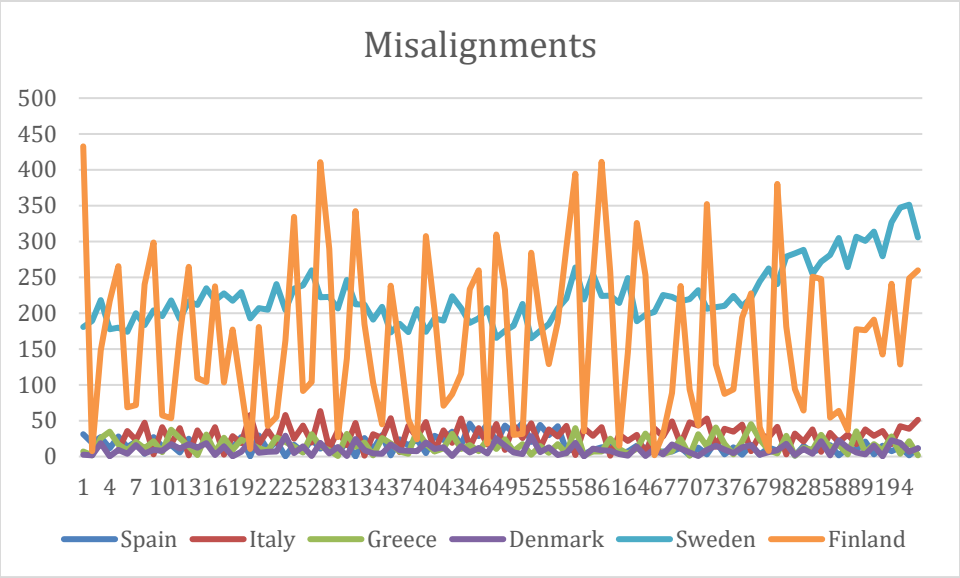

Figure 10. Misalignmets

4. Country Growth

In this section, we will use the misalignments obtained for each country to made a regression of growth. Using the same process as the previous section, first checking the existence of cointegration between the variables. The results are in the appendix section. All the regressions have a relation in the long-rut, all present cointegration. The equation of growth is:

$$grow_t^q = \alpha_0 + \alpha_1 gov_t + \alpha_2 inv_t + \alpha_3 mis_t + \alpha_4 emp_t + \alpha_5 con_t$$

The variables for explain the growth are government expenditure (gov), investment (inv), misalignments (mis), employment (emp) and consumption expenditure of households (con). See the data appendix for a definition and the data sources of the variables. In this equation we have the same two variables the government expenditure and investment previously used in section 3, but in addition misalignments obtained of VEC coefficients and employments and consumption as new variables. These variables are selected as a complement of determinants of growth and for have a more complete equation, while the misalignments are the main component for analyse. Through impulse in VEC model, we will see the comportment of the growth when the misalignments vary.

	(1)	(2)	(3)	(4)	(5)	(6)
	Spain	Italy	Greece	Denmark	Sweden	Finland
GROWTH	1.000	1.000	1.000	1.000	1.000	1.000
GOVERMENT EXPENDITURE	-4.93E-05*** (1.4E-05)	-4.26E-05 (3.9E-05)	-5.60E-05 (0.00019)	-6.35E-05 (0.00012)	0.000178 (0.00021)	3.52E-05 (0.00066)
INVESTMENT	-3.94E-05*** (1.5E-05)	1.27E-05* (8.7E-06)	4.18E-05 (4.2E-05)	8.43E-05 (8.4E-05)	0.000105*** (4.1E-05)	0.000239** (0.00012)
MISALIGNMENTS	0.009596*** (0.00365)	-0.078448*** (0.00913)	-0.012774** (0.00888)	-0.022478*** (0.00756)	0.007814*** (0.00368)	-0.001406* (0.00100)
EMPLOYMENT	0.000554*** (0.00013)	0.000539*** (0.00021)	-0.001379*** (0.00049)	-0.001736* (0.00157)	-4.66E-05 (0.00044)	-0.003027** (0.00195)
CONSUMPTION OF HOUSEHOLDS	-2.20E-05* (2.0E-05)	-3.22E-05** (2.0E-05)	9.99E-05** (6.0E-05)	6.09E-05 (0.00011)	-6.63E-05 (7.5E-05)	9.18E-06 (0.00017)
CONSTANT	-2.155325	0.428130	2.017949	2.568420	-2.265176	3.738214

*Table 2. VEC of growth. Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.*

After applying VEC model I obtain the coefficients for analyse it. The estimation in the Table 2 follows the strategy of estimate a long-run growth for time series since 1998 until 2018 in quarters. The coefficient of growth is normalized to 1 and the level of significance is indicated with *. The first coefficient government expenditure, is only significant for Spain with a negative sign that significate when more spend more growth. It is strange that only for one country is significative but that is not the main component to analyse.

Following with investment, this is significative for four countries. Spain Italy Sweden and Finland, the sign is positive with the exception of Spain. In this case the expected sing is positive because when more invest more economic growth, but in this case Italy, Sweden and Finland have a contrary effect with a reduction of growth when investment increase.

Leaving the misalignments for later, employments is significative for 5 countries. The sign is positive in three of them and negative in two, it is curious in Spain and Italy because affect negatively in the growth may be for the big impact of the crisis the result is not the expected. Although, in Greece, Swede and Finland the effect is the expected where an augment of employment is related positively to growth.

The next coefficient, consumption of households is only significant for the southern countries. In Spain and Italy an augment of consumption increments the growth while in Greece reduces it, so it is a strange comportment of the variable that will be negative. As we can see the sign of coefficients in some cases are not the expected, it does not matter to much because the analysed coefficients of variables are only a complement to create a better equation of economic growth with a misalignment as main component.

Before explain the comportment of growth when misalignment vary using impulse response function of VEC models, lets watch the coefficients and the sign of cointegration equation. For all the countries the coefficient is significant, the sign is negative in Italy, Greece, Denmark and Finland meaning a positive relationship between misalignments and growth. On the other hand, Spain and Sweden have a negative relation between misalignments and growth, an increment of misalignments reduces the growth.

The sign of coefficient may be explained how is the growth comportment but, in some cases, can not be true this relationship. For obtain a more accurate response of the Growth when misalignments changes, we use the Impulse Response to Cholesky One S.D. Innovations. Through this it is possible obtain in a better way the effect on the

growth. After all, using the VEC model it is possible obtain the long-run relationship of misalignments with the growth, in this case for a period of 40 quarters.

The first country to analyse is Spain, once obtained the Figure 9 there is a clear trend. The effect in the growth is positive, during the first periods the influence of misalignments onto growth grow up from 0% in the period 1 to 0.06% in the period 3 when the influence stabilizes until period 5. Starting to this period the influence starts to decrease period after period until period 12 that we can see a change, after that the influence decrease more until -0.04% when stabilizes. Anyways, for a long period of ten years the pattern, even though is positive at the beginning, is negative misalignments affect negative to growth as the sign of coefficient.

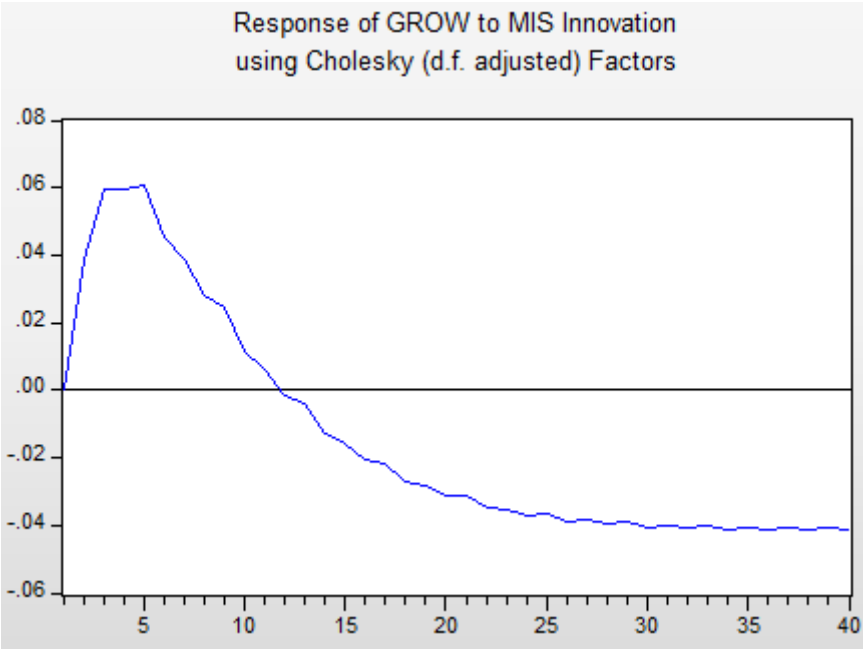

Figure 11. Spain impulse response

The next country is Italy, in the Figure 10 we can see the results of the response of grow to misalignments. Starting from 0% in the first period the relation goes down until -0.09% approximately in period 2, since this period the trend changed. After period 2 the effect of misalignments to growth recover the initial value 0%, but after this the relationship starts to be positive. As the highest point in the period 7 with almost 0.08%, after some positives periods but with a big variance the value stabilizes around 0.03%. In this case, as the sign of the coefficient, the relationship between the growth and misalignments is positive, even though has a few periods of negative relation.

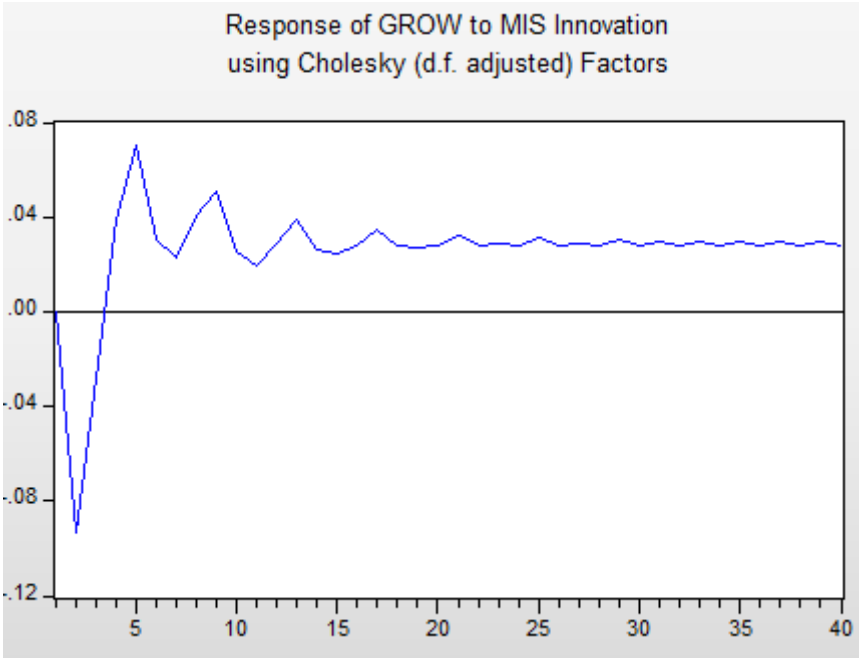

Figure 12. Italy impulse response

Following with the last southern country, Greece. The results are in the Figure 11. In this case the relation between growth and misalignments is always positive, highlight the period 2- 3 when the value is almost 0.12%. After this maximum the value fall to 0.02% and start to oscillate around 0.06% and 0.04%, for stabilizing in the last periods around 0.05%. In the same form as Spain and Italy the response of growth to misalignments is like the sign of the coefficient obtained previously in VEC model.

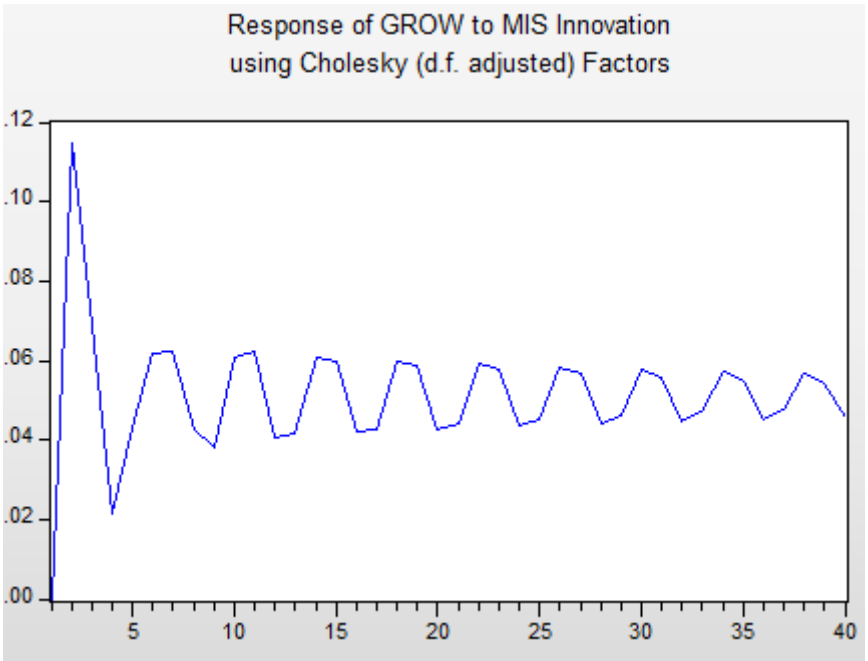

Figure 13. Greece impulse response

Starting with the first northern country, Denmark. The results are in the Figure 12. That results are similar to Greece but with less oscillation, at the beginning the value grow bit a bit the first 2-3 periods for jump to 0.12% at period 4. After, the value falls to 0.06% in period 6 for in the following periods oscillate between 0.11 and 0.09, and stabilize around 0.10% in the last 20 periods. As que can se the relation in this case is positive all the time with a big impact on the growth, following the same sign obtained in the coefficient.

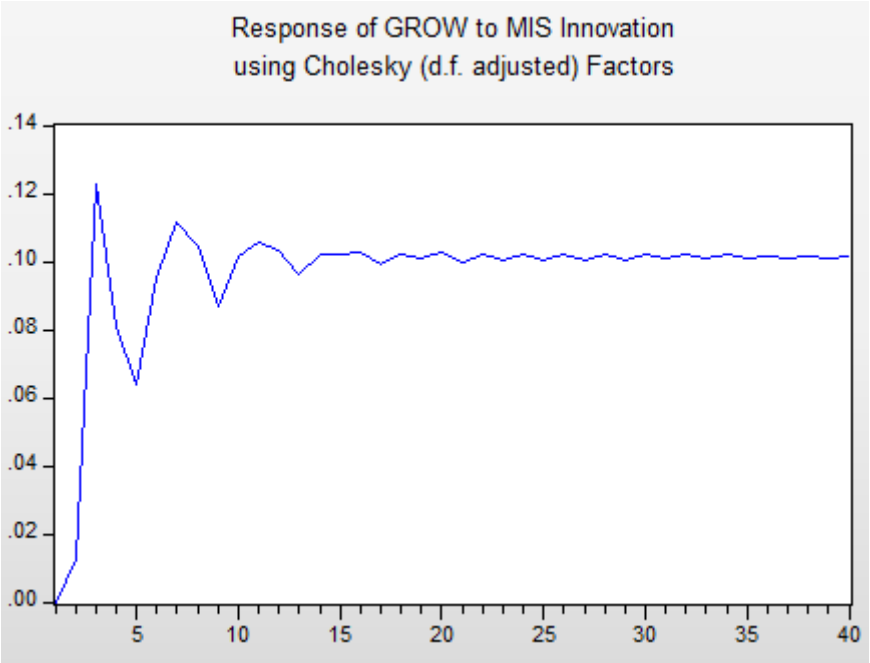

Figure 14. Denmark impulse response

Sweden has a curios comportment, form the first period fall to -0.06% in period 2 to grow up to 0.03% in period 3 and for finally fall to -0.08% in period 4. After this the value stabilizes in -0.08% some periods and fall with a little oscillation to -0.10%. In this case the relation is almost all the time negative, where misalignments affect negatively to economic growth. As the other countries the coefficient of VEC model coincide with the prediction of ten years even having a period of positive relation.

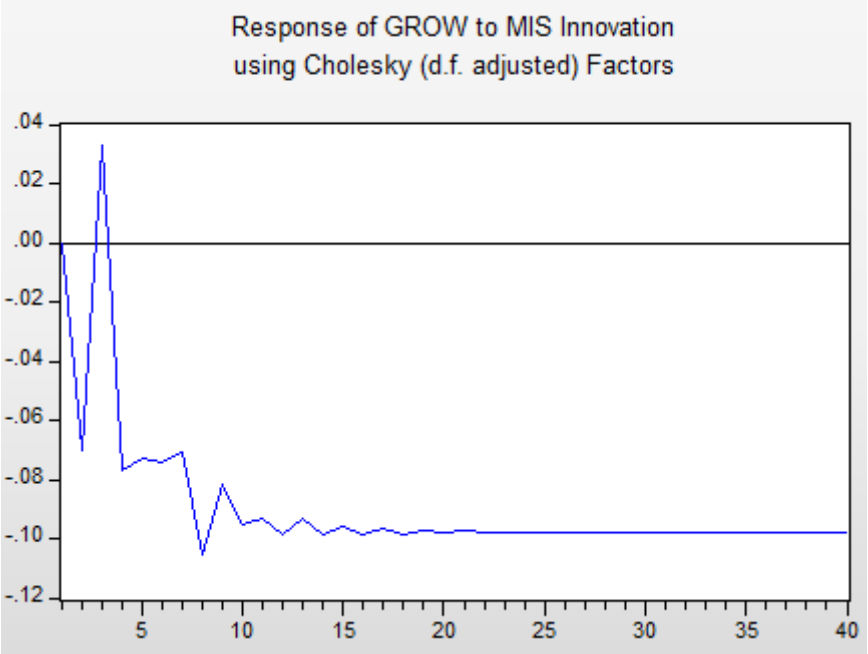

Figure 15. Sweden impulse response

The last is Finland. In the Figure 14 are the results. As Sweden, Finland has a strange comportment the first periods. In the periods between 2-3 the value is almost 0.12% for after fall to -0.01% in period 4, the next periods the oscillation is big around -0.01% and -0.04%. In this case the coefficient of VEC model it does match with the results, may be due to the big positive value that we can see in the period 3, anyways the conclusion is that misalignments have a negative effect to the economic growth.

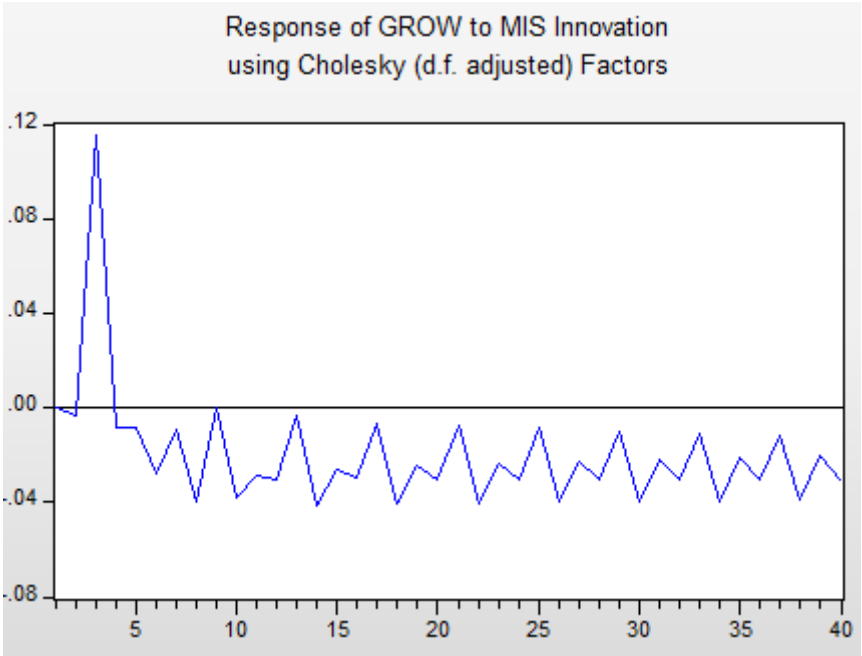

Figure 16. Finland impulse response

Once the countries are analysed, we can get some conclusions. The equation to relate economic growth and the misalignments has worked fine to obtain a consistence result. Although, in the VEC coefficients some of the variables have no signification the misalignments are significant in all the countries, where the sign with the exception of Finland are in the same way as the impulse response. Respect the north and the south, in the two cases are one exception, Italy and Greece have a positive effect from misalignments to the economic wroth while Spain has a negative. Sweden and Finland have both a negative effect from misalignments to economic growth while Denmark has a positive.

Using the information obtained in the section 3 where we calculate, through cointegration relationship, the theatrical equilibrium for each country, that we have obtained of the coefficients of the equation for RER. It is possible confirm one of the results previously saw in the literature. In the graph comparing the RER and que theoretical equilibrium from Sweden we see that the currency is undervalued, linking this to response impulse analysis can conclude that undervaluation has a negative effect to the economy. As Aguirre and Calderon (2006) and Schröder (2013) concludes, that over-valuated and undervalued affect negatively to the economy growth.

On the other hand, looking the graph of Italy can see an asymmetry because in the graph the tendency of Italian currency is over-valuated while in the growth analysis in the case of Italy the misalignments affect positively. So, the theory of Aguirre and Calderon (2006) and Schröder (2013) does not hold in this case.

5. Conclusions

The objective of this project is understanding how exchange rate are important for the economy and the possible effects. In a world where the exchange rates are increasingly important, with the clear example of China and it is policy of undervaluation for gain competitiveness. This added to the Balassa-Samuelson effect were variations of exchange rate may have important consequences to the economy. Selecting three northern countries (Denmark, Sweden and Finland) and three southern (Spain, Italy and Greece), with the simple reason to compare two realities inside the EU as euro area as a reference due to euro is the second most important currency at the world.

The misalignments are the main component of the project, through an equilibrium equation for RER. Applying cointegration by VEC model we obtain some results that

using the coefficients of cointegration can compute the theoretical RER equilibrium for each country. Spain before the crisis had an undervalued exchange rate but after the crisis the misalignments had reduced and the last years of recovery form the crisis the exchange rate started to stay over-valuated. Italy had an over-valuated exchange rate during all the analysed period and Greece has a similar result to Spain but with a high variance and the last years the exchange rate started to stay undervalued. Denmark is divided into three periods, the first the currency is undervalued, in the second the tend change and is over-valuated and finally in the last the currency is starting to stay undervalued. In the Sweden case the currency is clearly undervalued during all the period analysed. Finally, Finland is hard to analyse because a high variance during all the periods that makes impossible analyse the state of exchange rate.

The results of this is much more misalignments in the northern countries than southern with the exception of Denmark, with Finland and Sweden on the head followed by Greece, Italy, Spain and Denmark respectively. So, we can see the first differences between north and south. These misalignments are crucial because we include it into the next regression of growth, the process is the same as previously, highlight the big significance of the coefficient misalignments in all the countries.

Through impulse response in the VEC model we obtain the last results. In Spain the relation of misalignments and growth is positive the first periods but later this begins to be negative little by little. Italy with a negative peak at the firsts periods becomes positive with the following periods with a big positive peak for later stabilize to a lower value. Greece characterized for at a big positive peak at the beginning for stabilizes to a lower positive value in the next periods after some variance. Denmark similar to Greece peak at the beginning and stabilizes in the next periods but a high value. Sweden has a strange behaviour, first the relation is negative with a peak in the next to periods the relation is positive with a big value and finally fall to a negative value bigger than the first peak. Finally, Finland start with a big positive value and fall to a negative in the next periods where vary between 0.01% and 0.04%.

In the north and the south, we see a tendency with an exception in both. Sweden and Finland have a negative effect of misalignments in the economic growth while Denmark has a positive relation being the biggest respect the positive countries. Italy and Greece have both positive effect of misalignments over the economic growth but Spain has a negative relation. It is hard getting a conclusion of this results because we would need more countries for analyse the behaviour for discard that the case of Spain and Denmark

are isolated cases for conclude. In the case of Denmark, the fact that his currency is linked to the euro with ERM II, that does not allow fluctuate more than 15% from the euro can have the explanation of the different result respect the northern countries.

In the case of excluding Spain and Denmark, the differences between the north the south are clear. The northern countries have a negative relation between misalignments and growth and the southern have a positive relation between growth and south, other pattern is that Sweden and Finland have more high misalignments compared to Italy and Greece. So, in this theoretical case we can conclude that if there are to much misalignments probably the effect of this in the economy will be bad, as the case as Sweden and Finland.

Mixing the results of the RER and growth sections, we can see a relation saw in the literature. If we compare the theoretical RER equilibrium of Sweden with the conclusion of all the time the currency is undervalued linked to the conclusion of negative effect of misalignments into the growth. We can prove on part of the theory of Aguirre and Calderon (2006) and Schröder (2013), that over-valuated and undervalued affect negatively to the economy growth.

Although, looking the case of Italy we have an invers result respect Aguirre and Calderon (2006) and Schröder (2013), in this case the exchange rate of Italy is overvalued and the effect of misalignments is positive so the theory does not hold. Highlight that this mix of the two sections was done with these countries because in the theoretical exchange rate have a clear tendency. Anyways, that theory does not hold, one thing is clear in this project.

Exchange rates play a crucial role in the growth of countries and more in an increasingly globalized world, whether negative or positive these misalignments cause as we have seen reactions in countries and their growth for this the importance of the policies will increase more. In this work we have not been able to obtain a clear answer about the possible differences between the countries of the north and the south, because of the lack of analysing more countries, or through a more select selection of variables that would allow us to get closer to reality. Although there is an individual response for each country and the effects that the misalignments have on them.

6. Appendix

In the first moment in the project we want to use a VAR model and apply an impulse response of the variables because is a perfect model for a time series. But for use this model we need stationary variables, hard thing to get. Continuing, checking the stationarity, all the variables are integrated ergo no stationary. After the first analysis we can not use the VAR model, in this case que can do two things. Transform the variables in stationary, for example using growth rates of the variables but if we do this the possible relations of cointegration are eliminated and the we lose important information. Or using the cointegration test by Johansen (1988, 1991) check if the variables have a long-run relation for use a Vector Error Correction (VEC) model, that is an extension of VAR model for cointegrated and integrated series.

We use the cointegration test by Johansen (1988, 1991) in the RER equation from section 3. In the Table 3 we have the test for Spain, Italy and Greece respectively, as we can see the p-value of MacKinnon-Huag-Michelis at 0.05 level indicate at least four cointegration equations for Spain and Italy and three for Greece. As the Table 3, Table 4 shows the results for Denmark, Sweden and Finland. Where the p-value at 0.05 we can see Denmark with three cointegration equations, Sweden with two cointegrated equations and Finland with seven cointegrated equations.

Sample (adjusted): 1995Q4 2018Q4
Included observations: 93 after adjustments
Trend assumption: Linear deterministic trend
Series: EX PIBPC BP GOV INV INT PC
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.368105	161.0341	125.6154	0.0001
At most 1 *	0.321557	118.3442	95.75366	0.0006
At most 2 *	0.304885	82.26444	69.81889	0.0037
At most 3 *	0.198847	48.44244	47.85613	0.0440
At most 4	0.161605	27.82406	29.79707	0.0830
At most 5	0.095916	11.43134	15.49471	0.1863
At most 6	0.021843	2.053898	3.841466	0.1518

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Sample (adjusted): 1996Q4 2018Q4
Included observations: 89 after adjustments
Trend assumption: Linear deterministic trend
Series: EX PIBPC GOV INV INT PC
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.615637	187.0388	95.75366	0.0000
At most 1 *	0.337504	101.9397	69.81889	0.0000
At most 2 *	0.320556	65.29486	47.85613	0.0005
At most 3 *	0.170832	30.89816	29.79707	0.0372
At most 4	0.103527	14.22554	15.49471	0.0770
At most 5 *	0.049294	4.498940	3.841466	0.0339

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Sample (adjusted): 1995Q4 2018Q4
Included observations: 93 after adjustments
Trend assumption: Linear deterministic trend
Series: EX PIBPC GOV INV INT PC
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.413430	130.6061	95.75366	0.0000
At most 1 *	0.293667	80.99396	69.81889	0.0049
At most 2 *	0.195749	48.66078	47.85613	0.0419
At most 3	0.157843	28.40132	29.79707	0.0718
At most 4	0.076817	12.42492	15.49471	0.1377
At most 5 *	0.052259	4.991653	3.841466	0.0255

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 3. South RER cointegration

Sample (adjusted): 1995Q4 2018Q4
Included observations: 93 after adjustments
Trend assumption: Linear deterministic trend
Series: EX PIBPC GOV INV INT PC
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.408019	129.1598	95.75366	0.0000
At most 1 *	0.283162	80.40173	69.81889	0.0056
At most 2 *	0.197443	49.44151	47.85613	0.0352
At most 3	0.130355	28.98595	29.79707	0.0618
At most 4 *	0.107061	15.99666	15.49471	0.0420
At most 5 *	0.057076	5.465620	3.841466	0.0194

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Sample (adjusted): 1995Q4 2018Q4
Included observations: 93 after adjustments
Trend assumption: Linear deterministic trend
Series: EX PIBPC BP GP INV INT PC
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.567203	180.0970	125.6154	0.0000
At most 1 *	0.322500	102.2108	95.75366	0.0167
At most 2	0.213251	66.00164	69.81889	0.0970
At most 3	0.185644	43.69602	47.85613	0.1165
At most 4	0.179546	24.59772	29.79707	0.1763
At most 5	0.057487	6.193246	15.49471	0.6727
At most 6	0.007361	0.687148	3.841466	0.4071

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Sample (adjusted): 1995Q4 2018Q4
Included observations: 93 after adjustments
Trend assumption: Linear deterministic trend
Series: EX PIBPC BP GOV INV INT PC
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.536942	212.0232	125.6154	0.0000
At most 1 *	0.470505	140.4223	95.75366	0.0000
At most 2 *	0.244645	81.29001	69.81889	0.0046
At most 3 *	0.210096	55.19729	47.85613	0.0088
At most 4 *	0.151406	33.26383	29.79707	0.0192
At most 5 *	0.132601	17.99563	15.49471	0.0206
At most 6 *	0.049954	4.765799	3.841466	0.0290

Trace test indicates 7 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 4. North RER cointegration

Once obtained the results we can see that the VEC model for each country can be applied, we can interpret de coefficients respect the RER and obtain the behaviour of the variables as we saw in the section 3.

Following with the equation of the section 4 we did the same process as in sector 3, we use the cointegration test by Johansen (1988, 1991) in the equation that relate growth and misalignments. In the Table 5 we have the test for Spain, Italy and Greece respectively, as we can see the p-value of MacKinnon-Huag-Michelis at 0.05 level indicate at least three cointegration equations for Spain, two for Italy and seven for Greece. As the Table 3, Table 6 shows the results for Denmark, Sweden and Finland. Where the p-value at 0.05 we can see Denmark with three cointegration equations, Sweden with one cointegrated equation and Finland with two cointegrated equations.

Sample (adjusted): 1995Q4 2018Q4
Included observations: 93 after adjustments
Trend assumption: Linear deterministic trend
Series: EX PIBPC GOV INV INT PC
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.408019	129.1598	95.75366	0.0000
At most 1 *	0.283162	80.40173	69.81889	0.0056
At most 2 *	0.197443	49.44151	47.85613	0.0352
At most 3	0.130355	28.98595	29.79707	0.0618
At most 4 *	0.107061	15.99666	15.49471	0.0420
At most 5 *	0.057076	5.465620	3.841466	0.0194

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Sample (adjusted): 1995Q4 2018Q4
Included observations: 93 after adjustments
Trend assumption: Linear deterministic trend
Series: EX PIBPC BP GP INV INT PC
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.567203	180.0970	125.6154	0.0000
At most 1 *	0.322500	102.2108	95.75366	0.0167
At most 2	0.213251	66.00164	69.81889	0.0970
At most 3	0.185644	43.69602	47.85613	0.1165
At most 4	0.179546	24.59772	29.79707	0.1763
At most 5	0.057487	6.193246	15.49471	0.6727
At most 6	0.007361	0.687148	3.841466	0.4071

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Sample (adjusted): 1995Q4 2018Q4
Included observations: 93 after adjustments
Trend assumption: Linear deterministic trend
Series: EX PIBPC BP GOV INV INT PC
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.536942	212.0232	125.6154	0.0000
At most 1 *	0.470505	140.4223	95.75366	0.0000
At most 2 *	0.244645	81.29001	69.81889	0.0046
At most 3 *	0.210096	55.19729	47.85613	0.0088
At most 4 *	0.151406	33.26383	29.79707	0.0192
At most 5 *	0.132601	17.99563	15.49471	0.0206
At most 6 *	0.049954	4.765799	3.841466	0.0290

Trace test indicates 7 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 5. South growth cointegration

Sample (adjusted): 1998Q4 2018Q4
Included observations: 81 after adjustments
Trend assumption: Linear deterministic trend
Series: GROW GOV INV MIS EMP CON01
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.624810	186.8048	95.75366	0.0000
At most 1 *	0.456931	107.3987	69.81889	0.0000
At most 2 *	0.328494	57.94672	47.85613	0.0043
At most 3	0.176038	25.68996	29.79707	0.1382
At most 4	0.077376	10.00585	15.49471	0.2803
At most 5	0.042084	3.482607	3.841466	0.0620

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Sample (adjusted): 1998Q4 2018Q4
Included observations: 81 after adjustments
Trend assumption: Linear deterministic trend
Series: GROW GOV INV MIS EMP CON01
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.577828	138.2960	95.75366	0.0000
At most 1	0.329229	68.44630	69.81889	0.0640
At most 2	0.198356	36.10079	47.85613	0.3913
At most 3	0.149645	18.19242	29.79707	0.5519
At most 4	0.058488	5.062208	15.49471	0.8022
At most 5	0.002226	0.180495	3.841466	0.6709

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Sample (adjusted): 1998Q4 2018Q4
Included observations: 81 after adjustments
Trend assumption: Linear deterministic trend
Series: GROW GOV INV MIS EMP CON01
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.630192	162.8468	95.75366	0.0000
At most 1 *	0.371349	82.27023	69.81889	0.0037
At most 2	0.199251	44.67173	47.85613	0.0966
At most 3	0.153800	26.67286	29.79707	0.1099
At most 4	0.088342	13.14586	15.49471	0.1096
At most 5 *	0.067424	5.654150	3.841466	0.0174

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 6. North growth cointegration

In this case as the previous case with the RER equation, the results allow use a VEC model for our equation of growth, we can interpret de coefficients respect the growth and obtain the behaviour of the variables, also the impulse response of the growth to misalignments as we saw in the section 4.

Point that, all the econometric process, augmented Dickey-Fuller test, Johansen (1988,1991) test for cointegration, VEC model and impulse response of VEC model, has been done using the program EViews.

7. Data Appendix

The data of variables for RER equation almost are all obtained from Eurostat since 1995 until 2018 in quarters, consumer price index is from Federal Reserve of St. Louis. RER is linked to 2010 where 2010 is the base year (2010=100), GDP per capita is chain linked volumes (2010) in million euro and seasonally and calendar adjusted as government expenditure and investment. Balance of payments is defined in million euros of the

current account of the total economy, bond yields are adjusted according EMU convergence criteria and the consumer price index is linked to 2015 as base year.

The data of the variables of growth equation all are obtained from Eurostat since 1998 until 2018 in quarters, government expenditure and investment are the same data as RER equation. The misalignments are obtained from section 3 with a coefficient of the VEC model, GDP growth it is calculated by myself from a series of GDP chain linked to 2010 and seasonally and calendar adjusted. Employment cover from 15 year old to 64 year old and final consumption expenditure of households is chain linked to 2010 and seasonally and calendar adjusted. The misalignment data are obtained in the section 3 using the cointegration coefficient of each country with the sign inverted for obtain the theoretical equilibrium and calculate the difference.

Point that all data are recollected, for the two equations, using Excel, for later import to EViews.

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