Real exchange rate misalignment in the Eurozone

Country specific values

Zain Syed

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Forfatter Zain Syed

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Abstract

Looking at the Current Account balances of the Eurozone, one might draw the conclusion that the Eurozone is running a sustainable Current Account balance. The Eurozone is however made up of sovereign nations where the economic conditions differ. Some countries in the monetary union have been running a persistent large Current Account deficit, while others a surplus. According to the Fundamental Equilibrium Exchange Rate (FEER) theory these asymmetric values can be brought to balance through Real Exchange Rate realignments.

The objective of this paper is to assess the degree of currency misalignment of the euro countries. Using the partial model approach in (Salto and Turrini 2010) we firstly identify the Real Effective Exchange Rates that are consistent with the Fundamental Equilibrium Exchange Rate Theory. Secondly using (Cline 2008) we convert the Fundamental Equilibrium Exchange Rates to Real Bilateral Exchange rates relative to Germany. Using the results from (Cline 2008), I assess the asymmetrical Current Account imbalance of the first major signatories of the Maastricht treaty.

The results identify that the real exchange rate deviates from the FEER values. The Euro currency is especially difficult for the southern half of the continent.

Preface

I would like to thank my thesis supervisor Professor Asbjørn Rødseth for his much needed guidance and immense patience. My friends when my motivation was low and family when my funds where. A special thanks to Torkil Bårdsgjerde for the idea, when I had none myself

For my paternal grandmother, for whom this paper comes too late.

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1 Introduction

The recent financial crisis (dubbed by some the Great Recession) has led to major divergences in the macroeconomic variables amongst Euro countries. With politics following unpleasantly close on the path of the Great Depression, the European political scene has seen a rise of popular parties that lend their support to nationalistic thoughts and Euroscepticism (Sarotte September 29, 2010). Some prominent voices have lent their support for extreme solutions like a breakup of the euro currency as being a solution to alleviate the problems facing the union(Granville and Kawalec 16.05.2013, Evans-Pritchard 2013).

By looking at the Euro countries separately one realizes that the monetary union is facing large asymmetrical shocks. These shocks are manifesting in the Eurozone in different ways. One of the asymmetries in the Eurozone are the large Current Account imbalances and how they are distributed amongst the euro countries.

"*I think everyone would agree that the new mark would soar in value, making German manufacturing much less competitive*" (Krugman 2013). Krugman makes the claim that in the case of a euro breakup, (or if Germany had its own independent currency) the German Mark would appreciate. This can be understood as a possible misalignment of the exchange rate of the German Mark. According to Krugman the Euro can be understood as a "de facto foreign exchange intervention to keep the de facto Deutsche mark weak"

According to the Fundamental Equilibrium Exchange Rate theory (FEER), large deviation of the Current Account can be reduced by having an adjustment in the exchange rate. Based on the Fundamental Equilibrium Exchange Rate theory, this paper tries to illuminate the question whether the real exchange rates between the euro countries are misaligned according to their equilibrium values. How have the equilibrium exchange rates changed during the lifespan of the euro currency. Based on these values the paper will try and identify the impact of the recent financial crisis by the country specific FEER vales.

This paper does not focus on the advantages of increased trade between countries or how it should improve the mechanism of the currency union.[1] The paper also limits itself by avoiding the possible multiplying effect a common currency might have on trade and trade patterns, or even the political role the euro currency has for the European identity.

The structure of this paper is separated in five chapters. The **First** chapter gives an introduction to the FEER methodology and the implications a monetary union has for a country's currency. In the **Second** chapter I highlight the difference between the nominal exchange rate and the real Exchange rate. The **Third** chapter is used to show the methodology as outlined by (Salto and Turrini 2010) to calculate the FEER consistent exchange rate. In the **Fourth** chapter I use the Symmetrical Matrix Inversion Method (SMIM) by Cline (Cline 2008) to calculate the bilateral exchange rate. The **Fifth** chapter of the paper is set aside for the data used in the calculations. After presenting the data for the specific countries, I dedicated the last pages for the results of the calculations. The paper limits itself geographically to the earliest major countries to sign and ratify the Maastricht treaty[2]

[1] Se Campos, N. F., F. Coricelli and L. Moretti (2014). "Economic Growth and Political Integration: Estimating the Benefits from Membership in the European Union Using the Synthetic Counterfactuals Method." Institute for the Study of Labor (Available at SSRN: http://ssrn.com/abstract=2432446).

[2] Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal and Spain

1.1 The Euro

The euro currency's importance in the world cannot be underrated. 18 of the 24 members of the European Union are as of 2014 members of the monetary union. The inhabitants of the participating countries equal close to 320 million people. Aggregated the Eurozone countries make up the second largest economy in GDP only behind USA.

The Eurozone is one of the largest trading partner for USA and China. 3 As well as being a large economy it also plays an integral part in the forex markets. The euro currency is the second most traded currency after the US dollar. According to (Cohen 2009), the euro currency is also the closest alternative to a world reserve currency after the US dollar.

The significance of the euro currency is not limited to the participating countries. For the countries choosing not to introduce the euro, the Eurozone as a whole is still usually their biggest trading partner, this is also true for Norway. Some of the participating countries also have overseas territory, which implies that the euro is also a legal tender in some Caribbean islands and the United Kingdom.4 The Euro is also due to historical reasons a legal tenders in the European sovereign enclaves.5 The Euro currency is also the preferred currency peg for the West African CFA franc and Central African Franc. It is also the currency the French Polynesian islands peg their currency to.

Because of the oddities mentioned above, the value and the stability of the euro currency has direct implications for peoples living in Africa, Caribbean and the Pacific.

[3] http://www.census.gov/foreign-trade/statistics/highlights/top/top1212yr.html#2012
http://stat.wto.org/CountryProfile/WSDBCountryPFView.aspx?Language=E&Country=CN

[4] The French Caribbean island of St. Bartheley and Saint Pierre & Miquelon islands. The British overseas territories of Akrotiri and Dhekelia are little more than military bases on the island of Cypres

[5] The Vatican City, San Marino, Andorra and Monaco

As well as the major economic importance of the common currency it also has an important political role. The euro is seen as a major symbol of the common European identity and the ideals of the European Union. The Euro is therefore regarded both as an economic goal, but also as a means to an end for the political and social integration of Europe.

1.2 The Cline and Williamsons Series

The Fundamental Equilibrium Exchange Rate Theory (FEER) methodology has its roots in the seminal paper by (Williamson 1983), further developed by amongst (Bayoumi, Clark et al. 1994) and (Williamson 1994). In the literature there is not a dominating model amongst the FEER methodology. The methodology has changed over time and does not follow a strict procedure , see (Akram, Brunvatne et al. 2003). This paper uses the model by (Salto and Turrini 2010) in combination with (Cline 2008) to calculate the equilibrium exchange rate.

In a series of bi-annual papers by William Cline and John Williamson at the Peterson Institute, calculate the Fundamental Equilibrium Exchange Rate values for 34 large economic countries (the 35th is an aggregate economic zone to ensure consistency in the model named Rest of the World). (Cline 2008, Cline and Williamson 2009, Cline and Williamson 2010a, Cline and Williamson 2010b, Cline and Williamson 2010c, Cline and Williamson 2011a, Cline and Williamson 2011b, Cline and Williamson 2012a, Cline and Williamson 2012b, Cline 2013a, Cline 2013b). For simplicity the set of papers are noted as The Series in this paper.

The Series use the model outlined by (Cline 2008) to determine the equilibrium bilateral exchange rate relative to the US dollar. Using the latest IMF World Economic Outlook, The Series calculates the deviations of Current Account to GDP ratio from its medium term equilibrium value based on the projected Current Account to GDP. The FEER methodology calculates the exchange rate that is needed to eliminate the deviations of the current account. The equilibrium exchange rate in the FEER model is coined the FEER consistent exchange rate, or simplified as the FEER value. The model takes center stage in this paper and will be detailed later.

The choice of countries in The Series, leads them to calculate separate FEER values for hard pegged exchange rates, while they treat the Eurozone as a single economy. They therefore calculate a one-size-fits-all value for the Eurozone. In later additions to The Series, they do calculate the country specific FEERs for a selected few euro countries. I will in this paper argue that the Eurozone must be treated as the strictest form of a multilateral fixed exchange rate between the participating countries. The model in (Cline 2008) should therefore be compatible with countries in a monetary union. The goal of the paper is not to calculate the currency specific euro FEER but rather the country specific “intra-Euro” FEER.

Aside from The Series, the (Cline 2008) model has in the past only to my knowledge been used in two different papers (Bårdsgjerde 2011) and (Jeong, Mazier et al. 2010). In (Bårdsgjerde 2011) the author utilizes the model to assess the presence of currency intervention in the Chinese currency. The methodology stays true to the original model in (Cline 2008). (Jeong, Mazier et al. 2010) use the model to calculate the misalignment of the euro country’s exchange rate. While (Jeong, Mazier et al. 2010) have the same aim as this paper, their methodology differs to a degree. Going forward it will be natural to compare the methodology in this paper with these stated papers.

1.2.1 The Salto and Turrini adjustment

In (Salto and Turrini 2010) the authors asses different methods in calculating the exchange rate misalignment in the European Union, one of these models are the FEER methodology. While The Series calculates the projected misalignments in the exchange rate, (Salto and Turrini 2010) calculate the ex-ante values. Due to the different time perspectives, they advocate adjusting the ex-ante FEER values. As the Current Account can be affected by many variables, the adjustment of the current account tries to eliminate short term fluctuations in the Current Account. While this paper stays true to (Cline 2008) for the projected values, I will deviate when calculating the ex-post calculations, and adjust the Current Account according to (Salto and Turrini 2010)

1.3 The OCA

The economic literature is rich with articles that determine which countries are best suited for a common currency. This part of the literature is known as the Optimal Currency Area (OCA). The OCA theory tries to apply a cost benefit analysis to determine if countries should introduce a common currency. The benefits of joining a monetary union are associated with higher price transparency as the nominal exchange rate is fixed. The increased price transparency leads to increased trade across countries. The cost of joining a currency area is often associated with what is known as asymmetrical shocks and the loss of the nominal exchange rate as an automatic stabilizer. The OCA literature can be traced back to the seminal paper by (Mundell 1961). Subsequent papers by(McKinnon 1963) and (Kenen 1969) also had an important contribution to the literature.

(Mundell 1961) hypothesized a situation where aggregate world demand was to shift from one country to another. In the case of two countries, a shift in demand would lead one country (Country A) to face high demand while the other country faced lower demand (Country B). The demand shifts will lead to high wage and price growth in country A, and lower wage and price growth in B. In line with the different levels of unemployment it will also lead to lower unemployment in A and higher in country B.

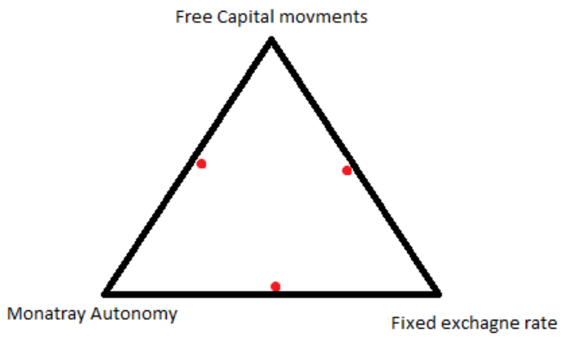
These different price and wage pressures should under flexible exchange rate lead to Country A's currency to nominally appreciate relative to country B. For country A, the changing exchange rate makes the imported goods from country B relatively less expensive, while making the export to country B more expensive. The changing exchange rate would therefore be beneficial to both A and B as it would help alleviate both the unemployment and price pressures in both countries. This automatic stabilizer of a flexible exchange rate is forgone by both the countries by employing a fixed exchange rate policy.

This cost of having a fixed exchange rate can, according to Mundell, be offset by a high degree of labor mobility and increased price and wage flexibility. Both these would allow the unemployment rate to be more stable. Wage flexibility would imply frequent changes in wages, while high labor mobility would allow the labor force to move from country B to country A. The cost and benefit are also determined by the bilateral trade relationship and the production diversification of the common currency members. (De Grauwe 2009)

1.3.1 The Trilemma and the Euro

In an open economy, a country is faced with something that is known in literature as the Impossibility Trinity. As the name indicates the monetary policy has to choose between three possible monetary goals. A country can only choose two monetary goals and at the same time exclude the third option. The tradeoff between the three different goals not only implies that one excludes a goal; the country also limits its policy tools that are consistent with the chosen goals. The three possible monetary goals are

1- Full freedom in cross –border capital markets.
2- Fixed exchange rate (Gold or another pegged currency)
3- Monetary policy with the objective to stabilize the domestic economy

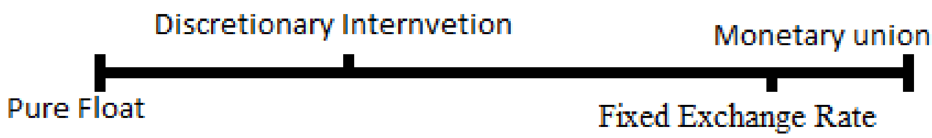


The simple picture on the left shows the trilemma, with the three possible monetary policy solutions marked with the red dots. The first regime is where the capital movement is restrained. The monetary policy is dedicated to stabilizing the domestic economy and having a fixed currency regime. On the picture this is the same as the dot on the horizontal line. The second regime is indicated with a dot on the upper left side, where the country has a floating exchange rate. The monetary policy is set to stabilize the economy while having free cross-border capital movements. The third regime is shown as the dot on the upper left side, where the country gives up its monetary autonomy. The goals are set to having a fixed exchange rate and ensuing free capital movements. (Obstfeld and Taylor 2003). (Obstfeld, Shambaugh et al. 2005) go through the literature in further details.

For the Eurozone the monetary policy can be understood as being twofold, either currency specific or country specific. If we fallow the early papers in The Series, we can understand the monetary policy for the currency where the monetary policy for the whole of the Eurozone is understood as the second regime. The euro is regarded as a floating exchange rate with both free movement of capital. The monetary policy in the Eurozone is set by the ECB with an aim of stabilizing the inflation "*inflation rates below, but close to, 2% over the medium term*" (ECB 2014)

If we consider the monetary policy for the countries individually, the monetary policy can be understood as the third regime discussed above. The 18 member countries have a fixed exchange rate relative to each other. As a part of the European Union they are committed to allow free movement of capital. This implies that by joining the momentary union, the countries forgo the policy goal to have an independent monetary policy that is dedicated to stabilize the country's economy.

The EMS can be considered a pegged exchange rate with some flexibility. The picture below shows the different degrees of the exchange rate, with the pure float and the monetary union as the two extremes. If a country enters a monetary union it forgoes the nominal exchange rate as a possible automatic stabilizer. A monetary union should therefore be regarded as the strictest possible form of fixed exchange rate regime. This peg holds for the relative exchange rate of the participating countries and not for the monetary union's currency relative to the rest of the world. The implication of participating in a monetary union is that the participating countries denominate the wage and prices in a common currency. This paper will regard the monetary union as a stricter from of a fixed exchange rate. Extrapolating from The Series, we should therefore be able to calculate the equilibrium exchange rates for the participating countries and not for the Eurozone as a whole.



2 The Nominal and the Real

A fixed exchange rate is implemented by having a fixed nominal exchange rate. The fundamental equilibrium exchange rates methodology calculates the real exchange rate. This chapter follow in the footsteps of (Bårdsgjerde 2011) and is dedicated to clarify how these two exchange rates are determined, and how they relate to each other. At the end of this chapter I will also highlight different versions of the Real exchange rate, as well as some characteristic.

2.1 Determining the nominal exchange rate

The nominal exchange rate can be defined as the relative price of two currencies. Another way of understanding the nominal exchange rate is the value of one currency one has to forgo to gain another currency. The simplest exchange rate theory is built on the Law of One Price (LOP). As with most laws in the economic literature, it should be accepted with a deal of skepticism. The LOP says that when measured in the same currency, the same good sold at different locations must have the same value.

The LOP states that for any given good i the exchange rate between two currencies should reflect the difference in the prices measured as a ratio. The exchange rate is considered endogenous.

2. 1 $$E_{DM/\,FF} = \frac{P^i_{DM}}{P^i_{FF}}$$

P^i_{DM} is the price for good i, denoted in German Mark. P^i_{FF} is the price for the same good i denoted in France Franc. In equation 2.1 the LOP $E_{DM/\,FF}$ is determined to hold true as the exchange rate. If the LOP holds true then the nominal exchange rate is the same as the price ratio between the two goods.

One can consider the Purchasing Power Parity (PPP) theory, as an extension of the LOP.

2.2 $$E_{DM/\,FF} = \frac{P_{DM}}{P_{FF}}$$

Note now that by dropping the subscript for the i-th good the equation 2.2 does not reflect the price for a single good, but rather a basket of goods and services. A basket of these goods and services are sold for a given price in both countries. The exchange rate will not show the different prices between the goods and services, but rather reflect the relative values of the two baskets of goods and services.

Like in the LOP, the nominal exchange rate is endogenous. (Cassel 1918) stated that "*As long as…free movement of merchandise and…comprehensive trade between the two countries takes place, the actual rate of exchange cannot deviate very much from this purchasing power parity*". If the LOP holds for every goods in the basket, then the PPP must also hold true.

If $E_{DM/\,FF}$in equation 2.2 is larger the PPP value then the exchange rate is deemed misaligned as overvalued This misalignment must lead to a reduction in the value of the nominal exchange rate. If the value of the nominal exchange rates falls, it is said to nominally depreciate. If $E_{DM/\,FF}$is smaller than the PPP value it is considered undervalued and must therefore increase in value. This increase is named a nominal appreciation.

The PPP theory stated above is known as the Absolute PPP. A popular use of the Absolute PPP is the Bigmac Index (Economist 2013). An alternative understanding of the PPP theory is known as the Relative PPP. The Relative PPP states that the rate between the two countries price level may be stated as a proportionate relationship and that "t*he percentage change in exchange rate between two currencies over any period equals the difference between the percentage changes in national price levels.*" (Krugman 2009) is understood to show the difference in price growth, rather than price level within a time period. Converting equation 2.2 to growth rates we gain the function for the relative PPP, shown in equation 2.3 bellow.

2.3 $$\pi_{DM} - \pi_{FF} = \dot{e}_{DM/FF}$$

Under the relative PPP, π_{DM} is the German inflation rate for a basket of goods and services, π_{FF} is the inflation rate for the similar basket of goods and services in France. Deviations between the inflation rates will now lead to changes in the exchange rate. This is shown by $\dot{e}_{DM/FF}$, an appreciation is shown as an positive value. Negative values indicate depreciation.

Inflation is shown using π_i for Germany and France.

Relative PPP states that the difference in inflation between two countries must lead to a change in the exchange rate. This means that, if France has a relative higher rate of inflation than Germany, then this must lead to a depreciation of the French Franc vis-à-vis the German Mark for the relative PPP to hold true.

There seems to be a consensus amongst economist that the Absolute PPP does not hold empirically. The Relative PPP is on the other hand a hotly contested subject. When it comes to the Relative PPP we have to distinguish between the short term and the long run. In the short run there is again a broad agreement that it does not hold empirically. On the subject of the long run convergence of Relative PPP economist disagree on the conclusion. (Balassa 1964, Rogoff 1996, Taylor 2003). Although the FEER theory assume that the PPP does not hold, it does lead us to the building block for our model.

2.2 The real exchange rate

In the previous section we defined the nominal exchange rate as the *"relative price of two currencies"*. The equation in 2.2 must be regarded as an oversimplification. In the real world many different factors like transportation cost, trade quotas and taxes make it difficult using price comparison to determine the value of goods. The real exchange rate attempts to incorporate all these factors. The Real Exchange rates are a measure of overall competitiveness of the economy. In equation 2.4 the real exchange rate in is defined as the nominal exchange rate, adjusted with the price of goods and services of the countries.

$$2.4 \qquad R_{DM/\,FF} \equiv \frac{P_{FF} * E_{DM/\,FF}}{P_{DM}}$$

The $E_{DM/\,FF}$ is the nominal exchange rate, while the price ratio is denoted by the two price indexes for France and Germany. In a fixed exchange rate regime the nominal exchange rate is held constant.

If we assume that Absolute PPP holds empirically then changes in the price levels will be completely offset by an inverse movement in the exchange rate. Under Absolute PPP, the nominal exchange rate ensures that the real exchange rate is held constant over time. If relative PPP is validated empirically then slow moving convergence of the nominal exchange rate will lead the real exchange rate to fluctuate around a long run trend.

An increase in the real exchange rate is defined as a real depreciation; it happens if the foreign price increase or the nominal exchange rate appreciates relative to the home price.[6] It implies that the country (Germany in this example) must sell more to get the same amounts of goods. The country is said to become less competitive. If the real exchange rates depresiates the denominator country (Germany in this example) gains competitiveness.

[6] The denominator increases relative to the numerator

If the home prices increase larger than the foreign price or the nominal exchange rate falls, then the real exchange rate falls[7]. This is referred to as a real appreciation. The home country can gain more of the foreign basket by having to give up less of home consumption. In this example the Germany loses competitiveness.

2.2.1 Real exchange rate in a monetary union

By entering a fixed exchange rate the nominal exchange rate of the participating countries is set to a constant value. $E_{DM/\,\mathrm{FF}} = k$. In the case of a monetary union it follows that the individual currencies are abandoned and replaced with a common currency. The nominal exchange rate is effectively set to 1 (in this case, $k = 1$). By inserting this value in equation 2.4, we see that the equation for the real exchange rate on the right hand side collapses to the same as the price ratio between two currencies. Imposing $k = 1$on equation 2.4, the we get

2.5 $$\frac{P_{\mathrm{FF}}*1}{P_{DM}} = R_{DM/\,\mathrm{FF}} = \frac{P_{\mathrm{FF}}}{P_{DM}}$$

In the case of a monetary union, any changes in the Real exchange rate must therefore be equal to differences in the price levels. Equation 2.5 will be used later in the paper as a benchmark to the calculated equilibrium exchange rates. By calculating equation 2.4 to growth rates, we get

2.6 $$\dot{R}_{\mathrm{DM}/FF} = \mathrm{e}_{\mathrm{DM}/FF} + \pi_{FF} - \pi_{\mathrm{DM}}$$

Furthermore we can impose a zero growth rate in the nominal exchange rate, $\mathrm{e}_{\mathrm{DM/FF}} = 0$, giving us

[7] The Numerator grows larger relative to the denominator

2.7 $\dot{R}_{\mathrm{DM}/FF} = \pi_{FF} - \pi_{\mathrm{DM}}$

In a monetary union a realignment of the real exchange rate between the participating countries can only be done through the relative inflation rates (assuming that the currency union is credible and is not expected to fail). This is understood as “Internal devaluation”. It is defined in this paper as real exchange rate realignment through price growth in the absence of a floating nominal exchange rate. This implies that a real depreciation in equation 2.7 is understood as French inflation exceeding German inflation rate. A real appreciation must, on the other hand, imply that the German inflation exceeds the French inflation.

2.2.2 The bilateral and the effective

In the previous section we defined the relationship between the real exchange rate and the nominal exchange rate. In this section we expand our understanding of the Real exchange rate and define the relationship between the bilateral exchange rate and the real efficient exchange rate.

The definition for the real exchange rate used in the previous section is what is known as the bilateral exchange rate. As the name indicates it defines the real exchange rate value between two countries. A country usually has multiple trading partners leading to multiple bilateral exchange rates. By calculating the weighted average of the bilateral real exchange rates (RBER) we get the Real Effective Exchange Rate. The Effective part is added to emphasize that the exchange rate has been adjusted by the trade weights.

2.8 $R_i = \prod_{j=1}^{n} \left(R_{i,j}\right)^{x_{i,j}} \;\; i = 1, 2 \ldots n \,, j = 1, 2 \ldots n \;\; , i \neq j,$

In equation 2.3 the variable R_i is the trade weighted Real Effective Exchange Rate for country i. the variable $R_{i,j}$is a series of bilateral real exchange rate between country i and its trading partner, country j. The exponent on the right hand side of 2.8 is the bilateral trade weight, $x_{i,j}$. The equation shows how the real exchange rate is defined as a product of bilateral exchange rate that are raised to the power of $x_{i,j}$. In (Cline 2008), the sum of all trade weights must equal to one to ensure that the REER reflect all the countries the i-th country trades with. Mathematically this implies.

2.9 $$\sum_j^i x_{i,j} = 1$$

The choice of trade weights can have a large impact in the calculation of a country's Real exchange rate and will be detailed in appendix A

Changes in the REER, R_i can only change in tandem with change in $R_{i,j}$, the counties bilateral real exchange rate vis-à-vis the j-th country. A real effective exchange rate (REER) appreciation (depreciation) can only happen because of real bilateral appreciation (depreciation). In a monetary regime with floating nominal currency, this can be achieved by a nominal appreciation. In a monetary union, like the Eurozone, this has to be achieved by price realignments between the participating countries, i.e. internal devaluation.

For three countries($i = 3$), equation 2.8 can be shown as equation 2.10

2.10 $$R_1 = R_{1,2}^{x_{1,2}} + R_{1,3}^{x_{1,3}}$$

An interesting observation is that the real effective exchange rate is not determined by a right hand variable $R_{1,1}^{x_{1,1}}$. The equation 2.10 can be converted to growth rates assuming the trade weights are held constant. Using the logarithmic values total differentiating the equation (Bårdsgjerde 2011)we can write the changes in the REER as a linear approximation of the changes in the RBER as equation 2.13

2.11 $$ln(R_1) = x_{1,2} * ln(R_{1,2}) + x_{1,3} * ln(R_{1,3})$$

2.12 $$\frac{\Delta(R_1)}{R_1} = x_{1,2} * \frac{\Delta(R_{1,2})}{R_{1,2}} + x_{1,3} * \frac{\Delta(R_{1,3})}{R_{1,3}}$$

The dot-accent again indicate percentage change.

2.13 $$\dot{R_1} = x_{1,2}\dot{R_{1,2}} + x_{1,3}\dot{R_{1,3}}$$

Equation 2.13 shows that percent changes in the countries real effective exchange rate $\dot{R_1}$must correspond with a percentage change in any of the bilateral exchange rates $\dot{R_{1,J}}$ $\text{j} = 1, 2 \ldots \text{n} \;\; i \neq j$ weighted for the relative trade weights $x_{i,j}$. Due to the trade weights, it stands to reason that the bilateral exchange rates bust be more or equally volatile than the effective exchange rate. Assume for $\dot{R_{1,2}}$ change is at 0,5% while $\dot{R_{1,3}}$ is unchanged. If the trade weight is 0,5 for both countries, then the total change in the REER is

$$0{,}25\% = 0{,}5 * 0{,}5\%$$

As the real effective exchange rate in a monetary union is defined as the price levels due to the absence of nominal exchange rate, the change in the real bilateral exchange rate are understood as differences in the inflation rates between two countries.

The triangular relationship and the inverse

Before we end this chapter we need to highlight two important properties the RBER exhibits. These relationships will be used later in the paper for the calculation of the equilibrium values.

We assume that the currency market eliminate arbitrage possibilities. The currency market must be in a state where the exchange rate has a stable triangular relationship. With three countries one of the bilateral exchange rates can be calculated by using the two bilateral exchange rates.

Assume that we have the values for two bilateral exchange rate between the German Mark and the French Franc, $R_{\mathrm{DM}/FF}$ and the exchange rate between the German Mark and the Spanish Peseta, $R_{DM/ESP}$. We can therefor calculate the exchange rate between Spanish Peseta (ESP in the equations) and the French Franc, $R_{ESP/FF}$ as equation 2.14 shows

2.14 $$\frac{R_{DM/FF}}{R_{ESP/FF}} = R_{DM/ESP}$$

The Triangular relationship can also be expanded to show that the bilateral exchange rate between two countries must give the following real depreciation rates. Converting equation 2.14 to growth rates gives the following relationship

2.15 $$R_{D\dot{M}/FF} - R_{ES\dot{P}/FF} = R_{D\dot{M}/ESP}$$

The bilateral exchange rate is, as the name indicates, a relationship between two countries (or currencies). This relationship can be stated in two ways depending on the choice of the denominator. The dual relationship of DM and Pts can be stated as DM/ESP, or the inverse ESP/DM can be calculated by taking the inverse of equation 2.14.

2.16 $$R_{DM/ESP} = \frac{R_{\mathrm{DM}/FF}}{R_{ESP/FF}} = \left(\frac{R_{ESP/FF}}{R_{\mathrm{DM}/FF}}\right)^{-1} = \left(R_{ESP/DM}\right)^{-1} = \frac{1}{R_{ESP/DM}}$$

And converting it to growth rates

2.17 $$\dot{R}_{DM/ESP} = -\dot{R}_{ESP/DM}$$

A real appreciation of DM/ESP must imply an equivalent real depreciation of ESP/DM.

3 The FEER of the REER

We now turn our attention to determining the equilibrium value of the real effective Excahnge rate (REER). The method chosen in this paper is the FEER methodology as pioneered by John Williamson. (Salto and Turrini 2010) calculate how much the REER must change to achieve the equilibrium value. In equation 2.13 this is equivalent to the left hand side of the equation. As we will see at the end of the chapter, there are many different ways to determine the equilibrium exchange rate.

The aim of the Fundamental equilibrium exchange rate models is to determine what the is the equilibrium Real Effective Exchange Rate that is consistent with the macroeconomic internal and external balance (Williamson 1983) .

The definition of external and internal balance has been updated through the years to keep up with the changes in the economic field. With internal balance it is understood as the country's economic activity that is consistent with its supply level. In modern context this translates to an inflation rate that is stable in the medium run. For the Eurozone that can be understood as being close to 2% or lower. The external balance is defined by the Current Account levels achieving a sustainable level in the medium term.

The focus of the (Salto and Turrini 2010) model is only on the external balance and is therefore understood as being a partial model. In a partial FEER model the internal balance is assumed to converge towards balance in the given time period. Identifying some of the euro countries as being in internal balance or converging to an internal balance might seem farfetched. In (Cline and Williamson 2008) the authors argue that *"If unemployment is being deliberately sought in order to reduce inflation to an acceptable target, then one might still want to classify a country as being in internal balance."*

According to the Optimal Currency Theory (OCA) discussed in chapter 1.3 the high unemployment rate can be understood as a natural result of low labor mobility and/or low price and wage flexibility in a monetary union. I will assume for the sake of argument that the high unemployment rate is deemed acceptable for the policymakers as a means to cope with asymmetric shocks.

A possible downside of using a partial approach is that it ignores possible multiplying effects from changes in the REER on to the GDP and the current account. These multiplying effects are understood as being small according to (Akram, Brunvatne et al. 2003)

An alternative approach would be to focus on both the internal and the external balance. Models that focus on both the internal and external are categorized as general models. The model in Jong et al can be stated as being a general model.

The external balance is achieved through the REER having a value that is consistent with the equilibrium Current Account level. The relationship can be stated as $CA = F(\mathrm{R})$. The R is the real exchange rate, while the CA is the Current Account level. If there is a deviation of the REER from its FEER value, the adjustment that is needed, is dictated by the deviation between the actual Current Account and the equilibrium Current Account. $CA - \overline{CA} = F(\mathrm{R} - \overline{\mathrm{R}})$. Deviations between the actual economic level and the equilibrium value can be given as a misalignment that is measured in percentage. In The Series the definition of the FEER is given as the exchange rate that is *"indefinitely sustainable on the basis of existing policies".*

In (Salto and Turrini 2010) the relationship is stated as taking the form in equation 3.1. All the variables are in the same time period. I suppress the country specific and the time subscript for simplicity.

3.1 $\frac{R-R^F}{R} = \frac{uca-cat}{\gamma}$

The R^F variable is the REER consistent FEER value and can be understood as the real exchange rate in equilibrium in the model. The R is the actual Real Effective Exchange Rate. The parameter γ, it is the Current Accounts semi-elasticity and is known under the name of Current Account Impact Parameter in The Series. The nominator on the right side is made up of two variables, the first is the uca, the scond is cat. The cat variable is the target Current Account that is considered in equilibrium. In this paper I will work with two different definitions for the cat. The uca variable is the underlying current account. The uca is the Current Account level that is given by the cyclical and lagged adjusted Current Account. Both the uca and cat are measured as percentage of GDP.

In the Series the authors only calculate the projected FEER values. As this paper aims to calculate the equilibrium values after the fact, I deviate from the from The Series by using the Underlying Current Account. While i will be using the cyclical and lagged Current Account as stated in (Salto and Turrini 2010), The Series use the projected IMF values.

Equation 3.1 can be simplified to

3.2 $\dot{R} = \frac{\dot{ca}}{\gamma}$

The deviation between the uca and cat is the Current Account Gap, it can also be understood as the external balance gap. The Current Account Gap is the change needed to ensure that the country is in external balance. In equation 3.2 the current account gap is defined as $\dot{ca}$. The deviation between the observed REER and the R^F is measured in percentage $\dot{R}$ and is equivalent to the left side of equation 2.8. For this calculation we need to understand the relationship between the real exchange rate movements and the Current Account gap. In the proceeding sections we show how the variables are calculated in further details.

The first step will be to calculate the uca. The second step is to define the equilibrium Current Account as the current account that is consistent with the external balance of the economy, cat.The last step of the model we calculate the Current Account semi-elasticity.

3.1 The Underlying Current Account - uca

In The Series, Cline and Williamson use the IMF WEO projections as the underlying balance. For projected values of the FEER we will follow this procedure. For the ex post calculations I will calculate the cyclical adjusted values of the Current Account. Calculating the ex-post underlying Current Account balance follows the method by (Salto and Turrini 2010). The adjustment is through two channels, the cyclical and the lagged, as shown in equation 3.3.

3.3 $$uca_i = ca_i + I_i + T_i$$

The first channel is the cyclical changes for the country and its trading partners income in variable I_i. The recent financial crisis has led to fluctuations in the Current Account levels. We assume that these fluctuations are short term and not persistent. These fluctuations will affect the current account gap from equation 3.2 and therefore give a more volatile equilibrium real exchange rate. To be able to separate the short term fluctuation of the Current Account Gap, we start by adjusting the Current Account for cyclical fluctuations on the output gap.

The second channel is the lagged changes in the real exchange rate in variable T_i. The argument for adjusting the ca for the real exchange rate is based on trade being rigid in the short term due to the auto regressive impact of the REER. There might be different reasons for the real exchange rate to lag. Preexisting trade agreements, slow adjusting preferences, price rigidity and lagging adjustments by trading partners might explain some of the reasons.

The last variable in equation 3.3 is the actual Current Account to GDP ratio ca_i. The ratio is defined by equation 3.4, the GDP is measured in nominal terms.

3.4 $$ca_{i,t} = \frac{\mathrm{CA}_{i.t}}{P_{i.t} * GDP_{i.t}}$$

Cyclical effects - I_i

As the Current Account is defined as the same as the trade balance in this paper we adjust for the cyclical effects on both the import and export side. If country I's trading partner is experiencing an economic contraction, it will lead to a reduction in how much they import from country i (export to country i).The reduction in the trading partners economic activity will therefore lead to a reduction in the Current Account level for country i. If the home country is in an economic expansion, it will increase its imports, leading to a reduction in the Current Account balance.

3.5 $$I = \theta_M * \frac{P^m{}_{i.t} * M_{i.t}}{P_{i.t} * GDP_{i.t}} * \frac{GDP_t - GDP_t{}^*}{GDP_t} - \theta_{Ex} * \frac{P^{ex}{}_{i.t} * Ex_{i.t}}{P_{i.t} * GDP_{i.t}} * \frac{GDP_t^F - GDP_t^{F*}}{GDP_t^F}$$

The degree of economic activity is measured as output gaps, defined as the percentage deviation of the nominal GDP_t form its trend value $GDP_t{}^*$. The subscript $*$ is used to denote the trend value, while the subscript F is used to denote for the counties trading partner. The cyclical effects are determined by adjusting the output gaps by two factors. The first factor is the export and ratio. The trade ratios are calculated using the import and export values ($P^m{}_{i.t} * M_{i.t}$ and $P^{ex}{}_{i.t} * Ex_{i.t}$) and dividing by the GDP measured in current prices $P_{i.t} *$

$GDP_{i.t}$. In equation 3.5 they are defined as $\frac{P^{m}{}_{i.t} * M_{i.t}}{P_{i.t} * GDP_{i.t}}$ and $\frac{P^{ex}{}_{i.t} * Ex_{i.t}}{P_{i.t} * GDP_{i.t}}$ respectively. Both ratios are measured in nominal GDP.

The second factor that is used to adjust the output gaps are income elasticity for import and export, shown in equation 3.5 as θ_M and θ_{Ex} for import and exports. The elasticity values are discussed later in this chapter. An increase of either ratio or elasticity will imply a larger effect of output gap, and therefore bigger changes on the uca.

Lagging effects - T_i

In (Salto and Turrini 2010), the lagging effect is the product of two factors.

3.6 $$T = \left(\frac{P^{ex}{}_{i.t} * Ex_{i.t}}{P_{i.t} * GDP_{i.t}} \sigma_{Ex} - \frac{P^{m}{}_{i.t} * M_{i.t}}{P_{i.t} * GDP_{i.t}} \sigma_m\right) \left(0{,}25 * \Delta reer_{t,t-1} + 0{,}15\Delta * reer_{t,t-2}\right)$$

The first parentheses is the *“long term semi-elasticity of trade volumes with respect to the REER”* (Salto and Turrini 2010). The semi-elasticity is the change in trade due to changes in the real exchange rate. Again the trade ratio and elasticity is used and follow the same method as outlined above. I will discuss the semi-elasticity in further detail in the next sub chapter.

3.7 $$\left(\frac{P^{ex}{}_{i.t} * Ex_{i.t}}{P_{i.t} * GDP_{i.t}} \sigma_{Ex} - \frac{P^{m}{}_{i.t} * M_{i.t}}{P_{i.t} * GDP_{i.t}} \sigma_m\right)$$

The second parentheses is added based on the calculations by (Bayoumi and Faruqee 1998). Salto & Turrini assume that the effect the changes in real exchange rate have on trade lasts for three years. 60% of the lag takes place in the first year, while the following years the value are 25% and 15%. This auto regressive relationship is shown in equation 3.8

3.8 $$(reer_t - 0{,}6 * reer_t - 0{,}25 * reer_{t-1} - 0{,}15 * reer_{t-2})$$

(Salto and Turrini 2010) advocate using the OECD values of the REER and denoting the REER in logarithmic value. With the Δ denoting the different between time period, the equation 3.8 reduces to

3.9 $$0{,}4 * reer_t - 0{,}25 * reer_{t-1} - 0{,}15 * reer_{t-2}$$

Rewriting the first term as $(0{,}25 - 0{,}15)\Delta reer_{t,t-1}$ the equation 3.7 becomes. The Δis the difference operator between the two time periods

3.10 $$\left(0{,}25 * \Delta reer_{t,t-1} + 0{,}15\Delta * reer_{t,t-2}\right)$$

Salto and Turrini assume that the REER lags only affect the trade volumes while the adjustment in the price is assumed to be instantaneous. In this paper it only affects the volume.

Combining the equations 3.7 and 3.10 gives us the adjustment induced on the Current Account due to the rigidity of the REER, shown as equation 3.6

3.1.1 The total adjustment and the (Cline 2005) assumptions

Inserting for I and T from equation 3.5 and 3.6 in equation 3.3 gives the uca.

3.11 $$uca = \frac{\mathrm{CA}_{i.t}}{P_{i.t} * GDP_{i.t}} + \theta_M \frac{P^m{}_{i.t} * M_{i.t}}{P_{i.t} * GDP_{i.t}} * \frac{GDP_t - GDP_t{}^*}{GDP_t} - \theta_{Ex} \frac{P^{ex}{}_{i.t} * Ex_{i.t}}{P_{i.t} * GDP_{i.t}} * \frac{GDP_t^F - GDP_t^{F*}}{GDP_t^F}$$

$$+ \left(\frac{P^{ex}{}_{i.t} * Ex_{i.t}}{P_{i.t} * GDP_{i.t}} \sigma_{Ex} - \frac{P^m{}_{i.t} * M_{i.t}}{P_{i.t} * GDP_{i.t}} \sigma_m \right) \left(0{,}25 * \Delta reer_{t,t-1} + 0{,}15\Delta * reer_{t,t-2}\right)$$

Before going forwards we need to adjust the uca to make it compatible with the (Cline 2008). (Cline 2005) assumes that the countries import income elastic for both the import and exports are at unity. $\theta_M = 1$, $\theta_{Ex} = 1$, along with the import price elasticity $\sigma_m = 1$. Compounding the equation and suppressing the subscript we end up with the following equation. The small letters are used for ratios and logarithmic values of the REER.

3.12 $$uca = ca + m * y - ex * y^f$$

$$+(ex\sigma_{Ex} - m) \left(0{,}25 * \Delta reer_{t,t-1} + 0{,}15\Delta * reer_{t,t-2}\right)$$

The uca values will be more sensitive to the output gap the larger the trade ratios of the countries. The uca will also be more sensitive the larger the values of the output gap. The REER variables in this paper are used on a year-to-year basis. The details for the chosen data will be determined later in chapter 5. The calculations for the selected countries are shown in appendix B.

3.2 Current Account Target - cat

Just like the choice of trade weights, the FEER model is also sensitive to the choice of the Current Account targets. (Williamson 1994) writes that the Current Account targets have a *"normative element"*, this leads the FEER calculations also to have normative elements.

The Current Account might be accumulating a surplus or a deficit for reasons that might be "*good*" or "*bad*" (Blanchard and Milesi-Ferretti 2011). A surplus might arise as a consequence of intern temporal shift in consumption because of an expected positive income growth in the country. A deficit might arise due to increased foreign investment in the country. The existence of a surplus or deficit in itself can be understood as neither good nor bad for a country. Assuming that a Current Account target at 0% percent of GDP qualifies as a possible alternative; It is highly unlikely to be a desirable in the medium term. A country running a zero Current Account over time forgoes potential intertemporal gains. Because of this reason, we will avoid using 0%percent as a possible Current Account target.

To determine the Current Account target I will in this paper use two different methodologies. The first method is called "rule of thumb" while the second is the Net Foreign Assets approach (NFA). Both targets are used in The Series at different occasions.

Rule of Thumb

In The Series Cline and Williamson the "*rule of thumb*" approach is using a Current Account target the value of +/- 3%. In their panel of 35 economies they define the targets in detail based on the different conditions for the counties.

The reasoning for the +/- 3% level is based on Cline and Williamson's interpretation of

(Reinhart, Rogoff et al. 2003). (Reinhart, Rogoff et al. 2003) identify that emerging economies can have an stable external debt to GDP, if it is lower than 40% with zero risk of default, internal markets must therefore at least absorb 60% of debt to GDP.

With an assumption that emerging countries have a real growth rate of 4-5% yearly and that the world inflation is close to 2.5%. The nominal GDP growth rate of 7% can therefore be. If the external debt to GDP must be stable at 40% and the assuming nominal GDP is at 7%, then the external debt can grow at a given rate and still be assumed to be sustainable.

3.13 $$40\% * 7\% = 2{,}8\% \approx \%3$$

In The Series if the IMF forecast for the counties Current Account to GDP was projected to be within the threshold of +/-3% it is considered stable and the country does not have to have a Current Account adjustment. If the ratio is within the Current Account target, the country does not need to change its REER value.

A similar approach is used by (Bårdsgjerde 2011) and (Bayoumi, Clark et al. 1994). With the breakup of the Bretton Woods and the Smithsonian Agreement (Bayoumi, Clark et al. 1994) calculate the counterfactual real exchange rate values with a Current Account target of +1% in 1970. The Current Account target was chosen as the authors' claim it was *"close to actual surplus"* and that it was close to the implicit target for the US. In (Bårdsgjerde 2011) the stable current account ratios are discussed based on different parameters, and given an interval that is deemed sustainable. The intervals vary between +3% and -3%.

While the 3% target is calculated based on emerging economies, the CA/GDP ratio for industrialized countries can be stable close to 5% (Freund 2000). If the ratio increases above 5% the economy starts to show a lower income growth. According to (Freund 2000) the Current Account balance reversal falls in line with shifts in the business cycle as "*the Current Account is largely a symptom of the business cycle*». In (Freund and Warnock 2007) a Current Account deficit is correlated with slow growth in income and that for countries with limited exchange rate adjustment (monetary union, fixed exchange rate or managed system) will "*deteriorate more than if the exchange rate were flexible*".

In a traditional unilateral fixed exchange rate system the central bank is given the responsibility to maintain the exchange rate. If the country faces capital flight the central bank must intervene in the supply of currency. The choice of policy tools disposable to the central bank can vary. Essentially the central bank must intervene to defend the nominal peg in the exchange rate market by selling its foreign reserve and buy the home countries currency. The intervention is limited to the value of the central banks foreign exchange reserves. Once the foreign exchange reserve is depleted or close to depletion the country is forced to give up the currency peg.

In the case of the Eurozone, the National Central Banks (NCB) are allowed to balance their balance sheets through TARGET2 (Trans-European Automated Real-time Gross Settlement Express Transfer System) (ECB 2013). In a simplified way the Target2 works as an extension of the country's foreign exchange reserve (Cecchetti, McCauley et al. 2012). This allows the country to hold a fixed exchange rate as long as the NCB has a supply of foreign reserves and access to loans through the TARGET2 system. For the Current Account this means that the country is able to finance a higher Current Account deficit and surplus.

Since it effectively works as an auxiliary foreign reserve allowing, for a larger Current Account Deficit (Cecchetti, McCauley et al. 2012), the 3% target must *a priori* be understood as being very strict. In this paper I will regardless assume that the lowest possible sustainable limit for Current account GDP ratio should not exceed -3%.

The model assumes that a Current Account deficit below the constraint of -3% must lead the countries exchange rate to have a real depreciation. In general we don't have to define an upper limit to the CA/GDP ratio, but we also cannot consider a surplus to be stable over time. The reason for that is given by the global balance equation. Assume a world with only two countries as in chapter 2, Spain and Germany. If Spain has a lower limit on its debt to GDP ratio, it implicitly implies that Germany has an upper limit that equals the lower limit of Spain. We therefore use the target from The Series of +/-3%.

For this model to give consistent values, the sum of all the Current accounts must sum to zero. In our model it is highly unlikely that the selected countries will simultaneously achieve a balance that is consistent with the global balance. For the global Current Accounts to be in balance, we add an extra country marked as Rest Of the World (RoW). The RoW country is an aggregate country, for all trade done by the selected countries in this paper. The values are calculated as residuals from the selected countries. This ensures that the global balance must equal to zero.

The REER values for the RoW do not make any analytical sense and will therefore be dropped in the analysis. The second advantage of using the RoW country is that the sum of all the trade weights equal to one, making it possible to use the (Cline 2008) model (See appendix A).

The NFA target

In (Cline and Williamson 2008) alternative Current Account target is defined by the Net Foreign Asset (NFA). In the first articles Cline and Williamson are initially critical of IMF and their methodology, but admit that the NFA approach does have redeeming properties in that it ensures that the NFA value is consistent with a no-Ponzi condition. In (Cline and Williamson 2011b) they use this methodology again as an alternative to the +/-3% target. While the 3% follows a “one target fits all”, the NAF targets are calculated individually, using the given economic condition of the country.

In the NFA approach, the cat is defined as the CA that is consistent with a stable NFA to GDP ratio. I use the model as defined by (Bussière, Ca'Zorzi et al. 2010). We start to calculate the NFA target with the Balance of Payment identity (BoP).

3.14 $$CA_t + K_t + (H_{Lt} - H_{At}) + Z_t = 0$$

In equation 3.14 we find the Current Account again defined as the trade of goods and services. Following the Current Account is the capital account K_t. The Financial account is separated for liabilities and assets, H_{Lt} and H_{At}.[8] . The variable $Z_t$is the balancing item account.

An increase in the financial account is defined as capital gains (or loss, if negative).

3.15 $$KG_t = KG_{At} - KG_{Lt}$$

The capital holdings can, like the financial account be separated by assets and liabilities

3.16 $$KG_{At} = (A_t - A_{t-1} - H_{At})$$

3.17 $$KG_{Lt} = (L_t - L_{t-1} - H_{Lt})$$

A and L are aggregates for all financial holdings, including foreign reserves, private sector and public sector holdings, assets owned by foreign holders, FDI and many others

We can first insert equations 3.16 and 3.17 in 3.15

3.18 $$KG_t = (A_t - A_{t-1} - H_{At}) - (L_t - L_{t-1} - H_{Lt})$$

Furthermore equation 3.18 can be solved with respect to H_{At} and H_{Lt}

[8] A for Assets and L for liabilities

3.19 $$KG_t - (A_t - L_t) + (A_{t-1} - L_{t-1}) = (H_{At} + H_{Lt})$$

The first parenthesis on the left side of 3.19 shows the net foreign assets in time period t, while the second parenthesis shows the same in time period $t-1$. Equation 3.19 gives us an interesting insight, the financial account is defined as the capital gains and the increase in net foreign assets. Inserting 3.19 in the BoP identity and assuming that balancing items, Z_t, capital transfer, K_t, and capital gains KG_t, are all zero.

3.20 $$CA_t - (A_t - L_t) + (A_{t-1} - L_{t-1}) = 0$$

Defining parenthesis as $(A_t - L_t) = NFA_t$ and solving with respect in the right hand side we can rewrite equation 3.20 as

3.21 $$CA_t = NFA_t - NFA_{t-1}$$

Equation 3.21 shows that the Current Account must be regarded as the flow in the time period $(t, t-1)$, while NFA is the stock at a given time. It also tells us how the current account balance is financed. The NFA can be defined as "*the difference between the value of foreign assets owned by the country's residents and the value of the country's assets owned by foreigners*" (Schmitt-Groh´e & M. Uribe 2014). Before going forwards we assume that this equation always holds.

Since I want to define the equilibrium current account as a given value of the NFA we need to solve equation 3.21 for the NFA and CA. I start by dividing equation 3.21 by nominal GDP_t so that the variables are measured as percentage of GDP. The growth rate is defined as $GDP_t =$

$(1+g)GDP_{t-1}$ and price growth as $P_t = (1+\pi)P_{t-1}$, the g being the nominal GDP growth rate and the π the price growth i.e. inflation.

3.22 $$\frac{\mathrm{CA_t}}{\mathrm{GDP_t}*P_t} = \frac{\mathrm{NFA_t}}{\mathrm{GDP_t}*P_t} - \frac{\mathrm{NFA_{t-1}}}{\mathrm{GDP_t}*P_t}$$

The left hand side takes the form of current account to GDP ratio, the left hand side needs more explaining. The first step is multiplying the last term with $\frac{\mathrm{GDP_{t-1}}*P_{t-1}}{\mathrm{GDP_{t-1}}*P_{t-1}}$

3.23 $$\frac{\mathrm{NFA_t}}{\mathrm{GDP_t}*P_t} - \frac{\mathrm{NFA_{t-1}}}{\mathrm{GDP_{t-1}}*P_{t-1}} * \frac{\mathrm{GDP_{t-1}}*P_{t-1}}{\mathrm{GDP_t}*P_t}$$

The factor on the last term must be rewritten, by using the growth rates.

The growth rates can be rewritten as $\frac{1}{(1+g)} = \frac{GDP_{t-1}}{GDP_t}$ and $\frac{1}{(1+\pi)} = \frac{P_{t-1}}{P_t}$ inserting them in equation 3.23 gives

3.24 $$ca_t = nfa_t - nfa_{t-1}\left[\frac{1}{(1+\mathrm{g})(1+\pi)}\right]$$

The variables denoted by lower case letters are measured in percentage of GDP. We add and subtract with nfa_{t-1}on the right hand side and solve with respect to $nfa_t - nfa_{t-1}$. The equation then gives us the following relationship

3.25 $$nfa_t - nfa_{t-1} = ca_t - \frac{g+\pi+g\pi}{(1+g)(1+\pi)}nfa_{t-1}$$

To calculate the steady state of the nfa, the left hand side must equal zero. Allowing us to get the steady state value of the Current Account ratio if the nfa is unchanged, that is when the right hand side of the equation is zero.

3.26 $$ca_t^{nfa} = \frac{g+\pi+g\pi}{(1+g)(1+\pi)} nfa_{t-1}^*$$

With the nfa_{t-1}^* being the steady state levels of the NFA, it gives the nfa consistent Current Account target, ca_t^{nfa}. Again the GDP is measured in current prices, the g is the nominal growth rate of the economy, while the π is the rate of inflation. To ensure that the NFA consistent Current Account target is not affected by short run fluctuations I will take the average of time period t and $t-1$. Compared to the IMF Methodology (Lee, Ostry et al. 2008), this model assumes that the capital gains and the valuation effects are zero, otherwise it stays true to the original IMF methodology.

Choosing the Benchmark for nfa^*

(Cline and Williamson 2011b) define the steady state level nfa^* as "*reducing the Current Account deficit so that NIIP/GDP will not increase, assuming the deficit was not scheduled to fall as in IMF forecast*" another way of stating this target is using the previous year's nfa, unless the projected nfa is not assumed to fall, in which case they use the projected value. The subscript p denotes the projected values from IMF WEO.

$$if\ nfa_{t-1} < nfa_t^p\ \ then\ nfa^* = nfa_{t-1}$$

$$if\ nfa_{t-1} > nfa_t^p\ \ then\ nfa^* = nfa_t^p$$

It is a useful definition if one is calculating ex ante FEER, but difficult for ex post calculations for the fact that that the WEO does not have country specific data projections for the timeframe in mind for the paper.

IMF (2006) states that the choice of a benchmark might be “to some extent arbitrary, and may reflect a variety of considerations”. The original methodology advocated by IMF is to use “*latest year for which complete data are available*”. This methodology is also the one advocated in (Salto and Turrini 2010) Following the IMF I will in the ex-ante calculations use $nfa_{t-1}$to determine the Current Account target ca_t^{nfa} . For the projected calculations I will use the latest nfa consistent target available.

3.3 Current Account Impact Parameter - γ

The third variable in the Salto & Turrini model that needs defining is the Gamma, the denominator on the left side of equation 3.1 (p22). This is variable is known in The Series as the Current Account impact parameter (CAIP). In the Salto & Turrini model it is known as the Current Account semi-elasticity. In this section we use the methodology by (Cenedese and Stolper 2012) to show how this calculation for the variable. At the end of this section we apply the assumption used in (Cline 2008) to get the CAIP that is used in this paper. As a starting point the Current Account is defined again as the trade balance.

3.27 $$CA_t = Ex_t - I_t$$

A Current Account surplus arises if exports are larger than the imports. $Ex > I \leftrightarrow CA > 0$. If imports are larger in then export, the country enters a Current Account deficit $Ex < I \leftrightarrow CA < 0$. Total export and import are defined by the quantity and price.

3.28 $$Ex_t = p_t^x * eks_t$$

3.29 $$I_t = p_t^i * i_t$$

The eks_t denotes the total volume of exports equivalently the i_t is for import. The price for export and imports are respectively p_t^x and p_t^i. Inserting this in the 3.27 we get the

3.30 $$CA_t = p_t^x * eks_t - p_t^i * i_t$$

The real exchange rate can be stated as a function of export price and import price. In the monetary union the nominal exchange rate is set to 1 and the real exchange rate can therefore be reduced to

3.31 $$\frac{p_t^i * 1}{p_t^x} = R_t$$

We can calculate the differential of equation 3.30 with respect to the real exchange rate

3.32 $$\frac{\partial CA_t}{\partial R_t} = \frac{\partial ex_t}{\partial R_t} * p_t^x + \frac{\partial p_t^x}{\partial R_t} * ex_t - \frac{\partial i_t}{\partial R_t} * p_t^i - \frac{\partial p_t^i}{\partial R_t} * i_t$$

Cenedese and Stolper argue that since the export goods are priced in the local currency then changes in the exchange rate do not affect the export prices, therefore $\frac{\partial p_t^x}{\partial R_t} = 0$ must hold. The parallel argument for this statement is that the import prices are determined by the changes in the exchange rate. Furthermore the import prices are assumed unit elastic with respect to changes in the real exchange rate implying $\frac{\partial p_t^i}{\partial R_t}\frac{R_t}{p_t^i} = 1 <=> \frac{\partial p_t^i}{\partial R_t} = \frac{p_t^i}{R_t}$. Using these relationships the equation 3.32 we get

3.33 $$\frac{\partial CA_t}{\partial R_t} = \frac{\partial eks_t}{\partial R_t} * p_t^x - \frac{\partial i_t}{\partial R_t} * p_t^i - \frac{p_t^i}{R_t} * i_t$$

We multiply the first term with $\frac{R_t}{eks_t}\frac{eks_t}{R_t}$ and the second term with $\frac{R_t}{i_t}\frac{i_t}{R_t}$, shifting the factors giving.

3.34 $$\frac{\partial CA_t}{\partial R_t} = \left(\frac{\partial eks_t}{\partial R_t}\frac{R_t}{eks_t}\right) * \left(\frac{eks_t * p_t^x}{R_t}\right) - \left(\frac{\partial i_t}{\partial R_t}\frac{R_t}{i_t}\right) * \left(\frac{i_t * p_t^i}{R_t}\right) - \left(\frac{i_t * p_t^i}{R_t}\right)$$

A keen observer will see that the variables inside the first and the third parentheses are the same as the import and exports elasticity. $\sigma_x \equiv \frac{\partial eks_t}{\partial R_t}\frac{R_t}{eks_t}$ and $\sigma_i \equiv \frac{\partial i_t}{\partial R_t}\frac{R_t}{i_t}$. The numerators in the second, fourth and fifth brackets are the same as the value of import and export defined in equation 3.28 and 3.29, while the denominator is the real exchange rate. Inserting for the elasticities and multiplying with R on both sides gives a similar equation as used in Salto and Turrini (2010).

3.35 $$\frac{\partial CA}{\partial R/R} = \sigma_x * Ex - (\sigma_i - 1) * I$$

In (Salto and Turrini 2010) the trade ratios are calculated using a five year backward-looking moving averages. This is done to reduce the short term fluctuation affecting the FEER values. The elasticity are set to $\sigma_x = -1{,}5$ and $\sigma_i = -1{,}25$ for all the countries. I will depart from their method and again use the method used by Cline (2005).

Using the (Cline 2005) assumption the model coincides with the (Cline 2008) model. He assumes that the changes in the price of imports are offset by the change in the volume of imports. The reason for this is that import elasticity is set to unity. $\sigma_i = 1$. This implies that any changes in the Current Account must happen due to change on the export side of the economy. By inserting this assumption in to the equation above, the parenthesis $(\sigma_i - 1)$ sums to zero implying that we drop the import side from the equation.

3.36 $$\frac{\partial CA}{\partial R/R} = \sigma_x * Ex$$

This must not be misunderstood as the countries imports are unaffected by the changes in the real exchange rate. The model assumes that changes in the volume of trade will cancel out any changes in the import prices.

(Cline 2008) assumes that the both the import and export price pass through (ERPT) ratio are at unity. (Campa, Goldberg et al. 2005) conclude that the ERPT ratio for import over four months for the first twelve euro countries is close to 0,8. As my calculations have a longer time horizon the assumption of an ERPT close to 1 can be safely assumed to be valid.

We can divide equation 3.36 with nominal GDP and solve the equation with respect to the Current Account ratio. The current account on the left hand side is now a percentage of GDP

3.37 $$\frac{\partial ca}{\partial R/R} = \sigma_x ex$$

The left hand side of the equation is similar as equation 3.2 in the beginning of this chapter.

The right hand side of the equation is the product of two variables; the first being the export elasticity whiles the second variable is the export to GDP ratio. According to (Cline 2008) the product of the two factors is the same as the Current Account impact parameter.

3.38 $$\sigma_x ex = \gamma$$

While Salto and Turrini (2010) assume the elasticities are constant, (Cline 2008) assumes that the export elasticity can be assumed to hold the following form.

3.39 $$\sigma_x \equiv -1{,}056 + 0{,}56ex$$

(Cline 2005) builds on the empirical work of (Gagnon 2003, Gagnon 2007). Gagnon shows that by excluding the supply side of import and export from an econometric model, one ends up with estimates of the demand side that are higher than their true value. To compensate for this possible misspecification error (Cline 2005) assumes that a country with a higher trade ratio must have an export supply that is more responsive for changes in the exchange rate.

This responsiveness on the supply side is assumed to affect the our model through the export elasticity σ_x. (Cline 2005) assumes that a country with a low export to GDP ratio will have export elasticity at unity. With an increasing trade ratio the export elasticity must fall, for a country with 100% export to GDP ratio the elasticity will be close to 0,5. As the ratio grows the country is understood to have an export supply that is more sensitive to changes in the real exchange rate.

The values of the elasticity are defined by the degree of export ratio in equation 3.39. The export ratio between 0 and 1 gives possible export elasticity between -1 and -0,5.
$If\ \lim_{ex\to 0} \sigma_x = -1,\ if\ \lim_{ex\to 1} \sigma_x = -0{,}5$ this also holds for $ex < 1$. We therefor assume $\sigma_x \in (-1, -0.5)$

By inserting for the export elasticity from equation 3.39 in equation 3.38 the semi-elasticity is written as the following second degree polynomial.

3.40 $$\sigma_x * ex = -1{,}056 * ex + 0{,}56 * ex^2 = \gamma$$

It is important to note that the export elasticity is negative leading the semi-elasticity also to be negative. This implies that changes in the REER and the Current Account gap have a negative relationship. If the country is faced with a positive Current Account gap $(uca > cat)$ then the REER must be expected to depreciate to accommodate the external balance, and vice versa).

The CAIP will be calculated annually for the individual countries. In the case of projected values I will be limited to use the last year of available export data. As the appendix B shows, the values are fairly stable over time for the different countries.

Alternative models and methodology

In the economic literature there are many different models for calculating the equilibrium exchange rates. Before continuing we take a short side step to summarize the difference between the alternative models.

The models shift between determining an equilibrium value of either the nominal or the real exchange rate values. I will for the sake of simplicity only use exchange rate in this sub chapter. As the different models operate with different time horizon the models must be understood as being complementary to each other.

With the different time horizons, come different definitions of equilibrium. For example in the short run the Uncovered Interest Parity utilizes the differential between two countries interest rates as being the expected change in the exchange rate. The medium term models on the other hand use the internal and external balance approach. Along with the FEER methodology the behavioral equilibrium exchange rate methodology follows in this group (Clark and MacDonald 1998). For the long run exchange rate the PPP is frequently used.

The methodologies also differ from being model based or estimation based. The model based methodology assumes that the exchange rate can be calculated given a set of equations, The estimation based approach advocates that the exchange rate must be estimated based on econometrics.

(Ellis 2001) (Driver and Westaway 2003) (Cenedese and Stolper 2012) and (Isard 2007) give a thorough discussion on the different methodologies.

As with the alternative methods that are used for the exchange rate, there are also different approaches determining the equilibrium Current Account. In this paper I apply two different definitions, the +/-3% and the Net Foreign Asset approach. One of the more frequently used method to determine the cat is using panel regression. While the NFA approach relies on the accounting identity of the Balance of Payment, the Panel regression uses statistical calculation to estimate the Current Account norm. Although not used in this paper it has the advantage of having a cat that is adjusted for the projections of the individual country's demographics. This method is the approach used by among other by (Jeong, Mazier et al. 2010) For further discussion see (Bussière, Ca'Zorzi et al. 2010)and (Ca'Zorzi, Chudik et al. 2012)

4 The SMIM

In the previous chapter we used the Underlying Current Account (uca), the different definitions of the Current account targets (cat) and the CAIP to calculate the what we deem to be the Fundamental Equilibrium Exchange rate (FEER) values. We now turn our attention to the (Cline 2008). As stated in Chapter 2.2.2, the Real Effective Exchange Rate (REER) is equivalent to the sum of weighted real bilateral exchange rate. Using the FEER values from (Salto and Turrini 2010), we now use the Cline model to calculate the Real Bilateral Exchange Rate (RBER). Based on the RBER values we will be able to analyze the degree of asymmetry in the monetary union.

The Cline (2008) model uses something called the Symmetrical Matrix Inversion Method, or SMIM for short. It has in the past been used to calculate the degree of intervention in the currency markets (Bårdsgjerde 2011), and by (Jeong, Mazier et al. 2010) currency misalignment in the Eurozone. The SMIM has not (to my knowledge) been used with methodologies other than the FEER methodology. It stands to reason that the SMIM should be compatible with any other models that determine the equilibrium REER value.

Before using the matrix notation of the model we take a step back to describe the model using equations. At the end of this chapter the methodology for calculating the SMIM will be outlined. This chapter will also conclude the theoretical background needed for the calculations in the paper. As the SMIM is simple but tedious to calculate, I will include a step by step calculation for the year 1999 in Appendix D.

4.1 The equations

The model uses the calculated Current Account gap and the semi- elasticity to calculate the real bilateral exchange rate that is consistent with the FEER values calculated in chapter 3. For the specific country i this can be written as equation 3.2

3.2 $$\dot{R} = \frac{c\dot{a}}{\gamma}$$

We insert the definition for the REER in equation 3.2 in to the equation for the RBER from equation 2.5. Equation 4.1 shows this relationship for $i = 1$

4.1 $$\dot{R} = \frac{c\dot{a}_1}{\gamma_1} = x_{1,2}\dot{R}_{1,2} + x_{1,3}\dot{R}_{1,3} + x_{1,4}\dot{R}_{1,4} \ldots$$

In the SMIM, the REER and the trade weights are the exogenous variable while the RBER is the endogenous in the model. The equations equates the percentages changes of the sum of the trade weighted RBER to be equal to the percentage changes in the REER. Following (Cline 2008) and (Bårdsgjerde 2011) we start by duplicate the equation 4.1 for three countries.

A

$$\frac{c\dot{a}_1}{\gamma_1} = \dot{R}_1 = x_{1,2}\dot{R}_{1,2} + x_{1,3}\dot{R}_{1,3}$$

$$\frac{c\dot{a}_2}{\gamma_2} = \dot{R}_2 = x_{2,1}\dot{R}_{2,1} + x_{2,3}\dot{R}_{2,3}$$

$$\frac{c\dot{a}_3}{\gamma_3} = \dot{R}_3 = x_{3,1}\dot{R}_{3,1} + x_{3,2}\dot{R}_{3,2}$$

For the set of equations to be consistent with the SMIM in (Cline 2008) and (Bårdsgjerde 2011), We have to denominated the real exchange rate to a numéraire country, in this section it is done with country 1 in mind. To be able to do this we first need to multiplying the set A with -1.

Set A

$$-\dot{R}_1 = -x_{1,2}\dot{R_{1,2}} - x_{1,3}\dot{R_{1,3}}$$

$$-\dot{R}_2 = -x_{2,1}\dot{R_{2,1}} - x_{2,3}\dot{R_{2,3}}$$

$$-\dot{R}_3 = -x_{3,1}\dot{R_{3,1}} - x_{3,2}\dot{R_{3,2}}$$

Furthermore we need to change the right hand side of the second and third equations by using both the inverse relationship and the triangular relationship as explained in chapter 2 by equation 2.17 and 2.15

2.15 $$\dot{R_{DM/FF}} - \dot{R_{ESP/FF}} = \dot{R_{DM/ESP}}$$

2.17 $$\dot{R_{DM/ESP}} = -\dot{R_{ESP/DM}}$$

We start by taking the inverse from equation 2.17

4.2 $$-x_{2,1}\dot{R_{2,1}} - x_{2,3}\dot{R_{2,3}} = x_{2,1}\dot{R_{1,2}} + x_{2,3}\dot{R_{3,2}}$$

4.3 $$-x_{3,1}\dot{R_{3,1}} - x_{3,2}\dot{R_{3,2}} = x_{3,1}\dot{R_{1,3}} + x_{3,2}\dot{R_{2,3}}$$

Note that the trade weights are unchanged, but the subscript change along with the values now being positive again. We advance by using the equation 2.15 on the last terms of 4.2 and 4.3

4.4 $\dot{R}_{3,2} = \dot{R}_{1,3} - \dot{R}_{1,2}$

4.5 $\dot{R}_{2,3} = \dot{R}_{1,3} - \dot{R}_{1,2}$

Equations 4.2 and 4.3 are now

4.6 $x_{2,1}\dot{R}_{1,2} + x_{2,3}\left(\dot{R}_{1,3} - \dot{R}_{1,2}\right)$

4.7 $x_{3,1}\dot{R}_{1,3} + x_{3,2}\left(\dot{R}_{1,3} - \dot{R}_{1,2}\right)$

We can rearrange the last term and utilize the fact that the sum of all the trade weights equal one, and reduce to the following set.

B

$$-\dot{R}_1 = -x_{1,2}\dot{R}_{1,2} - x_{1,3}\dot{R}_{1,3}$$

$$-\dot{R}_2 = \dot{R}_{1,2} - x_{2,3}\dot{R}_{1,3}$$

$$-\dot{R}_3 = \dot{R}_{1,3} - x_{3,2}\dot{R}_{1,3}$$

The first equation in B stands out as it has only negative terms on the left hand side. Assume an isolated depreciation of the denominator country's REER (fall in the value of $-\dot{R}_1$). Due to the inverse relationship and the fact that the RBER have negative terms, a deprecation of the denominator country ($\dot{R}_1$) must imply a depreciation of the RBER (negative $R_{1,2}$ and $\dot{R}_{1,3}$). The inverse therefore implies that the nominated country must appreciate (positive $R_{1,2}$ and $\dot{R}_{1,3}$ for $\dot{R}_2$ and $\dot{R}_3$). Bårdsgjerde (2011) details the inverse and the triangular relationship in greater detail.

The second and third equation also needs some attention. They are set up as all the changes in the REER are initially relative to the RBER of the denominator country $\dot{R}_{j,1}$. The counties

REER will change relative to the denominator RBER, but the changes will be smaller the more important the rest of the trading partners are for the country in question. For Country 3 this implies that changes in $\dot{R}_3$ are initially assumed to be one-to-one with $\dot{R}_{3,1}$. The more important the other trading partners are (country 2) the less the changes in $\dot{R}_3$ will be, due to $x_{2,3}$. For country 2 it would be equivalent but with respect to $\dot{R}_{2,1}$ and $x_{3,2}$.

By changing the equation we step out of the frying pan and in to the fire. The alteration of the set of equations gives us two unknown with three equations, leading to an overdetermination problem. To solve this, we again follow Cline (2008) Cline calculates all solutions and takes the average of all the possible solutions. (Bårdsgjerde 2011) shows that the overdetermination problem has small if any effect on his calculations. (Bårdsgjerde 2011) expands the three equation model, and uses it for five country model.

4.2 Matrix notation

Having determined the equations needed to calculate the SMIM with three countries, we now turn or attention to replicating the SMIM for the selected countries. Cline (2008) states that the general equation for the denominated country in question takes this form.

4.3 $$\dot{R}_{\iota} = \sum_{i=1}^{j} x_{i,j} \dot{R}_{\iota,J} \quad for\ i = 1,2 \ldots 12$$

The left side from set B takes the simple form of a column vector Γ for the 12 economies (11 euro and one RoW), giving the dimensions 12x1. The countries are sorted alphabetically with RoW on the 12th row. The value for the elements in the Γ vector are equal to the changes needed to close the Current Account gap based on (Salto and Turrini 2010)

4.4 $$\begin{bmatrix} -\frac{c\dot{a}_1}{\gamma_1} \\ \vdots \\ -\frac{c\dot{a}_{12}}{\gamma_{12}} \end{bmatrix} = \begin{bmatrix} -\dot{R}_1 \\ \vdots \\ -\dot{R}_{12} \end{bmatrix}_{1x12} = \Gamma$$

The right hand side of the equation can be written as a product of a matrix and a vector. The vector is the set of the unknown RBER, with the dimension 12x1.

4.5 $$\begin{bmatrix} \dot{R}_{1,J} \\ \vdots \\ \dot{R}_{12,J} \end{bmatrix}_{12x1} = Z$$

The second matrix on the right hand side is the set of trade weights. The elements in the matrix are determined by equation A.1 from appendix A.

4.6 $$\begin{bmatrix} 0_{1,1} & x_{2,j} & \dots & x_{12,1} \\ x_{i,2} & 0_{i,j} & \dots & x_{12,2} \\ \vdots & \dots & \ddots & \vdots \\ x_{1,12} & x_{2,12} & \dots & 0_{12,12} \end{bmatrix}_{12x12} = X$$

Noting the fact that the diagonal (i=j) is zero, we have to change it to confine with the set B. Following (Cline 2008) we subtract matrix X from an identity matrix

$$I_{12} - X_{12x12} = \varphi_{12}$$

4.7 $$\begin{bmatrix} 1 & -x_{2,j} & \cdots & -x_{12,1} \\ -x_{i,2} & 1 & \cdots & -x_{12,2} \\ \vdots & \cdots & \ddots & \vdots \\ -x_{1,12} & -x_{2,12} & \cdots & 1 \end{bmatrix}_{12x12} = \varphi_{12}$$

There are two notable differences; the first is that the elements for the trade weight are now negative. The second difference is that, a part from the diagonal is that the diagonal elements are now equal to one. This gives the following relationship for the matrixes.

4.8 $$\Gamma = \varphi Z$$

Regarding set B, I stated that the denominator country does not change relative to itself. The SMIM therefore eliminates the denominator country in the Z vector (we arrange the economies alphabetically, making Germany the fifth country). To ensure that 4.2 can be multiplied we also eliminate the fifth column in φ. The augmentations gives Z vector a 1x11 dimension, while φ is now a 11x12 matrix.

Having now altered the dimensions of the matrix, we move towards the calculations of the SMIM. As the aim is to determine the values of the Z vector we need to left hand side multiply equation 4.8 to have the Z vector isolated on the left side of the equation. This is done by first ensuring that φ can be inverted. As φ is a non-square matrix, we start by eliminating one country form the row of φ. The inverted φ matrix now yields φ^{-1} with the dimensions 11x11. Again the need for altercation comes up as Γ has the dimensions 1x12. It is therefore not possible to multiply before removing one country from the row of vector Γ. We remove the same country from Γ as we did for φ.

$$\varphi^{-1}_{11x11}\Gamma_{1x11} = Z_{1x11}$$

The row removal from equation 4.8 is repeated for every single country one at a time, giving us i numbers of calculation. (Cline 2008) highlights alternative methods of averaging the calculations and concludes that a simple average is the method that yields the best result.

5 The Results

With the theoretical framework at hand, we now turn our attention to the data and the results from the calculations. The beginning of this chapter is dedicated to clarifying the variables and the intermediate calculations needed for the SMIM calculations. In the following section I will present the general trend in the calculation before going on to the specific countries.

5.1 Data

The calculation uses different sources for the data, all shown in the table below. All the variables are measured annually, with OECD REER calculated by the average of monthly figures and indexed in year 2005. The choice of index year does not have a profound impact on the calculations as we use the logarithmic values before calculating the REER lag in equation 3,7. The GDP, Total Export and Total Import are all measured in current prices. The Net Foreign Assets are collected from Eurostat, and like the Current Account are also measured in percentage of GDP.

Table 1: Dataset

Variable	Database
Nominal GDP	IMF WEO October 2013
Current Account level	IMF WEO October 2013
Total Export of Goods & Services	DG ECFIN AMECO
Total Imports of Goods & Services	DG ECFIN AMECO
Countries Specific Output Gap	OECD Economic Outlook 2013/2
World Output Gap	OECD Economic Outlook 2013/2
Real Effective Exchange Rates CPI Based, Index=2010	OECD MEI
Net International Investment Position	Eurostat
GDP growth	IMF WEO October 2013
HICP, All-Items HICP Y/Y Change	Eurostat/ECB

The Output gaps are taken from OECD Economic Outlook 2013/2 database. The World output gap is calculated by the OECD , they first calculate the real GDP growth by "*moving nominal GDP weights, using purchasing power parities*" (OECD 2013), followed by applying the HP-filter on the aggregated data.

The Current Account data is separated between the ex post and the ex-ante values as stated in the paper. The IMF WEO October 2013 calculates the country specific Current Account up to the year 2012 while the variables between 2013 and 2018 are the projected values. Because of this limitation the ex-post variables will be calculated between 1999 and 2012.

The country specific NFA data in the given timeframe is available for the selected countries, except for Belgium. The reason for the lack of data is due to the fact that Belgium was in an economic union with Luxembourg (The union included monetary union amongst other economic policies). The Belgium NFA data is aggregated with the Luxemburg data. It is not an obstacle for the 3% target. Since the model rests on the assumption that the trade weights are equal to one, we are limited to calculate the NFA target using data from 2002. Furthermore the NFA target for time period t is calculated using data form the previous time period t-1, the first possible NFA target we can calculate is for 2003. The NFA target will therefore be calculated from 2003 up to 2012. The projected values of the NFA in the time periodes 2013-2018 are based on the NFA from 2012.

5.2 Trade weight

The trade weights are calculated using the bilateral trade flows from Eurostat COMEXT database. The database has some minor inconsistencies. It states different values for the bilateral trade flows based on the country reporting the data. In a perfect world the import to country A from country B should be consistent with export from country B to country A. This inconsistency is a recurring problem in international trade statistics. (This is also true for the data in IMFs Direction of Trade Statistics database)

One possible explanation given for this is the different currency used to value the trade in. This should not be an issue for the selected countries, as they use the same currency. Other possible explanation for the inconsistent data may be different accounting practices. Assume a good is traded across a sea route. A country might register a good exported when it leaves the port but may not be registered as imported before it enters the destination countries territorial waters. The time spent in transit, the goods are considered to be in a state of limbo. It is also possible that some goods go to waste due to ineffective transport methods or dishonesty.

The Series does not advocate any solution to this obstacle. (Bårdsgjerde 2011) chooses to use only export data for the calculation of the trade weights. In this paper I try and overcome this inconsistency in data by calculating the average of the reported export and import before using these averages to calculate the trade weights. Se Appendix A for the calculations.

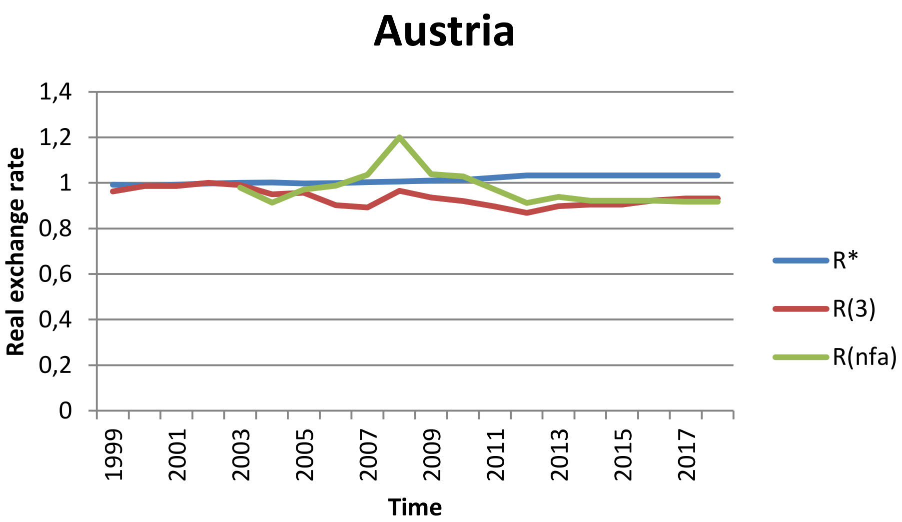
5.3 The FEER values

In appendix C, the tables show three different values for the countries Real Bilateral Exchange Rate with Germany as the denominator. The two FEER values are marked as R(3) and R(NFA) for the +/-3% and NFA values respectively. To assess the degree of constraint I compare the FEER values with the REBR, using equation 2.1 as a benchmark value. The benchmark RBER is named R* in the tables. The price index used to calculate R*is the HICP. The HCPI is the year to year change at the end of fourth quarter. Being limited by the NFA data, I index the R* to 100 in year 2003. The R* value of 2012 will be extended up to 2018 for the sake of comparison.

The FEER results should be understood as synthetic counterfactual, the RBER values that would and should prevail if the Current Account Gap were eliminated (equivalent to achieving external balance). A FEER value larger than the prevailing RBER (R*) must be understood as overvalued, to achieve equilibrium the real exchange rate must appreciation. Symmetrically the case of a FEER values smaller than R* must be understood as the real exchange rate is undervalued. A real depreciation is needed to close the Current Account Gap. The data is reported in Appendix C

I want to analyses the misalignment in three different distinct time periods, The early years, The Great Recession and Post Great Recession. The Great Recession impacted the countries at differently times. In this paper I define the time period between 2008 and 2012 as The Great Recession. The early years are from 1999 to 2007. The Post Great Recession is defined as 2013 to 2018.

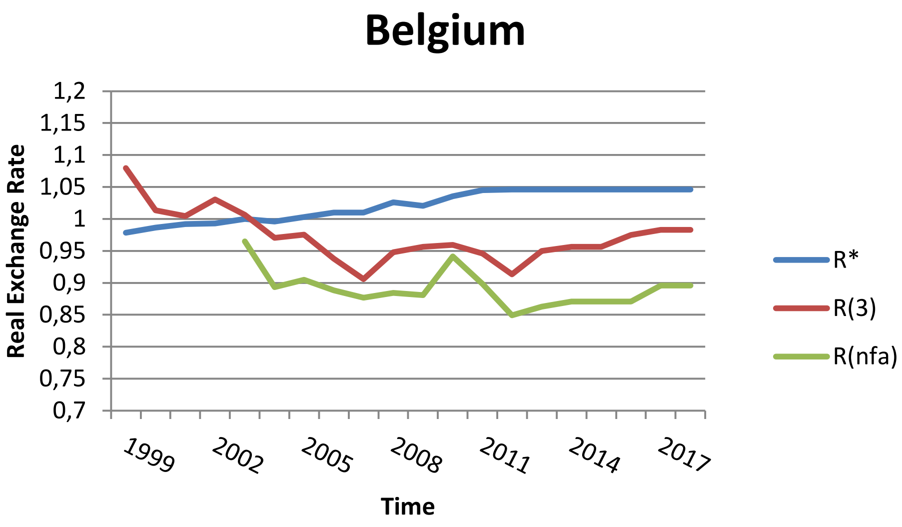
Austria



During the early part of the Euro currency the FEER targets and the actual RBER stay very close to each other until 2003. From then on we see a detachment with a minor overvaluation of the real exchange rate. During the Great recession we see a distinct deviation between the three values. The highest in the FEER values is the R(NFA) in 2008 with a FEER value equal to 1,20 while R* is 1,00. R(3) indicates that the economy needs an appreciation, the lowest value is in 2012 at 0,86 when R* is 1,03. In the Post Great Recession we see a convergence of the FEER values to projected real appreciation. The lowest FEER value is the R(3) in 2012 with the RBER overvalued with 19%.

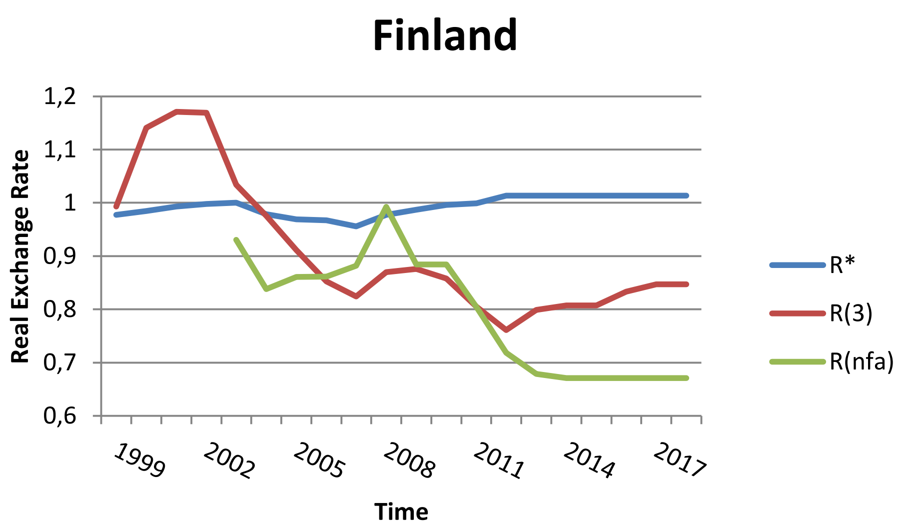
Belgium

For Belgium we again see that the FEER consistent RBERs follow each other closely. From 1999 to 2003, R(3) is larger than R* indicating a need for an appreciation. This relationship switches from 2003 onwards, both for the ex-post and the ex-ante calculation. The Great Recession does have a minor impact in that it reduces the deviation between the FEERs and R*. The highest FEER value is the R(3) in 1999 with an undervaluation of 9%. The lowest FEER value is in 2012, with an overvaluation of 23%



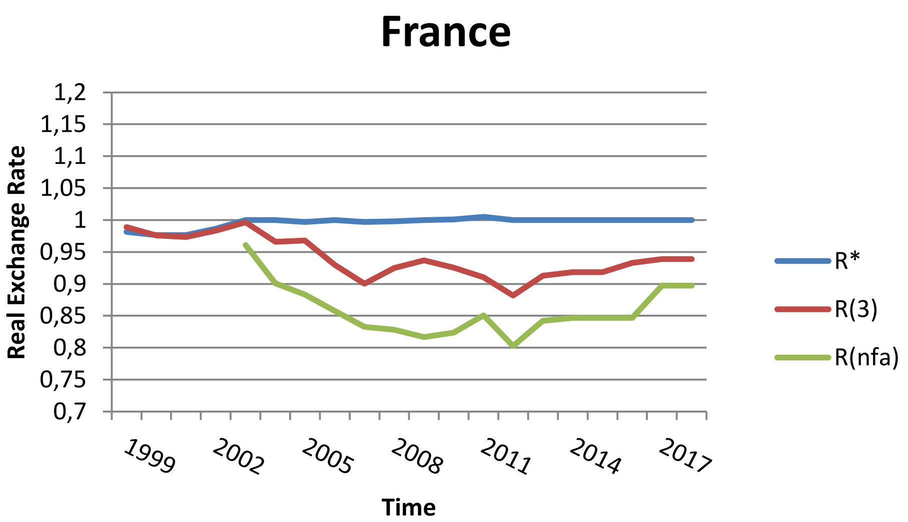
Finland

In the early years of the Monetary Union indicated a need for appreciation with an the exchange rate undervalued by 33%. Like Belgium the pressure subsides and shifts. The degree of deviation between the FEER values and R* is larger than for Belgium, indicating a



larger degree of undervaluation. The shift from appreciation to depreciation coincides with R* having a bilateral depreciation relative to Germany. In 2008 the R(nfa), like Austrias R(nfa) has a spike in the FEER values. The projected values show a large degree of uncertainty in the FEER values. While the R(3) FEER expects close to 20 % depreciation while R(nfa) expects close to 40% depreciation relative to today's R*.

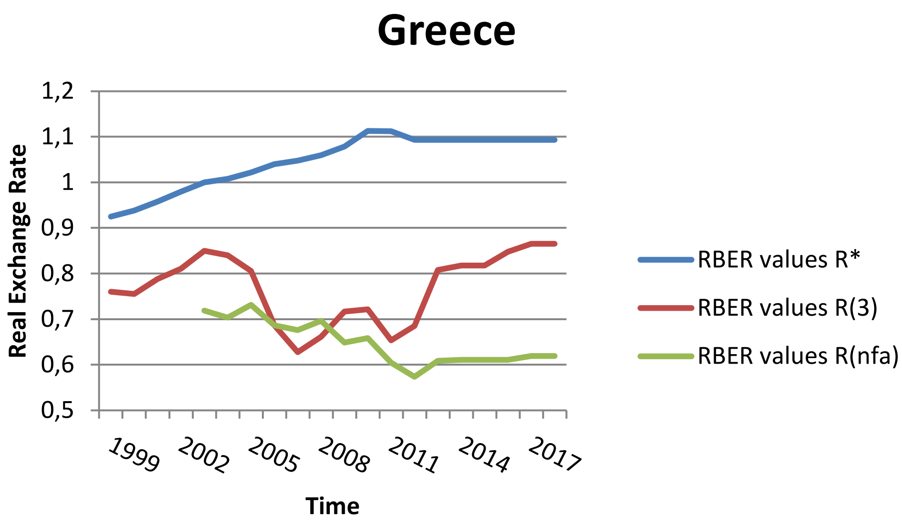
France



In the initial years of the union, France has a R(3) value that exactly follows R*. Again the 3% target is more conservative than the NFA target. In the time period 2004-2012 the FEER values expect depreciation, after the Great Recession the deviation between the FEERs and R* stabilizes around 18% depreciation for R(NFA) and 7% for the R83). Again we can see the trend of reduced deviation between the FEER consistent RBERs and R* in the projected values, while the RBER is overvalued during the Great Recession.

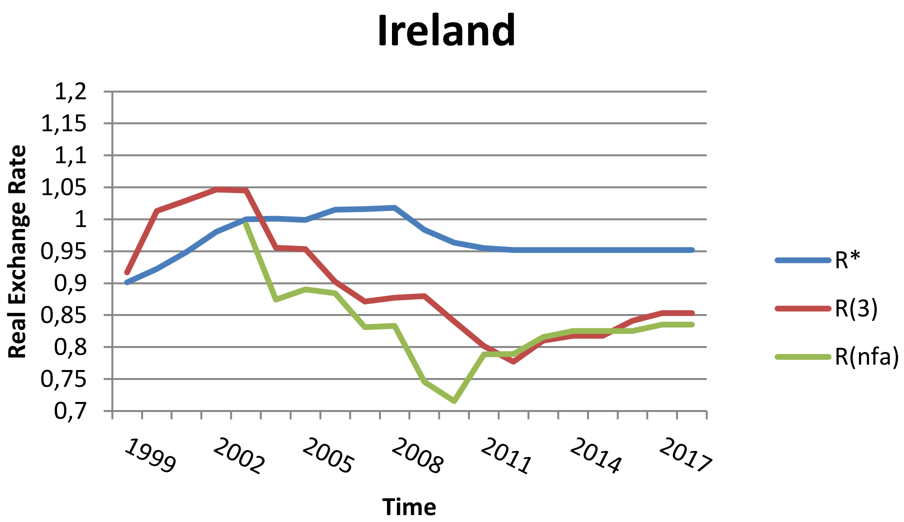
Greece

Greece is the country that has the largest deviation between both the FEER values and R*. The deviation between Greece's FEERs and R* are equal to an overvaluation of up to 20% during the Great Recession. Between 2006 and 2012 the FEER targets dips further down. The overvaluation is 90% according to R(nfa) and 70% according to R(3). In the Post Great Recession time period the overvaluation is reduced, helped by the internal devaluation in 2010, 2011 and 2013. While the R (3) appreciates, R (nfa) holds the same value probably due to the use of 2012 NFA numbers.



Ireland

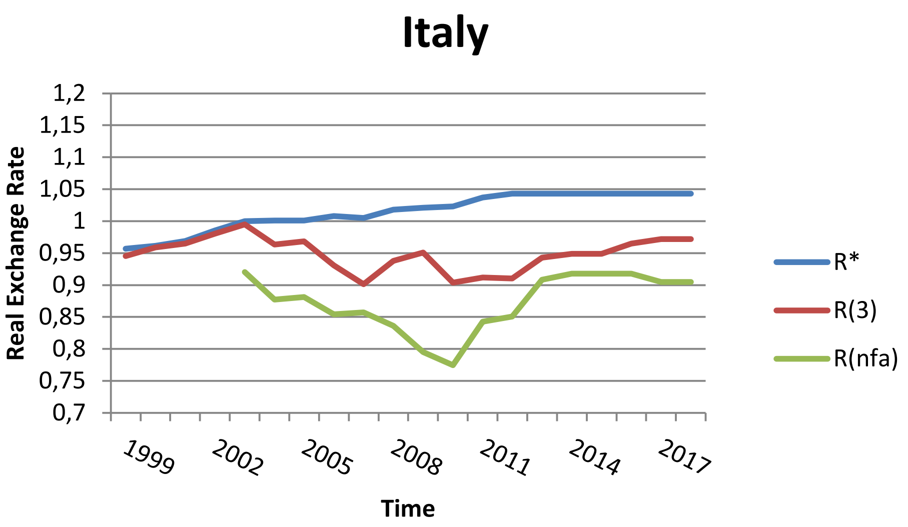
Ireland, like Belgium and Finland, starts with a R(3) value that is higher than R*. After 2004 this relationship again follows the similar pattern of a lower persistent FEER values in relationship with R*. Relative to the other countries Irelands FEER values shows high degree of consistency, especially after 2011. The largest overvaluation is



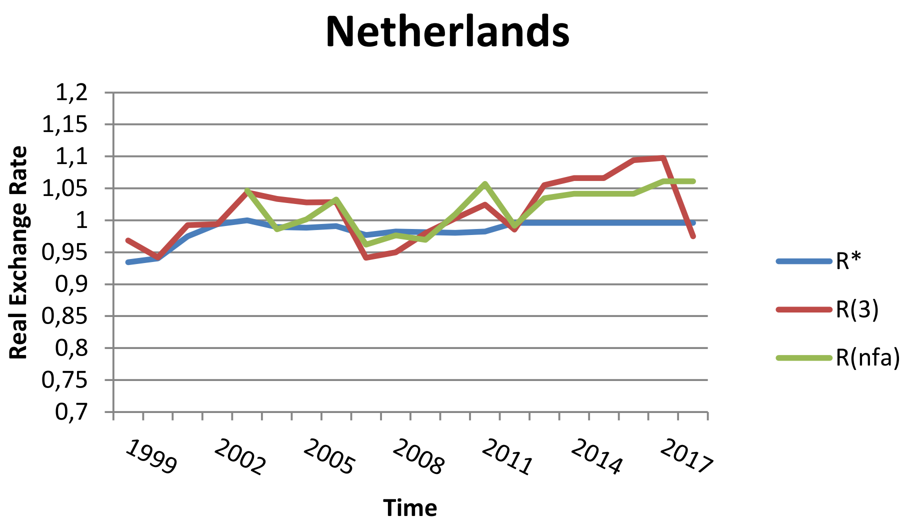
according to R(nfa) high as 34% in 2010 and a undervaluation as low as 9% in 2000. An interesting aspect of the Ireland data is that it has been able to reduce the deviation from the FEERs and R* by having an internal devaluation (the same can be observed in the Greece calculations, but to a lesser extent). This reflects deflation in 2009 and 2010). During the Great Recession the R(nfa) dips temporarily in year 2009 and 2010 (from 0,83 to 0,71), while R(3) displays less volatile values.

Italy

Italy mimics France's RBER in the initial years and before following the rest of the countries with an overvaluation, similarly to Austria and Belgium. Compared with the R(nfa) target we get some conflicting pictures of Italy. An interesting aspect is that the FEERs diverge in 2009 and 2010, almost mirroring each other. R(nfa) advocates a lower RBER value than R(3), with the lowest point at 0,77 in 2010, equal to an overvaluation of 32%. The overvaluation for R(3) at the same time is 7% and 13% for 2009 and 2010. The projected values for the FEERs show lower degree of deviation between the FEERs and R*.

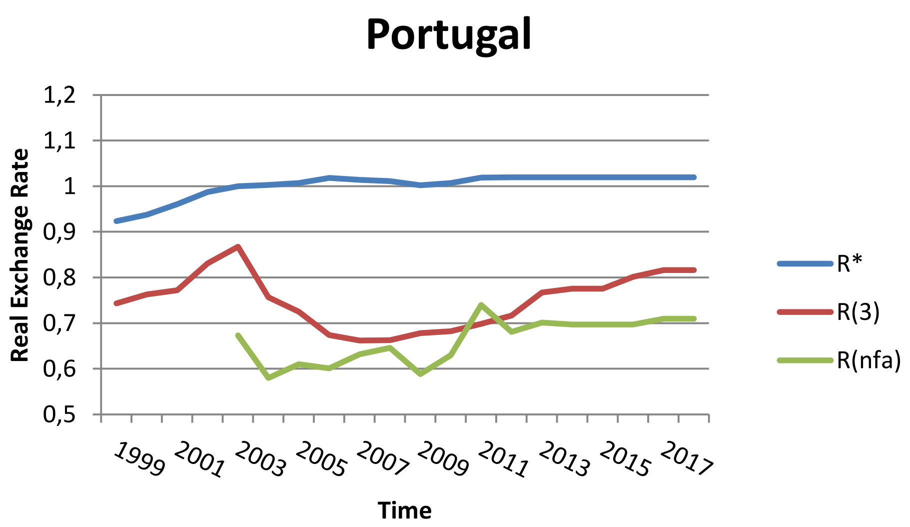


Netherlands



Of the selected countries, Netherlands is the one that clearly stands out. It is the only country that persistently an undervalued real bilateral exchange rate. The highest overvaluation is 3% and 1,5% for R(3) and R(NFA), they both follows R* fairly closely. The largest deviation in the Ex-post calculation is found in 2011 when the R* is 0,07% lower than the R(nfa). During the Great Recession the FEERs exhibit dips, but compared to the other countries must be understood as being insignificant in size. Both the projected FEERs imply that Netherlands should have a depreciation, relative to Germany Netherlands is undoubtedly the country that is least constrained by the Union.

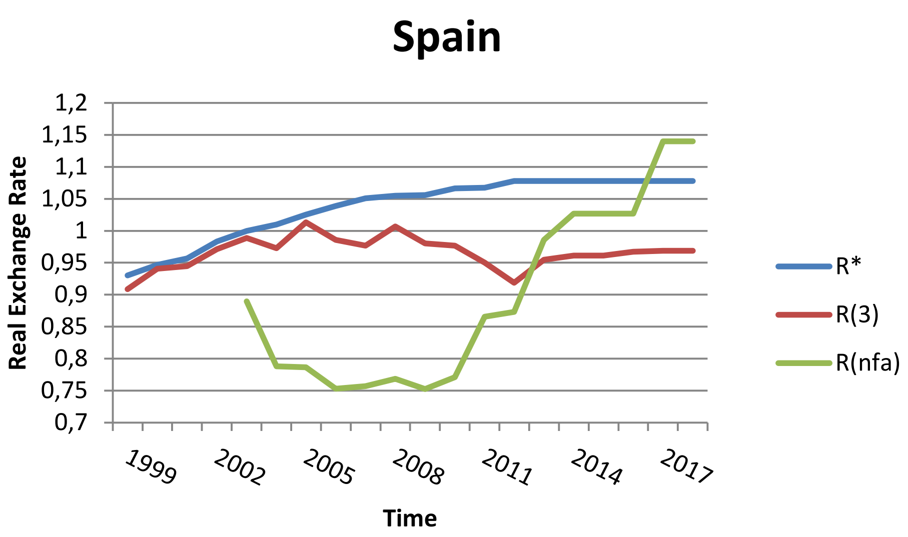
Portugal



Of all the countries, Portugal is the country with the least volatile FEER values. On the other hand it is also the country (with Greece and Spain) that needs the largest real exchange rate misalignment. Like Greece it has a lower FEER value than R* when entering the union, 24% overvalued. The lowest deviation between the FEERs and R* is in 2002 and

2003 (18% and 15% overvalued R(3)). Surprisingly, the Great Recession seems not to lead to a major shift on R(3) and a minimal effect on R(nfa). We do on the other hand observe a small dip in R* in 2009, but this must again be considered minute changes, as it goes from 1,0108 in 2008 to 1,0018 in 2009 and back to 1,006 and 1,015 in 2010 and 2011. The largest overvaluation is according to R(nfa) in 2009 at 70%. For R(3) it is 53% in 2007.

Spain



Spain has a R(3) close to R* in the initial years, but start to experience a detachment in 2003. In the first time period the undervaluation is at most 7%. Following R(nfa) we get a different picture, with 40% overvaluation. While the R(3) has in average between 1999 and 2012 an overvaluation of 5%. Like Italy, Spain has FEER values that move in opposite directions during the Great Recession, the R(3) jumps from 1% to 17% from 2003 to 2012., The R(nfa) overvaluation is rapidly decreasing in the same time.

5.4 Conclusion

The purpose of the paper is to asses if exchange rates have misaligned, and how these misalignments have changed in the early years of the common currency. The value are calculated from 1999 to 2018 and separated in three periods. The Early years from 1999 to 2007, the Great Recession between 2008 and 2012, and post Great Recession from 2013 to 2018.

The models applied in this paper are the partial Fundamental Equilibrium Exchange Rate model of (Salto and Turrini 2010), used simultaneously with Cline 2008. In this paper we used two different definitions for the equilibrium Current Account, and calculated the exchange rate with Germany as numeraire. The first target is the 3% target; the second is the Net Foreign Asset target. The values are compared with the actual real exchange rate between the countries using the ECB Harmonized Index of Consumer Prices. Since we are calculating the bilateral exchange rate, if an exchange rate is deemed overvalued it also implies that Germany at the same time is overvalued. This mirrored relationship also holds for a country that is undervalued, Germany will be overvalued.

The two targets give different degree of overvaluation or undervaluation, but are general trend is the 3% target giving lower degree of undervaluation and overvaluation. The average difference between the two targets is 9%, 6%, and 10% for the stated time periods. It should be noted that the difference in values for the early years (between 2003 and 2007) is affected because of the lack of data for the NFA prior to 2002.

In Table 2 below, the average values of the misalignments of the targets are shown using the row four and five for the given country from appendix C. The values are relative to Germany, separated in the three time periods. It is calculated using the values in appendix C under the column SMIM. The names are shortened, and presented alphabetically[9]. The values in the cell

[9] Austria (Aus), Belgium (Bel), Finland (Fin), France(Fra), Greece (gre), Ireland (Ire), Italy (Ita), Netherlands (Neth), Portugal (Por) and Spain (Spa)

are in percentages. Positive values shoe undervaluation, while negative values show overvaluation.

Table 2 Average Bilateral misalignment

Average values of both targets (in percentage)	Aus	Bel	Fin	Fra	Gre	Ire	Ita	Neth	Por	Spa
The Early Years (1999-2007)	3,29	5,87	5,87	7,82	37,95	6,98	8,82	-1,78	47,29	16,15
Great Recessen (2008-2012)	5,36	12,93	12,93	15,39	65,71	21,44	18,52	-0,92	51,04	21,41
Post Great Recessen (2013-2018)	12,31	13,68	13,68	11,97	54,55	14,78	11,62	-5,32	37,03	7,04

During the early years the exchange rates are misaligned to a low degree. According to the 3%-targets, the countries are 9% undervalued relative to Germany, while according to the Net Foreign Asset (NFA) targets is 19%. Finland and Ireland to a lesser degree (also Belgium in 1999) are according to the model undervalued. Austria, France, Italy, Netherland, Spain and Belgium (for 2000-2007), must be regarded in equilibrium as the model assesses minute changes need for real exchange rate. Prior to the Great Recession, we identify larger misalignment with the southern countries, Greece and Portugal. Greece has at most a real exchange rate overvaluation of R(3) in 2007 at 67% overvaluation. For Portugal this R(NFA) value in 2007 is 53% overvaluation

During the Great Recession the number of countries categorized as overvalued increase, along with the degree of misalignment, with Greece increasing from on average overvaluation before the Great Recession is 37% while during the Great Recession it is 65%. For Portugal the average values are 47% and 51%. The targets for Ireland show an increasing degree of overvaluation. Both Ireland and Greece are able to reduce the overvaluation through deflation in the counties price level column . For Austria, Belgium, France Finland, Italy and Netherlands the values show relative low degree of misalignment. Spain is a special case as the two targets tell two different stories; the 3% target says the real exchange rate is slightly overvalued around 10%, while the NFA target says 30% a value close to Portugal in the previous time period. The Current Account vales in this time period shows increased fluctuation with the southern countries running an increase Current Account Deficit, and the

Northern countries like Germany, Netherlands and Austria are running a current account surplus.

In the projected Post Great Resection values the equilibrium values are compared to the actual real exchange rate in 2012, the last year with complete data. Greece, Italy, Ireland and Portugal are identified as in still in the need of a real realignment. For Spain the values differ based on which targets are chosen. The 3% target gives a projected undervaluation of 12% and falling in the time period. The NFA target predicts an overvaluation of 5% by 2017.For the rest of the countries the projected undervaluation are projected to last around the Great Recession levels, with some reduction. The reasons might be due to the use of values from 2012. Some note should be taken for the values of Netherlands as it is the only country to have a real exchange rate that is persistently undervalued in all three time periods.

Greece and Portugal are identified as the countries, with the need for greatest realignment even prior to the start of the Euro. During the Great Recession the need for realignment is increased dramatically with the overvaluation calculated at 90% and 70% at most. Netherlands and Austria are the countries in this paper the least need for realignment.

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7 Appendix

7.1 Appendix A – Trade Weights

The Trade weights in the model are calculated according to Cline (2008).

A.1 $$x_{i,j} = \frac{t_{i,j}+t_{j,i}}{Ex_i+M_i}, i \neq j$$

The denominator is the sum of country i's export and import. The nominator is the sum of two bilateral trade flows. The subscripts denote the participating country and the directions of the trade flow, with the first subscript denoting the sender while the second subscript denotes the recipient. The first variable therefore becomes country i's import from j (equivalent to export from j to i), and the second variable the country i's export to country j (equivalent to import to j form i). In the case of i=j the nominator must obviously be zero ensuring that the elements in the diagonal of the trade weight matrix must be $x_{i,i} = 0$.

We start by first calculating the arithmetic averages of the import and export data (see Chapter 5). For the second step we need to calculate the countries bilateral trade flow with the RoW. This is done by calculating the RoW as the residuals of the euro countries export and import from their total trade flow. For export trade flow we subtract the sum of bilateral trade flow for country j from the other Euro countries, from the sum of the total export for country j

A.2 $$t_{i,12} = Ex_i - \sum_{j=1}^{11} t_{i,j} \ for \ i = 1,2 \dots 11$$

For import trade flow we subtract the sum of bilateral trade flow for country j from the other Euro countries, from the sum of the total import for country j

A.3 $$t_{12,j} = M_j - \sum_{i=1}^{11} t_{i,j} \ for \ j = 1,2 \dots 11$$

The total export and import for Row is calculated as the sum of the bilateral trade flows

A.4 $$Ex_{12} = \sum t_{12,j}$$

A.5 $$M_i = \sum t_{i,12}$$

7.2 Appendix B – Underlying Current Account, Targets & CAIP

Applying the (Salto and Turrini 2010) adjustment on the Current Account we get the following values as the uca. In the table under the Current Account is only adjusted for the ex-post calculations while the ex-ante are the same as the IMF WEO October 2013 projections. The Ex-ante Current Account Semi-Elasticizes are held constant after 2012.

In the tables below shows the REER targets calculated for the individual countries. All values are shown in percentage. The first column (from the left) shows the uca from 1999 to 2012, from 2013 and onwards the columns show the IMF projections. The second and third columns show the Current Account targets based on the two Current Account targets chosen in this paper. The firth and fifth shows the corresponding Current Account gaps based on the difference between the uca and the two different targets. The sixth column is the yearly updated Current Account semi-elasticity, it is calculated using equation 3.24. the export ratio is calculated the same way as in equation 3.10. The last two columns show the changes in the REER needed to achieve the FEER targets. They are calculated by dividing column four and five with the corresponding CAIP for the given year. It is also equivalent to the left side vector in the SMIM (se equation 4.3).

Austria								
Year	UCA	Target		Output gap		CAIP	FEER adjusted REER	
		R (3%)	R (NFA)	R (3%)	R (NFA)		R (3%)	R (NFA)
2018	2,383	2,383	-2,421	0,000	4,804	-0,421	0,000	-11,417
2017	2,337	2,337	-2,375	0,000	4,712	-0,421	0,000	-11,198
2016	2,345	2,345	-2,383	0,000	4,728	-0,421	0,000	-11,236
2015	2,364	2,364	-2,402	0,000	4,766	-0,421	0,000	-11,326
2014	2,436	2,436	-2,474	0,000	4,910	-0,421	0,000	-11,669
2013	2,802	2,802	-2,840	0,000	5,642	-0,421	0,000	-13,408
2012	1,506	1,506	-1,544	0,000	3,051	-0,421	0,000	-7,250
2011	1,272	1,272	-1,573	0,000	2,844	-0,421	0,000	-6,752
2010	2,931	2,931	-2,980	0,000	5,911	-0,409	0,000	-14,464
2009	2,915	2,915	-2,933	0,000	5,848	-0,388	0,000	-15,062
2008	5,237	3,000	-6,115	2,237	11,352	-0,429	-5,213	-26,453
2007	3,672	3,000	-4,874	0,672	8,546	-0,428	-1,570	-19,981
2006	2,862	2,862	-3,823	0,000	6,685	-0,417	0,000	-16,021
2005	2,031	2,031	-2,783	0,000	4,814	-0,406	0,000	-11,850
2004	2,099	2,099	-2,599	0,000	4,698	-0,395	0,000	-11,886
2003	2,004	2,004	-2,548	0,000	4,552	-0,379	0,000	-12,008
2002	3,481	3,000		0,481		-0,381	-1,262	
2001	-0,048	-0,048		0,000		-0,378	0,000	
2000	0,059	0,059		0,000		-0,368	0,000	
1999	-1,081	-1,081		0,000		-0,345	0,000	

Belgium								
Year	UCA	Target		Output gap		CAIP	FEER adjusted REER	
		R (3%)	R (NFA)	R (3%)	R (NFA)		R (3%)	R (NFA)
2018	0,847	0,847	1,595	0,000	-0,748	-0,494	0,000	1,513
2017	0,651	0,651	1,595	0,000	-0,944	-0,494	0,000	1,910
2016	0,351	0,351	1,595	0,000	-1,244	-0,494	0,000	2,517
2015	0,002	0,002	1,595	0,000	-1,593	-0,494	0,000	3,224
2014	-0,279	-0,279	1,595	0,000	-1,874	-0,494	0,000	3,792
2013	-0,700	-0,700	1,595	0,000	-2,295	-0,494	0,000	4,645
2012	-1,374	-1,374	1,595	0,000	-2,969	-0,494	0,000	6,010
2011	-0,295	-0,295	2,619	0,000	-2,913	-0,493	0,000	5,912
2010	2,368	2,368	0,887	0,000	1,481	-0,486	0,000	-3,047
2009	-0,843	-0,843	0,236	0,000	-1,080	-0,474	0,000	2,278
2008	-1,161	-1,161	1,332	0,000	-2,493	-0,492	0,000	5,063
2007	1,336	1,336	1,498	0,000	-0,162	-0,490	0,000	0,331
2006	1,389	1,389	1,491	0,000	-0,102	-0,488	0,000	0,209
2005	1,727	1,727	1,316	0,000	0,410	-0,484	0,000	-0,847
2004	3,439	3,000	1,353	0,439	2,086	-0,479	-0,917	-4,355
2003	3,312	3,000	0,921	0,312	2,391	-0,475	-0,658	-5,037
2002	4,957	3,000		1,957		-0,480	-4,073	
2001	3,710	3,000		0,710		-0,483	-1,471	
2000	4,368	3,000		1,368		-0,483	-2,830	
1999	8,001	3,000		5,001		-0,465	-10,762	

Finland								
Year	UCA	Target		Output gap		CAIP	FEER adjusted REER	
		R (3%)	R (NFA)	R (3%)	R (NFA)		R (3%)	R (NFA)
2018	-1,355	-1,355	0,757	0,000	-2,112	-0,336	0,000	6,282
2017	-1,429	-1,429	0,757	0,000	-2,186	-0,336	0,000	6,502
2016	-1,527	-1,527	0,757	0,000	-2,284	-0,336	0,000	6,794
2015	-1,672	-1,672	0,757	0,000	-2,429	-0,336	0,000	7,225
2014	-1,830	-1,830	0,757	0,000	-2,587	-0,336	0,000	7,695
2013	-1,631	-1,631	0,757	0,000	-2,388	-0,336	0,000	7,103
2012	-1,976	-1,976	0,757	0,000	-2,734	-0,336	0,000	8,130
2011	-1,273	-1,273	1,162	0,000	-2,435	-0,339	0,000	7,190
2010	1,136	1,136	-0,019	0,000	1,155	-0,335	0,000	-3,448
2009	0,994	0,994	0,042	0,000	0,952	-0,316	0,000	-3,009
2008	3,800	3,000	-1,445	0,800	5,245	-0,372	-2,153	-14,109
2007	5,294	3,000	-0,832	2,294	6,127	-0,366	-6,265	-16,729
2006	4,386	3,000	-0,702	1,386	5,088	-0,365	-3,802	-13,959
2005	3,189	3,000	-0,396	0,189	3,585	-0,343	-0,551	-10,441
2004	6,111	3,000	-0,946	3,111	7,057	-0,332	-9,372	-21,260
2003	4,622	3,000	-1,200	1,622	5,823	-0,325	-4,995	-17,927
2002	8,548	3,000		5,548		-0,336	-16,512	
2001	8,601	3,000		5,601		-0,342	-16,385	
2000	7,978	3,000		4,978		-0,354	-14,070	
1999	5,434	3,000		2,434		-0,326	-7,476	

France								
Year	UCA	Target		Output gap		CAIP	FEER adjusted REER	
		R (3%)	R (NFA)	R (3%)	R (NFA)		R (3%)	R (NFA)
2018	-0,011	-0,011	-0,569	0,000	0,558	-0,248	0,000	-2,253
2017	-0,303	-0,303	-0,569	0,000	0,266	-0,248	0,000	-1,074
2016	-0,632	-0,632	-0,569	0,000	-0,063	-0,248	0,000	0,255
2015	-1,077	-1,077	-0,569	0,000	-0,508	-0,248	0,000	2,053
2014	-1,578	-1,578	-0,569	0,000	-1,009	-0,248	0,000	4,077
2013	-1,585	-1,585	-0,569	0,000	-1,016	-0,248	0,000	4,105
2012	-2,543	-2,543	-0,569	0,000	-1,974	-0,248	0,000	7,974
2011	-1,974	-1,974	-0,507	0,000	-1,467	-0,244	0,000	6,024
2010	-1,642	-1,642	-0,074	0,000	-1,569	-0,233	0,000	6,728
2009	-1,422	-1,422	0,067	0,000	-1,488	-0,216	0,000	6,884
2008	-1,883	-1,883	-0,045	0,000	-1,838	-0,244	0,000	7,537
2007	-0,996	-0,996	0,049	0,000	-1,045	-0,243	0,000	4,296
2006	-0,408	-0,408	0,041	0,000	-0,450	-0,244	0,000	1,839
2005	-0,321	-0,321	-0,191	0,000	-0,131	-0,239	0,000	0,545
2004	0,784	0,784	-0,164	0,000	0,949	-0,238	0,000	-3,989
2003	0,995	0,995	0,093	0,000	0,902	-0,236	0,000	-3,821
2002	1,710	1,710		0,000		-0,248	0,000	
2001	2,294	2,294		0,000		-0,254	0,000	
2000	1,763	1,763		0,000		-0,258	0,000	
1999	3,334	3,000		0,334		-0,239	-1,397	

Germany								
Year	UCA	Target		Output gap		CAIP	FEER adjusted REER	
		R (3%)	R (NFA)	R (3%)	R (NFA)		R (3%)	R (NFA)
2018	4,607	3,000	1,388	1,607	3,219	-0,397	-4,051	-8,114
2017	4,833	3,000	1,388	1,833	3,445	-0,397	-4,620	-8,684
2016	5,076	3,000	1,388	2,076	3,688	-0,397	-5,233	-9,296
2015	5,397	3,000	1,388	2,397	4,009	-0,397	-6,042	-10,106
2014	5,721	3,000	1,388	2,721	4,333	-0,397	-6,859	-10,922
2013	5,972	3,000	1,388	2,972	4,584	-0,397	-7,491	-11,555
2012	7,545	3,000	1,388	4,545	6,157	-0,397	-11,456	-15,520
2011	6,531	3,000	1,916	3,531	4,615	-0,391	-9,028	-11,799
2010	5,847	3,000	0,248	2,847	5,599	-0,376	-7,573	-14,891
2009	5,239	3,000	-0,307	2,239	5,546	-0,347	-6,445	-15,964
2008	5,854	3,000	1,067	2,854	4,787	-0,379	-7,538	-12,643
2007	6,726	3,000	1,550	3,726	5,176	-0,373	-9,977	-13,859
2006	5,408	3,000	0,830	2,408	4,578	-0,365	-6,605	-12,557
2005	3,897	3,000	0,309	0,897	3,588	-0,341	-2,631	-10,531
2004	3,898	3,000	0,117	0,898	3,781	-0,324	-2,773	-11,675
2003	1,591	1,591	0,047	0,000	1,544	-0,306	0,000	-5,050
2002	2,142	2,142		0,000		-0,305	0,000	
2001	0,267	0,267		0,000		-0,300	0,000	
2000	-1,914	-1,914		0,000		-0,290	0,000	
1999	-1,594	-1,594		0,000		-0,262	0,000	

Greece								
Year	UCA	Target		Output gap		CAIP	FEER adjusted REER	
		R (3%)	R (NFA)	R (3%)	R (NFA)		R (3%)	R (NFA)
2018	1,077	1,077	4,920	0,000	-3,843	-0,244	0,000	15,730
2017	0,743	0,743	4,920	0,000	-4,177	-0,244	0,000	17,097
2016	0,263	0,263	4,920	0,000	-4,657	-0,244	0,000	19,062
2015	0,096	0,096	4,920	0,000	-4,824	-0,244	0,000	19,746
2014	-0,459	-0,459	4,920	0,000	-5,379	-0,244	0,000	22,018
2013	-0,986	-0,986	4,920	0,000	-5,906	-0,244	0,000	24,175
2012	-7,078	-3,000	4,920	-4,078	-11,998	-0,244	16,695	49,115
2011	-12,301	-3,000	2,347	-9,301	-14,648	-0,229	40,542	63,846
2010	-10,420	-3,000	0,125	-7,420	-10,546	-0,207	35,816	50,901
2009	-9,777	-3,000	-0,553	-6,777	-9,224	-0,183	37,107	50,505
2008	-12,895	-3,000	-4,321	-9,895	-8,573	-0,222	44,529	38,582
2007	-12,365	-3,000	-6,370	-9,365	-5,995	-0,220	42,663	27,310
2006	-9,812	-3,000	-5,216	-6,812	-4,596	-0,214	31,765	21,432
2005	-7,108	-3,000	-4,158	-4,108	-2,950	-0,215	19,114	13,726
2004	-5,045	-3,000	-4,485	-2,045	-0,560	-0,213	9,619	2,633
2003	-6,041	-3,000	-3,909	-3,041	-2,132	-0,193	15,748	11,039
2002	-6,812	-3,000		-3,812		-0,202	18,869	
2001	-7,610	-3,000		-4,610		-0,226	20,379	
2000	-8,656	-3,000		-5,656		-0,235	24,048	
1999	-6,232	-3,000		-3,232		-0,216	14,951	

Ireland								
Year	UCA	Target		Output gap		CAIP	FEER adjusted REER	
		R (3%)	R (NFA)	R (3%)	R (NFA)		R (3%)	R (NFA)
2018	3,458	3,000	-2,963	0,458	6,421	-0,488	-0,939	-13,169
2017	3,475	3,000	-2,963	0,475	6,438	-0,488	-0,974	-13,204
2016	3,324	3,000	-2,963	0,324	6,287	-0,488	-0,664	-12,894
2015	3,140	3,000	-2,963	0,140	6,103	-0,488	-0,287	-12,517
2014	3,050	3,000	-2,963	0,050	6,013	-0,488	-0,103	-12,332
2013	2,316	2,316	-2,963	0,000	5,279	-0,488	0,000	-10,827
2012	-1,006	-1,006	-2,963	0,000	1,957	-0,488	0,000	-4,014
2011	-3,958	-3,000	-1,003	-0,958	-2,955	-0,494	1,939	5,983
2010	-4,357	-3,000	4,987	-1,357	-9,344	-0,496	2,736	18,835
2009	-4,186	-3,000	3,913	-1,186	-8,099	-0,497	2,387	16,299
2008	-5,116	-3,000	-0,687	-2,116	-4,429	-0,491	4,310	9,019
2007	-1,351	-1,351	-0,407	0,000	-0,944	-0,487	0,000	1,938
2006	0,863	0,863	-1,863	0,000	2,727	-0,485	0,000	-5,620
2005	1,119	1,119	-1,215	0,000	2,334	-0,488	0,000	-4,778
2004	3,666	3,000	-1,248	0,666	4,914	-0,491	-1,356	-10,004
2003	5,514	3,000	-1,381	2,514	6,894	-0,491	-5,118	-14,039
2002	6,471	3,000		3,471		-0,498	-6,973	
2001	7,147	3,000		4,147		-0,496	-8,357	
2000	7,498	3,000		4,498		-0,497	-9,045	
1999	5,436	3,000		2,436		-0,496	-4,908	

Italy								
Year	UCA	Target		Output gap		CAIP	FEER adjusted REER	
		R (3%)	R (NFA)	R (3%)	R (NFA)		R (3%)	R (NFA)
2018	-1,081	-1,081	-0,457	0,000	-0,624	-0,268	0,000	2,326
2017	-0,740	-0,740	-0,457	0,000	-0,283	-0,268	0,000	1,054
2016	-0,427	-0,427	-0,457	0,000	0,030	-0,268	0,000	-0,113
2015	-0,035	-0,035	-0,457	0,000	0,422	-0,268	0,000	-1,576
2014	0,206	0,206	-0,457	0,000	0,663	-0,268	0,000	-2,474
2013	-0,011	-0,011	-0,457	0,000	0,446	-0,268	0,000	-1,665
2012	-1,704	-1,704	-0,457	0,000	-1,246	-0,268	0,000	4,648
2011	-3,633	-3,000	-0,908	-0,633	-2,725	-0,258	2,452	10,559
2010	-4,099	-3,000	0,072	-1,099	-4,171	-0,241	4,556	17,298
2009	-2,469	-2,469	0,386	0,000	-2,855	-0,219	0,000	13,023
2008	-3,013	-3,000	-0,682	-0,013	-2,331	-0,255	0,051	9,136
2007	-1,315	-1,315	-0,933	0,000	-0,382	-0,258	0,000	1,479
2006	-1,365	-1,365	-0,594	0,000	-0,771	-0,249	0,000	3,099
2005	-0,808	-0,808	-0,546	0,000	-0,262	-0,236	0,000	1,113
2004	-0,126	-0,126	-0,433	0,000	0,308	-0,230	0,000	-1,335
2003	-0,452	-0,452	-0,350	0,000	-0,102	-0,224	0,000	0,456
2002	0,201	0,201		0,000		-0,233	0,000	
2001	0,995	0,995		0,000		-0,243	0,000	
2000	0,130	0,130		0,000		-0,243	0,000	
1999	1,030	1,030		0,000		-0,223	0,000	

Netherlands								
Year	UCA	Target		Output gap		CAIP	FEER adjusted REER	
		R (3%)	R (NFA)	R (3%)	R (NFA)		R (3%)	R (NFA)
2018	10,849	3,000	0,915	7,849	9,934	-0,496	-15,836	-20,043
2017	11,143	3,000	0,915	8,143	10,228	-0,496	-16,429	-20,636
2016	11,382	3,000	0,915	8,382	10,467	-0,496	-16,912	-21,119
2015	11,367	3,000	0,915	8,367	10,452	-0,496	-16,881	-21,088
2014	11,029	3,000	0,915	8,029	10,114	-0,496	-16,199	-20,406
2013	10,867	3,000	0,915	7,867	9,952	-0,496	-15,873	-20,079
2012	9,320	3,000	0,915	6,320	8,405	-0,496	-12,752	-16,959
2011	10,371	3,000	0,802	7,371	9,569	-0,492	-14,989	-19,459
2010	8,102	3,000	0,030	5,102	8,072	-0,484	-10,537	-16,671
2009	6,075	3,000	0,011	3,075	6,064	-0,461	-6,673	-13,159
2008	5,199	3,000	-0,259	2,199	5,458	-0,480	-4,585	-11,379
2007	6,506	3,000	0,161	3,506	6,345	-0,475	-7,378	-13,352
2006	8,585	3,000	-0,114	5,585	8,698	-0,472	-11,830	-18,426
2005	6,355	3,000	0,133	3,355	6,221	-0,464	-7,234	-13,415
2004	6,737	3,000	-0,044	3,737	6,781	-0,454	-8,226	-14,928
2003	5,061	3,000	-0,617	2,061	5,678	-0,443	-4,652	-12,816
2002	3,022	3,000		0,022		-0,447	-0,048	
2001	3,890	3,000		0,890		-0,457	-1,948	
2000	2,965	2,965		0,000		-0,465	0,000	
1999	4,833	3,000		1,833		-0,443	-4,136	

Portugal								
Year	UCA	Target		Output gap		CAIP	FEER adjusted REER	
		R (3%)	R (NFA)	R (3%)	R (NFA)		R (3%)	R (NFA)
2018	2,309	2,309	-0,560	0,000	2,869	-0,325	0,000	-8,838
2017	1,776	1,776	-0,560	0,000	2,336	-0,325	0,000	-7,196
2016	1,366	1,366	-0,560	0,000	1,926	-0,325	0,000	-5,933
2015	0,925	0,925	-0,560	0,000	1,485	-0,325	0,000	-4,575
2014	0,863	0,863	-0,560	0,000	1,423	-0,325	0,000	-4,384
2013	0,907	0,907	-0,560	0,000	1,467	-0,325	0,000	-4,519
2012	-3,704	-3,000	-0,560	-0,704	-3,144	-0,325	2,170	9,685
2011	-8,314	-3,000	-3,398	-5,314	-4,916	-0,306	17,383	16,080
2010	-11,094	-3,000	-0,728	-8,094	-10,366	-0,276	29,360	37,602
2009	-11,460	-3,000	1,078	-8,460	-12,539	-0,252	33,575	49,760
2008	-13,303	-3,000	-2,500	-10,303	-10,803	-0,284	36,319	38,081
2007	-10,767	-3,000	-3,396	-7,767	-7,371	-0,282	27,555	26,149
2006	-11,441	-3,000	-2,331	-8,441	-9,109	-0,273	30,933	33,384
2005	-10,780	-3,000	-2,297	-7,780	-8,484	-0,249	31,217	34,038
2004	-8,422	-3,000	-1,552	-5,422	-6,870	-0,252	21,505	27,248
2003	-6,291	-3,000	-1,630	-3,291	-4,661	-0,249	13,217	18,721
2002	-7,145	-3,000		-4,145		-0,249	16,659	
2001	-8,804	-3,000		-5,804		-0,252	23,001	
2000	-8,852	-3,000		-5,852		-0,259	22,626	
1999	-7,338	-3,000		-4,338		-0,245	17,710	

Spain								
Year	UCA	Target		Output gap		CAIP	FEER adjusted REER	
		R (3%)	R (NFA)	R (3%)	R (NFA)		R (3%)	R (NFA)
2018	5,956	3,000	-1,688	2,956	7,644	-0,285	-10,368	-26,810
2017	5,235	3,000	-1,688	2,235	6,923	-0,285	-7,839	-24,282
2016	4,440	3,000	-1,688	1,440	6,128	-0,285	-5,051	-21,493
2015	3,776	3,000	-1,688	0,776	5,464	-0,285	-2,722	-19,164
2014	2,649	2,649	-1,688	0,000	4,337	-0,285	0,000	-15,211
2013	1,434	1,434	-1,688	0,000	3,122	-0,285	0,000	-10,950
2012	-2,403	-2,403	-1,688	0,000	-0,715	-0,285	0,000	2,508
2011	-4,655	-3,000	-2,236	-1,655	-2,418	-0,272	6,074	8,877
2010	-5,047	-3,000	0,110	-2,047	-5,158	-0,247	8,288	20,881
2009	-4,750	-3,000	0,214	-1,750	-4,964	-0,221	7,928	22,490
2008	-9,233	-3,000	-3,778	-6,233	-5,456	-0,240	25,920	22,686
2007	-9,551	-3,000	-4,458	-6,551	-5,093	-0,244	26,896	20,911
2006	-8,481	-3,000	-3,648	-5,481	-4,833	-0,239	22,941	20,227
2005	-6,920	-3,000	-3,356	-3,920	-3,564	-0,234	16,741	15,219
2004	-4,730	-3,000	-2,625	-1,730	-2,105	-0,236	7,324	8,910
2003	-2,701	-2,701	-2,444	0,000	-0,257	-0,239	0,000	1,074
2002	-2,284	-2,284		0,000		-0,247	0,000	
2001	-2,940	-2,940		0,000		-0,256	0,000	
2000	-3,346	-3,000		-0,346		-0,260	1,335	
1999	-2,517	-2,517		0,000		-0,242	0,000	

7.3 Appendix C - FEER consistent RBER

The first two columns show the HICP indexed for 2003, Column three and four are the results from the SMIM calculations. The last three equations on the right side are the three different RBER used for comparison. R* is calculated using the HICP with Germany as the denominato. The two FEER consistent RBER are calculated based on the R* and the corresponding SMIM value

	HICP (Indexed 2003)		SMIM		RBER values		
	Austria	Germany	R(3%)	R(nfa)	R*	R(3%)	R(NFA)
1997	91,64	93,01			0,985		
1998	92,10	93,20			0,988		
1999	93,66	94,41	0,0304		0,992	0,963	
2000	95,35	96,49	0,0012		0,988	0,987	
2001	97,07	97,84	0,0057		0,992	0,987	
2002	98,72	99,01	-0,0034		0,997	1,000	
2003	100,00	100,00	0,0088	0,0211	1,000	0,991	0,979
2004	102,50	102,30	0,0545	0,0971	1,002	0,950	0,913
2005	104,14	104,45	0,0415	0,0260	0,997	0,957	0,972
2006	105,81	105,91	0,1065	0,0112	0,999	0,903	0,988
2007	109,51	109,19	0,1240	-0,0319	1,003	0,892	1,036
2008	111,15	110,39	0,0433	-0,1608	1,007	0,965	1,200
2009	112,37	111,28	0,0794	-0,0279	1,010	0,936	1,039
2010	114,85	113,39	0,1009	-0,0158	1,013	0,920	1,029
2011	118,75	116,00	0,1419	0,0538	1,024	0,897	0,971
2012	122,20	118,32	0,1897	0,1316	1,033	0,868	0,913
2013	122,20	118,32	0,1493	0,1001	1,033	0,899	0,939
2014	122,20	118,32	0,1415	0,1199	1,033	0,905	0,922
2015	122,20	118,32	0,1415	0,1199	1,033	0,905	0,922
2016	122,20	118,32	0,1191	0,1199	1,033	0,923	0,922
2017	122,20	118,32	0,1081	0,1250	1,033	0,932	0,918
2018	122,20	118,32	0,1081	0,1250	1,033	0,932	0,918

	HICP (Indexed 2003)		SMIM		RBER values		
	Belgium	Germany	R(3%)	R(nfa)	R*	R(3%)	R(NFA)
1997	89,86	93,01			0,966		
1998	90,49	93,20			0,971		
1999	92,39	94,41	-0,0937		0,979	1,080	
2000	95,16	96,49	-0,0269		0,986	1,014	
2001	97,07	97,84	-0,0125		0,992	1,005	
2002	98,33	99,01	-0,0361		0,993	1,030	
2003	100,00	100,00	-0,0066	0,0363	1,000	1,007	0,965
2004	101,90	102,30	0,0267	0,1149	0,996	0,970	0,893
2005	104,75	104,45	0,0280	0,1083	1,003	0,976	0,905
2006	106,95	105,91	0,0765	0,1371	1,010	0,938	0,888
2007	110,27	109,19	0,1150	0,1517	1,010	0,906	0,877
2008	113,25	110,39	0,0822	0,1600	1,026	0,948	0,884
2009	113,59	111,28	0,0670	0,1587	1,021	0,957	0,881
2010	117,45	113,39	0,0794	0,1004	1,036	0,960	0,941
2011	121,21	116,00	0,1047	0,1632	1,045	0,946	0,898
2012	123,75	118,32	0,1453	0,2318	1,046	0,913	0,849
2013	123,75	118,32	0,1012	0,2121	1,046	0,950	0,863
2014	123,75	118,32	0,0936	0,2015	1,046	0,956	0,870
2015	123,75	118,32	0,0936	0,2015	1,046	0,956	0,870
2016	123,75	118,32	0,0726	0,2015	1,046	0,975	0,870
2017	123,75	118,32	0,0641	0,1678	1,046	0,983	0,896
2018	123,75	118,32	0,0641	0,1678	1,046	0,983	0,896

	HICP (Indexed 2003)		SMIM		RBER values		
	Finland	Germany	R(3%)	R(nfa)	R*	R(3%)	R(NFA)
1997	89,60	93,01			0,963		
1998	90,31	93,20			0,969		
1999	92,30	94,41	-0,0157		0,978	0,993	
2000	94,98	96,49	-0,1370		0,984	1,141	
2001	97,16	97,84	-0,1519		0,993	1,171	
2002	98,81	99,01	-0,1465		0,998	1,169	
2003	100,00	100,00	-0,0328	0,0748	1,000	1,034	0,930
2004	100,10	102,30	0,0029	0,1676	0,978	0,976	0,838
2005	101,20	104,45	0,0632	0,1257	0,969	0,911	0,861
2006	102,42	105,91	0,1347	0,1224	0,967	0,852	0,862
2007	104,36	109,19	0,1601	0,0840	0,956	0,824	0,882
2008	107,91	110,39	0,1241	-0,0151	0,977	0,870	0,992
2009	109,85	111,28	0,1268	0,1165	0,987	0,876	0,884
2010	112,93	113,39	0,1613	0,1264	0,996	0,858	0,884
2011	115,86	116,00	0,2414	0,2419	0,999	0,805	0,804
2012	119,92	118,32	0,3320	0,4114	1,014	0,761	0,718
2013	119,92	118,32	0,2684	0,4939	1,014	0,799	0,678
2014	119,92	118,32	0,2555	0,5101	1,014	0,807	0,671
2015	119,92	118,32	0,2555	0,5101	1,014	0,807	0,671
2016	119,92	118,32	0,2167	0,5101	1,014	0,833	0,671
2017	119,92	118,32	0,1970	0,5111	1,014	0,847	0,671
2018	119,92	118,32	0,1970	0,5111	1,014	0,847	0,671

	HICP (Indexed 2003)		SMIM		RBER values		
	France	Germany	R(3%)	R(nfa)	R*	R(3%)	R(NFA)
1997	91,11	93,01			0,980		
1998	91,38	93,20			0,981		
1999	92,66	94,41	-0,0074		0,981	0,989	
2000	94,23	96,49	0,0007		0,977	0,976	
2001	95,55	97,84	0,0033		0,977	0,973	
2002	97,66	99,01	0,0027		0,986	0,984	
2003	100,00	100,00	0,0036	0,0405	1,000	0,996	0,961
2004	102,30	102,30	0,0355	0,1101	1,000	0,966	0,901
2005	104,14	104,45	0,0301	0,1285	0,997	0,968	0,884
2006	105,91	105,91	0,0753	0,1661	1,000	0,930	0,858
2007	108,88	109,19	0,1072	0,1975	0,997	0,901	0,833
2008	110,18	110,39	0,0790	0,2055	0,998	0,925	0,828
2009	111,29	111,28	0,0676	0,2244	1,000	0,937	0,817
2010	113,51	113,39	0,0821	0,2154	1,001	0,925	0,824
2011	116,58	116,00	0,1039	0,1815	1,005	0,910	0,851
2012	118,32	118,32	0,1338	0,2461	1,000	0,882	0,803
2013	118,32	118,32	0,0957	0,1873	1,000	0,913	0,842
2014	118,32	118,32	0,0892	0,1814	1,000	0,918	0,846
2015	118,32	118,32	0,0892	0,1814	1,000	0,918	0,846
2016	118,32	118,32	0,0722	0,1814	1,000	0,933	0,846
2017	118,32	118,32	0,0650	0,1144	1,000	0,939	0,897
2018	118,32	118,32	0,0650	0,1144	1,000	0,939	0,897

	HICP (Indexed 2003)		SMIM		RBER values		
	Greece	Germany	R(3%)	R(nfa)	R*	R(3%)	R(NFA)
1997	82,31	93,01	0,00 %		0,885		
1998	85,35	93,20	0,00 %		0,916		
1999	87,31	94,41	0,2169		0,925	0,760	
2000	90,54	96,49	0,2425		0,938	0,755	
2001	93,71	97,84	0,2158		0,958	0,788	
2002	96,99	99,01	0,2088		0,980	0,810	
2003	100,00	100,00	0,1763	0,3918	1,000	0,850	0,718
2004	103,10	102,30	0,1998	0,4332	1,008	0,840	0,703
2005	106,71	104,45	0,2682	0,3964	1,022	0,806	0,732
2006	110,12	105,91	0,5154	0,5153	1,040	0,686	0,686
2007	114,42	109,19	0,6707	0,5499	1,048	0,627	0,676
2008	116,94	110,39	0,6028	0,5218	1,059	0,661	0,696
2009	119,98	111,28	0,5052	0,6631	1,078	0,716	0,648
2010	126,21	113,39	0,5431	0,6912	1,113	0,721	0,658
2011	128,99	116,00	0,7010	0,8406	1,112	0,654	0,604
2012	129,38	118,32	0,5954	0,9071	1,093	0,685	0,573
2013	129,38	118,32	0,3538	0,7958	1,093	0,808	0,609
2014	129,38	118,32	0,3380	0,7903	1,093	0,817	0,611
2015	129,38	118,32	0,3380	0,7903	1,093	0,817	0,611
2016	129,38	118,32	0,2895	0,7903	1,093	0,848	0,611
2017	129,38	118,32	0,2640	0,7661	1,093	0,865	0,619
2018	129,38	118,32	0,2640	0,7661	1,093	0,865	0,619

	HICP (Indexed 2003)		SMIM			RBER values		
	Ireland	Germany	R(3%)	R(nfa)		R*	R(3%)	R(NFA)
1997	80,12	93,01				0,861		
1998	81,88	93,20				0,879		
1999	85,08	94,41	-0,0169			0,901	0,917	
2000	88,99	96,49	-0,0893			0,922	1,013	
2001	92,82	97,84	-0,0784			0,949	1,029	
2002	97,09	99,01	-0,0631			0,981	1,047	
2003	100,00	100,00	-0,0430	0,0087		1,000	1,045	0,991
2004	102,40	102,30	0,0477	0,1446		1,001	0,955	0,874
2005	104,35	104,45	0,0479	0,1223		0,999	0,953	0,890
2006	107,48	105,91	0,1245	0,1473		1,015	0,902	0,885
2007	110,92	109,19	0,1658	0,2221		1,016	0,871	0,831
2008	112,36	110,39	0,1601	0,2218		1,018	0,877	0,833
2009	109,44	111,28	0,1176	0,3193		0,983	0,880	0,745
2010	109,22	113,39	0,1463	0,3461		0,963	0,840	0,716
2011	110,75	116,00	0,1910	0,2106		0,955	0,802	0,789
2012	112,63	118,32	0,2249	0,2061		0,952	0,777	0,789
2013	112,63	118,32	0,1748	0,1669		0,952	0,810	0,816
2014	112,63	118,32	0,1643	0,1535		0,952	0,818	0,825
2015	112,63	118,32	0,1643	0,1535		0,952	0,818	0,825
2016	112,63	118,32	0,1317	0,1535		0,952	0,841	0,825
2017	112,63	118,32	0,1157	0,1399		0,952	0,853	0,835
2018	112,63	118,32	0,1157	0,1399		0,952	0,853	0,835

	HICP (Indexed 2003)		SMIM		RBER values		
	Italy	Germany	R(3%)	R(nfa)	R*	R(3%)	R(NFA)
1997	86,99	93,01			0,935		
1998	88,47	93,20			0,949		
1999	90,33	94,41	0,0121		0,957	0,945	
2000	92,77	96,49	0,0026		0,962	0,959	
2001	94,81	97,84	0,0042		0,969	0,965	
2002	97,56	99,01	0,0049		0,985	0,981	
2003	100,00	100,00	0,0052	0,0867	1,000	0,995	0,920
2004	102,40	102,30	0,0388	0,1408	1,001	0,964	0,877
2005	104,55	104,45	0,0335	0,1360	1,001	0,969	0,881
2006	106,75	105,91	0,0825	0,1801	1,008	0,931	0,854
2007	109,73	109,19	0,1149	0,1724	1,005	0,901	0,857
2008	112,37	110,39	0,0855	0,2176	1,018	0,938	0,836
2009	113,60	111,28	0,0738	0,2836	1,021	0,951	0,795
2010	115,99	113,39	0,1318	0,3206	1,023	0,904	0,775
2011	120,28	116,00	0,1370	0,2303	1,037	0,912	0,843
2012	123,41	118,32	0,1459	0,2262	1,043	0,910	0,851
2013	123,41	118,32	0,1060	0,1480	1,043	0,943	0,909
2014	123,41	118,32	0,0993	0,1362	1,043	0,949	0,918
2015	123,41	118,32	0,0993	0,1362	1,043	0,949	0,918
2016	123,41	118,32	0,0812	0,1362	1,043	0,965	0,918
2017	123,41	118,32	0,0733	0,1529	1,043	0,972	0,905
2018	123,41	118,32	0,0733	0,1529	1,043	0,972	0,905

	HICP (Indexed 2003)		SMIM		RBER values		
	Netherlands	Germany	R(3%)	R(nfa)	R*	R(3%)	R(NFA)
1997	85,26	93,01			0,917		
1998	86,54	93,20			0,929		
1999	88,19	94,41	-0,0355		0,934	0,968	
2000	90,75	96,49	-0,0016		0,941	0,942	
2001	95,37	97,84	-0,0177		0,975	0,992	
2002	98,43	99,01	0,0001		0,994	0,994	
2003	100,00	100,00	-0,0419	-0,0444	1,000	1,044	1,046
2004	101,20	102,30	-0,0431	0,0031	0,989	1,034	0,986
2005	103,22	104,45	-0,0385	-0,0134	0,988	1,028	1,002
2006	104,98	105,91	-0,0363	-0,0401	0,991	1,029	1,033
2007	106,66	109,19	0,0377	0,0154	0,977	0,941	0,962
2008	108,47	110,39	0,0343	0,0064	0,983	0,950	0,976
2009	109,23	111,28	0,0018	0,0126	0,982	0,980	0,969
2010	111,20	113,39	-0,0221	-0,0287	0,981	1,003	1,010
2011	113,98	116,00	-0,0410	-0,0706	0,983	1,025	1,057
2012	117,85	118,32	0,0107	0,0046	0,996	0,986	0,991
2013	117,85	118,32	-0,0561	-0,0371	0,996	1,055	1,034
2014	117,85	118,32	-0,0656	-0,0438	0,996	1,066	1,042
2015	117,85	118,32	-0,0656	-0,0438	0,996	1,066	1,042
2016	117,85	118,32	-0,0896	-0,0438	0,996	1,094	1,042
2017	117,85	118,32	-0,0924	-0,0615	0,996	1,097	1,061
2018	117,85	118,32	0,0219	-0,0615	0,996	0,975	1,061

	HICP (Indexed 2003)		SMIM		RBER values		
	Portugal	Germany	R(3%)	R(nfa)	R*	R(3%)	R(NFA)
1997	83,36	93,01			0,896		
1998	85,70	93,20			0,920		
1999	87,15	94,41	0,2419		0,923	0,743	
2000	90,46	96,49	0,2290		0,938	0,763	
2001	93,99	97,84	0,2445		0,961	0,772	
2002	97,75	99,01	0,1885		0,987	0,831	
2003	100,00	100,00	0,1533	0,4861	1,000	0,867	0,673
2004	102,60	102,30	0,3255	0,7302	1,003	0,757	0,580
2005	105,17	104,45	0,3886	0,6506	1,007	0,725	0,610
2006	107,79	105,91	0,5107	0,6937	1,018	0,674	0,601
2007	110,70	109,19	0,5320	0,6046	1,014	0,662	0,632
2008	111,59	110,39	0,5253	0,5658	1,011	0,663	0,646
2009	111,48	111,28	0,4773	0,7036	1,002	0,678	0,588
2010	114,15	113,39	0,4758	0,5989	1,007	0,682	0,630
2011	118,15	116,00	0,4590	0,3774	1,019	0,698	0,739
2012	120,63	118,32	0,4229	0,4976	1,020	0,716	0,681
2013	120,63	118,32	0,3296	0,4546	1,020	0,767	0,701
2014	120,63	118,32	0,3146	0,4624	1,020	0,776	0,697
2015	120,63	118,32	0,3146	0,4624	1,020	0,776	0,697
2016	120,63	118,32	0,2716	0,4624	1,020	0,802	0,697
2017	120,63	118,32	0,2492	0,4361	1,020	0,816	0,710
2018	120,63	118,32	0,2492	0,4361	1,020	0,816	0,710

	HICP (Indexed 2003)		SMIM		RBER values		
	Spain	Germany	R(3%)	R(nfa)	R*	R(3%)	R(NFA)
1997	84,26	93,01			0,906		
1998	85,44	93,20			0,917		
1999	87,83	94,41	0,0239		0,930	0,909	
2000	91,34	96,49	0,0061		0,947	0,941	
2001	93,63	97,84	0,0130		0,957	0,945	
2002	97,37	99,01	0,0127		0,983	0,971	
2003	100,00	100,00	0,0112	0,1243	1,000	0,989	0,889
2004	103,30	102,30	0,0379	0,2817	1,010	0,973	0,788
2005	107,12	104,45	0,0121	0,3039	1,026	1,013	0,787
2006	110,01	105,91	0,0536	0,3798	1,039	0,986	0,753
2007	114,75	109,19	0,0760	0,3881	1,051	0,977	0,757
2008	116,47	110,39	0,0477	0,3729	1,055	1,007	0,768
2009	117,51	111,28	0,0770	0,4039	1,056	0,981	0,752
2010	120,92	113,39	0,0916	0,3833	1,066	0,977	0,771
2011	123,82	116,00	0,1232	0,2332	1,067	0,950	0,866
2012	127,54	118,32	0,1731	0,2347	1,078	0,919	0,873
2013	127,54	118,32	0,1291	0,0936	1,078	0,955	0,986
2014	127,54	118,32	0,1214	0,0495	1,078	0,961	1,027
2015	127,54	118,32	0,1214	0,0495	1,078	0,961	1,027
2016	127,54	118,32	0,1144	0,0495	1,078	0,967	1,027
2017	127,54	118,32	0,1126	-0,0546	1,078	0,969	1,140
2018	127,54	118,32	0,1126	-0,0546	1,078	0,969	1,140

7.4 Appendix D Step by step calculation for year 1999

The trade weights are calculated according to appendix A. Picking up from equation 4.8 we have

$$\Gamma^i = \varphi^i Z^i \ i = 1,2, \dots 11$$

The subscript on the right side of the matrix and vectors indicates the country the country that has been removed.

D.1 $\Gamma^1 = \varphi^1 Z^1$

D.2 ${\varphi^{-1}}^1 \Gamma^1 = Z^1$

Repeating D.1 and D12 for $i = 1,2, \dots 11$ gives the following values for Z^i (the matrix has been transposed)

	Aus	Bel	Fin	Fra	Gre	Ire	Ita	Lux	Neth	Por	Spa
Z1	31,501	-11,736	-7,921	-2,332	14,329	-5,730	-0,199	-5,343	16,830	-0,149	-0,422
Z2	-0,021	5,040	-7,443	-1,005	14,875	-4,913	0,151	-3,666	17,697	0,591	-0,028
Z3	0,289	-10,947	55,830	-1,606	15,257	-4,793	0,218	-4,478	17,674	0,609	0,451
Z4	0,085	-10,304	-7,400	5,733	15,071	-4,890	0,547	-4,503	18,095	1,248	0,174
Z5	0,261	-10,908	-7,021	-1,413	87,735	-4,774	0,867	-4,510	17,658	0,792	0,636
Z6	0,188	-10,710	-7,086	-1,389	15,211	30,774	0,319	-4,407	17,661	0,751	0,666
Z7	0,460	-10,905	-7,333	-1,210	15,594	-4,940	9,901	-4,644	17,867	0,943	0,277
Z8	0,004	-10,033	-7,342	-1,572	14,905	-4,977	0,044	6,160	17,529	0,450	0,042
Z9	0,037	-10,810	-7,329	-1,114	14,933	-5,049	0,415	-4,611	87,088	3,104	0,167
Z10	0,190	-10,786	-7,263	-0,829	15,198	-4,827	0,623	-4,559	20,235	17,107	0,356
Z11	0,395	-10,926	-6,942	-1,425	15,521	-4,434	0,436	-4,488	17,777	0,834	1,269

We calculate the average the 11 different values for the gives.

Aus	Bel	Fin	Fra	Gre	Ire	Ita	Lux	Neth	Port	Spa
3,035	-9,366	-1,568	-0,742	21,693	-1,687	1,211	-3,550	24,192	2,389	0,326