ERASMUS UNIVERSITY ROTTERDAM
Erasmus School of Economics
Master Thesis International Economics

Exchange Rates and Economic Performance in the Euro Area:
A Disparity Between Core and Periphery

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Date final version: 03 August 2020

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ABSTRACT

Through the nominal effective exchange rates (NEER), I focus on how the common currency affects the GDP and the Current Account Balance of the eurozone countries. Each country is bound by the same currency but holds a separate economy and trading partners. This study is to expose the winners and the losers of the fluctuations in the euro. Using a Dynamic Fixed-Effects NARDL model, the results show that the deviations in the NEER from the Euro Area NEER have a heterogeneous impact across the Eurozone. In the Core region, the short-run volatility in the NEER gap hurts the GDP growth, outlining a "fear of volatility". Whereas in the periphery, the long-run NEER gap is negatively correlated to the level of GDP. This suggests that the periphery is dependent on the Core's short-run influence on the fluctuations in the exchange rate. With regards to the Current account, the fluctuations in the NEER have a more significant impact on the core than the periphery. This result is most likely due to the larger tradeable sector in the core.

1. INTRODUCTION

The Euro Area is often described as an economic experiment and is greeted with both faith and scepticism. The idea of uniting a group of countries, to form a monetary union under the same currency, is a bold attempt to reinforce the EU as one of the world's leading trading blocks. The implementation of the single currency on 1 January 1999, shifted the EU's position in the "policy trilemma" to a state where each euro country benefits from perfect *capital mobility* and a common currency (*fixed exchange rate*) while sacrificing their *monetary autonomy*.

Under this framework, we have seen the deepening of the four European freedoms – the free movement of *goods, services*, *labour* and *capital* – in alignment with the EU objectives. However, since the financial crisis of 2007-08, the eurozone has witnessed the fragility of such a system. The dream of a common currency has become the burden of its worst hit members.

In this research, through nominal effective exchange rates (NEER), I will focus on how the common currency affects the economic performance of the eurozone countries. This concept of performance is derived from Lovell et al. (1995) as the four macroeconomic services a country provides for citizens, namely: the control of inflation, unemployment, GDP per capita and trade balance. This research aims to uncover the underlying relationship between the two latter services and the NEER. The idea of such a study is to expose the winners and the losers of the fluctuations in the euro. Each country is bound by the same currency but holds a separate economy and trading partners. As such, some countries (core) risk being undervalued, while others (periphery) overvalued (Comunale, 2017). This misalignment, therefore, leads to a Dutch disease phenomenon – the synthetic appreciation of the currency decreases the competitiveness of the country – which deepens the imbalance between member states.

Many studies have covered the impact of effective exchange rates on economic growth and trade balances across the world (see Lartey et al., 2012; Arize et al., 2017). However, the heterogeneity of the impact across Eurozone countries has often been overlooked. Consequently, in this paper, I will answer the following question: "*How does the exchange rate movements affect the economic performance of the Eurozone countries?*". I will attempt to find the asymmetric response across countries from movements in the NEER, using a dynamic fixed-effects specification and a non-linear auto-regressive distributed lag (NARDL) model.

The results show that the deviations in the NEER from the Euro Area NEER have a heterogeneous impact across the Eurozone. In the Core region, the short-run volatility in the

NEER gap hurts GDP growth. Whereas in the periphery, the long-run NEER gap is negatively related to the level of GDP. This may, as a result, benefit the periphery given that the Core does not overly influence the fluctuation in the exchange rate. With regards to the Current account variable, the fluctuations in the NEER have a more significant impact on the core than the periphery. This result is most likely due to the larger tradeable sector in the core.

The findings should bring a better understanding of the implications in joining the euro, and possibly explain why other member states refrain from converging into the single currency (e.g. Poland). These insights could further justify the current political position taken by countries with regards to the current crisis, as well as the variability in effectiveness by the ECB response. I hope this research will bring a new academic interest into the common currency and possibly expand our understanding of the workings of the "European Experiment".

Finally, I acknowledge that the sample selection bias should not affect the research due to the particularity of the Eurozone (i.e. a single currency trading block). Consequently, I should aim to maximise the internal validity of the research and recognise the limited external validity.

This paper is divided into a series of sub-parts. Firstly in the literature review, I will acknowledge the relevant former research done on the topic, learn from the various findings and derive the best-suited model to answer the aforementioned question. Secondly, in the data and methodology section, I will specify the econometric model derived based on the literature and comment on the sample used. Thirdly, the results will be presented and interpreted accordingly. Fourthly, a general conclusion and discussion will be presented to the reader, based on the results in the previous sections.

2. LITERATURE REVIEW

The following section is divided into two different subparts. First, I address a general discussion introducing the concept of exchange rates within the eurozone. This will build a thematical framework on which I will build a calibrated econometric model. Second, a more in-depth discussion of the methods used by previous papers is considered. I will focus on the different findings, as well as the methodologies and control variables. Using both subparts, a comprehensive model will be discussed in section 3.

2.1 Literature Review – The drivers of exchange rates

Mundell (1961) states that the loss of the exchange rates as a tool to manage external imbalances can be offset (or counterbalanced) by increasing the mobility of factors of production within an *optimum currency area*. His theory undoubtedly influenced the current economic model of the Eurozone. Nearly sixty years after, the empirical effectiveness of such an idea can still be questioned.

Today, research on whether the long-run purchasing power parity (PPP) is improved in post-euro formation, remains inconclusive. For instance, Huang and Yang (2015) show through a cross-sectional augmented Dickey-Fuller (ADF) equation that the mean-reverting behaviour of exchange rates is much weaker, after the introduction of the single currency. Whereas Parsley and Popper (2001) show through a sample of 82 countries that the opposite also holds for fixed exchange rate regimes across the globe.

The reason for this potential divergence in the REER has been greatly emphasised across academia. Hallet and Olivia (2015) discuss that the success of the economic integration of the EU has been impaired by the vulnerable fiscal and institutional framework of that same union. As a result, they emphasise that the "fear of integration" is at the root of the problem, and the economic performance can be considered as collateral damage. They further show that the introduction of the Euro has led to the convergence of the Southern countries' higher interest rates to the much lower interest rates of the North. This mismatch enforces imbalances which also translate to deepened current account deficits and surpluses, respectively. Comunale (2017) found that this valuation mismatch across the union was the result of inflows of bank loans, giving birth to a "Dutch disease".

Similarly, Rusek (2012) argues that the rent-seeking motivations of each member state are at the origin of the numerous imbalances. He claims that the difference of ambitions would lead some to influence the central monetary authority, as such to skew the economic vision of the whole group to their liking. As a result, this process can escalate tensions across the union and lead to the malfunction of the whole system. He further states that the disparity across exchange rates is seen as the cause of lower competitiveness, weaker growth, currency volatility, and resource misallocations. Edwards (1989) argues that keeping a persistent currency misalignment would lead to a disparity between the price of traded and non-traded goods. This mismatch would generate a resource misallocation and drive the economic performance down (which can be seen as a criticism of Mundell's aforementioned theory).

Likewise, Berka et al. (2018) study the impact of the Balassa-Samuelson model on the real exchange rate of eurozone countries. They argue that the respective sectorial productivity of the traded or non-traded sector is undoubtedly a driver of exchange rate differentials. They prove empirically that an improvement in productivity in the traded sector would result in a real appreciation, whereas an increase in the non-traded sector would lead to a real depreciation. They conclude by stressing the importance of controlling for unit labour cost and GDP per capita differentials across countries, as both are positively linked to currency appreciations. Hau (2002) adds that the level of trade openness is also a robust driving force of fluctuation in the exchange rate.

Others focus on exogenous explanations for the REER misalignments across the eurozone. Schmitz et al. (2012), while revisiting the REER methodology of the Euro, acknowledge the importance of trading partners in the computation of the variable. They emphasise that the growing importance of China is reflected in the updated trade weights of the REER computation. While the US also still plays a crucial role in the eurozone's competitiveness. Chen et al. (2012) state that China's strong demand for German machinery and equipment, and its displacement of EU's world exports by cheaper and more abundant products, led to the deepening of the current account imbalances across the eurozone. Therefore, the exposure of each member state to trade should be assessed when comparing performances.

Boar (2010) argues that the financial development of a country could be the reason for the greater vulnerability to exchange rate volatility. She states that increased capital mobility – as we observe in the EU for instance – increases the costs of maintaining a fixed exchange rates regime. As a result emerging European economies could be at risk. However, she does not find a significant cointegrating relationship to support the theory.

Given that the exchange rate fluctuations are subject to a series of socio-economic and political forces, one should acknowledge that the estimation of the relationship is bound to be biased. One should, therefore, turn to previous papers for guidance. In the literature, there are two predominant areas of research. Some focus on the impact of exchange rate volatility or misalignment on economic growth. While others look at its effect on trade balances. Here both findings are discussed, respectively.

2.2.1 Literature Review – The impact of exchange rates on growth

Communale (2017) focuses on the impact of exchange rates misalignments on the GDP growth of EU countries. She computes the misalignment using the so-called BEER method from the IMF's Consultative Group on Exchange Rate Issues (CGER), where one calculates the deviation in the real value of the effective exchange rate from its estimated behavioural equilibrium. Using a dynamic panel setup, she focuses on the cointegrating relationship between the misalignment and GDP growth. Her findings show a long-run negative relationship between the deviation in exchange rates and growth, with no significant impact in the short run. As such through time, a greater misalignment will lead to a larger decline in growth caused by a loss in competitiveness. She further states that the REER can be affected by different capital inflows (Dutch Disease), a variation in the terms of trade (Balassa-Samuelson effect) and the relative real GDP capita between the country and its trading partners. Therefore, those variables should be controlled for when assessing the significance of the results.

Aguirre and Calderón (2005) look at the real exchange rate deviations from their equilibrium values for a sample of 60 developing and industrialised countries. Using cointegration and a panel method, they find results consistent with Comunale (2017) with regards to the drivers of exchange rates fluctuations[1]. They show a significant negative relationship between real exchange rate misalignment and growth, which presents some asymmetric and non-linear properties. Indeed, it appears that overvaluations of the exchange rate lead to a greater change in growth than during undervaluations. Additionally, a greater fluctuation of the exchange rate will also lead to a disproportionately larger impact on growth than a smaller fluctuation. In fact, they find a positive relationship for small misalignments (up to 12%), which raises the possibility of an inverted J-curve phenomenon. They also find that developing countries suffer from larger RER misalignments than their industrial counterparts. This finding may not be relevant to the current research, however, it may justify controlling for the different core and periphery countries within the EU.

Berg and Miao (2010) on the other hand attempt to disentangle the reason for this relationship between the real exchange rate and economic growth. They focus on the two prevailing (contradicting) theories; The "Washington Consensus" view and the Rodrik (2008)

[1] An exchange rates appreciation is due to an increase in productivity, terms of trade, net foreign asset position and higher government spending, with regards to trading partners.

argument. Both conclusions inherently point towards the same conclusion, however, their views differ in the level of pessimism and optimism, respectively. This empirical comparison shows no statistical evidence of a favourable theory. This is due to a large identification problem, as the determinants of the fluctuation in exchange rates are likely to be drivers of growth patterns too.

Eichengreen (2008) empirically tests the relevance of exchange rate volatility in the growth process of a series of advanced, emerging and developing countries. His research does not infer exchange rate fluctuations as a driving factor of growth, but rather as a facilitating condition to promote growth. His argument considers the exchange rate as an incentive for greater resource allocations in the trading sector of a country. He further concludes that minimising the fluctuations and promoting competitive exchange rates, will lead to better growth. However, he finds weak statistical significance to support the theory.

The evidence of a negative relationship between the exchange rate and economic growth appears to be consistent with economic theory throughout empirical works. Yet some questions with regards to the internal validity remain. It appears that the identification method and the use of different controls can lead to variating results. I will now assess the existent literature on the impact of exchange rates on the current account.

2.2.2 Literature Review – The impact of exchange rates on the trade balance

According to theory, the volatility in the exchange rate should negatively impact trade openness. The portion of non-tradables that are consumed in a country determines the extent to which prices are rigid. To that end, a control for openness will be implemented as it indicates the propensity to adjust the price of a currency to an equilibrium level. Indeed, for instance, International trade theory suggests that a currency appreciation would decrease the price of imports and increase export prices. This phenomenon would lead to an improvement in the trade balance and adjust the relative terms of trade.

Arize (1994) focuses on retrieving the cointegrating relationship between the REER and the trade balance of nine developing Asian economies. He identifies long-run co-movements between the two variables with a negative relationship. As such, an appreciation of the currency leads to a worsening of the trade balance. To the extent of one's knowledge, He is the first to use an Augmented Dickey-Fuller test, an Engle-Granger method and Johansen procedure to examine the long-run relationship between the two variables. Following the extensive reasoning provided by the author, the current research will take inspiration and make use of similar criteria to establish significance. Each of the methods will be discussed further in the data and methodology section of the research.

Chen et al. (2012) document the link between the exchange rates and trade balances of each country since the accession to the euro. They show that the peripheral countries experienced an appreciation of their currency over the first decade of the formation of the EMU. This overvaluation is the result of both internal and external price movements. They further show that the current account of those countries significantly worsened during that same period, deepening the gap between core and periphery. Using a country and sector-specific fixed-effects specification, they infer a causal impact of real exchange rates on trade performance. They conclude by emphasising that amongst the drivers of the real exchange rates, the nominal exchange rate plays a predominant role as the driver of change in competitiveness in the periphery. This further confirms the robustness of the causal relationship.

Bussiere (2013) observes the non-linearities that occur in trade prices as a result of fluctuations in the exchange rates of the G7 economies. He stresses the importance of deviating from typical linear models as trade prices tend to be rigid downwards, and quantities upwards. He argues that when a currency depreciates, the exporters of that country gain in competitiveness. As a result, they opt to preserve their prices and drive their quantities upwards, but when full capacity is reached they can only increase the prices to gain rent. When faced with an appreciation (i.e. loss in competitiveness), the exporters can only lower their prices to match the market. However, these cannot go below marginal cost, forming a downward rigidity. Using polynomials to estimate this effect, statistical evidence shows a strong impact of asymmetry rather than a non-linearity. Despite these findings, he did find evidence of a non-linearity for Italy, France and Germany, implying a gap in price competitiveness in the EU.

Gnimassoun and Mignon (2015) investigate the impact of the deviations in the exchange rates on the persistence of current account imbalances in 22 countries, including 11 of the EU19. Using the BEER method introduced by the CGER, they retrieve the non-linear relationship between the two variables. They find no significant persistence during currency undervaluations and weak overvaluations. Their results gain significance for larger overvaluations, with higher significance in the eurozone even for lower overvaluations. They do stress that both the current account on the real exchange rate are endogenous variables which depend on productivity shock. The findings should, therefore, be assessed with caution.

Lane and Milesi-Ferretti (2002) cover the long-run co-movements between the external wealth (net foreign assets), the trade balance and the real exchange rates for a set of developed countries. They highlight that the long-run negative relationship between the trade balance and the real exchange rate is dependent on a series of controls. These include the relative output per capita, productivity level and terms of trade. The first control is used to ensure that the co-movement between the two variables is not subject to bias. The relative output per capita is used as a proxy for the Balassa-Samuelson effect, which drives the productivity differentials between the traded and non-traded sectors. As mentioned before, the size of the non-tradable sector can increase price rigidities within the country and lead to exchange rate misalignments. In the absence of sectoral productivity data, they argue for the validity of this proxy as output is likely to be positively correlated to the traded-sector productivity.

Arize et al. (2017) use a NARDL model to retrieve the non-linear cointegration between the changes in exchange rates and the trade balance of a set of Asian countries. They argue that the non-linearity and asymmetry of the relationship are the results of price stickiness and the "tolerance" of the national monetary authorities. Their first argument is consistent with Bussiere (2013), where prices are rigid downwards and quantities upwards. While the second argument implies that Central banks, through the management of their foreign reserves, react more to depreciation than appreciation of their currency. Both arguments imply a sharp asymmetry between both phenomena. Consistently, their results show a significant long-run impact of exchange rates on the trade balance, with a larger reaction to depreciation than appreciations.

Narayan (2006) finds a cointegrating relationship between the real exchange rate and the trade balance of China with regards to the USA. Using the bounds testing approach and an ARDL model, he discovers a significant short and long-run negative relationship between the two variables. As such, he argues that there is no evidence of a J-curve, which presents a contrasting view to former studies on developing countries. This phenomenon is generally described as a lag between the depreciation of a currency and the reaction of the trade balance. This implies that the trade balance will initially worsen following a decrease in the currency and progressively improve following the increase in competitiveness (vis-versa). Additionally, a simulated "one standard deviation" shock to China's exchange rates appears to generate a persistent misalignment of three years to its trade balance, which is somewhat consistent with Gnimassoun and Mignon's (2015) findings.

Given the extensive literature on the topic, one can reliably infer a negative long-run relationship between the exchange rate and the trade balance of a country. This being said, a concrete answer with regards to the shape and strength of these co-movements is still to be established. This research will, therefore, attempt to retrieve the non-linear and asymmetric impact of exchange rates on growth and trade balance variables respectively. To that end, I will present the data and methodologies used, in the following section 3.

3. DATA AND METHODOLOGY

This section of the research is divided into two sub-part. Firstly, I will describe the data used and derive the descriptive statistics in the Data section. Secondly, I will discuss the econometric model and its implications in the Methodology section.

3.1. Data and Methodology – Data

The data for this research covers a quarterly period from 2001q1 to 2020q1 (77 quarters). It includes the eleven first adopters of the euro, namely: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain. Greece is also included in the dataset as it joined the currency union at the beginning of the sampled period. These countries differ greatly in characteristics but are commonly segregated into two groups: the core and the periphery. Following the extensive literature on the topic, this research will use the same divide as to retrieve the notion of overvaluation and undervaluation described above. Therefore, in the core one finds Austria, Belgium, Finland, France, Germany, Luxembourg and the Netherlands. Whereas in the periphery, one finds Greece, Ireland, Italy, Portugal and Spain.

The dataset is built mainly from sources provided by the European Union agencies. The nominal exchange rate data, described as the *harmonised competitiveness indicator,* is retrieved from the ECB database. The ECB defines it as "a weighted average of nominal bilateral rates between the euro and a basket of foreign currencies", where an increase (decrease) in the index would suggest an appreciation (depreciation) of the euro with regards to the other currencies. It uses an indexed (2000q1=100) value and covers a quarterly period[2].

[2] Note that the geometric weighting method used by the ECB, follows the BIS methodology. It accounts for the share of bilateral imports and exports of a trading partner *i,* as a share of the total imports and exports of the country of interest. This suggests that countries with a higher share of the total trade are allocated a greater weight (see Schmitz et al., 2012)

To maximize the validity of the indicator, I have opted to select a NEER which take the weighted average of 42 countries as a benchmark for this research. Given that the ten largest trading partners with the EU account for approximately 65% of the EU's total trade, the selected NEER measurement would result is precise evaluation of its fluctuations. The NEER data is central to the research, consequently, all further data will be fitted using the same set of specifications. The dependent variables of this research – the level of GDP, Exports and Imports – are all retrieved from Eurostat and are denominated in millions of euros. The other control variables are retrieved from a set of reputed data sources and are found in Table 1 below[3].

Variables	*Sources*	*Frequency*	*Denomination*
NEER 42 countries	ECB	Quarterly	Index 2001q1=100
NEER Euro Area	ECB	Quarterly	Index 2001q1=100
GDP	Eurostat	Quarterly	Millions of Euro
Exports/Imports	Eurostat	Quarterly	Millions of Euro
Long-Term Interest Rates	WorldBank	Quarterly	Percentage %, Actual
ECB Assets	FED of st.Louis	Quarterly	Millions of Euro
Population	OECD	Quarterly	Thousands
Unemployment	Eurostat	Quarterly	Percentage %, Seasonally Adj.
Unit Labour Cost	OECD	Quarterly	Yearly Change, %
Terms of Trade	WorldBank	Yearly	Index, 2015=100

Table 1: Description of the data sources.

Most of the selected variables benefit from the same denominations. This may aid in the interpretation of the coefficients. However, the sample is most likely biased by the size of certain countries in the sample. As such, I will transform some of the aforementioned variables to shorten the distribution. For instance, the variables denominated in euros will be replaced by their logged values. The GDP will be divided by the population of the country, and the current account variables will be set as ratios of their national GDP. The descriptive statistics can be found in Table 2 below. Note that the table includes the order of integration of each variable. This research uses the Im-Pesaran-Shin unit-root test, which assesses whether there is a presence of a unit root in all of the panels. For the non-stationary variables, the table features the descriptive statistics for the differenced value. Given that the NEER gap and the

[3] Note that some of the missing data was completed using data from the FED of st. Louis.

dependent variables will be assessed in the long-run specification, both the level and the differenced values are represented.

Due to the extensive number of control variables, I will refrain from describing the impact of each on the dependent variables. For an in-depth analysis of the impact, the reader should consider the correlation analysis in the result section.

Variables	*Order of Integration*	*p-value*	*Mean*	*Std. Dev.*	*min*	*max*
NEER 42 countries	I(0)	0.000	109.258	7.756	83.577	125.053
NEER Euro Area	I(0)	0.000	110.104	7.341	88.603	122.462
NEER Gap						
Long-run	I(1)	0.999	-0.846	2.489	-8.241	6.112
Short-run	I(0)	0.000	0.001	0.372	-1.921	2.875
Ln(Exports/GDP)						
Long-run	I(1)	0.134	0.939	0.054	0.822	1.088
Short-run	I(0)	0.000	0.000	0.008	-0.043	0.027
Ln(Imports/GDP)						
Long-run	I(1)	0.134	0.936	0.045	0.871	1.071
Short-run	I(0)	0.000	0.000	0.008	-0.043	0.027
Ln(GDPperCapita)	I(1)					
Long-run	I(1)	0.485	2.061	0.423	1.124	3.299
Short-run	I(0)	0.000	0.006	0.053	-0.155	0.243
Ln(ECB Assets)	I(1)	1.000	0.023	0.057	-0.089	0.308
Long-Term Interest Rates	I(1)	0.991	-0.064	0.585	-7.526	5.703
Unemployment	I(1)	0.507	0.007	0.471	-1.9	2.6
Unit Labour Cost	I(0)	0.000	1.553	2.962	-18.801	12.463
Terms of Trade	I(1)	0.289	-0.005	0.805	-5.683	5.577

Table 2: Descriptive Statistics of the Variables used in the Models

3.1. Data and Methodology – Methodology

The methodology of this research is inspired by the reasoning from Arize et al. (2017), who assessed the asymmetric non-linear cointegration between exchange rates and trade balances of eight Asian countries.

The concept of cointegration is famously coined by Engle and Granger (1987). Their research shows that two non-stationary processes I(1) which have no mean-reverting properties when assessed singularly, become stationary I(0) when combined. This linear combination between the two variables is defined as the long-run equilibrium relationship.

The method allows for the analysis of the relationship between two variables from multiple angles.

On the one hand, the cointegration allows for the separation of the long-run and short-run relationship through the error correction term (ECT)[4]. This intertemporal specification allows to uncover the long-run impact of the exchange rate (as often documented in academia) on GDP and the Current Account, but can also be used to nuance the controls. For instance, Comunale (2017), suggested to proxy investment by FDI in the long-run and portfolio investment in the short-run.

On the other hand, the asymmetric analysis of the exchange rates can highlight the differences in impact between an appreciation and a depreciation. Arize et al. (2017) further emphasise that this division between the upward and downward movement allows controlling for the asymmetric response by the central banks, depending on their tolerances. As for the eurozone, each country is bound by the same (European) Central Bank. Therefore, in this research, the aforementioned tolerance is proxied for by the change in the ECB asset holdings and the long-term interest rates of each country.

Moreover, the objective of the research is to uncover the significant differences across countries. With two sub-samples, representing the undervalued (core) and the overvalued (periphery) position of a country relative to the average EA-NEER, as in Vieira and MacDonald (2012), I will assess how the euro affects the two groups of countries.

Additionally, the Bassala-Samuelson model argues that the persistence in the exchange rates are driven by productivity changes in the tradable and non-tradable sectors of each country; with an increase in productivity in the tradable sector leading to appreciation, while an increase in the non-tradable leads to depreciation. Some papers have proxied the tradable sector as the export-to-GDP ratio, while Rogoff (1996) or Berka et al. (2018), used the GDP-per-Capita or the unit labour cost, respectively. This research will account for those controls depending on the chosen dependent variable.

Furthermore, the financial crisis of 2007-08 has been a turning point in the world's economic performance and should be acknowledged. This exogenous shock situated in the middle of the dataset is expected to bias the data negatively. However, it is also expected to uncover some underlying differences across countries. This turning point will be registered as a dummy variable which will be implemented, along with the other aforementioned dummies.

[4] which coincidentally also retrieves the speed of adjustment of the variables (Lartey et al., 2012)

Thus, we can read the following dynamic fixed-effects autoregressive distributed lag specification for the research:

$$\Delta y_{t,i} = \alpha_0 + \sum_{j=1}^{n} \beta_i \Delta y_{t-j,i} + \sum_{k=0}^{n} \delta_i \Delta X_{t-k,i} + \sum_{l=0}^{n} \varphi_1 T_{t-l,i} + \varphi_2 D_{t,i} \cdot \Delta X_{t,i}$$
$$+ \theta\left[y_{t-1,i} - \gamma_i X_{t,i} - \rho_i D_i \cdot X_{t,i}\right] + \tau_i + \varepsilon_{t,i}$$

Where y is the set of dependent variables, for a country i at time t. X is the NEER gap and T is the set of non-binary controls, for a country i at time t. D is the set of dummy variables used to control for the differences across countries i at time t, interacted with the NEER gap. θ is the group-specific speed of adjustment coefficient, which is comprised within the [0; -1] bandwidth. $ECT = \left[y_{t-1,i} - \gamma_i X_{t,i} - \rho_i D_i \cdot X_{t,i}\right]$ is the error correction term. τ_i and $\varepsilon_{t,i}$ are the country-specific fixed-effects and the error terms, respectively.

Based on the dimensions of the heterogeneous panel where $T > N$ (77>12), I have opted to follow the ARDL specification. The selection of the model is completed based on the results of a Hausman test. Given the respective p-value of 0.9844, 0.9744 and 0.9870 for the GDP, Export and Import model, the Dynamic Fixed Effects specification is preferred over the Pooled-Mean Group specification.

Using the above-mentioned specification, I will first assess the long-run and the short-run impact of the NEER on the level of GDP per capita. Then, the same inference will be assessed for the Export and the Import to GDP, respectively. I choose to separate the current account variable into its two underlying components for two reasons. First, the Im-Pesaran-Shin unit-root test suggests that the current account is stationary in at least some of the panels, therefore making the research impossible. Second, the division of the variable will allow to identify the significant driving forces of the current account and lead to a better understanding of the relationship.

As such, each of the two tests will follow the same methodology.

First, a general correlation analysis between the NEER gap, the dependent variables, and a series of controls will help assess the relationship between each variable. I will use the economic theory as well as the results in the literature review to derive the meaning and the robustness of each correlation coefficient.

Second, The optimal lag selection for the ARDL model will be measured based on two popular criteria: the Schwarz/Bayesian and the Akaike Information Criterion. Based on the results given for each of the twelve countries, I will select the optimal lag length for the sample and use it consistently across the model specifications.

Third, the Pedroni test – a cointegration test – will analyse the presence of long-run co-movements between the NEER gap, the dependent variable(s) and some controls. It is commonly used in the literature when analysing panel data. It has the advantage of controlling for cross-sectional dependence and allows for heterogenous intercepts. Making use of a (modified) Phillips-Perron and an augmented Dickey-Fuller test, it tests for the alternative hypothesis of the presence of cointegration in all of the sampled panels. From which, the first models can be estimated.

Fourth, a dynamic fixed-effects autoregressive distributed lag model will be derived in the full sample. I will first assess the linear relationship, then test for possible asymmetries and non-linearities. In the case of asymmetry, using an interaction term, I will interact the (differenced) NEER gap with a dummy which takes the value of 1 when the change in the NEER gap is negative. The significance and sign of the term will indicate the presence of a (short-run) long-run asymmetry. Similarly, in the case of non-linearity, an interaction term with a dummy taking the value of 1 when a change in deviation greater than one standard deviation will be used to derive the concavity of the relationship.

Fifth, once a comprehensive model is derived for the full sample, the same estimations will be computed for the core and periphery region of the euro area. I hope that the differences in the coefficients will help outline the differences across countries.

4. RESULTS

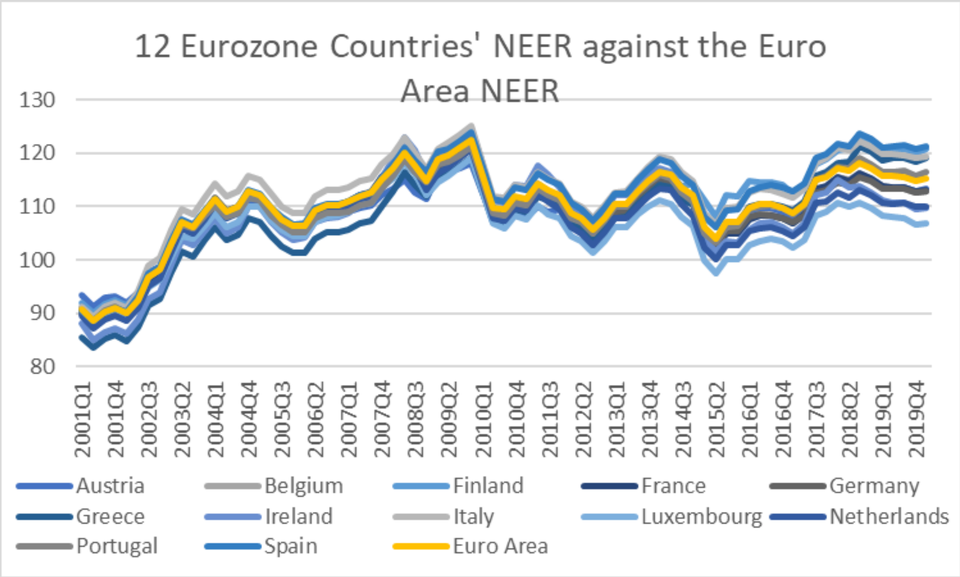
I will now present the results using the data and methodology described in the aforementioned section 3. The following section will be divided into three main sub-parts, which will help retrieve a complete understanding of the co-movements between the selected variables. To this end, I will first attempt a graphical analysis of the exchange rate variables through time. Once a clear understanding of the differences in the NEER across the eurozone countries is established, I will analyse the impact of the NEER on *GDP* and the *Current Account*. Both sub-parts will proceed similarly. First, correlation analyses will outline the relationship across variables and potentially indicate the presence of undesirable multicollinearities. Second, following the Schwarz/Bayesian Information Criterion (S/BIC), a simple optimal lag selection test will indicate the preferred short-run lag length between the NEER and the dependent variables. Third, using the Pedroni test, a cointegration analysis will determine the presence of long-run co-movements between the two variables. Fourth, a model estimation will be derived based on the information gathered in each of the previous sub-sections. In this sub-part, I will first derive a basic linear model, then check for possible asymmetries and non-linearities. Finally, the robustness of the results will be assessed by differentiating between various sub-samples (i.e. Core and Periphery). This last part will drive the discussion of the research and give quantitative insights into the disparity between the different regions of the EU.

4.1. Results – Graphical Analysis

In this section, I will assess the differences and similarities in the evolution of the NEER across a sample of twelve eurozone countries. To do so, I will focus on the co-movements of the NEER across the total sample, the individual progression of the variable across each country, and the different patterns in terms of deviations from the Euro Area NEER.

Figure 1 below shows the progression of the national NEER of 12 eurozone countries and the NEER of the euro area. The first main observation shows that each of the 13 trends are heavily correlated. The progression of the euro area curve (yellow) is closely accompanied by each of the other countries with no distinguishable deviations from the fluctuations in the Euro. Given that each of the countries seem to be bound by a common trend, this finding suggests promising results with regards to the assumption of a common long-run cointegration across the panel. Additionally, It appears that the differences in the exchange rates represent only a small part of the disparity across euro countries. Figure 1 in Appendix A, shows the progression of the REER of each of the 12 countries, with regards to the Euro Area REER. A comparison of both figures shows that the REER is subject to greater deviations from the Euro average. This is due to the calculation of the variable itself, where the NEER only accounts for the forex movements, while the REER includes the price levels of a country relative to a basket of countries. I believe that the NEER measurement is preferable for this research as it promotes the notion of exogeneity in the fluctuations in the euro.

Figure 1: The NEER of Twelve Euro Area Countries against the NEER of the Eurozone

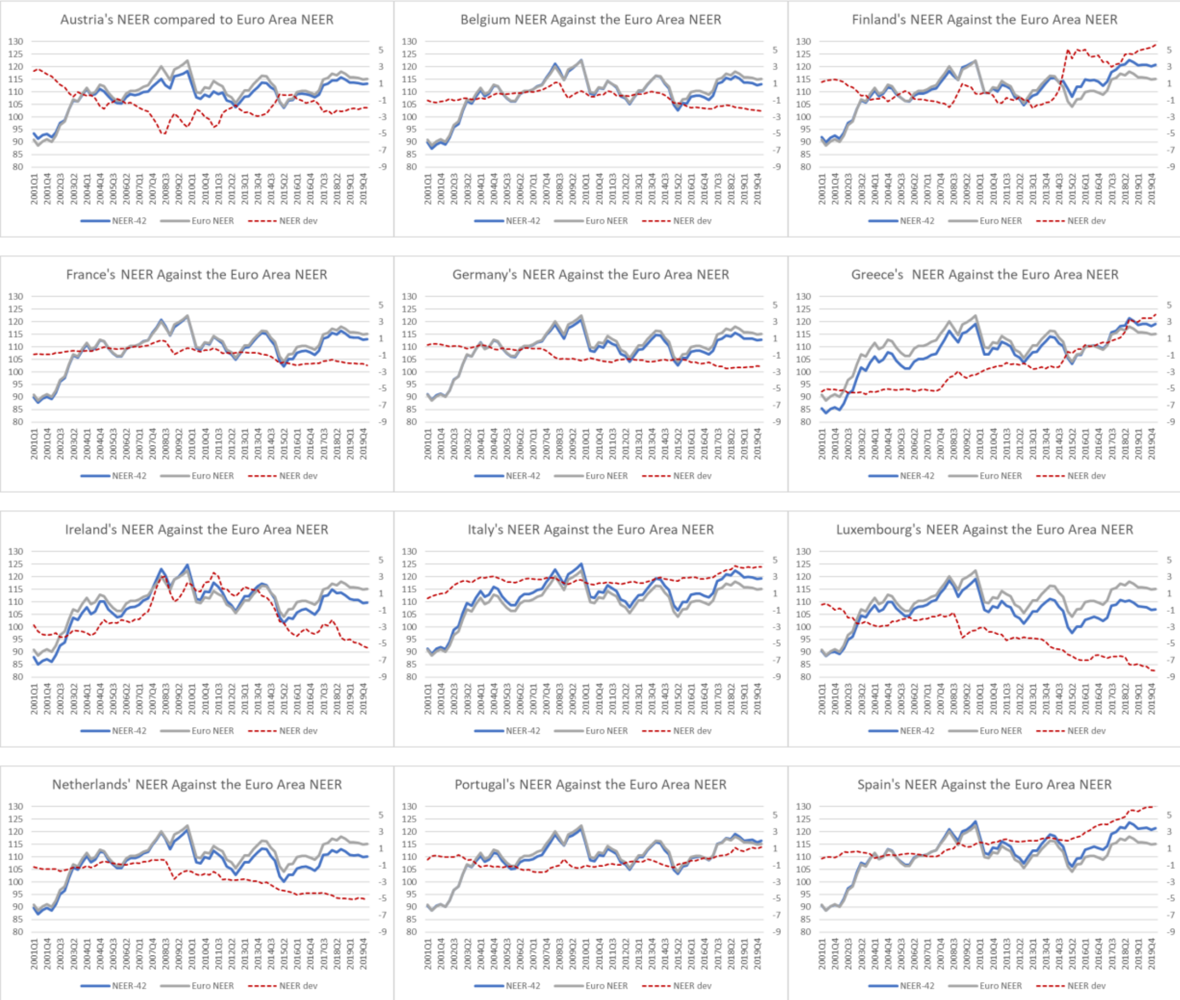


The second observation, which is derived from the comparative analysis of the NEER and the REER in the first observation, suggests that the concept of undervaluation and overvaluation – highly present in the literature of the euro – loses its "clear-cut" division between core and periphery in the NEER analysis. This suggests that these observations are more likely to be the result of a difference in purchasing power parity, rather than forex movements. As such in this research, the concepts of undervaluations and overvaluations will not be assessed but implied when comparing the performance of the core and periphery of the EA.

The third observation indicates the presence of a possible break in 2008, as each of the variables followed a positive trend until the great recession and eventually levelled off to a relatively flat trend, up until 2020. The double-dip recession of the eurozone (2008-12) does not appear to have a significant impact with regards to the NEER across countries. Whereas, the REER witnessed a clearer negative trend during that same period. This suggests that the REER is indeed greatly influenced by a change in PPP.

I will now address the individual progression of the NEER across the 12 eurozone countries. Figure 2 below shows the NEER of a given country against the euro area average. The following graphs also include a curve indicating the deviation of the country's NEER from the EA's NEER.

Figure 2: The NEER of Twelve Eurozone Countries against the EA-NEER



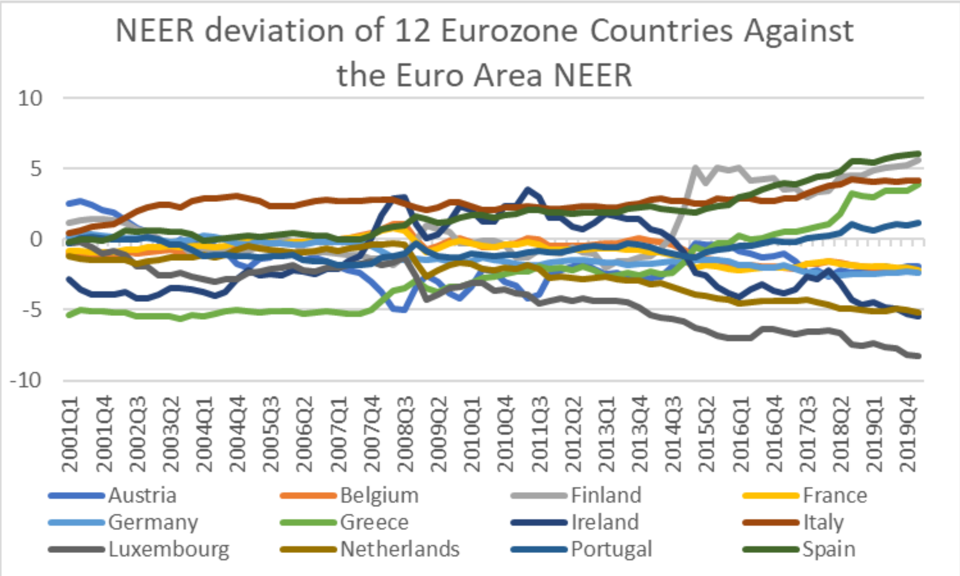
From this, three types of countries can be observed. The countries with increasing positive deviations, deepening negative deviations, and the relatively constant deviations. In the first group, countries like Finland, Greece, Ireland (pre-2008), Italy and Spain, show a relatively positive and increasing deviation from the EA-NEER. This suggests that following the literature, these are being (increasingly) overvalued and are progressively less competitive as a result. Note that Finland is an outlier in this model. According to DG ECFIN of the European Commission (2015), Finland was subject to a sharp loss in the demand in its major export sectors (i.e. Electronics and paper). The wages could not adjust and drove the unit labour costs up, which worsened the country's competitiveness, and consequently, inflated the NEER.

The second group, which includes Belgium (post-2008), Germany, Ireland (post-2008) Luxembourg, and the Netherlands, includes the countries which have gained relative competitiveness over their EA partners. This implies that they should be "better-off" within the Euro. The third group, which includes Austria, France and Portugal, are relatively well tied to the EA-NEER. This suggests that their economic performances should be in line with the European average.

As suggested before, the same "clear-cut" division can hardly be inferred compared to the REER measurement. However, these findings remain consistent with the theory and suggest a certain disparity between the core (group two) and the periphery (group one).

As such, in this research, I will focus on the deviations from the EA-NEER as shown in Figure 3 below.

Figure 3: The NEER deviations of Twelve Eurozone Countries from the EA-NEER



As discussed above, the sample contains countries which experience consistent positive and negative deviations. However, it appears that the deviations, and consequently, the differences across countries are further deepened as a result. This may suggest a path of divergence as suggested in the literature above.

Given the preliminary results of section 4.1, one should acknowledge the diverging nature of NEER across different EA countries, when assessing the long-run relationship between the NEER and the dependent variables.

4.2. Results – NEER on GDP

This section of the paper will consider the relationship between the NEER and GDP. I will first perform a correlation-analysis to establish a clear outline of the relationship between the two variables of interest and a series of controls. Second, I will follow the Schwarz/Bayesian Information Criterion (S/BIC) to indicate the preferred short-run lag length between the NEER and GDP. Third, the presence of a cointegration will be determined using the Pedroni test. Fourth, a model estimation will be derived based on the information gathered in each of the previous sub-sections. In this sub-part, I will first derive a basic linear model, then check for possible asymmetries and non-linearities. Finally, the robustness of the results will be assessed by differentiating between various sub-samples (i.e. Core and Periphery).

4.2.1 Results – NEER on GDP – Correlation Analysis

Table 3 below shows the correlation analysis between GDP and the deviation in the NEER across the twelve sampled countries. Using theory on the topic, I will derive the general relationship between the NEER and GDP, as well as, the impact of a set of controls on them.

	NEER Dev	*GDP*	*GDP per Cap*	*Terms of Trade*	*ECB Assets*	*Unit Labour Costs*
NEER Dev	1					
GDP	0.2204	1				
GDP per Cap	-0.4742	0.1803	1			
Terms of trade	0.1095	-0.0341	0.0991	1		
Interest Rates	0.1054	-0.2017	-0.4212	-0.1966	1	
Unit Labour Costs	-0.1197	-0.0138	0.0521	0.0420	-0.0953	1

Table 3: NEER and GDP correlation analysis for the full sample

Table 3 shows the correlation between six key variables which will be further described below. Given the size of the correlation coefficients (Corr. Coef.< 0.7), it can be assumed that the dataset is not subject to multicollinearity.

The link between GDP and the deviation in the NEER shows a positive value. Therefore, a greater positive (negative) deviation from the EA-NEER will lead to a higher (lower) GDP[5]. This result is not consistent with the predominant theory on the subject and will lead to a biased result, as the correlation is affected by the size of the economy rather than the variation of the variable itself. As a result, the GDP per capita should be used as a measure of GDP instead, where the expected negative relationship is safeguarded.

[5] Note that this result is mainly driven by the Periphery, as seen in Appendix B.II

The link between the deviation in the NEER and terms of trade shows that an appreciation of the currency will lead to relatively more expensive exports, therefore, improving the terms of trade. However, when assessing the link between GDP per Capita and NEERdev, there appears to be some disparity between the core and periphery countries (Appendix B.I/II, Table(s) 1 and 2) where an improvement of the terms of trade can hurt the level of GDP per capita in core countries. This may, for instance, be the result of competing economies supplying cheaper goods and displacing local exports, as seen in the literature review.

The rate of interest is seen to be positively related to NEERdev and negatively related to GDP per capita. These results are consistent with economic theory. On the one hand, an increase in the interest rate will lead to a higher demand for the currency and result in an appreciation of the currency, increasing the NEER gap. On the other hand, the interest rate is also considered an expansionary and contractionary tool. It is lowered in times of economic downturns and increased to mitigate economic expansions. This control of growth, therefore, shows a negative relationship to GDP per capita.

The unit labour costs, in this research, are used as a differentiating tool between the twelve economies. The literature suggests that countries with higher unit labour costs benefit from higher productivity. Hence, the negative relationship with NEER gap and the positive relationship with GDP per capita, as generally observed in core euro countries.

4.2.2 Results – NEER on GDP – Optimal lag length criterion

Table 4 below shows the optimal lag length for an autoregressive distributed lag model comprising the log GDP per Capita and the NEER gap, for each country. The optimal lag selection is measured based on two popular criteria: the Schwarz/Bayesian and the Akaike Information Criterion. Based on the results given for each country, I will select the optimal lag length for the sample.

Firstly, it appears that the results are relatively consistent across both information criteria. The differenced log GDP per capita shows an autoregressive pattern in the short-run. The change in GDP per Capita shows a high statistical significance for up to four quarter across all sampled countries (except Ireland). Based on the AIC and the S/BIC, I will select a lag period of one year (4 quarters) in all future computations of the relationship between the differenced ln(GDPperCapita) and the differenced NEERdev.

Country	*ARDL(S/BIC)*	*Adj R-squared*	*ARDL(AIC)*	*Adj R-Squared*	*Observations*
Austria	(4, 0)	0.796	(4, 2)	0.806	73
Belgium	(4, 2)	0.931	(4, 2)	0.933	73
Finland	(4, 0)	0.815	(4, 0)	0.815	73
France	(4, 3)	0.781	(4, 4)	0.788	73
Germany	(4, 0)	0.469	(4, 0)	0.469	73
Greece	(4, 0)	0.679	(4, 1)	0.688	73
Ireland	(1, 0)	0.021	(2, 1)	0.067	73
Italy	(4, 0)	0.928	(4, 0)	0.928	73
Luxembourg	(4, 3)	0.737	(4, 3)	0.737	73
Netherlands	(4, 0)	0.851	(4, 4)	0.869	73
Portugal	(4, 0)	0.677	(4, 3)	0.696	73
Spain	(4, 0)	0.888	(4, 1)	0.890	73

Table 4: Optimal Lag Length Determination for ARDL(ln(GDPperCapita), NEERdev)

Secondly, the differenced NEER gap shows a weak short-run statistical significance for most of the sampled countries. Indeed, for most of them, the S/BIC deems optimal to drop the variable altogether in the short-run. This result is consistent with the literature and will not be contested. However, the AIC shows greater variability in the lag selection and appears to be more lenient in the number of lags used. It should also be noted that those results are robust to the addition of control variables.

Considering the relatively identical R-squared in both criteria and the more consistent lag-lengths recommended by the S/BIC. One should, therefore, focus on the relatively more conservative and consistent S/BIC as a determinant of optimal lag selection in one's model specification. As a result, the model in section 4.2.4 will be an ARDL(4, 1, …). I will keep the lagged NEER gap in the specification for economic significance even if statistical significance is not reached.

<u>4.2.3 Results – NEER on GDP – Cointegration Analysis – Pedroni Test</u>

The Pedroni test – a cointegration test – analyses the presence of long-run co-movements between two or more variables. It is commonly used in the literature when analysing panel data. It has the advantage of controlling for cross-sectional dependence and allows for heterogenous intercepts. Making use of a (modified) Phillips-Perron and an augmented Dickey-Fuller test, it tests for the alternative hypothesis of the presence of cointegration, in all of the sampled panels. Table 5 shows the following results.

Test/Criterion	*t-statistic*	*p-value*
	Without Controls	
Modified Phillips-Perron	-2.812	0.0025
Phillips-Perron	-4.013	0.0000
Augmented Dickey-Fuller	-8.244	0.0000
	With Controls	
Modified Phillips-Perron	-9.269	0.0000
Phillips-Perron	-12.322	0.0000
Augmented Dickey-Fuller	-15.928	0.0000

Table 5: The Pedroni Test for Cointegration between the ln(GDPperCapita) and NEER-dev.

It seems that the long-run relationship between the NEER gap and the log(GDP per capita) is statistically significant at all levels. All three tests show the presence of a cointegration across all panels. This result appears to also gain robustness after controls are included. Therefore, a model covering the long-run relationship between the two variables can be confidently estimated.

4.2.4 Results – NEER on GDP – Model Estimation

The aforementioned sections showed that there exists a long-run relationship between the NEER gap and the GDP per capita. This section will assess the significance of the relationship as well as its asymmetric and non-linear properties in the short and long-run. To that end, the following results will be divided into two sub-parts. First, using a dynamic fixed-effects specification, an autoregressive distributed lag model will be used to assess the robustness of the relationship to a series of controls. Second, multiple asymmetries and non-linearities will be added to the model to retrieve the shape of the relationship.

Using the relevant results of the S/BIC lag length criterion and the Pedroni test for cointegration, the following ARDL estimations are derived in Table 6. Note that the selection of control variables is derived from the literature review and the correlation analysis in 4.2.1.

Other controls have been omitted if they lacked significance or showed no distinguishable impact on the relationship between the NEER deviation and GDP per Capita.

The first estimation (1) shows the ARDL(4, 1) model suggested by the S/BIC criterion. The expected negative relationship between the NEER gap and the ln(GDPperCapita) is consistent with the literature in the short- and long-run. The relationship in the long-run is significant at a 5% level and shows a relatively weak impact of -0.041 to any unit of deviation in the NEER. Contrastingly, the results show no significant relationship between the two variables in the short-run. Therefore any deviation in the NEER gap should have no impact on the change of GDP growth per capita. This is consistent with the prevailing academic literature on the subject.

Variables	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
			Long-run				
NEER gap	-0.041** (0.017)	-0.055 (0.034)	-0.050*** (0.016	-0.049*** (0.016)	-0.048*** (0.016)	-0.050*** (0.016)	-0.053*** (0.017)
			Short-run				
ECT	-0.025*** (0.005)	-0.015* (0.008)	-0.028*** (0.005)	-0.027*** (0.005)	-0.027*** (0.005)	-0.027*** (0.005)	-0.026*** (0.005)
d.Ln(GPDperCap)							
t-1	-0.173*** (0.023)	-0.195*** (0.026)	-0.224*** (0.023)	-0.219*** (0.023)	-0.219*** (0.023)	-0.220*** (0.023)	-0.226*** (0.023)
t-2	-0.121*** (0.023)	-0.140*** (0.026)	-0.184*** (0.024)	-0.178*** (0.024)	-0.181*** (0.024)	-0.178*** (.024)	-0.170*** (0.024)
t-3	-0.140*** (0.023)	-0.158*** (0.025)	-0.199*** (0.024)	-0.196*** (0.023)	-0.199*** (0.024)	-0.196 (0.024)	-0.210*** (0.024)
t-4	0.768*** (0.023)	0.753*** (0.025)	0.708*** (0.023)	0.715*** (0.024)	0.713*** (0.024)	0.714*** (0.024)	0.706*** (0.023)
d.NEER gap	-0.001 (0.002)	-0.002 (0.002)	-0.002 (0.002)	-0.002 (0.002)	-0.002 (0.002)	-0.002 (0.002)	-0.002 (0.247)
Post-2008		-0.003 (0.002)					
d.Unemployment			-0.012*** (0.002)	-0.011*** (0.002)	-0.012*** (0.002)	-0.011*** (0.001)	-0.012*** (0.002)
d.ln(ECB Assets)				-0.021* (0.012)	-0.022* (0.012)	-0.022* (0.012)	-0.000 (0.000)
d.Interest Rate					0.001 (0.001)		
d.Terms of Trade						-0.000 (0.000)	
d.Exports to GDP							0.076*** (0.021)
Constant	0.054*** (0.011)	0.037** (0.015)	0.062*** (0.011)	0.059*** (0.011)	0.061*** (0.011)	0.060*** (0.011)	0.058*** (0.011)

Table 6: Dynamic Fixed-Effects ARDL estimation of the impact of the NEER gap on GDP per Capita. Note: The numbers in parentheses represent the standard error of each coefficient. The *, ** and *** descriptions indicate the statistical significance at a 10%, 5% and 1% level, respectively.

The error correction term (ECT) is within the [0; -1] bandwidth and therefore shows a long-run convergence of the model. It indicates the speed at which a short-run deviation from the equilibrium will converge again to a long-run steady state. In this instance, the ECT is highly significant and shows a weak rate of convergence of 2.5% per quarter. This implies that the half-life of the disequilibrium is approximately 27.4 quarters[6] or 6.85 years. This implies that any deviations in the NEER gap of a eurozone member will take on average 7 years to dissipate at 50%.

The second (2) estimation includes a dummy variable. This time variable accounts for the impact of the 2008 crisis. It can be assumed that the GDP worsened across the world and the *Post-2008* dummy should, therefore, outline the drop in the variable. However, the short-run (and the long-run[7]) impact is not significant and appears to interfere with the overall significance of the model. Indeed, the model disconnects the two variables and suggests no long-run significance. I will, therefore, omit this variable from the GDP per Capita analysis and assume that, in the long-run, the relationship is safeguarded.

The third (3) model includes the impact of the change in the rate of unemployment. The variable shows a highly significant negative impact on the change in GDP per capita. Its impact is relatively small[8], however, it is expected since both variables fluctuate similarly throughout the sample. This control appears to enlighten the model as it increases the economic significance of all the variables. A higher level of unemployment is synonymous of a less performing economy. Hence, controlling for it allows to better control for the difference between a "well-performing" and "struggling" economies.

The fourth (4) model attempts to control for the change in the reserves of the ECB. With this result, it is assumed that the central bank will react to economic downturns and manage the eurozone's economic performance. This variable is expected to be negatively correlated with the GDP per Capita growth. Controlling for this variable should also give a first insight into the possible asymmetric fluctuation of the NEER. The model predicts that increasing the ECB reserves will only result in a rather insignificant impact on the GDP per capita growth. Additionally, with regards to the third model (3), only a relatively small decrease in the coefficient of the NEER is observed. This might suggest no dampening effect.

[6] This number is retrieved with the following computation: $(1 - ECT)^n = 0.5$
[7] This result is kept to the author, as it showed no significance.
[8] Note that the standard deviation of the ΔGDPperCapita and ΔUnemployment is 0.053 and 0.471, respectively.

Models (5) and (6) control for the change in interest rates and the terms of trade. The first control, similarly to unemployment, is used as a measurement of the economic performance of the selected member states. It indicates the propensity of a country to experience an economic downturn, as well as the propensity of being subject to cash inflows, generating a case of Dutch disease in some countries. Thus, higher interests rates should be correlated with lower growth and currency appreciation. In this model, this impact is not significant. Similarly, a change in the terms of trade should indicate a change in the competitiveness of a country, which should be reflected in the NEER and GDP. However, no statistical significance is found to support this assumption. Therefore, neither of the two controls will be included in the final model.

In the last model (7), I include the change in exports to GDP as a proxy for trade openness, as well as the size and performance of the tradable sector. Following the Balassa-Samuelson theorem, an expansion of the tradable or non-tradable sector would lead to an appreciation or depreciation of the currency, respectively. A dominant export sector would also yield a current account improvement, thence a GDPperCapita increase. The model estimation (7) shows a strong significant and positive impact of the change in export on the change of GDP per Capita. Additionally, a deepening of the long-term impact of the NEER gap is found. This would suggest a significant link between the size of the export sector and the NEER gap, as described in the literature. Moreover, the change in Exports to GDP appears to displace the significance of the impact of the ECB holdings. I will, therefore, remove this control from the final model.

The link between the NEER gap and the GDP per Capita is robust to a set of highly significant controls. Indeed, the size of the long-term coefficient remains significant throughout the estimations and slightly increases in size after controlling for multiple economic variables. The error correction term remains consistent and shows a relatively identical half-life of convergence throughout the models. Moreover, the size and significance of the constant term persist throughout the estimations, confirming the assumption of a stable relationship between the two variables.

I will, therefore, use the estimation (7) as a base model to test for asymmetries and non-linearities. As such, the following tests are found in Table 7 below. Note that the estimation (1) is the same as the estimation (7) in Table 6, at the exception of the *ECB Assets* control not being included. The following model estimations (2) and (3) will control for the potential asymmetric impact of the NEER gap on the GDP per capita. To do so, I will include an interaction term with a dummy variable which takes the value of 1 when the change in the NEER gap becomes negative. This implies that for countries which have a positive NEER gap, the negative change will result in a NEER closer to the EA-NEER. Whereas countries with a negative NEER gap, a negative change will result in the deepening of the gap. Therefore, one should consider this interaction term as a gain in competitiveness in the long-run.

Variables	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Long-Run						
NEER gap	-0.052*** (0.016)	-0.059*** (0.020)	-0.047*** (0.016)	-0.048*** (0.016)	-0.033** (0.016)	-0.033** (0.016)
NEERgap×Neg.		0.013 (0.020)				
NEERgap×Std.Dev.					-0.057** (0.027)	
Positive Std.Dev.						-0.024 (0.034)
Negative Std.Dev.						-0.087** (0.036)
Short-Run						
ECT	-0.028*** (0.005)	-0.027*** (0.005)	-0.027*** (0.005)	-0.027*** (0.005)	-0.027*** (0.005)	-0.028*** (0.005)
d.Ln(GPDperCap)						
t-1	-0.228*** (0.023)	-0.227*** (0.023)	-0.230*** (0.023)	-0.231*** (0.023)	-0.232*** (0.023)	-0.233*** (0.023)
t-2	-0.172*** (0.024)	-0.172*** (0.024)	-0.176*** (0.024)	-0.175*** (0.024)	-0.179*** (0.024)	-0.180*** (0.024)
t-3	-0.212*** (0.024)	-0.211*** (0.024)	-0.212*** (0.024)	-0.212*** (0.024)	-0.214*** (0.024)	-0.216*** (0.024)
t-4	0.702*** (0.023)	0.703*** (0.023)	0.701*** (0.231)	0.701*** (0.023)	0.702*** (0.023)	0.700*** (0.023)
d.NEER gap	-0.002 (0.002)	-0.002 (0.002)	-0.009*** (0.003)	-0.005 (0.005)	-0.009*** (0.003)	-0.009*** (0.003)
d.Unemployment.	-0.012*** (0.002)	-0.012*** (0.002)	-0.012*** (0.002)	-0.012*** (0.002)	-0.012*** (0.002)	-0.012*** (0.002)
d.Exports to GDP	0.076*** (0.002)	0.076*** (0.021)	0.072*** (0.021)	0.073*** (0.021)	0.073*** (0.021)	0.073*** (0.021)
d.NEERgap×Neg.			0.014*** (0.005)	0.014*** (0.005)	0.016*** (0.005)	0.018*** (0.005)
d.NEERgap×Std.Dev				-0.005 (0.005)		
Constant	0.061*** (0.011)	0.059*** (0.011)	0.037** (0.015)	0.062*** (0.011)	0.062*** (0.011)	0.063*** (0.011)

Table 7: Dynamic Fixed-Effects NARDL estimation of the impact of the NEER gap on GDP per Capita. Note: The numbers in parentheses represent the standard error of each coefficient. The *, ** and *** descriptions indicate the statistical significance at a 10%, 5% and 1% level, respectively.

The model estimation (2) shows the impact of the "gain in competitiveness" in the long-run. The 0.013 coefficient has two implications. In the case of an "undervalued" (core) country with a negative NEER gap, a negative change in the NEER deviation will result in a milder increase in the GDP per Capita[9]. Whereas in an "overvalued" (peripheral) country with a positive NEER gap, a negative change in the NEER deviation will result in a milder decrease in the level of GDP per capita[10]. Additionally, due to the binary property of the interaction term, an identical result with the same level of significance holds for positive deviations (i.e. Coeff. = -0.013). However, this result is not statistically significant and could be biased by the large disparity between both groups of countries. Hence, this result should be further considered in the regional model estimation in section 4.2.5.

The model estimation (3) retrieves the same (more pronounced) asymmetry in the short-run. However, in this instance, the result is highly significant and appears to drive the significance of the short-run change in the NEER gap. This finding implies that a decrease in the short-run NEER gap would even lead to a small reduction in the GDP per capita[11]. This result might suggest the presence of a J-curve phenomenon between the short- and long-run specification. The existence of a short-run relationship between the ΔNEER gap and the ΔGDP per capita is rarely inferred and diverges from the popular literature on the subject. As such, one should treat this result with caution and assess its robustness. Note that this inconsistent sign only holds for a negative change in the NEER gap. A positive change in the NEER gap will still result in a short-run GDP per capita decrease. This implies that both NEER movements will result in a decrease in the GDP per capita.

The potential asymmetries of the full sample have been assessed. The following estimations (4) to (6) will attempt to retrieve the short-run and long-run non-linearities of the model. To do so, I will consider an interaction term with a dummy variable which takes the value of 1 when the change in the NEER gap surpasses a one standard deviation increase or decrease. This implies countries which have a change in their NEER gap which is greater than ± 0.372[12].

The models (4) and (5) look at the non-linearities in the short- and long-run, respectively. In the first model (4), large deviations in the ΔNEER gap do not have a significant

[9] $(-1) \times (-0.059 + 0.013) = 0.046 < 0.059 = (-1) \times (-0.059 + 0)$
[10] $1 \times (-0.059 + 0.013) = -0.046 > -0.059 = 1 \times (-0.059 + 0)$
[11] $(-1) \times (-0.009 + 0.014) = -0.005.$
[12] Note that this implies a value outside of the following bandwidth [-0.371; 0.373] as it focuses on the standard deviation from the mean change in the log(GDPperCapita).

effect on GDP per Capita growth. In fact, they reduce the significance of the ΔNEER gap altogether. However, interestingly, the interaction term showing the asymmetric impact of the ΔNEER gap remains significant, with a negative outcome. This may suggest that in the short-run, the euro area economy is negatively correlated to any volatility in the short-run NEER gap and any deviations from the equilibrium will result in a GDP per capita decrease. In the long-run (5), the model is significantly non-linear. This suggests that for a country with a positive NEER gap of 1, a significant increase will lead to a 0.09 decrease in the GDP per capita, instead of 0.033. Contrastingly, any country with a negative NEER gap of -1, which sees a significant increase will see its GDP per capita decreased by 0.024 instead of increasing by 0.033. This result is significant at 5% level but relatively unprecise since the impact of an increase and decrease is likely to be different as shown in the asymmetry part of the table.

In the last estimation (7), the long-run non-linearity interaction term is divided into the standard deviation increase and decrease, respectively. According to the estimation, a one standard deviation decrease leads to a relatively economically strong and statistically significant (5%) impact on the long-run level of GDP per capita. Thus, in an overvalued country with a NEER gap of 1, a strong negative deviation would result in a 0.054 increase in GDP per Capita, instead of a 0.033 decrease. This result implies that overvalued countries can reach a higher than average GDP per Capita, following a larger deviation.

This section of the research has shown that the relationship between the NEER gap and the GDP per capita remains robust to a set of asymmetries and non-linearities. In the short-run, including the option of an asymmetry leads to a highly significant short-term impact. Interestingly, any deviation leads to the worsening of the ΔGDP per capita. This result may infer a negative relationship between NEER volatility and GDP per capita growth. In the long-run, the relationship is more likely to be the result of non-linearities, with a risk that larger short-run deviations will lead to the opposite of the expected effect. This may suggest a desire for long-term stability. This conclusion is consistent with the prediction of the error correction term which remained consistently persistent across the table. However, since the sample is comprised of countries with positive and negative NEER gaps, a robust interpretation is difficult. Therefore, in the following section (4.2.5), I will derive the differences between the core and periphery region of the EA.

4.2.5 Results – NEER on GDP – Regional Model Estimation

The following Table 8 shows the relationship between the NEER gap and the log(GDP per Capita), across the eurozone's core and periphery region. The estimations (1) to (3) show the long- and short-run relationship in the core region, whereas the models (4) to (7) cover the periphery region. Both series of tests will start with the same specification (7) retrieved in Table 6 and will both include the same interaction terms as in Table 7.

Variables	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
		Core			*Periphery*		
				Long-Run			
NEER gap	-0.000 (0.024)	0.020 (0.028)	0.022 (0.029)	-0.106** (0.044)	-0.108** (0.048)	-0.070** (0.016)	-0.068** (0.042)
NEERgap×Neg.		-0.025 (0.026)			0.001 (0.034)		
NEERgap×Std.D						-0.093** (0.045)	
Positive Std.D.							-0.027 (0.042)
Negative Std.D.							-0.021*** (0.072)
				Short-Run			
ECT	-0.020*** (0.005)	-0.021*** (0.005)	-0.019*** (0.005)	-0.029*** (0.010)	-0.028*** (0.010)	-0.034*** (0.010)	-0.038*** (0.010)
d.Ln(GPD/Cap)							
t-1	-0.246*** (0.032)	-0.257*** (0.032)	-0.256*** (0.032)	-0.284*** (0.039)	-0.284*** (0.039)	-0.279*** (0.039)	-0.283*** (0.039)
t-2	-0.180*** (0.031)	-0.190*** (0.031)	-0.189*** (0.031)	-0.248*** (0.024)	-0.249*** (0.042)	-0.252*** (0.042)	-0.260*** (0.041)
t-3	-0.225*** (0.031)	-0.238*** (0.030)	-0.235*** (0.030)	-0.251*** (0.024)	-0.252*** (0.041)	-0.254*** (0.040)	-0.271*** (0.041)
t-4	0.711*** (0.031)	0.692*** (0.031)	0.696*** (0.031)	0.657*** (0.023)	0.657*** (0.039)	0.661*** (0.038)	0.652*** (0.038)
d.NEER gap	-0.000 (0.002)	-0.009*** (0.003)	-0.016*** (0.003)	-0.007* (0.005)	-0.006 (0.006)	0.006 (0.003)	0.006 (0.009)
d.Unemployment.	-0.009*** (0.002)	-0.008*** (0.002)	-0.008*** (0.002)	-0.017*** (0.003)	-0.017*** (0.003)	-0.017*** (0.003)	-0.017*** (0.003)
d.Exports/GDP	0.121*** (0.025)	0.105*** (0.024)	0.101*** (0.025)	0.013 (0.040)	0.013 (0.040)	0.020 (0.040)	0.022 (0.039)
d.NEERgap×Neg		0.021*** (0.005)	0.022*** (0.005)		-0.003 (0.011)		
d.NEERgap×Std.			0.006 (0.005)			-0.013 (0.009)	
Positive Std.D.							-0.011 (0.010)
Negative Std.D.							-0.013 (0.011)
Constant	0.051*** (0.012)	0.056*** (0.012)	0.053*** (0.012)	0.058*** (0.018)	0.058*** (0.018)	0.068*** (0.018)	0.074*** (0.018)

Table 8: Dynamic Fixed-Effects NARDL estimation of the regional impact of the NEER gap on GDP per Capita. Note: The numbers in parentheses represent the standard error of each coefficient. The *, ** and *** descriptions indicate the statistical significance at a 10%, 5% and 1% level, respectively.

The estimation (1) shows that in the core region of the euro area, there appears to be a disconnect between the NEER gap and the ln(GDP per Capita). Both periods indicate a relatively null impact with no statistical significance. The long-run standard error is exponentially larger than the coefficient suggesting that the likelihood of reaching a significant result is meagre. On the other hand, the sign and the size of each coefficient are consistent with the theory and previous tests.

I will test for asymmetries in the model estimation (2). The results indicate that in the core region of the eurozone, the relationship between the NEER gap and the GDP per capita is exclusively significant in the short-run. Compared to the full-sample analysis, the region is less affected by a change in unemployment, but more sensitive to the size of the export sector. Similarly to the previous section, the model identifies some adversity to the NEER gap volatility. A one-unit increase in the NEER gap will result in a significant decrease of 0.009% in the GDP per Capita, whereas a decrease of the same size will yield a decrease of 0.012%.

The estimation (3) suggests that the short-run relationship is not subject to non-linearity. This result is also consistent in the long-run, but considering the lack of significance of the NEER gap, the impact of a large deviation would realistically not gain significance. This result is therefore omitted to the reader. Contrastingly to Table 7 in the previous section, the short-run relationship remains robust to the implementation of the second interaction term. From this, it can be inferred that the core's (short-run) aversion to short-run NEER fluctuations is robust and significant.

The periphery region of the sample, unlike the core region, witnesses a long-run relationship between the two variables, as suggested by the model (4). The size of the NEER gap coefficients are significantly larger than the full-sample estimates in Table 7. Interestingly in this region, the size of the export sector does not seem to significantly affect the relationship between the NEER gap and the GDP per capita.

Model (5) tests for the presence of asymmetry in the short- and the long-run. Following the results, no significant difference is found between a positive and a negative change in the NEER gap. Similarly, model (5) tests for the presence of non-linearity in the short- and long-run. Expectedly, a statistically significant long-run non-linearity is found, which will be further described in the model (6).

By differentiating between a large increase and decrease in the NEER gap, the highly significant impact of the non-linear decrease in the NEER gap is observed. A larger decrease in the NEER gap is set to result in a 0.021 unit smaller increase than a smaller decrease would yield. As such, contrarily to the predictions of the full sample model or the short-run "fear of volatility", the periphery of the EA is not subject to a sign-reversal under high fluctuations. The impact on the GDP per Capita follows a diminishing slope over time.

To conclude, the differences between the two regions of the euro area are the following. First, the difference in size between the ECT of the core and periphery. A shock to the long-run equilibrium relationship between the NEER gap and the GDP per capita is twice as persistent in the core than in the periphery. With a half-life of 36 and 18 quarters (9 and 4.5 years), the periphery appears to be more efficient at absorbing short-run shocks. Second, the two regions witness the impact of the relationship in different timeframes. The core region is only sensitive to short-run fluctuations, whereas the periphery is only subject to long-run fluctuations. This disparity between the two regions might result in a topic of dispute, as the core will attempt to micromanage the fluctuations of the NEER, while the periphery will only witness the long-term results of the core's decisions. Third, the impact of a change in unemployment is twice as prominent in the periphery, whereas the core is more sensitive to fluctuations in the size of their export industry. This is probably because the periphery has accounted for higher levels of unemployment during and after economic downturns. Those higher unemployment rates are synonymous of lower competitiveness, which would yield lower GDP per capita levels than their core region counterparts. Whereas, the core region is comprised of countries which are prominent on the international trade scene. Consequently, a change to a large component of their GDP would have a significant impact on their economic performance.

4.3. Results – NEER on the Current Account

This section of the paper will consider the relationship between the NEER and the Current Account. However, given the stationary nature of the latter variable, the log(Exports to GDP) and log(Imports to GDP) will be used as dependent variables. The division of the Current Account variable into its two underlying movements will prove beneficial to the research. The dissected form of the CA will allow for a more thorough analysis of the relationship between the NEER and the CA. To do so, I will first perform a correlation analysis to establish a clear outline of the relationship between the three variables of interest and a series of controls. Second, I will follow the Schwarz/Bayesian Information Criterion (S/BIC) to indicate the preferred short-run lag length between the NEER and the current account components. Third, the presence of a cointegration will be determined using the Pedroni test. Fourth, a model estimation will be derived based on the information gathered in each of the previous sub-sections. In this sub-part, I will first derive a basic linear model, then check for possible asymmetries and non-linearities. Finally, the robustness of the results will be assessed by differentiating between various sub-samples (i.e. Core and Periphery).

4.3.1 Results – NEER on the Current Account – Correlation Analysis

Table 9 below shows the correlation analysis between the components of the current account and the deviation in the NEER across the twelve sampled countries. Using theory on the topic, I will derive the general relationship between the NEER and current account, as well as, the impact of a set of controls on them.

	NEER Dev	*lnCurrent Account*	*lnExports to GDP*	*lnExports to GDP*	*Terms of Trade*	*Trade Openness*	*Unemploy ment*	*Interest Rates*
NEER Dev	1							
lnCurrent Account	0.0041	1						
lnExports to GDP	-0.4983	0.4716	1					
lnImports to GDP	-0.4155	0.6692	0.9706	1				
Terms of Trade	0.1095	0.4148	0.0502	0.1580	1			
Trade Openness	0.1595	0.2961	-0.0871	-0.0029	0.1217	1		
Unemployment	0.3698	-0.2046	-0.4198	-0.4075	-0.1397	-0.0987	1	
Interest rates	0.1054	-0.2680	-0.2910	-0.3139	-0.1966	-0.3424	0.4405	1

Table 9: NEER and the Current Account correlation analysis for the full sample

Table 9 shows the correlation between seven (8) key variables which will be further described below. Given the size of the correlation coefficients (Corr. Coef.< 0.7), it can be assumed that the dataset is not subject to multicollinearity, at the exception of the log(exports to GDP) and the log(Imports to GDP). However, both components of the current account will be assessed in separate models, therefore, the risk of multicollinearity is avoided.

As described in the data and methodology section, the current account analysis will be divided into its two underlying components to retrieve the cointegrating relationship with the

NEER gap. This being said, the correlation between the current account and the NEER gap is insignificant and positive. This result is not indicative of any relationship and is biased by the sample selection (see appendix C.I and C.II). Indeed, when I control for the sub-samples, the correlation becomes highly negative and positive for the core and the periphery, respectively.

However, when the correlation between the NEER gap and the two components of the CA is assessed, one finds that there exists a somewhat highly negative correlation across the sub-samples. This indicates that a larger positive NEER gap for a peripheral country will result in the worsening of the trade performance. Whereas, a larger negative NEER gap for a core country will result in the improvement of its trade performances. This result indicates the presence of a gain in competitiveness through the undervaluation of the country.

With regards to the Terms of trade variable, it is positively correlated with the NEER gap across all the sub-samples. Naturally, the ToT, a variable which takes the ratio of the price of exports on the price of imports, will be positively correlated with the fluctuations of the currency. It is also negatively correlated to the core's CA components (-0.13, -0.07), and positively correlated to the periphery's CA components (0.16, 0.31). This indicates that the variable is more affected by the general level of competitiveness of a country, as opposed to the fluctuations in the CA. Indeed, a ToT improvement would lead to fewer exports and more imports instead. this control will, therefore, be used as a measure of price competitiveness.

The level of trade openness indicates the size of the tradable sector of a country. It is computed with the sum of exports and imports as a ratio of that country's GDP[13]. Thus, a more open economy is expected to have greater levels of exports and imports on average. However, in the core region of the EA(appendix C.I, Table 3), this positive correlation does not hold. In fact, a more open economy is set to have lower levels of exports and imports to GDP. This negative correlation is counterintuitive and inconsistent with the theory. However, the correct sign is re-established in the ARDL models below.

On the other hand, the unemployment variable indicates a correct sign for each of the variables. Indeed, it is expected that countries with higher levels of unemployment will see a slowdown of their tradable sector. Similarly, countries which experience a higher interest rate will experience higher barriers to trade and lower levels of exports (imports) to GDP levels.

[13] Trade Openness $= \frac{X+M}{GDP}$

4.3.2 Results – NEER on GDP – Optimal lag length criterion

Table 10 below shows the optimal lag length for an autoregressive distributed lag model comprising the log *Exports to GDP* and the *NEER gap* for each country on the left, and the log *Imports to GDP* and the *NEER gap* on the right of the table. Based on the results given for each country, I will select the optimal lag length for the sample.

Country	*Exports*		*Imports*		*Observations*
	ARDL(S/BIC)	ARDL(AIC)	ARDL(S/BIC)	ARDL(AIC)	
Austria	(4, 0)	(4, 0)	(1, 0)	(1, 0)	73
Belgium	(4, 1)	(4, 4)	(4, 0)	(4, 4)	73
Finland	(1, 0)	(3, 1)	(1, 0)	(1, 0)	73
France	(1, 0)	(1, 1)	(1, 1)	(3, 3)	73
Germany	(1, 0)	(1, 4)	(1, 0)	(3, 0)	73
Greece	(4, 0)	(4, 0)	(1, 0)	(4, 4)	73
Ireland	(4, 1)	(4, 1)	(2, 0)	(2, 0)	73
Italy	(4, 0)	(4, 0)	(4, 1)	(4, 1)	73
Luxembourg	(3, 1)	(4, 1)	(1, 1)	(3, 1)	73
Netherlands	(1, 0)	(1, 2)	(1, 0)	(2, 1)	73
Portugal	(4, 0)	(4, 1)	(1, 0)	(1, 0)	73
Spain	(4, 0)	(4, 0)	(1, 0)	(3, 0)	73

Table 10: Optimal Lag Length Determination for ARDL(ln(Exports/Imports perCapita), NEERdev)

Firstly for the Exports analysis, the results are relatively consistent across both information criteria. Based on the AIC and the S/BIC, I will select a lag period of one year (4 quarters) in all future computations of the relationship between the differenced ln(Exports/GDP) and the differenced NEERdev.

For the Imports analysis, the S/BIC shows a more conservative approach than the AIC criterion, with a majority of the sample suggesting a one-lag specification. As such, to compromise between both results, I will apply two lags to the ln(Import/GDP) estimation. Thus, I will maintain a rather conservative specification, with an acknowledgement of some potential variability across countries.

Secondly, for both analyses, the differenced NEER gap shows a weak short-run statistical significance for most of the sampled countries. Indeed, for most of them, the S/BIC deems optimal to drop the variable altogether in the short-run. This result is consistent with the literature and will not be contested. However, the AIC shows greater variability in the lag selection and appears to be more lenient in the number of lags used.

As a result, the model in section 4.3.4 will be an ARDL(4, 1, …) for the export analysis and ARDL(2, 1, …) for the import analysis. I will keep the lagged NEER gap in the specification for economic significance even if statistical significance is not reached. It should also be noted that those results are robust to the addition of control variables.

4.3.3 Results – NEER on GDP – Cointegration Analysis – Pedroni Test

The Pedroni test – a cointegration test – analyses the presence of long-run co-movements between two or more variables. It is commonly used in the literature when analysing panel data. It has the advantage of controlling for cross-sectional dependence and allows for heterogenous intercepts. Making use of a (modified) Phillips-Perron and an augmented Dickey-Fuller test, it tests for the alternative hypothesis of the presence of cointegration, in all of the sampled panels. Table 11 shows the following results.

Test/Criterion	*t-statistic*	*p-value*
	Exports to GDP	
Modified Phillips-Perron	-3.792	0.0001
Phillips-Perron	-3.681	0.0001
Augmented Dickey-Fuller	-4.594	0.0000
	Imports to GDP	
Modified Phillips-Perron	-3.679	0.0001
Phillips-Perron	-3.614	0.0002
Augmented Dickey-Fuller	-4.840	0.0000

Table 11: The Pedroni Test for Cointegration between the ln(Exports/Imports perCapita)and NEER-dev.

It seems that the long-run relationship between the NEER gap and the two components of the current account is statistically significant at all levels. All three tests show the presence of a cointegration across all panels. This result is also robust after controls are included, as seen in appendix D, Table 5. I will therefore confidently estimate a model estimating the relationship between each of the three variables.

4.3.4 Results – NEER on the Current Account – Model Estimation

The aforementioned sections showed that there exists a long-run relationship between the NEER gap and the components of the current account. This section will assess the significance of the linear relationship. This will provide a robust base model for the asymmetric and non-linear analysis in the following section.

To that end, the following Table 12 will present the ARDL results for the Exports to GDP and Imports to GDP estimations. The following results are organised as such. The model estimation (1) to (3) will focus on the relationship between the *log(Export to GDP)* and the *NEER gap*, and the model estimation (4) to (6) will assess the impact of the *NEER gap* on the *log(Imports to GDP)*.

The first estimation (1) looks at the direct impact of the NEER gap on the *Exports to GDP*, without controlling for country-specific variables. It shows that in the long-run, the NEER gap has no significance over the fluctuations in the level of exports of a country. Additionally, the positive coefficient would suggest that an appreciation of the currency, deepening the NEER gap, would result in higher levels of exports. This sign is not consistent with the prevailing economic theory and is probably biased due to the large disparity between the core and periphery. The error correction term remains highly significant and of considerably greater size than the GDP analysis.

The post-2008 time-dummy is significant (5%) in the short-run and leads to the improvement in the standard error of the NEER gap when implemented in the long-run[14]. The model estimation (2) shows a quasi-significant long-run relationship between the level of exports and the NEER at a 10% level. This suggests an important break in the data following the Great Recession.

In the second estimation (2), trade controls are added to control for trade performance differentials across the sample. Both controls are highly significant and show a correct sign. Consistently with the theory, an increase in trade openness would yield a larger export sector, improving the level of export per capita. Similarly, an improvement in the terms of trade would result in more expensive exports, reducing the level of local goods demanded internationally.

[14] The standard error of the NEER gap is 0.001 when the time-dummy is added in the long-run. This exponentially improves the NEER gap term, but a 10% significance level is not reached.

Variables	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
	Exports to GDP			*Imports to GDP*		
	Long-Run					
NEER gap	0.001 (0.017)	0.001 (0.001)	0.001 (0.001)	-0.001* (0.001)	-0.001 (0.001)	-0.001 (0.001)
Post-2008		0.018*** (0.004)	0.019*** (0.004)	0.011*** (0.002)	0.012*** (0.003)	0.012*** (0.002)
	Short-Run					
ECT	-0.080*** (0.014)	-0.064* (0.011)	-0.055*** (0.012)	-0.150*** (0.024)	-0.123*** (0.024)	-0.144*** (0.024)
d.Ln(X or M)/GDP						
t-1	-0.134*** (0.028)	-0.175*** (0.023)	-0.184*** (0.023)	-0.356*** (0.037)	-0.414*** (0.036)	-0.416*** (0.036)
t-2	-0.198*** (0.027)	-0.119*** (0.026)	-0.127*** (0.023)	0.093*** (0.035)	-0.008 (0.035)	-0.000 (.024)
t-3	-0.173*** (0.026)	-0.174*** (0.025)	-0.181*** (0.021)			
t-4	0.679*** (0.025)	0.553*** (0.021)	0.546*** (0.022)			
d.NEER gap	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)
Post-2008	0.001** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.002*** (0.000)	0.001*** (0.000)	0.002** (0.000)
d.Trade Openness		0.019*** (0.001)	0.019*** (0.000)		-0.009*** (0.001)	0.008*** (0.001)
d.Terms of Trade		-0.001*** (0.000)	-0.001 (0.000)		-0.001*** (0.000)	-0.001* (0.000)
d.Unemployment			0.000 (0.000)			-0.001*** (0.000)
d.Interest Rate			0.000 (0.000)			-0.001* (0.000)
Constant	0.075*** (0.013)	0.037** (0.015)	0.062*** (0.011)	0.141*** (0.023)	0.114*** (0.022)	0.134*** (0.022)

Table 12: Dynamic Fixed-Effects ARDL estimation of the impact of the NEER gap on the dissected Current Account. Note: The numbers in parentheses represent the standard error of each coefficient. The *, ** and *** descriptions indicate the statistical significance at a 10%, 5% and 1% level, respectively.

In the third estimation (3), I control for the economic performance differentials between countries. It is assumed that during economic downturns, the level of trade would be reduced. Hence, the level of exports to GDP would decrease. However, neither of the two controls show a statistically or economically significant result. They will, therefore, be removed from the *Export to GDP* analysis.

The second specification (2) will be used in the non-linear regional model in section 4.3.5. The following model estimations will now cover the short- and long-run linear relationship between the NEER gap and the log(Imports per capita).

The fourth specification (4) shows an ARDL (2, 1) as suggested by the S/BIC test. In the long-run, a weakly significant impact of the NEER gap is found, with a sign contradicting the economic theory. Indeed, this would suggest that a currency appreciation would result in a lower (ability to purchase) demand for foreign goods. This result is not consistent and is most likely biased by the high correlation between the import and exports variable (0.971). As such, a positive NEER gap would result in lower competitiveness, and lower trade volumes. Those results are most likely the result of the disparity between the core and periphery of the EA. Indeed, it is assumed that core countries, with negative NEER gaps, would trade higher amounts than the periphery.

Estimations (5) and (6) include the trade- and economic-performance controls. In the first specification (5), a highly significant result is observed for both controls. However, both variables show an incorrect sign. The negative coefficient of trade openness suggests that higher levels of trade would result in a lower import to GDP ratio. Whereas the negative sign of the ToT variable implies that the number of imports, purchased per level of exports, is lower upon the improvement of the ToT.

In the latter model estimation (6), a positive change in the unemployment and the interest rate would result in the worsening of the import to GDP ratio. I will, therefore, use this specification to estimate the non-linear regional model.

The full-sample estimation suggests that the NEER gap has no significant economic impact on the components of the current account. However, given the highly significant coefficients of the error correction terms[15], I could argue that the (lack of) results are due to the sample bias. Thus, in the following section, the impact of the NEER gap on the components of the current account will be assessed in each sub-sample separately.

[15] Note that the size of ECT is considerably larger than in the GDP analysis. For the estimations (2) and (6), the model suggests that the half-life of a deviation from the long-run equilibrium is 10 and 4.5 quarters.

4.3.5 Results – NEER on the Current Account – Regional Model Estimation

This section of the research will focus on the impact of the NEER gap on the Current Account in the core and periphery region of the eurozone. To that end, it will be divided into two distinct sub-part. Firstly in Table 13, I will use the linear specifications (2) and (6) from Table 12 and test for the possible asymmetries and non-linearities in the Core region of the EA. Secondly, in Table 14, I will assess the same impact in the periphery region.

The specification (1) in Table 13 shows the linear relationship between the NEER gap and the log(exports to GDP) in the Core region of the eurozone. In this subsample, the long-run impact of the NEER is highly significant but shows a very weak impact. With a coefficient of -0.002, a core economy with a NEER gap of -1 is set to have a ratio of exports to GDP 0.2% higher than an economy with a NEER gap of 0. This suggests a very weak impact given that the mean log(export to GDP) in the region is 95.8% and the standard deviation is 5.1%. Interestingly, the highly significant time-dummy shows a level of exports which is 0.8% higher in the long-run, following the crisis. This result may indicate the effectiveness of the EU's plan to further integrate the economic block. However, there is no evidence to confirm the validity of this impact.

In the short-run, the impact of the ΔNEER gap remains insignificant and will remain so in the following models. I may thus conclude that there is no short-run relationship between the NEER gap and the Δlog(exports to GDP) in the core region. The trade controls have a significantly robust effect across the models (1) to (3) with results that are consistent with the literature. Indeed, an increase in the level of trade openness is expected to increase the level of exports, while a positive change in the terms of trade is set to have a negative effect.

The error correction terms indicate a relatively high speed of conversion, with an expected half-life varying from 5.9 to 6.4 quarters. This suggests that the tradable sector can adjust relatively quickly to a shock to the exchange rate. Additionally, the specifications (2) and (3) infer no statistically significant non-linearities or asymmetries between the NEER gap and the level of Exports to GDP. This result is consistent in the short- and the long-run.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
		Exports to GDP			*Imports to GDP*	
				Long-Run		
NEER gap	-0.002***	-0.002***	-0.002***	-0.002**	-0.002*	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
NEERgap×Neg.		0.000				
		(0.000)				
NEERgap×Std.D			0.001			-0.001
			(0.001)			(0.001)
Post-2008	0.008***	0.009***	0.008***	0.013***	0.014***	0.014***
	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
				Short-Run		
ECT	-0.102***	-0.107***	-0.111***	-0.097***	-0.104***	-0.104***
	(0.011)	(0.020)	(0.020)	(0.021)	(0.022)	(0.022)
d.Ln(X or M)/GDP						
t-1	-0.090**	-0.088**	-0.090**	-0.162***	-0.163***	-0.164***
	(0.038)	(0.038)	(0.038)	(0.036)	(0.042)	(0.042)
t-2	0.043	0.044	0.039	-0.110***	0.112***	0.113***
	(0.035)	(0.034)	(0.035)	(0.039)	(0.039)	(0.039)
t-3	-0.188***	-0.183***	-0.187***			
	(0.034)	(0.035)	(0.035)			
t-4	0.426***	0.429***	0.429***			
	(0.034)	(0.034)	(0.034)			
d.NEER gap	-0.001	-0.000	-0.001	-0.001**	-0.001	0.001
	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
Post-2008	0.001***	0.001***	0.001***	0.001***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000))	(0.000)
d.Trade Openness	0.016***	0.015***	0.015***	0.014***	0.013***	0.013***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
d.Terms of Trade	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
d.Unemployment				0.001*	0.001*	0.001*
				(0.000)	(0.000)	(0.000)
d.Interest Rate				0.001***	0.001**	0.001**
				(0.000)	(0.000)	(0.000)
d.NEERgap×Neg.		0.002*	0.001		0.003***	0.003***
		(0.001)	(0.001)		(0.001)	(0.001)
d.NEERgap×Std.D			0.001			0.001
			(0.001)			(0.001)
Constant	0.097**	0.102***	0.105***	0.091***	0.102***	0.098***
	(0.019)	(0.019)	(0.019)	(0.020)	(0.020)	(0.020)

Table 13: Dynamic Fixed-Effects NARDL estimation of the impact of the NEER gap on the dissected Current Account in the core region of the Eurozone. Note: The numbers in parentheses represent the standard error of each coefficient. The *, ** and *** descriptions indicate the statistical significance at a 10%, 5% and 1% level, respectively.

Therefore, I can conclude that in the Core region of the Eurozone there exists a weak but significant relationship between the NEER gap and the level of log(Exports to GDP).

The linear impact of the NEER gap on the log(Imports to GDP) is shown in the model specification (4). Similarly to the export model, a long-run undervaluation of the currency significantly (5%) promotes the level of imports, however, it leads to a relatively small change in the import ratio. With a mean ratio of 94.9% and a standard deviation of 4.6%, the improvement of 0.2% is somewhat negligible. According to economic theory, the improvement in the level of imports following a depreciation of the currency is unlikely. However, in term of deviations from the EA-NEER, a gain in competitiveness might act as a facilitating force and lead to greater trade openness and increased imports. In the short-run contrastingly, a positive change in the NEER gap does lead to the worsening of the import ratio. This result is significant but weak. Additionally, the post-2008 dummy also suggests an improvement of 1.3% following the crisis. Considering its similar effect on the export variable, one might further consider the hypothesis of a deepened integration of the economic block.

The model estimation (5) suggests that there exists a short-run asymmetry in the impact of a change in the NEER gap[16]. However, as a result, the change in the NEER gap variable loses its significance. This result might be interpreted as a "fear of devaluation" where an appreciation does not impact the components of the current account, whereas a devaluation decreases both the imports and exports of a said country (see model estimation (2)).

In the last model (6) of Table 13, I test for possible non-linearities within the import model. The interaction terms do not provide statistically significant reasons to infer any impact. Consequently, the relationship between the NEER gap and the imports to GDP ratio is considered to be linear with a short run asymmetry, which can be described as a "fear of devaluation".

Note that the sign of the economic controls is inconsistent with the prevailing economic theory. For instance, a higher unemployment rate leads to a higher ratio of imports to GDP. This result is counter-intuitive but may be caused by the contraction of the country's GDP improving the ratio. However, the coefficient has a weak significance and does not lead to a large impact. With regards to the interest rates variable, the positive coefficient is probably the result of a reversed causality, where an improvement of the ratio will trigger a contractionary monetary policy from the country (ECB).

As such, in the core region of the Eurozone, there is a statistically significant weak causal effect between the NEER gap and the level of export to GDP in the long-run. The same could be inferred for the import to GDP variable, with a lower significance. In the short-run,

[16] Note that the long-run estimation is not provided as it did not show significance.

the model is only sensitive to negative changes in the NEER gap, with a more significant effect for the import to GDP variable.

I will now focus on the periphery region of the Eurozone. Table 14 below will use the linear specifications (2) and (6) from Table 12 and test for the possible asymmetries and non-linearities in the Periphery region of the EA.

The model (1) in Table 14 shows the linear relationship between the NEER gap and the log(exports to GDP) in the Periphery region of the eurozone. In this subsample, the long-run impact of the NEER is significant at a 10% level and shows a very weak positive impact. With a coefficient of 0.002, a peripheral economy with a NEER gap of 1 is expected to have a ratio of exports to GDP 0.2% higher than an economy with a NEER gap of 0. This suggests a very weak impact is however inconsistent with the prevailing economic theory. Therefore, the following results should be assessed with care as they might be biased.

The time variable has a coefficient three times greater than in the core model. With a coefficient of 0.024, the expected log(export to GDP) would be 2.4% larger than the period preceding the crisis[17]. This might indicate a greater integration in the periphery region.

In the short-run, the effect of a change in the NEER gap is insignificant, but of a correct sign. This result is consistent with the prevailing literature on the topic. The trade-performance controls are very significant and of an expected sign. Indeed, the change in trade openness has a positive impact on the change in exports to GDP, while the change in ToT has a small yet significant effect on the ratio.

The models (2) and (3) test for possible asymmetries and non-linearities in the model.

While the model (2) shows no sign of a short- and long-run asymmetry in the periphery region, model (3) indicates a significant (10%) presence of a non-linear long- and short-run relationship between the NEER and the level of Exports. This being said, the coefficients of the short- and long-run NEER gap remain insignificant. This suggests that the periphery region of the EA is only sensitive to a larger deviation in the NEER gap.

[17] Note that the mean log(Export to GDP) in the periphery is 91.3% with a standard deviation of 4.6%

Variables	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
	Exports to GDP				*Imports to GDP*		
				Long-Run			
NEER gap	0.002* (0.002)	0.003 (0.002)	0.001 (0.002)	0.001 (0.002)	-0.001 (0.001)	-0.000 (0.001)	-0.001 (0.001)
NEERgap×Neg.		0.000 (0.002)				-0.001 (0.001)	
NEERgap×Std.D			0.007* (0.004)				-0.000 (0.002)
Positive Std. D				0.003 (0.003)			
Negative Std. D				0.014** (0.007)			
Post-2008	0.024*** (0.007)	0.024*** (0.006)	0.026*** (0.002)	0.028*** (0.008)	0.012*** (0.004)	0.012*** (0.003)	0.012*** (0.004)
				Short-Run			
ECT	-0.072*** (0.017)	-0.073*** (0.017)	-0.066*** (0.017)	-0.062*** (0.017)	-0.211*** (0.047)	-0.213*** (0.047)	-0.209*** (0.047)
d.Ln(X or M)/GDP							
t-1	-0.181** (0.017)	-0.181** (0.035)	-0.187*** (0.034)	-0.192*** (0.034)	-0.480*** (0.060)	-0.479*** (0.061)	-0.479*** (0.061)
t-2	-0.131*** (0.034)	-0.129*** (0.034)	-0.133*** (0.034)	-0.130*** (0.034)	-0.056 (0.060)	-0.054 (0.060)	-0.051 (0.060)
t-3	-0.177*** (0.032)	-0.176*** (0.032)	-0.174*** (0.032)	-0.174*** (0.032)			
t-4	0.560*** (0.033)	0.560*** (0.033)	0.565*** (0.034)	0.567*** (0.032)			
d.NEER gap	-0.001 (0.001)	-0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	-0.002* (0.001)	-0.001 (0.002)	0.000 (0.002)
Post-2008	0.002*** (0.001)	0.002*** (0.001)	0.002*** (0.000)	0.002*** (0.001)	0.003*** (0.001)	0.003*** (0.001)	0.003*** (0.001)
d.Trade Openness	0.019*** (0.002)	0.019*** (0.002)	0.019*** (0.002)	0.019*** (0.002)	0.006** (0.002)	0.005** (0.002)	0.005** (0.002)
d.Terms of Trade	-0.001** (0.000)	-0.001** (0.000)	-0.001*** (0.000)	-0.000** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)
d.Unemployment					-0.003*** (0.001)	-0.003*** (0.001)	-0.003* (0.001)
d.Interest Rate					0.001* (0.000)	0.001* (0.000)	0.001* (0.000)
d.NEERgap×Neg.		0.001 (0.002)				-0.001 (0.003)	
d.NEERgap×Std.D			-0.002* (0.001)				-0.002 (0.002)
Positive Std. D				-0.003* (0.001)			
Negative Std. D				-0.002 (0.002)			
Constant	0.065*** (0.015)	0.066*** (0.019)	0.102***. (0.019)	0.055*** (0.015)	0.193*** (0.043)	0.194*** (0.043)	0.190*** (0.043)

Table 14: Dynamic Fixed-Effects NARDL estimation of the impact of the NEER gap on the dissected Current Account in the periphery region of the Eurozone. Note: The numbers in parentheses represent the standard error of each coefficient. The *, ** and *** descriptions indicate the statistical significance at a 10%, 5% and 1% level, respectively.

As such the model (4) will disentangle which non-linearities are significant.

In the long-run, a larger negative deviation in the NEER gap appears to positively impact the level of Exports per GDP. With a significant (5%) coefficient of 0.014, a peripheral country with a NEER gap of 1, which was subject to a sharp "gain in competitiveness", will benefit from a 1.4% increase in its export to GDP ratio. Whereas in the short-run, this same country will find that its ratio has decreased by 0.3% following a one standard deviation increase in its NEER gap. The long-run result is significant and somewhat consistent with the findings of this research. it can be inferred that the periphery's export to GDP ratio is sensitive to larger devaluations of the currency. On the other hand, the short-run finding shows a rather unusual result. Therefore, this result should be interpreted with caution and no short-run relationship should be assumed.

Lastly, the model (5) to (7) show the (lack of) relationship between the NEER gap and the level of log(import to GDP). The first linear model (5) finds the coefficients of the NEER gap have the correct sign, however, lack significance. After implementing an asymmetry and non-linear interaction term, the long-run and short-run relationship between the two variables fails to gain significance. The large size of the constant and the error correction terms suggest that the variables in the model do not have a strong economic impact. It can, therefore, be inferred that there is no relationship between the NEER gap and the level of imports per GDP through time.

To conclude, the relationship between the current account and the NEER gap is not as robust as the one found in the GDP per Capita analysis. In the core region of the Euro, I found a relatively strong long-run relationship between the NEER gap and the level of exports to GDP. The same result was found for the import sector, with less robust coefficients. Additionally, the short-run relationship indicated the presence of a "fear of devaluation" as the tradable sector appeared to be significantly hurt by the deepening of the NEER gap. This finding was considerably more robust for the import sector, but due to the high correlation between the performance of the import and export variable, one might extend this finding to the export sector. The periphery region of the EA does not offer convincing results to infer a relationship between the NEER gap and the components of the current account. The short- and long-run models failed to convey a significant relationship, even when exposed to asymmetries and non-linearities. One might perhaps find that the export sector is somewhat sensitive to larger devaluations in the currency. However, this result does not provide enough evidence to suggest that result is robust.

5. CONCLUSION AND DISCUSSION

With distinct intertemporal differences between the two regions, the relationship between the NEER gap, the GDP and the current account is heterogeneous across the eurozone.

In the first analysis, I find that a shock to the long-run equilibrium relationship between the NEER gap and the GDP per capita is twice as persistent in the core than in the periphery. With a half-life of 36 and 18 quarters (9 and 4.5 years), the periphery appears to be more efficient at absorbing short-run shocks. Additionally, the two regions witness the impact of the relationship in different timeframes. The core region is only sensitive to short-run fluctuations, whereas the periphery is only subject to long-run deviations. This disparity between the two regions might result in a topic of dispute, as the core will attempt to micromanage the fluctuations of the NEER, while the periphery will only witness the long-term results of the core's decisions.

Moreover, the impact of a change in unemployment is twice as prominent in the periphery, whereas the core is more sensitive to fluctuations in the size of their export industry. This is probably because the periphery has accounted for higher levels of unemployment during and after economic downturns. Those higher unemployment rates are synonymous of lower competitiveness, which would yield lower GDP per capita levels than their core region counterparts. Whereas, the core region is comprised of countries which are prominent on the international trade scene. As such, a change to a large component of their GDP would have a significant impact on their economic performance.

In the second analysis, the evidence of a relationship between the NEER gap and the current account components is weak and more variable across models. The relationship is not as robust as the one found in the GDP per Capita analysis. In the core region of the Euro, I find a relatively significant long-run relationship between the NEER gap and the components of the CA. However, the impact is small. This is consistent with the finding that the Core is dependent on its tradable sector.

The short-run relationship indicates the presence of a "fear of devaluation" as the tradable sector appeared to be significantly hurt by the deepening of the NEER gap. This finding is considerably more robust for the import sector, but due to the high correlation between the performance of the import and export variable, I will extend this finding to the export sector.

The periphery region of the EA does not offer convincing results to infer a causal relationship between the NEER gap and the components of the current account. Therefore, I will assume that there exists no robust relationship in the region.

However, there are limitations to the research. I find that, through the asymmetry channel, the economic variables are adversely impacted by any change in the NEER gap in the short-run. This implies that the economies of the eurozone are sensible to the NEER volatility. As such, a topic of further research might consider the impact of the volatility in the NEER on the economic variables.

Additionally, this research used the nominal effective exchange rate as an independent variable. This allowed for a “ceteris paribus” analysis in the fluctuations of the Forex movements. Therefore, one might also consider the real effective exchange rate to assess the differences in impact between the two variables.

Finally, the literature argues extensively about the differences in sectoral productivity. One might, therefore, consider the impact of industry-specific exchange rates on the economic performance of the EU.

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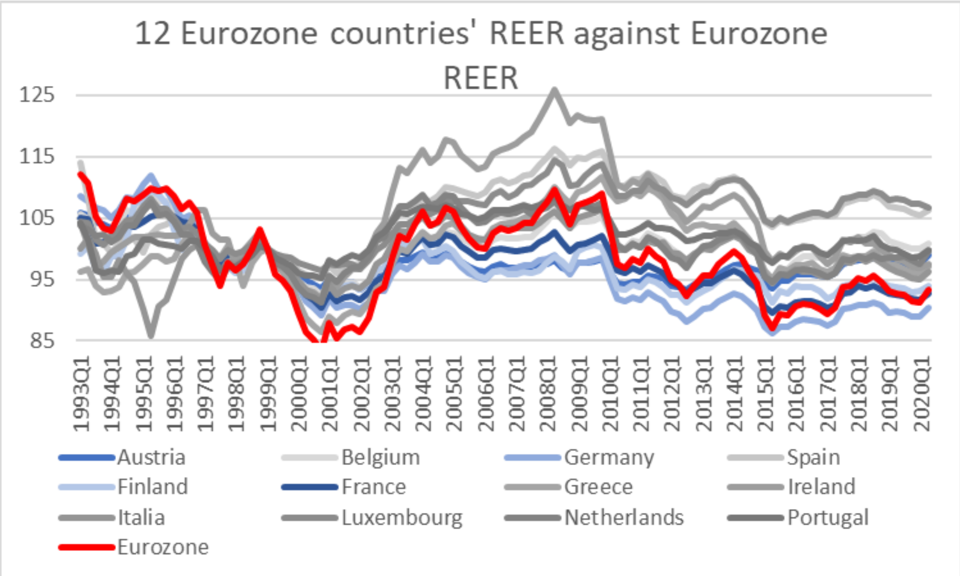
APPENDIX

Appendix A

Figure 1: The REER of 12 Eurozone Countries Against the EA-REER



Appendix B.I

	NEER Dev	*GDP*	*GDP per Cap*	*Terms of Trade*	*Interest Rates*	*Unit Labour Costs*
NEER Dev	1					
GDP	0.0767	1				
GDP per Cap	-0.6270	-0.3625	1			
Terms of trade	0.0483	-0.2690	-0.1223	1		
Interest Rates	0.3224	-0.1383	-0.3707	0.1441	1	
Unit Labour Costs	-0.1373	-0.1055	0.1736	-0.1006	0.1041	1

Table 1: NEER and GDP correlation analysis for the Core EA countries

Appendix B.II

	NEER Dev	*GDP*	*GDP per Cap*	*Terms of Trade*	*Interest Rates*	*Unit Labour Costs*
NEER Dev	1					
GDP	0.6855	1				
GDP per Cap	-0.1169	0.0142	1			
Terms of trade	0.2733	0.3271	0.2733	1		
Interest Rates	-0.1749	-0.2475	-0.3353	-0.3284	1	
Unit Labour Costs	-0.0750	0.0736	-0.1816	0.1160	-0.1452	1

Table 2: NEER and GDP correlation analysis for the Periphery EA countries

Appendix C.I

	NEER Dev	*lnCurrent Account*	*lnExports to GDP*	*lnExports to GDP*	*Terms of Trade*	*Trade Openness*	*Unemployment*	*Interest Rates*
NEER Dev	1							
lnCurrent Account	-0.4190	1						
lnExports to GDP	-0.6218	0.4314	1					
lnImports to GDP	-0.6343	0.5412	0.9917	1				
Terms of Trade	0.0483	0.3010	-0.1316	-0.0787	1			
Trade Openness	-0.0418	0.1693	-0.3282	-0.3474	-0.2122	1		
Unemployment	0.3824	-0.4182	-0.4654	-0.4889	0.0231	0.1699	1	
Interest Rates	0.3224	0.1099	-0.2079	-0.1713	0.1441	-0.2048	0.0661	1

Table 3: NEER and the Current Account correlation analysis for the Core EA countries

Appendix C.II

	NEER Dev	*lnCurrent Account*	*lnExports to GDP*	*lnExports to GDP*	*Terms of Trade*	*Trade Openness*	*Unemployment*	*Interest Rates*
NEER Dev	1							
lnCurrent Account	0.3580	1						
lnExports to GDP	-0.2288	0.4909	1					
lnImports to GDP	-0.0187	0.7716	0.9327	1				
Terms of Trade	0.2733	0.4525	0.1692	0.3172	1			
Trade Openness	0.6131	0.5322	0.1161	0.3066	0.4872	1		
Unemployment	0.2578	0.0811	-0.2810	-0.1744	-0.0934	-0.0374	1	
Interest Rates	-0.1749	-0.2245	-0.2055	-0.2401	-0.3284	-0.3927	0.3881	1

Table 4: NEER and the Current Account correlation analysis for the Core EA countries

Appendix D

Test/Criterion	*t-statistic*	*p-value*
	Exports to GDP	
Modified Phillips-Perron	-8.929	0.0000
Phillips-Perron	-10.261	0.0000
Augmented Dickey-Fuller	-12.271	0.0000
	Imports to GDP	
Modified Phillips-Perron	-12.616	0.0000
Phillips-Perron	-15.933	0.0000
Augmented Dickey-Fuller	-18.709	0.0000

Table 5: The Pedroni Test for Cointegration between the ln(Export to GDP), ln(imports to GDP) and NEER-dev, with controls.