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The Real Exchange Rate and Unemployment in the EU

Abstract

The relationship between the real exchange rate (RER) and unemployment is investigated from 1994-2017 in 12 countries of the EU. The purpose of the paper is to extend the current literature on RER and unemployment and devise policy suggestions, the research is based on the method of Frenkel & Ros (2006). The data show that there is a significant relationship between RER and unemployment. An appreciation (depreciation) of the RER increases (decreases) unemployment. This is in accordance with Frenkel & Ros (2006). The relationship appears to be stronger when the country is more open to trade, although other factors must be considered. This implies that when a country seeks to decrease unemployment, it is useful to devaluate the RER. This policy is the most effective in the Northern euro area countries of the dataset.

Keywords: Real Exchange Rate; Unemployment; Trade Openness; European Union

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1 Introduction

In January 2002, the euro was introduced in twelve countries of the European Union and was an ambitious project which faced many challenges. The euro area is not a perfect currency union, it is characterized by low labour mobility and low wage flexibility. Monetary policy in the euro area is set by the ECB and is therefore not likely to represent the ideal policy of an individual euro area member. Furthermore, countries in distress in the euro area have lost the ability of devaluing their currency through a change in the nominal exchange rate to improve the competitiveness of the economy.

These problems have become painfully clear in the aftermath of the financial crisis of 2007-2009. Not only were the PIIGS countries some of the countries hit hardest by the crisis, they were also faced with a very long recovery period with high unemployment rates compared to other crisis struck countries. It is believed that big capital inflows, exacerbated by the membership of the euro area, caused an amount of debt which the countries were unable to pay off. In the years leading up to the crisis, the real exchange rates of the PIIGS countries appreciated which left the countries with uncompetitive economies. Today, most of the PIIGS countries still face unemployment rates that exceed pre-crisis levels.

Although the euro area members lost the ability to devalue their currency through the nominal exchange rate to increase the competitiveness of their economies, devaluation can still take place through the setting of real wages and prices. The size of the effect of devaluation through setting of prices and wages is thus especially important for euro area members.

The purpose of this paper is to investigate the relationship between RER and unemployment in the EU. The research is based on the method Frenkel & Ros (2006) and the results will be compared to their findings. The dataset comprises twelve EU countries from 1994-2017. The EU countries were carefully selected and can be split up into three distinctive groups: Northern euro-area countries, Southern euro-area countries and Eastern non-euro-area countries. The goal is to extend the current literature and to devise policy suggestions.

In the next chapter, a summary of the current literature and relevant specific information for this research is given. After this, the data and methods that are used to determine the relationship between the RER and unemployment are discussed. Subsequently, these methods are used to perform regressions. The results of these regressions are discussed in chapter 4.
We shall conclude that an appreciation (depreciation) of the RER increases (decreases) unemployment, and the size of this effect is positively influenced by the trade openness of the economy.

2 Literature review

The nominal exchange rate indicates how much foreign currency is needed to exchange against one unit of home currency. It is a measure of how much foreign currency can be bought with an amount of home currency, but it doesn't say what can be done with this foreign currency.

$$e = \frac{FC}{HC} \tag{1}$$

The nominal exchange rate is not a measure of the real value of the foreign currency compared to the home currency, it is a measure of the nominal value. In other words, the nominal exchange rate doesn't provide information on where it is best to spend your money: at home or abroad. To this end the real exchange rate (RER) is introduced, this is a measure of the real value of the home currency compared to the foreign currency. The RER is defined as in Eurostat:

$$RER = e * \frac{P}{P^*} \tag{2}$$

With P and P* the prices at home and abroad respectively. An increase in the price at home, with foreign prices and nominal exchange rate equal, is understood as an appreciation of the home currency and increases the RER. A drop in the nominal exchange rate, with prices at home and abroad equal, will depreciate the home currency and lower the RER.

The prices P and P* stand for the price of a basket of goods. Goods can be interpreted in a broad way. The basket of goods can contain consumer prices, tradable goods, unit labour costs… When the RER at home is compared to a range of other countries with a certain basket of goods, the RER is called the real effective exchange rate (REER).

The real exchange rate influences trade through the setting of relative prices, i.e. the relative price between domestic and foreign countries and the relative price between tradable and non-tradable goods. The RER can be devalued directly in three ways: a change in the nominal exchange rate, real wages or prices. Frenkel & Taylor (2006) state that the RER has diverse effects on the economy, affecting, among others, resource allocation, economic development, the external balance and employment.

2.1 The Real Exchange Rate and Unemployment

In this paper, research will be conducted similar to Frenkel & Ros (2006) who investigated the relationship between RER and unemployment in Latin American countries between 1980 and 2002. Frenkel & Ros (2006) distinguished three channels through which the RER affects unemployment: the macroeconomic channel, the labour intensity channel and the development channel. They found a statistically significant relationship where a 10% appreciation

(depreciation) leads to a 5,6% increase (fall) in the unemployment rate. The research of Frenkel & Ros (2006) serves as a framework in this paper and the model they used will be explained hereafter.

Alexandre *et al*. (2010) investigated the impact of labour adjustment costs in the determination of exchange rates on employment in 23 OECD countries. They devise a theoretical model in which the effect of RER on employment is stronger when the economy is more open, and find that this theory holds in the period 1988-2006 in 23 OECD countries. When a 1-year lag is used a 10% depreciation of the RER increases employment by 4%, and an increase in the openness by 10% increases employment by 2,3%. They also introduce the term employment RER elasticity ($\Delta RER*Open_{t-1}$) and find the coefficient to be 0,89 significant on the 5% level.

Bakhshi & Ebrahimi (2016) investigated the relationship between RER volatility and unemployment in Iran during the period 1981-2012. They used an autoregressive econometric model with distributed lag with a double log regression. They selected a lag of 1 year for the unemployment rate, and found a negative relationship between RER volatility and unemployment. No relationship was found between exports or imports and unemployment.

Demir (2010) investigated the effect of RER volatility on unemployment in 691 firms in Turkey from 1983-2005 using a general reduced form of a labor demand specification derived from a Cobb-Douglas production function (Hammermesh, 1993). They found that, for an average firm, a one standard deviation increase (reduces) employment growth between 1,42 and 2,11 percentage points. Feldmann (2011) investigated this effect of RER volatility on unemployment in 17 industrial countries from 1982-2003 and found a robust positive effect where a one standard deviation increase (decreases) unemployment between 0,21 and 0,36 percentage points.

Chimnani *et al*. (2012) used the ordinary least squares (OLS) method to investigate the relationship between exchange rate volatility and unemployment in ten Asian countries from 1995-2005. In the regression, the variable Exports serves as an estimate for openness. They don't find a link between GDP/capita and unemployment, but find a positive effect of RER volatility and unemployment. An increase of RER volatility (ΔRER) by 10% increases unemployment by 5,5%, significant on the 1% level. They conclude that exchange rate is an important tool to manage unemployment.

Pelaez & Sierra (2016) used the empirical approach of Demir (2010) to investigate the effect of the RER on industrial employment and 59 industrial sectors in Colombia. They find that an appreciation of 10% decreases industrial employment between 40 and 47%.

Branson and Love (1988) investigate the link between RER and unemployment in the U.S and Japan from 1970-1986 and focus mainly on the manufacturing industry. Branson & Love (1988) build their own theoretic framework and find that an appreciation leads to an increase of the unemployment rate. The decrease of unemployment rate exists on average; results differ depending on the sector and kind of worker (production or non-production worker).

Furthermore, they point out that a hysteresis effect in trade might exist, which means that companies might not move back after a period of appreciation because it isn't cost effective.

Most of the literature on RERs investigates the influence of the RER on economic development, i.e. GDP growth. Economic development isn't the same as unemployment, but in the model of Frenkel & Ros (2006) unemployment is influenced by RER and economic development through the development channel. One of the most comprehensive studies to date researching the relation between RER and economic development is the research conducted by Rodrik (2008), who used a dataset of 188 countries and 11 five-year periods. Rodrik concludes that periods of undervaluation are associated with economic growth, and especially in developing economies: undervaluation shifts the relative price of tradable goods between home and foreign so that exportable goods become more competitive at home, which increases exports, and therefore increases economic growth. Other research papers conclude the same relationship of RER and economic growth: Dao & Chen (2011) come to this conclusion in China, Tarwalie (2010) in Sierra Leone, Bhorat *et al.* (2014) in South Africa, etc.

In this paper, the relationship between the RER and unemployment in the European Union is researched using the framework of Frenkel & Ros (2006). The current literature generally differs from the research that will be conducted in this paper in three ways:

- The RER can be changed in three ways: changing of the nominal exchange rate, changing of prices and changing of wages. Some of the countries that are investigated in this paper are part of a currency union, the option of changing the RER through the nominal exchange rate therefore doesn't exist.

- In general, the literature doesn't assume the downward rigidity of nominal wages, which impedes depreciation through wages in a currency union during an economic downturn (Schmitt-Grohé & Uribe, 2016).

- This paper investigates the effect of the level of the RER on unemployment, while some literature investigates the effect of RER volatility on RER. The literature investigating the effect of RER volatility on unemployment is useful because other meaningful variables that have an influence on unemployment are cited.

2.1.1 The model of Frenkel & Ros

The model of Frenkel & Ros (2006) is used to investigate the link between the RER and unemployment in Latin American countries between 1990 and 2002. The model is based on a two-sector open economy approach (Harris Todaro) and the model of Ros & Skott (1998). Frenkel & Ros conclude that there are three channels through which the RER influences employment: the macroeconomic channel, the labor-intensity channel and the development channel. Frenkel & Ros (2006) provide a framework to investigate the relationship between RER and unemployment, a summary of the calculations is added in appendix A.

2.1.1.1 Assumptions

The model is constructed on following assumptions:

- The model assumes two sectors: the tradable sector and the non-tradable sector. The tradable sector produces only one good and workers in the non-tradable sector earn the average product of labour.

- It is easy for a worker to find employment in the informal (non-tradable) sector, therefore unemployment only exists because unemployed workers have a higher chance of finding a job in the (better paid) formal sector. The implication of this assumption is that unemployment is driven by wage rate convergence between formal and informal sector.

- Idle capacity and involuntary unemployment exist; this is necessary for the RER to have a short-term effect.

2.1.1.2 Effects of RER on unemployment

Frenkel & Ros (2006) distinguish three channels through which the RER affects unemployment: the macroeconomic channel, the labour-intensity channel and the development channel.

The Macroeconomic Channel

The traditional argument is that depreciation increases competitiveness of domestic firms, therefore a depreciated RER increases net exports. The export growth increases demand on domestic activities and leads to a higher output and level of employment.

A real devaluation increases the output and level of employment in the tradable sector and therefore the supply of labour in the informal sector decreases, in figure 1 the supply curve shifts to the left. Furthermore, a real devaluation increases demand for employment in the informal sector through the increase of demand of domestic activities and shifts the demand curve outwards (right). The new equilibrium will result in a decrease of the unemployment rate, in the model this coincides with a decrease of the wage gap between informal and formal employment.

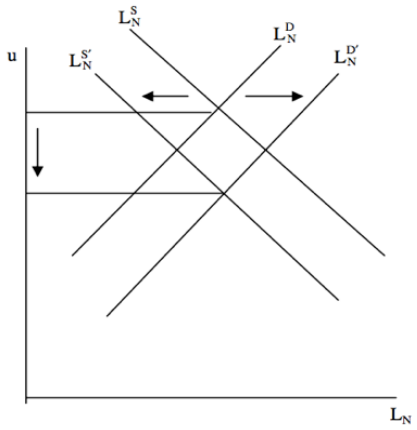


Figure 1: The effect of a devaluation on unemployment (Frenkel & Ros, 2006)

It is assumed that other factors of aggregate demand are unaltered, per Frenkel & Ros (2006) this argument is usually well founded. Furthermore, an expansion of employment will only occur if other negative effects don't predominate. Thus, the possible contractionary effects of devaluation must be considered. Among others these include: the fall of the real value of the money stock and the altering of distribution of income towards industries with a higher saving propensity caused by the fall in real wages (Krugman & Taylor, 1978).

If the contractionary effects don't predominate and idle capacity and unemployment exist, the RER devaluation should be implemented together with monetary and fiscal expansionary policies (Frenkel & Ros, 2006).

Labour-intensity Channel

The RER determines the relative price of labour; a devaluation will make labour relatively cheaper. This will cause the traded goods sector to increase the labour intensity of output, which takes place through (Frenkel & Ros, 2006): "the adoption of more labour-intensive techniques or the reallocation of labour and investments toward labour-intensive tradable goods."

The relative price of labour to capital is important because capital goods in developing countries have a significant portion of imported components. The RER determines the relative price of imports and labour, significant changes are expected to affect the employment/output ratio. This effect is not a short run effect; the changes occur because of a modification in the structure of output and through the production basket of each individual firm. The whole economy adapts to new relative prices, therefore the prices must hold for a longer period to have an effect.

The Development Channel

This channel focuses on the relationship between RER and economic development, and subsequently employment. Rodrik (2003) highlights the importance of a competitive RER to boost growth, according to his research an ignition factor is needed in the short run and an implementation of policies and creation of institutions is needed in the long run. The required policies are country-specific, but in general a competitive RER increases growth and

investment. A competitive RER is effectively a subsidy of all non-tradable goods and doesn't invite rent-seeking behaviour or corruption.

2.2 The Real Exchange Rate and Unemployment in the Eurozone

In the Eurozone, nominal exchange rates are fixed. Changing the nominal exchange rate to devaluate a currency, a process defined as external devaluation, is not possible. Therefore, the only way to change the RER is to change prices or wages, a process defined as internal devaluation.

Some difficulties might arise when the RER is internally devalued because the Eurozone lacks some of the characteristics of an optimal currency union, most notably real wage flexibility and labour mobility (Mankiw & Taylor, 2015). In this research, internal devaluation is assumed to be constrained by a nominal wage rigidity as in Schmitt-Grohé & Uribe (2016). Meaning that during times of economic contraction, nominal wages can't move downwards while at the same time the nominal exchange rate is fixed, which results in a real downward wage rigidity that impedes internal devaluation through wage setting after a crisis.

The assumption of downward real wage rigidity is not researched in this paper. The reason is that the difficulty of researching this assumption surpasses depth of this paper. The assumption of downward real wage rigidity in the years after the financial crisis of 2007-2009 should be researched on a case by case basis. This is because this period was characterized by unusual measures and circumstances.

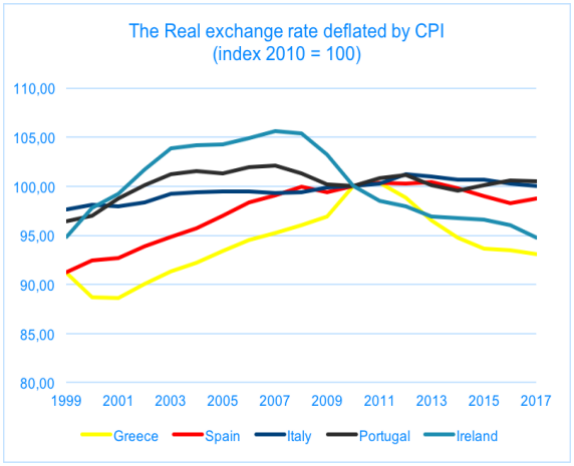
2.2.1 The Southern EU countries and Ireland

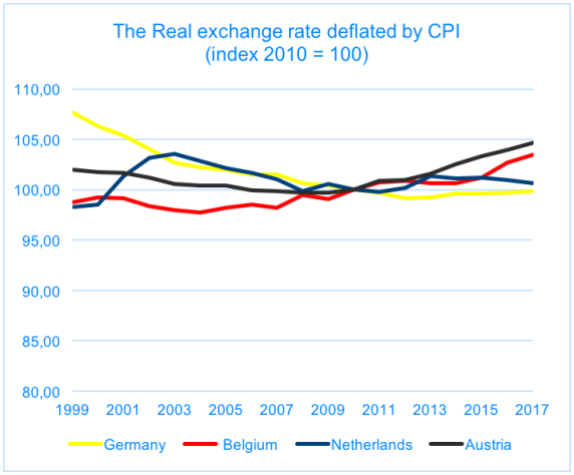
In the years leading up to the crisis the unit labour costs in the PIIGS countries were growing faster than productivity, which resulted in a real appreciation (Kersan-Škabić, 2016). The increase in wages and drop in unemployment were fuelled by an increase in lending (Kuvshinov *et al*., 2016). Frenkel & Ros (2006) state that the relationship between RER and unemployment, where an appreciation of the RER leads to an increase in unemployment, only holds if no other predominant negative effects predominate.

When the crisis hit, the lending stopped and the PIIGS countries were left with an appreciated REER compared to the 1999-level. This can be seen in the graph below, a rise in the index is an appreciation. The index of all the PIIGS countries is higher, more appreciated, in 2008 than in 1999 when the currencies were fixed to each other. In 2017, the RERs of the Southern PIIGS countries are still more appreciated compared to the 1999-level. At the same time, nominal wage remained at the same pre-crisis level, which is believed to have led to high involuntary unemployment (Schmitt-Grohé and Uribe, 2016).

A lot of research has been conducted investigating downward nominal wage rigidity (Elsby, 2009) and found that wage setters are reluctant to cut workers' wages (Howitt, 2002). An influential study by Bewley (1999) states that this is due to the belief of damaging the morale of worker, which is important for productivity. In a currency union, the nominal wage rigidity translates into a real downward wage rigidity because the nominal exchange rate is fixed. This means that in the event of real downward wage rigidity, wages can only change downwards at the rate of inflation, which was subdued in the period after the crisis (Kuvshinov *et al.*, 2016).

This is important because after the crisis, the RER couldn't quickly devaluate. The REER in most of the PIIGS countries depreciated but are generally still more appreciated compared to the 1999-level.

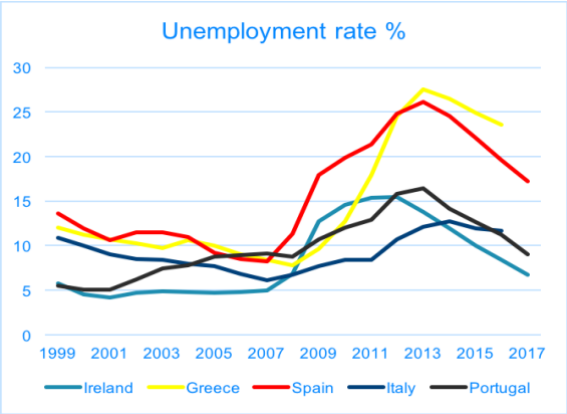


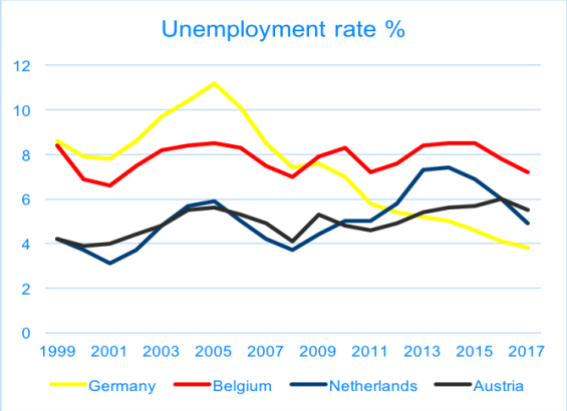


Graph 1: the REER deflated by CPI (19 euro area members), a rise in the index is an appreciation (data Eurostat)

2.2.2 The Northern European countries

Not all countries in the euro area enjoyed appreciating RERs in the years leading up to the crisis, some, most notably Germany, enjoyed a depreciating RER. A depreciated currency is believed to have a beneficial effect on unemployment because it improves competitiveness by lowering the prices of exports and increasing the prices of imports (Frenkel & Ros, 2006). When the crisis in these countries hit, the unemployment shock was notably smaller than in the PIIGS countries as can be seen in the graph below.





Graph 2: unemployment rate % (data Eurostat)

2.3 Trade openness

In the theoretical models of Chimnani *et al*. (2012) and Alexandre *et al*. (2010) an increase in openness to trade amplifies the relationship between the RER and unemployment. Chimnani *et al*. (2012) tested this relationship for ten Asian countries by using the net exports as a replacement for trade openness and found a significant relationship on the 1% level. The dataset and method of Alexandre *et al*. (2010) seems favourable because they investigated 23 OECD countries, including European countries, from 1988-2006.

Alexandre *et al*. (2010) devised a model in which worker's protection is included, this will be excluded in this research. The simplified fixed effects regression is:

$$\Delta Emp = a * \Delta REER(t-1) + b * Open(t-1) + c * \Delta REER(t-1) * Open(t-1) + d * \Delta GDP + e * Year + c \quad (3)$$

Emp:	Employment
REER:	Real effective exchange rate
Open:	Openness to trade
GDP:	Gross domestic product
Year:	Time variable

They conclude that a depreciation of 10% increases employment with 4%, while a 1 point increase in the openness index ((Exports + Imports)/GDP) increases employment with 0,23%. The employment exchange rate elasticity increases with openness, the coefficient c is 0,8851 with a standard deviation of 0,3999 significant on the 5% level. An increase of the openness with 10%, ceteris paribus, will increase employment by 8,851%.

2.4 Possible contractionary effects of a real depreciation

Although most of the literature finds that the undervaluation of a currency has expansionary effects on the economy, some research finds this relationship to be ambiguous. Krugman & Taylor (1977) show that depreciation can cause contractionary effects when: imports initially exceed exports, there are differences in income propensities between wages and prices and when government revenues are increased by devaluation. Furthermore, the findings of Kim *et al*. (2015) suggest that contractionary devaluation is more likely to happen in developing countries, while expansionary devaluation is more likely to happen in developed economies.

The southern PIIGS countries had a negative external balance before the crisis and a devaluated currency after the crisis. Krugman & Taylor (1977) state that the effect of devaluation on aggregate demand doesn't matter because governments can respond with the necessary monetary or fiscal policy, and therefore devaluation will accomplish the main goal of substitution. Contrary to what Krugman & Taylor assumed, the monetary policy wasn't set by the government in the southern PIIGS countries but by the ECB[1]. The depreciation in these countries could be deflationary and needs to be researched.

3 Data and methods

A sample of twelve countries from the European Union, 8 euro area members (4 Southern and 4 Northern countries) and 4 non-euro area members, from 1994-2017 are researched. Only yearly data will be used because of the long-term effect of the RER in the literature. Furthermore, the studies that are used as comparative measure in this paper only use yearly data. A panel data regression with a double log and fixed effects is used as in Frenkel & Ros (2006). The results are compared to the literature to draw meaningful conclusions.

Four Southern euro area members (Portugal, Italy, Greece, Spain), four Northern euro area members (Germany, Belgium, Austria and the Netherlands) and four EU (but non-euro area) members (Poland, Hungary, Romania, Czech Republic) are compared. Not all countries were members of the EU during the sample period: Poland, Hungary and Czech Republic joined in 2004, while Romania joined in 2007. This might have consequences for the data, but no countries on the eastern periphery of the EU are available that were members of the EU during the whole sample period.

The Southern euro area members (Spain, Italy, Portugal, Greece) are some of the countries that have been hit hardest by the crisis in the EU, and the recovery in these countries after the crisis has been slower than other EU members.

[1] European Central Bank. (n.d.). Introduction Monetary Policy. Retrieved May 7, 2018, from https://www.ecb.europa.eu/mopo/intro/html/index.en.html

The Northern euro area members (Germany, Belgium, Austria and the Netherlands) all have above average GDP/capita compared to the EU average. These countries have returned to GDP and unemployment levels that are better than pre-crisis. Furthermore, they have known favourable RERs in the years before the crisis compared to the other members of the euro area.

The Eastern European union members, but non-euro area members (Poland, Hungary, Romania and Czech Republic), are chosen based on being part of the EEA. They are used to compare the relationship between the RER and unemployment in – and outside of a currency union during the sample period. These countries have low levels of GDP/capita and have withered through the crisis with relatively low unemployment levels compared to the Southern Euro area members.

3.1 Data

3.1.1 The Real Effective Exchange Rate

The Real Effective Exchange Rate (REER) of a country is the RER compared to a range of other countries deflated by a deflator. In the database of Eurostat, the RER compared to the 19 euro area members, the 28 EU members and the 37 biggest trading partners is available. The differences between these REERs is relatively small, considering that the biggest trading partners are usually part of the euro area.

The REER is most commonly deflated by: The Consumer Price Index (CPI), the Producer Price index (PPI), the GDP Deflator (GDPD), the unit labour cost in the manufacturing industry (ULCM) or the unit labour cost in the total economy (ULCT) (Schmitz *et al*., 2012). To determine which deflator is used, one must not only account for theoretical considerations, but one must also take note of the availability of data during these periods (Schmitz *et al*., 2012). Therefore, only the CPI and ULCT will be considered, as these are readily available in the database of Eurostat.

3.1.1.1 Deflator of the REER

The Consumer Price Index (CPI) deflator is used the most because of the wide availability and comparability of this data. A downside of this deflator is that in its basket of goods, many non-tradable goods and services are used while intermediate and capital goods are excluded. Consequently, CPI isn't good for comparing international competitiveness and even less so if there's a big difference in productivity between the non-tradable and tradable sector (i.e., developing economies) (Schmitz *et al*., 2012).

Quarterly data of the Unit Labour cost in the Total economy (ULCT) deflator is readily available in Eurostat but also includes the labour costs in the non-tradable goods sector. Furthermore, UCLT doesn't include the taxes incurred by companies or the cost of capital. In general, price measures typically have a higher data quality than cost measures.

Ca'Zorzi and Schnatz (2008) compared the use of different deflators to explain export performance, they concluded that no deflator is superior. In Frenkel & Ros (2006), the REER is bilateral with the US and deflated by consumer prices. In this research a wide deflator is used that encompasses most of the trading partners. The REER deflated by EU28 and the 9 major trading partners of the EU is chosen, as this provides the best representation for all the countries included in the dataset. This data will be deflated by CPI as in Frenkel & Ros (2006) because of the comparability of this data (Schmitz *et al*., 2012).

3.1.2 Unemployment

The unemployment rate is the dependent variable in the regressions, it is defined as the percentage of the population in the labour force that is unemployed (aged 15-74, data from Eurostat). The labour force is the total number of unemployed and employed people, these definitions are in accordance with the definitions made in the model of Frenkel & Ros.

3.1.3 Gross Domestic Product

Gross domestic product (GDP) is the result of production activity of resident producer units (data from Eurostat), it is a measure for economic development. It is represented as an index in which 2010 = 100.

3.1.4 Labour force

The labour force variable is added as in Frenkel & Ros (2006) and represents the size of the labour force. The data comes from the IMF international financial statistics database.

3.1.5 Openness index

Trade as % of GDP ((export + import)/GDP), from the database of Worldbank.

3.2 Methods

3.2.1 Method based on Frenkel & Ros (2006)

A panel data regression with a double log and fixed effects is used as in Frenkel & Ros (2006) to estimate the relationship between REER and unemployment. This is the basic regression in this paper:

$$\log(Unemp_{i,j}) = \mathrm{a} * \log(GDP_{i,j}) + b * \log(REER(t+x)_{i,j}) + d * Year + C \quad \text{(FE)} \qquad (4)$$

Unemp: Unemployment rate
GDP: Gross domestic product
REER: Real effective exchange rate deflated by CPI (37 biggest trading partners EU)

Year: Time variable
C: Constant
i: Country
j: Year
x: Lag of REER

The time variable is added to control for autonomous movements in unemployment, resulting from a growth in the labour force (Frenkel & Ros, 2006). In Frenkel & Ros (2006) the lag of the REER was empirically assessed to be two years and will therefore need to be revalidated for the new dataset. The fixed effects panel data regression is used because it controls for systematic differences between countries, it is the same as the least square dummy variable (LSDV) method without inclusion of the dummies. This means that the coefficients a, b, d and C are equal in the regression (4) and (5).

$$\begin{aligned}\log(Unemp_{i,j}) = \mathrm{a} * \log(GDP_{i,j}) + b * \log(REER(t+x)_{i,j}) + d * Year \\ +e_2 * Country_2 + e_3 * Country_3 + e_4 * Country_4 + e_5 * Country_5 \\ +e_6 * Country_6 + e_7 * Country_7 + e_8 * Country_8 + e_9 * Country_9 \\ +e_{10} * Country_{10} + e_{11} * Country_{11} + e_{12} * Country_{12} + C\end{aligned} \quad (5)$$

Furthermore, a labour force variable (LF) is added in Frenkel & Ros (2006), where an increase of LF resulted in an increase of unemployment. This variable is tested for the 12 EU countries.

3.2.2 Trade openness

This basic regression will be expanded based on the literature. The new variable openness to trade (Open) is added, as in Chimnani *et al.* (2012):

$$\begin{aligned}\log(Unemp_{i,j}) = \mathrm{a} * \log(GDP_{i,j}) + b * \log(REER(t+x_1)_{i,j}) \\ +c * \log(Open(t+x_2) + d * Year + C \qquad \text{(FE)}\end{aligned} \quad (6)$$

The difference with Chimnani *et al.* (2012) is that a possible new lag (x_2) is introduced, in Alexandre *et al.* (2010) the lag was selected to be one year. The above regression can't be compared to the literature but gives an idea about the influence of trade openness on unemployment.

To further determine the relationship between REER and Open, the openness to trade variable is inserted in an interaction term with the REER.

$$\log(Unemp_{i,j}) = \mathrm{a} * \log(GDP_{a,b}) + b * \log(REER(t+x) * Open(t+x)) + d * Year + C$$

(FE)

The coefficient of the interaction term b is positive in Alexandre *et al.*(2010), this means that the unemployment exchange rate elasticity increases with openness: the RER will thus have a stronger effect when the economy is more open to trade. This assumption is tested.

3.2.3 Contractionary devaluation in the Southern EU countries

The RERs of the Southern EU (Spain, Italy, Portugal, Greece) have all known a period of depreciation after the crisis. Krugman & Taylor (1977) stated that a depreciation can be contractionary when imports initially exceed exports, differences exist in income propensities between wages and prices or when government revenues are increased by devaluation.

The possible contractionary effect of the devaluation in the Southern EU countries is investigated after the financial crisis of 2007-2009 because imports initially exceeded exports in these countries and have known depreciation after the crisis. A dummy variable is added to the basic regression that represents the effect of the contractionary devaluation.

The dummy variable has the value zero before the crisis, and one after the crisis. The exact year that the crisis starts will be empirically assessed by controlling where the dummy variable is most significant. A positive sign of the dummy means that a trend of increasing unemployment exists after the crisis, which can't be explained by GDP, the RER or the time variable.

4 Results

All the regressions are performed with Stata 13 software, the results can be found in appendix B.

4.1 RER, GDP and unemployment

4.1.1 Lag of the RER

First, the lag of the RER needs to be empirically assessed as in Frenkel & Ros (2006) for the whole dataset. The following double log panel data regression with fixed effects is used:

$$\log(Unemp_{i,j}) = \mathrm{a} * \log(GDP_{i,j}) + b * \log(REER(t+x)_{i,j}) + c * Year + d \qquad (7)$$

The beta of the RER is always positive; this means that an appreciation will increase the unemployment rate. Most of the results are very significant, the result is most significant for a negative lag of two years. This result doesn't depend on the deflator used for the REER and is

in accordance with the results of Frenkel & Ros (2006) who found a negative lag of two years to be the best in their calculations.

4.1.2 Unemployment, GDP and REER in the European Union

The basic regression, as in Frenkel & Ros (2006), is used to determine the relationship between REER, GDP and unemployment in the dataset of 12 EU countries.

$$\text{Log}(Unemp_{i,j}) = \text{a} * \log(GDP_{i,j}) + b * \log(REER(t-2)_{i,j}) + c * Year + d \qquad (8)$$

Table 1 : Coefficients of the basic regression (12 EU countries)

	Coefficient	t-value
a	-2,60*	-16,99
b	1,03*	8,74
c	0,017*	12,10

*: significant at the 1% level
R-square within = 0,55
probability > F = 0
258 observations

GDP has a strong negative effect on unemployment, an increase of the GDP by 10% will decrease unemployment by 26%. The effect of GDP on unemployment is twice as strong and more significant as in Frenkel & Ros (2006) when they investigated a sample of 17 Latin American countries. Some individual countries had similar effects compared to those found for the 12 European countries. This might suggest that there is a discrepancy between countries, therefore it might be interesting to split up the countries to test this.

The REER with a lag of two years has a positive effect on unemployment, an increase of the REER(t-2) (appreciation) by 10% will increase unemployment by 10,3%. This result is stronger than the result found by Frenkel & Ros (2006) when they investigated 17 Latin-American countries. Hereafter, the variable openness to trade is introduced as in Alexandre et al. (2010) which can explain this difference.

As in Frenkel & Ros (2006), a significant effect of the time variable on unemployment is found. This result is positive, which means that a trend exists in which unemployment increases 'ceteris paribus'.

The results when the 12 European countries are split into three groups (Northern Europe, Southern Europe and non-Euro Eastern Europe) are listed in the table below:

Table 2: Coefficients of GDP and REER in the basic regression (Countries split up into geographic groups)

	a (GDP)	b (REER)
Europe	-2,60*	1,03*
Northern Europe	-1,42***	1,51*
Southern Europe	-3,1*	1,26*
Eastern Europe	-1,79*	0,92*

*significant on the 1% level
***significant on the 10% level

Extra information on these regressions can be found in appendix B.

In Northern Europe, the coefficient of GDP is significant on the 10% level and the coefficient of RER on the 1% level. The results show discrepancies with the results found in the Europe dataset. The effect of GDP on unemployment is lower and the effect of RER on unemployment is higher.

In Southern Europe, the results are significant on the 1% level and the coefficients are larger than in the Europe dataset.

In Eastern Europe, the results are significant on the 1% level. The coefficient of GDP is lower than in the Europe dataset.

4.2 Size of the labour force

The variable for the size of the labour force is added as in Frenkel & Ros (2006) for the twelve European countries:

$$\log(Unemp_{i,j}) = \mathrm{a} * \log(GDP_{i,j}) + b * \log(REER(t+x)_{i,j}) + c * logLF + d * Year + e \quad (FE) \tag{9}$$

Table 3: Coefficients for regression (9) (12 EU countries)

	Coefficient	t-value
logGDP	-2,66*	-17,46
logREER37CPI(t-2)	0,88*	7,58

logLF	-0,62*	-2,77
Year	0,020*	12,94

*significant on the 1% level
R-square within 0,5815
probability > F = 0
258 observations

The coefficients for GDP and REER(t-2) remain significant but the coefficient of REER(t-2) becomes smaller. The effect of the variable LF on unemployment is negative, this is the opposite sign compared to Frenkel & Ros (2006). This result is discussed in the next chapter.

4.3 Trade openness

The trade openness variable is introduced as in Alexandre *et al*. (2010), the lag of the REER and trade openness were empirically assessed to be 2 years. The 12 European countries are regressed using following equation:

$$\log(Unemp_{i,j}) = \mathrm{a} * \log(GDP_{i,j}) + b * \log(REER(t-2)_{i,j}) + c * \log(Open(t-1)) + d * Year + C \quad \text{(FE)} \tag{10}$$

Table 4: coefficients of regression (10) (12 EU countries)

	Coefficient	t-value
a	-2,53*	-15,52
b	1,00*	8,32
c	-0,19	-1,24
d	0,018*	10,34

*: significant at the 1% level
R-square: 0,58
probability > F=0
258 observations

The openness variable isn't statistically significant which means that it can't be proven that an increase in the openness to trade of a country decreases or increases unemployment. The openness to trade variable is investigated in an interaction term with REER.

$$\log(Unemp_{i,j}) = \mathrm{a} * \log(GDP_{a,b}) + b * \log(REER(t-2) * Open(t-2)) + c * Year + C \quad \text{(FE)} \tag{11}$$

Table 5: coefficients of regression (11) (12 EU countries)

	Coefficient	t-value
a	-2,59*	-14,15
b	0,53*	4,68
c	0,013*	7,43

*significant on the 1% level
R-square = 0,43
probability > F = 0
258 observations

The coefficient of the interaction term is positive as in Alexandre *et al*. (2010), no comparison with the size of the coefficient can be made because the regression of Alexandre *et al*. (2010) was of another form. This means that the effect of the RER on unemployment is stronger when the openness index is higher.

The difference of the effect of RER on unemployment is tested with the basic regression for the 4 countries in the dataset that had the lowest and the highest trade openness during the period 1994-2017[1]. A significant difference is found between the low trade openness countries and the high trade openness countries.

Table 6: Coefficient of the REER in high and low trade openness countries

	Coefficient REER	t-value
Low trade openness (Greece, Italy, Spain, Romania)	0,82*	4,49
High trade openness (Belgium, Netherlands, Czech Republic, Hungary)	1,43*	7,49

*significant on the 1% level
***significant on the 10% level

The coefficient of the low trade openness countries is significant on the 1% level, a devaluation in these countries will have a smaller effect on unemployment compared to the dataset of the 12 European countries. This group of countries includes mostly Southern European countries.

[1] Lowest trade openness countries chosen to be the countries with the lowest trade openness in 2017, highest trade openness countrieschosen to be the countries with the highest trade openness in 1995.

The coefficient in the high trade openness countries is significant on the 1% level but lower than in the Northern EU countries, this means that the openness index is not the only relevant variable for determining the relationship of the RER and unemployment. The Northern EU countries differ from the Eastern European countries with a high trade openness in several ways: higher GDP/capita, member of the euro area, member of the EU during the whole dataset… It is difficult to find the determining factor and the answer of how these variables influence unemployment could be the subject of a new paper.

4.3.1 Contractionary devaluation in the Southern EU countries

To investigate the possible contractionary effect of a devaluation after the crisis, a dummy variable (Crisis) is added.

$$\mathrm{Log}(Unemp_{i,j}) = \mathrm{a} * \log(GDP_{i,j}) + b * \log(REER(t-2)_{i,j}) + c * Crisis + d * Year + e \quad (12)$$

The dummy is most significant when the dummy is one after 2009, the results of the regression are shown in the table 7.

Table 7: coefficients of regression (12) (Southern EU countries)

	Coefficient	t-value
a	-2,68*	-10,12
b	1,09*	3,38
c	0,088**	2,61
d	0,012*	4,19

*: significant at the 1% level
**: significant at the 5% level
R-square: 0,82
probability > F=0
84 observations

The coefficients of the basic regression are significant on the 1% level but have a lower t-value and the R-square is high (0,82). The crisis dummy is significant on the 5% level and is positive, this means that the hypothesis of a possible contractionary devaluation after the crisis in the Southern EU can't be rejected. Furthermore, when the same regression is made for the 12 EU countries, the dummy is one after 2007 (significant on the 10% level) and has a negative sign.

5 Discussion

5.1 Comparison to the results in Frenkel & Ros (2006)

The results of the regressions in this paper that were based on the basic regression that was introduced in Frenkel & Ros (2006) adds strength to the claim of Frenkel & Ros (2006) that an appreciation (depreciation) of the RER lagged by two years increases (decreases) unemployment. In general, the results are very similar to the research of Frenkel & Ros (2006).

The lag of the RER is empirically assessed to be two years, which is equal to Frenkel & Ros (2006). Frenkel & Ros (2006) built a theoretical model in which RER influences unemployment through the macroeconomic channel, the development channel and the labour intensity channel. The macroeconomic channel influences unemployment in the short run and the development channel captures the indirect effects of RER on unemployment (output). Therefore, they conclude that the two year lag is consistent with their hypothesis of how the RER influences unemployment through the labour intensity channel.

An appreciation of 10% will increase unemployment by 10,3% in the 12 EU countries in this paper as opposed to 5,7% for the 17 Latin American countries in Frenkel & Ros (2006). This difference can be explained by other variables such as trade openness. this will be explained in the section 'trade openness' hereafter.

The sign of the variable 'size of the labour force' is negative in this paper but positive in Frenkel & Ros (2006). This means that the model of Frenkel & Ros (2006) doesn't entirely hold in the 12 EU countries. Frenkel & Ros (2006) assume that unemployment only exists because of the expectance of a higher wage in the tradable sector than in the non-tradable sector. When more people join the labour force, the informal workers will earn a lower wage because they earn the average product of labour. This wage divergence leads to an increase in open unemployment in the model of Frenkel & Ros (2006). In developed economies, other drivers of reduction of the size of the labour force could be important (extended studying, study, work or traineeships abroad, more sabbaticals, parental leaves, early retirement...) This however would require further investigation that is out of the scope of this paper.

5.2 Trade openness

The sample of Frenkel & Ros included Latin American countries from 1980-2002, the emphasis was put on Mexico, Argentina, Chile and Brazil. The openness index differs between countries, but in general the openness index in the Latin American countries from 1980-2002 is smaller than in the European countries from 1994-2017. In the results the interaction term between REER and openness to trade was positive, which means that a country with a higher openness will in general have a stronger relationship between REER and unemployment. This logic might explain the difference in the strength of the relationship between RER and unemployment between Frenkel & Ros (2006). The analysis in this paper however doesn't provide firm estimates for the size of the influence of trade openness.

Trade openness is not the only factor that influences the size of the relationship between REER and unemployment. The reasoning behind this statement is that the size of the relationship is

bigger for the 4 Northern Euro countries than the group of 4 countries with the highest trade openness in the dataset.

5.3 Contractionary devaluation in the Southern EU countries

The hypothesis of a possible existence of a contractionary devaluation in the Southern EU countries after the financial crisis 2007-2009 was investigated and can't be rejected. The positive and significant sign of the dummy variable means that an upward trend in unemployment exists that can't be explained by GDP, REER or the time variable. The negative, but less significant, sign of the dummy in the 12 EU countries means that the upward trend isn't present in every EU country.

The increase in lending (Kuvshinov *et al.*, 2016) in the Southern EU countries in the years leading up to the crisis could be a culprit of this upward trend in unemployment after the crisis. Nevertheless, the assumption of a contractionary devaluation in these countries can't be rejected. More research is needed to determine if a contractionary devaluation has taken place in the years after the crisis in the Southern EU countries.

5.4 Real downward wage rigidity

Members of the euro area can't change their nominal exchange rate to increase the competitiveness of their respective economies. Euro area members can only change their real exchange rate (RER) through the setting of real wages and prices. In this paper, it was assumed that a real downward wage rigidity exists in a currency union (Schmitt-Grohé & Uribe, 2016). This real downward wage rigidity impedes the devaluation of the RER through wages in an economic downturn. The assumption was not researched but provides grounds for new research.

5.5 Policy suggestions

The competitiveness of an economy compared to the biggest trading partners is important. A loss of competitiveness will be accompanied by an increase in the unemployment rate. Trade openness in the EU countries, which has been proven to influence the relationship between RER and unemployment, is increasing. Therefore, the importance of the competitiveness of an economy in Europe is more important than ever. Policies should be aimed towards keeping economies at a competitive level.

A country that wants to lower the unemployment rate should consider devaluing their RER. The devaluation will be most effective in the Northern European countries and countries with a high trade openness. The policies should be implemented together with fiscal and monetary stimulus (Frenkel & Ros, 2006). The monetary policy within the euro area is determined by the ECB. Therefore, policies aimed towards devaluing the RER will only reach their full potential when the ECB's monetary policy is expansionary.

6 Conclusion

This paper investigated the relationship between the RER and unemployment for 12 European countries from 1994-2017. The research was based on the method of Frenkel & Ros (2006), who built a theoretical model in which the RER influences unemployment through three distinctive channels: the macroeconomic channel, the labour intensity channel and the development channel. First, the lag of the REER was determined to be two years. This result is equal to Frenkel & Ros (2006) and should mainly be attributed to the labour intensity channel.

The 12 European groups were split up into three groups: Northern euro area countries, Southern euro area countries and Eastern non-euro area countries. The main statement of Frenkel & Ros (2006), which was that an appreciation (depreciation) of the RER leads to an increase (decrease) of unemployment, was validated for each group. For the Southern euro area countries, the hypothesis of a possible contractionary effect of devaluation was investigated in the years after the financial crisis of 2007-2009 and can't be rejected.

The size of the relationship between RER and unemployment was bigger in this research than in Frenkel & Ros (2006), this can partly be explained by the higher trade openness of the countries in the dataset used in this paper compared to Frenkel & Ros (2006). A higher trade openness will increase the size of the relationship between RER and unemployment, but this is not the only factor that influences the size of this relationship.

In the theoretical model of Frenkel & Ros (2006) an increase of the labour force increases unemployment. This relationship is inversed for the 12 European countries. Therefore, it is possible that a revision of the model of Frenkel & Ros (2006) for developed economies is required.

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Appendix A: Calculations Model Frenkel & Ros

The Cobb Douglas production function is used to find a relationship between capital stock, employment and the production of tradable goods.

$$T = AK_T^a L_T^{1-a} \tag{1}$$

T:	Production of traded goods
K:	Capital stock
L_T:	Employment in the traded goods sector
A & a:	Constants dependent on technology

Employment in the traded goods sector (L_T) is determined by profit maximization under competitive conditions and price-taking behaviour:

$$L_T = \left[(1-a)A\left(\frac{p_T}{w_T}\right)\right]^{\frac{1}{a}} K_T \tag{2}$$

p:	prices
w:	wages
$p_{T=}$	ep*
e:	nominal exchange rate

Non-traded goods production (N) is generated by the informal sector under conditions of diminishing returns to labour and, to simplify, we assume away the use of capital in this sector so that labour (L_N) is the only input.

$$N = L_N^{1-d}, 0 < d < 1 \tag{3}$$

Workers who do not find a job in the formal sector work and choose not to work in the informal sector become openly unemployed. Thus:

$$L_T + L_N + U = L \tag{4}$$

U:	open unemployment
L:	total labour force

Workers who work in the informal sector earn an income equal to the average product of labour.

$$w_N = p_N L_N^{-d} \tag{5}$$

Despite easy entry into the informal sector, the existence of open unemployment can be explained along Harris–Todaro lines: the perceived probability of finding a (well paid) job in the formal sector is higher for an unemployed worker than for a worker in the informal sector. Then, the unemployment rate (u) in the formal sector is determined by the following equation:

$$u = \frac{U}{(L_T+U)} = h(w_T/w_N) \tag{6}$$

h function is influenced by characteristics of the labour market.

On the demand side, the following conditions are satisfied: workers do not save and the propensity to save out of profits (s) is constant.

$$p_N C_N + p_T C_T = w_N L_N + w_T L_T + (1-s)P \tag{7}$$

C: Consumption

P is total profits given by:

$$P = a p_T T = [a/(1-a)] w_T L_T \tag{8}$$

Non-traded good is used for consumption only, in equilibrium:

$$N = C_N \tag{9}$$

The utility function has a constant elasticity of substitution (r) between T and N goods so that

$$\frac{C_T}{C_N} = B(\frac{p_N}{p_T})^{\sigma} \tag{10}$$

After carefully combining the equations, following relationship determinants are found for unemployment:

$$u = \mathrm{U}\left(-K_T, L, {}^{w_T}/_{p_T}\right) \tag{11}$$

Formal sector unemployment is negatively affected by capital stock (less unemployed) and positively affected by the size of the total labour force.

Capital accumulation reduces informal sector employment (more people will work in formal sector) and raises average product of labour (higher productivity per worker) in this sector. This results in a narrowing of the wage differential between the two sectors and a reduction in unemployment rate.

Higher RER (depreciation) has a negative effect on unemployment: higher RER can be seen as a reduction in product wage.

Appendix B: Results of the regressions (Stata 13 software)

```
. xtreg logUnemp logGDP L2.logREER37CPI Year, fe

Fixed-effects (within) regression               Number of obs      =       258
Group variable: Country                         Number of groups   =        12

R-sq:  within  = 0.5531                         Obs per group: min =        19
       between = 0.0217                                        avg =      21.5
       overall = 0.2337                                        max =        22

                                                F(3,243)           =    100.24
corr(u_i, Xb)  = -0.0509                        Prob > F           =    0.0000
```

logUnemp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
logGDP	-2.603911	.1533052	-16.99	0.000	-2.905887	-2.301934
logREER37CPI L2.	1.030804	.1178762	8.74	0.000	.7986146	1.262994
Year	.0167459	.001384	12.10	0.000	.0140196	.0194721
_cons	-29.59917	2.558303	-11.57	0.000	-34.63845	-24.55989
sigma_u	.15181677					
sigma_e	.08473395					
rho	.76247847	(fraction of variance due to u_i)				

F test that all u_i=0: F(11, 243) = 83.51 Prob > F = 0.0000

Result 1: Result of the basic regression for the 12 EU countries

```
. xtreg logUnemp logGDP L2.logREER37CPI Year, fe

Fixed-effects (within) regression               Number of obs      =        84
Group variable: Country                         Number of groups   =         4

R-sq:  within  = 0.8040                         Obs per group: min =        19
       between = 0.0004                                        avg =      21.0
       overall = 0.5183                                        max =        22

                                                F(3,77)            =    105.28
corr(u_i, Xb)  = -0.0772                        Prob > F           =    0.0000
```

logUnemp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
logGDP	-3.104963	.2182694	-14.23	0.000	-3.539593	-2.670333
logREER37CPI L2.	1.258536	.3267643	3.85	0.000	.6078654	1.909207
Year	.0188136	.001561	12.05	0.000	.0157053	.0219219
_cons	-33.05074	2.77821	-11.90	0.000	-38.58286	-27.51862
sigma_u	.12038709					
sigma_e	.06829527					
rho	.75652908	(fraction of variance due to u_i)				

F test that all u_i=0: F(3, 77) = 129.09 Prob > F = 0.0000

Result 2: Result of the basic regression of the Southern euro area countries

```
. xtreg logUnemp logGDP L2.logREER37CPI Year, fe

Fixed-effects (within) regression               Number of obs      =        88
Group variable: Country                         Number of groups   =         4

R-sq:  within  = 0.2142                         Obs per group: min =        22
       between = 0.1584                                        avg =      22.0
       overall = 0.1688                                        max =        22

                                                F(3,81)            =      7.36
corr(u_i, Xb)  = 0.0838                         Prob > F           =    0.0002

------------------------------------------------------------------------------
    logUnemp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      logGDP |  -1.416425   .7471679    -1.90   0.062    -2.903055    .0702047
             |
logREER37CPI |
         L2. |   1.514941   .4068558     3.72   0.000     .7054252    2.324456
             |
        Year |    .008436   .0051469     1.64   0.105    -.0018047    .0186766
       _cons |  -16.3769    8.955436    -1.83   0.071     -34.1954    1.441612
-------------+----------------------------------------------------------------
     sigma_u |  .10011102
     sigma_e |   .0853689
         rho |  .57898204   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(3, 81) =    30.87                 Prob > F = 0.0000
```

Result 3: Result of the basic regression for the Northern euro area countries

```
. xtreg logUnemp logGDP L2.logREER37CPI Year, fe

Fixed-effects (within) regression               Number of obs      =        86
Group variable: Country                         Number of groups   =         4

R-sq:  within  = 0.4763                         Obs per group: min =        21
       between = 0.9647                                        avg =      21.5
       overall = 0.5876                                        max =        22

                                                F(3,79)            =     23.95
corr(u_i, Xb)  = 0.4462                         Prob > F           =    0.0000

------------------------------------------------------------------------------
    logUnemp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      logGDP |  -1.785319   .3677849    -4.85   0.000    -2.517376   -1.053261
             |
logREER37CPI |
         L2. |   .9165916   .1650034     5.55   0.000     .5881607    1.245023
             |
        Year |   .0071647   .0050355     1.42   0.159    -.0028583    .0171877
       _cons |  -11.77184   9.393584    -1.25   0.214    -30.46931    6.925616
-------------+----------------------------------------------------------------
     sigma_u |  .05913661
     sigma_e |  .09355601
         rho |  .28548388   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(3, 79) =     7.29                 Prob > F = 0.0002
```

Result 4: Result of the basic regression fort he Eastern non-euro area countries

```
. xtreg logUnemp logGDP L2.logREER37CPI logLF Year, fe

Fixed-effects (within) regression               Number of obs      =       247
Group variable: Country                         Number of groups   =        12

R-sq:  within  = 0.5815                         Obs per group: min =        19
       between = 0.0930                                        avg =      20.6
       overall = 0.0005                                        max =        21

                                                F(4,231)           =     80.26
corr(u_i, Xb)  = -0.7916                        Prob > F           =    0.0000
```

logUnemp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
logGDP	-2.655691	.1520704	-17.46	0.000	-2.955313	-2.356069
logREER37CPI						
L2.	.8844822	.1166259	7.58	0.000	.6546956	1.114269
logLF	-.6163449	.2227621	-2.77	0.006	-1.05525	-.1774397
Year	.0201596	.0015577	12.94	0.000	.0170904	.0232287
_cons	-31.76434	2.508596	-12.66	0.000	-36.707	-26.82169
sigma_u	.28907539					
sigma_e	.07933477					
rho	.92995654	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(11, 231) =    69.83                 Prob > F = 0.0000
```

Result 5: Result of the basic regression expanded with the variable LF for the 12 EU countries

```
. xtreg logUnemp logGDP L2.logREER37CPI L1.logOpen Year, fe

Fixed-effects (within) regression               Number of obs      =       258
Group variable: Country                         Number of groups   =        12

R-sq:  within  = 0.5559                         Obs per group: min =        19
       between = 0.2326                                        avg =      21.5
       overall = 0.3553                                        max =        22

                                                F(4,242)           =     75.72
corr(u_i, Xb)  = 0.0694                         Prob > F           =    0.0000
```

logUnemp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
logGDP	-2.533881	.1632726	-15.52	0.000	-2.855498	-2.212265
logREER37CPI						
L2.	1.000464	.1202767	8.32	0.000	.763541	1.237387
logOpen						
L1.	-.1853746	.1498955	-1.24	0.217	-.480641	.1098918
Year	.0180661	.0017468	10.34	0.000	.0146254	.0215069
_cons	-31.97139	3.195338	-10.01	0.000	-38.26562	-25.67717
sigma_u	.13508994					
sigma_e	.0846418					
rho	.71809368	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(11, 242) =    64.12                 Prob > F = 0.0000
```

Result 6: Result of the basic regression expanded with the variable Open for the 12 EU countries

```
. xtreg logUnemp logGDP L2.logOpenREER37 Year, fe

Fixed-effects (within) regression               Number of obs      =       258
Group variable: Country                         Number of groups   =        12

R-sq:  within  = 0.4610                         Obs per group: min =        19
       between = 0.3128                                        avg =      21.5
       overall = 0.0000                                        max =        22

                                                F(3,243)           =     69.29
corr(u_i, Xb)  = -0.5737                        Prob > F           =    0.0000
```

logUnemp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
logGDP	-2.593494	.1833146	-14.15	0.000	-2.954583	-2.232406
logOpenREER37C L2.	.5298441	.1131636	4.68	0.000	.3069374	.7527509
Year	.0129739	.0017464	7.43	0.000	.0095339	.0164138
_cons	-22.07312	3.168517	-6.97	0.000	-28.31438	-15.83185
sigma_u	.21429205					
sigma_e	.09304959					
rho	.84136431	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(11, 243) =    58.44              Prob > F = 0.0000
```

Result 7: Result of regression (11) for the 12 EU countries

```
. xtreg logUnemp logGDP L2.logREER37CPI Year, fe

Fixed-effects (within) regression               Number of obs      =        87
Group variable: Country                         Number of groups   =         4

R-sq:  within  = 0.5471                         Obs per group: min =        21
       between = 0.0014                                        avg =      21.8
       overall = 0.3129                                        max =        22

                                                F(3,80)            =     32.21
corr(u_i, Xb)  = -0.1396                        Prob > F           =    0.0000
```

logUnemp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
logGDP	-4.048178	.4316327	-9.38	0.000	-4.907154	-3.189201
logREER37CPI L2.	1.434449	.191542	7.49	0.000	1.053268	1.81563
Year	.0246236	.0034146	7.21	0.000	.0178283	.0314189
_cons	-43.43035	6.197741	-7.01	0.000	-55.76425	-31.09645
sigma_u	.09248687					
sigma_e	.07256593					
rho	.61896137	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(3, 80) =    50.23              Prob > F = 0.0000
```

Result 8: Result of the basic regression for the 4 countries with the highest trade openness

```
. xtreg logUnemp logGDP L2.logREER37CPI Year, fe

Fixed-effects (within) regression               Number of obs      =        83
Group variable: Country                         Number of groups   =         4

R-sq:  within  = 0.7553                         Obs per group: min =        19
       between = 0.0057                                        avg =      20.8
       overall = 0.3542                                        max =        22

                                                F(3,76)            =     78.20
corr(u_i, Xb)  = -0.0152                        Prob > F           =    0.0000
```

logUnemp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
logGDP	-2.48119	.1777742	-13.96	0.000	-2.835258	-2.127122
logREER37CPI						
L2.	.8152308	.1813815	4.49	0.000	.4539783	1.176483
Year	.0186085	.0017033	10.92	0.000	.0152161	.0220009
_cons	-33.03151	3.181141	-10.38	0.000	-39.3673	-26.69572
sigma_u	.15759845					
sigma_e	.06726396					
rho	.84590678	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(3, 76) =   124.57                 Prob > F = 0.0000
```

Result 9:Result of the basic regression for the 4 countries with the lowest trade openness

```
. xtreg logUnemp logGDP L2.logREER37C Crisis10 Year, fe

Fixed-effects (within) regression               Number of obs      =        84
Group variable: Country                         Number of groups   =         4

R-sq:  within  = 0.8201                         Obs per group: min =        19
       between = 0.0006                                        avg =      21.0
       overall = 0.5373                                        max =        22

                                                F(4,76)            =     86.63
corr(u_i, Xb)  = -0.0580                        Prob > F           =    0.0000
```

logUnemp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
logGDP	-2.683819	.2651376	-10.12	0.000	-3.211886	-2.155751
logREER37CPI						
L2.	1.088686	.3217154	3.38	0.001	.4479339	1.729437
Crisis10	.0883409	.0338264	2.61	0.011	.0209698	.155712
Year	.0122583	.0029268	4.19	0.000	.0064291	.0180874
_cons	-20.42493	5.527075	-3.70	0.000	-31.43305	-9.416806
sigma_u	.11884929					
sigma_e	.06585174					
rho	.76510974	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(3, 76) =    71.12                 Prob > F = 0.0000
```

Result 10: Result of regression (12) for the Southern European countries

```
. xtreg logUnemp logGDP L2.logREER37C Crisis8 Year, fe

Fixed-effects (within) regression               Number of obs      =       258
Group variable: Country                         Number of groups   =        12

R-sq:  within  = 0.5592                         Obs per group: min =        19
       between = 0.0215                                        avg =      21.5
       overall = 0.2349                                        max =        22

                                                F(4,242)           =     76.75
corr(u_i, Xb)  = -0.0563                        Prob > F           =    0.0000
```

logUnemp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
logGDP	-2.663532	.1559858	-17.08	0.000	-2.970795	-2.356268
logREER37CPI L2.	1.076336	.1199022	8.98	0.000	.8401511	1.312521
Crisis8	-.0395463	.0215525	-1.83	0.068	-.0820007	.0029081
Year	.0197733	.0021493	9.20	0.000	.0155396	.024007
_cons	-35.62823	4.156712	-8.57	0.000	-43.81618	-27.44028
sigma_u	.15202951					
sigma_e	.08432429					
rho	.76473366	(fraction of variance due to u_i)				

```
F test that all u_i=0:     F(11, 242) =    76.79                 Prob > F = 0.0000
```

Result 11: Result of regression (12) for the 12 EU countries