Short and long run effects of exchange rate movements on the trade balance: a Eurozone perspective

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Abstract

The purpose of this paper is to examine the short and long run relationship between the real effective exchange rate (REER) and the trade balance of 12 Eurozone countries. Panel data is used and countries are also analysed separately. Using the autoregressive distributed lag (ARDL) model in error correction form, we investigate whether a depreciation of the euro and other determinants have an effect on the trade balance. Theory suggests a depreciation has a positive effect on the trade balance, at least in the long run. Using this approach, we do not find a significant short run relationship between the two variables which has also not been found in many other studies. In the long run a small positive relationship is found between the REER and the trade balance which corresponds to a negative effect of a depreciation on the trade balance. This is in contradiction with standard macroeconomic theory.

Introduction

When the European Commission (EC) published its spring 2015 European Economic Forecast, for the first time all the member states showed a positive growth rate. One of the reasons for this economic growth, the EC mentions, is the depreciation of the Euro.[1] Since 2014 the Euro has depreciated significantly, from 1.37 dollar in January 2014 to its minimum of 1.05 in April 2015.[2] According to macroeconomic theory a depreciation of the real exchange rate stimulates exports which could improve the balance of trade. An increase in exports could be a way to make an end on sluggish growth and lead to an export-led recovery.

According to the literature the effect of exchange rate movements on the balance of trade is ambiguous since empirical papers find mixed results. Export revenue increases which improves the balance of trade, however import expenditure could rise or fall. Import becomes more expensive which could mean an increase in expenditure or it means that the country is importing less which would lead to a balance of trade improvement. Many papers have analysed the effect using different econometric techniques on different sets of countries. Most of them focused on the US' trade balance and also Asian countries have been analysed extensively. But there is little research about the Euro movements and its effect on trade balances in the Eurozone.

The effect of a depreciation of the Euro is of great importance for macroeconomic policy. A central bank has a few tools to its disposal to influence the currency value. These tools are focused on increasing or decreasing the money supply. According to theory, an increase in the money supply generally leads to depreciation. So if there is a positive relation between depreciation and the trade balance, this would justify increasing the money supply. The ECB has started quantitative easing (QE) in January 2015 to try to reach their inflation goal. This means the ECB is purchasing bonds issued by euro area central governments, agencies, and European institutions. These asset purchases amount to 60 billion each month (ECB, 2015). QE can have an effect on the real economy in various ways, according to theory. One way is via the exchange rate channel.[3] The increase in money supply could contribute to

[1] The EC's spring 2015 European Economic Forecast and the press release can be found online at www.ec.europa.eu/economy_finance/eu/forecasts/2015_spring_forecast_en.htm
[2] For the latest EUR/USD exchange rate movements: https://www.ecb.europa.eu/stats/exchange/eurofxref/html/eurofxref-graph-usd.en.html
[3] See Interview with Casper de Vries http://www.eur.nl/ese/over_ese/documenten_en_rapporten/backbone3/ and https://www.ecb.europa.eu/mopo/intro/transmission/html/index.en.html about the exchange rate channel.

the current depreciation. The ECB expects overall economic boost via an increase in the trade balance. Another reason the Euro has depreciated in the last years is because of highly indebted countries, especially Greece, and the threat of them leaving the Eurozone.

This paper is about discovering if the Euro area could experience export-led growth via a depreciation. Therefore the relationship between a depreciation of the euro and the trade balances has been analysed. The real effective exchange rate (REER) is used and it is important to note that an increase in the REER means the currency is appreciating. Thus a positive effect of REER on the trade balance corresponds to a negative effect of a depreciation on the trade balance. This paper looks at the short and long run effects of a change in the real effective exchange rate using an ARDL model. For this model panel data was used including 12 Eurozone countries. Since results are likely to differ between countries because of trade relations, the size of the country, geographical location etc., the model has also been calculated for each country separately. In the international trade literature it is argued that the flows of goods respond only with time lags to changes in the exchange rate. As import prices typically react faster than trade volumes to exchange rate changes, the immediate impact of the depreciation of the euro on the trade balance is expected to be negative in the short term but should turn positive in the longer term. This is called the J-curve effect. A separate ARDL model has been calculated to detect the J-curve.

The rest of this paper is outlined as follows. In section 1 the theory behind the standard trade balance equation will be discussed. Theoretical background information on the relationship between the exchange rate and the trade balance including the J-curve effect will be given. The second section gives a literature review. This section will elaborate on what methods previous researches have used, which countries were investigated and what the results were. The third section describes the model, the data used, and the ARDL approach. Estimation is carried out using OLS. The empirical results are presented in section 4. Findings are brought together in section 5.

Section 1 – theoretical framework

This section explains the theory behind the relationship between the trade balance and exchange rate movements, which other factors influence the trade balance, and the J-curve phenomenon. The balance of trade is defined as the difference between value of exports and value of imports, including goods and services. A positive balance means the country is exporting more than it is importing. Traditional theory suggests that a depreciation benefits the trade balance and therefore the economy because exports become cheaper and imports become more expensive. Exports increase, imports decrease, and the current account benefits. But a depreciation can also have contractionary effects. If imports exceed exports, the net result is a decrease in real output. Gylfason and Schmid (1983) provide evidence that the final effect depends on the magnitude by which demand and supply curves shift because of devaluation. The magnitude of the effect a change in the exchange rate has on the trade balance depends on price elasticities. They describe the responsiveness of trade quantities to a shift in international prices. Whether a depreciation positively effects a firm producing export products also depends if the input materials are imported or produced domestically. A depreciation would only positively affect the firm if the increase in the price of imported materials is smaller than the increase in the profit margin or the extra sales because of extra demand. A large share of Germany's and France's exports exists of automobiles. A depreciation would mean European cars are cheaper outside the EU. The car manufacturer could decrease its price indicated in foreign currency to boost demand or it could just benefit from the extra profit margin. By how much profits would increase also depend on the price of materials used for manufacturing cars. If produced outside the EU, these become more expensive.

In this paper we will empirically analyse the effect of the exchange rate on the trade balance. Next to the exchange rate, the main factors influencing the trade balance are foreign and domestic income. An increase in domestic income is believed to have a negative effect since an increase in demand stimulates imports and an increase in foreign income is believed to have a positive effect since this stimulates exports. The standard trade balance equation is a function of the real exchange rate and domestic and foreign income as in, among others, Rose (1991), Ceglowski (1989), Hacker (2004), and Krueger (1983).

$$TB = F(r, Y, Y^*)$$

Where TB is the trade balance, r is the real exchange rate, Y is real domestic income, and Y^* is real foreign income. The real exchange rate is defined as (P^*E/P) where P^* is the foreign price level, E is the nominal exchange rate, and P is the domestic price level. An increase in the real exchange rate corresponds to a depreciation of the domestic currency. The trade balance is often defined as the ratio of exports over imports $TB = (X/M)$. When bilateral trade data is used, the foreign output usually corresponds to US or Japan output and the bilateral exchange rate uses the dollar or yen for the foreign price level. In other cases the real effective exchange rate (REER) is used which is an index that compares the domestic currency to a basket of other currencies (of the largest trading partners) and is corrected for their price levels. An increase of the REER corresponds to an appreciation of the domestic currency. In this paper the REER will be used since Eurozone countries major trading partners are neighbouring countries. So price levels in other Eurozone countries will be taken into account and not just that of the US.

Next to the exchange rate and income there are other factors that influence the trade balance. The more open an economy is, the more it is exposed to currency fluctuations, so the higher the effect of exchange rate changes. Malta, Luxembourg, and Ireland have the highest export to non-euro area countries scaled to GDP and France, Portugal, and Spain the lowest (ECFIN, Winter 2015). Trade openness is most often calculated as the sum of exports and imports divided by GDP. Another factor that needs to be taken into account is the pass through of depreciation to inflation which depends on price elasticity. If this is constant, a 10% depreciation will lead to an 10% increase in price. Full pass through is unlikely when demand is elastic because a firm might not raise its prices because the decrease in quantity will have a higher effect on profits than the price increase.

When conducting research on the effect of one variable on the other, one also has to take into consideration possible reverse causality. The effect the balance of trade has on the exchange rate is much less substantiated in theory and empirically than the other way around. The predictive power of fundamentals on the exchange rate has long been analysed in the macroeconomic literature and most of the evidence is against such a link. Current or lagged values of fundamentals do not seem to matter in predicting the exchange rate only future fundamentals matter for the determination of current exchange rates according to Engel&West (2005) and Sarno&Schmeling (2014). Meese and Rogoff even found that a random walk model performs just as well as some structural exchange rate models (Meese&Rogoff, 1983). In some exchange rate models, terms of trade is one of the variables used to determine the exchange rate. Exogenous terms of trade shocks such as a permanent change in oil prices may be reflected in the relative prices of traded goods. An oil price increase should therefore result in a real appreciation of the currency of the country less dependent on oil. According to the Balassa-Samuelson hypothesis, higher productivity growth in the traded goods sector tends to increase local input costs and therefore prices of non-tradable goods. Since traded goods prices tend to be equalized across countries this raises the local prices level and thus leads to an appreciation. In the structural exchange rate models this effect is taken into account by adding productivity differentials to the equation. Empirically this theory does not do well in explaining real exchange rate and the overall evidence is quite weak (Devereux, 2014). Because of the difficulty of predicting exchange rate movements it is not likely that reverse causality would be a problem.

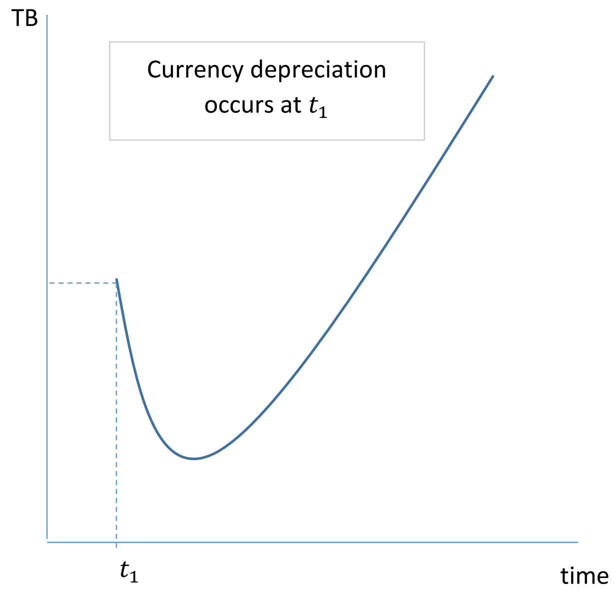
For more background on the relationship between the trade balance and the exchange rate, the real effective exchange rate and trade balance of the 12 Eurozone countries have been plotted in Figure 2 to see if there is a clear correlation (see Appendix). We expect the variables to move in opposite directions but there is no clear negative correlation visible. The relationship can be disturbed if there are factors that influence the path of the exchange rate and the trade balance in the same direction. Interest rates for example play an important role that could move both variables in the same direction. Higher interest rates attract foreign capital and cause the exchange rate to rise and vice versa. But higher interest rates also reduces spending and thereby aggregate demand. As discussed earlier, a decline in aggregate demand improves the current account because of a reduction in imports. Another factor influencing both the exchange rate and the trade balance is political stability. Investment funds move more towards stable economies. Political stability can affect trade relations and thereby improve the trade balance.[4] Due to these and other factors of which the relative importance is subject to much debate, the relationship between the exchange rate and the trade balance is not as evident. Furthermore, current values of the balance of trade do not seem to matter for the current value of the exchange rate (see Sarno and Schmeling, 2014) and the exchange rate might have a lagged impact on the balance of trade.

The J-curve phenomenon

The J-curve term is used to describe the movement over time of the trade balance: it may deteriorate at first and improvement may come later, following a depreciation. This phenomenon is displayed in Figure 2.

[4] See Alesina et al., 1996 and Schneider & Frey, 1985 for the effect of political instability on the economy.

Figure 2. J-curve



Firms and households do not react instantly to changes in prices but take time to adjust their decisions and habits. Because of trade contracts and because price inelastic goods, it will take some time for consumers to search for a cheaper alternative. That is why volumes may react slower than prices. Furthermore, prices might also not react immediately because of price agreements. When the price of a European car decreases, it might take some time for the foreign consumers to react and it might also take time for the manufacturer to meet the additional demand. Elasticities need time to increase, like Krueger (1983) argued. So when in the short run volumes stay stable and prices change, the trade balance will worsen. In the long run, a depreciation increases a country's competitiveness, exports increase and consumers will demand less imports because they become costlier. The theory behind the J-curve assumes that domestically produced alternatives exist. So over time the balance of trade improves. Junz and Rhomberg (1973) attribute the phenomenon to five lags in the process between a depreciation and their ultimate effect on the trade balance: lags in recognition of the changed situation, in the decision the change real variables, in delivery time, in the replacement of inventories and materials, and in production.

Section 2 – Literature review

Different approaches of analysing the effect of a change in the exchange rate on the trade balance have been developed over the years. In this section we will elaborate on the different approaches and the different results it has given. Bahmani-Oskooee (as from now indicated as BO) and Miteza conducted a survey to analyse the effects of a devaluation on domestic production and concluded that the impact is country specific and depends on model specification and results depend on the estimation technique (Bahmani-Oskooee & Miteza, 2003). Therefore this section will touch upon many papers to see what results have been found in the past and to show that the relationship between the exchange rate and the trade balance is still controversial.

The papers of J. Duasa (2007), P. Wilson (2001) and BO and Brooks (1999) are taken as a basis for this paper. These papers have used the ARDL approach which is also applied in this study. BO and Brooks used bilateral data from the U.S. and six of her largest trading partners to investigate the short and the long run response of the trade balance to a currency depreciation. The main conclusion of the paper could be summarized by saying that while there was no specific short run pattern supporting the J-Curve phenomenon, the long run results supported the economic theory, indicating that a real depreciation of the dollar has a favourable long run effect on the U.S. trade balance with her six trading partners. Wilson (2001) uses Johansen cointegration and an ARDL model to analyse three Asian economies and finds that the real exchange rate does not have a significant impact on the trade balance and only one country showed some evidence in support of the J-curve. The dependent variable is the first difference of the real trade balance and independent variables are the lagged and current values of real exchange rate, real domestic and foreign income. The equation is estimated for each country. The coefficients of the current and lagged values of the real exchange rate were insignificant and cycled from positive to negative or vice versa. Duasa's model (2007) is based on BO and Brooks. He found that the exchange rate does not impact the trade balance but strong evidence was found that income and money supply determine the long run behaviour of the trade balance.

Other studies regressing the exchange rate on trade balance added extra variables and used different estimation techniques. One of the most recent studies is from Alemu and Lee (2014) who analyse how depreciation could affect the export sector in 14 Asian economies. They regress trade balance on currency devaluation, degree of openness, income per capita, and a set of other control variables. A regression is estimated using random effect model (REM) and feasible generalized least squares (FGLS). In their sample of 14 countries no evidence is found for the effect of depreciation to improve the trade balance. When a subsample of the 8 largest economies is used, evidence of improvement is found. Rose (1991) finds negative results when examining the relationship between the real effective exchange rate and the aggregate real trade balance for five major OECD countries. Little evidence is found of any strong stable relationship between the exchange rate and the trade balance. In a study of BO in 1991 and 1994, the author used cointegration to find the long run relationship between the exchange rate and the trade balance but found contradicting results. Ogundipe et al. (2013) investigate the impact of a currency devaluation on Nigeria's trade balance using cointegration analysis, a VECM, and variance decomposition analyses from 1970-2010. Determinants of the trade balance are domestic and foreign income, domestic and foreign money supply, domestic and foreign interest rate, and the nominal exchange rate. Cointegration is found between trade balance and most of its determinants (except for foreign income and foreign interest rate). Devaluation worsens the trade balance in Nigeria in the long run. In the short run no causality is found from exchange rate to trade balance. In Onafowora (2003) short and long run effects of the real exchange rate on the real trade balance are analysed for Thailand, Malaysia and Indonesia in their bilateral trade to the US and Japan. For this study a cointegrating VECM is used. Generalized impulse response functions are estimated to investigate the response to shocks. Cointegration is found among the real trade balance, real exchange rate, real domestic and foreign income in each country. The results suggest that a depreciation has a positive effect on the trade balance in the long run with varying degree of J–curve effects in the short run, even though some variation exists in the results. For the regression they use the logarithm of trade balance (exports over imports) and regress it on real domestic and foreign income, real exchange rate, and a shift dummy variable for the period before and after 1997 (Asian financial crisis). Boyd et al. (2001) are trying to find the long-run relationship between the trade balance and the exchange rate using three different econometric models: a cointegrating VAR, a cointegrating VECM, and a single-equation ARDL. Variables used for estimation are trade balance, real effective exchange rate, and domestic and foreign income and the models differ in the degree to which they condition on exogenous variables. They estimate the models for eight OECD countries. Overall the results suggest that the ML condition (explained in the next paragraph) holds in the long run with statistically significant results in five of the eight countries. J-effects were apparent in six of the eight countries.

Elasticity approach

Another way of analysing the effect of a depreciation on the trade balance is the elasticity approach, which has been consistently discussed in the literature, both theoretically and empirically. What happens to import expenditure after a change in relative prices depends on the elasticity of demand for imports, whether it is greater or less than 1. Price elasticities of trade differ widely across countries. They describe the responsiveness of traded quantities to a shift in international prices. The Marshall-Lerner condition implies that the sum of the export supply and import demand elasticity must be greater than unity in order for a devaluation to have a positive effect on the balance of trade. Estimates of elasticities can be found in Houthakker and Magee (1969), Stern et al. (1976), Khan and Goldstein (1985) and Warner and Kreinin (1983). In a report of the European Commission by Imbs and Méjean in 2010 trade elasticities are calculated for more than 30 countries. The price elasticity of imports depends linearly on the preference parameters of the importing representative consumer. The price elasticity of exports, in turn, is given by a weighted average of preference parameters across exports destination markets. Big European economies like France, Germany, Spain have import elasticities around 2, Italy and Belgium even more than 2.5, and the smaller economies like Greece and Austria are below 1. Their results show heterogeneity is prevalent. The elasticities are a lot higher when unconstrained parameter estimates are used. Export elasticities almost never go below unity. The magnitude of estimates varies widely in their research but also across papers because of underlying parameters and assumptions. Preference parameters vary across countries and are hard to measure. A study of the IMF shows an average of 1 for import and export elasticities if general equilibrium effects are taken into account. For some countries elasticities are usually below one, for other countries it is around or above one (Tokarick, 2010). BO used cointegration techniques when estimating elasticities of LDCs in 1998. The result was that in most cases the elasticities were large enough to support the ML condition.

From studies on elasticities it is still hard to say whether a depreciation will have a favourable effect. When elasticities are estimated for a country, the question remains how stable these estimates are. A study by Hooper et al. (2000) tests the stability of price elasticities for the G7. They recognize that movements in international trade may respond differently in the short and long run to prices. The Johansen Cointegration method is used to estimate the long run elasticities and the error correction model (ECM) is used to estimate short run elasticities. Their results satisfy the ML condition and no pronounced instability of elasticities was found during the 90s. Besides around big events (like the German Reunification), elasticities are assumed to be stable. The Marshall-Lerner condition assumes full pass-through, which means that changes in foreign prices are fully reflected in domestic prices. In this case the pass-through coefficients are 1. Frankel, Parsley, and Wei (2005) estimate that for developing countries and emerging markets, the pass-through coefficient is in the range of 0.66 to 0.77.

Empirics of the J-curve

BO has written numerous papers about the J-curve effect and the results are ambiguous. In a study in 1985 a method to find the existence of the J-curve was presented using data of 4 developing countries. Trade balance was regressed on the variables real output, real world output, domestic high powered money and that of the rest of the world and real exchange rate. A lag structure was imposed on the exchange rate variable in order to detect the J-curve. This paper supported the existence of the J-curve. The current account might deteriorate first because of contracts already in force in specified currencies but improve after some time. In the 1994 study the short run relationship was re-examined again using error correction modelling techniques to test the J-curve and some evidence was found in support of the J-curve. An autoregressive model of the trade balance was used with the exchange rate as second dependent variable. In a study of BO in 2003 he found that when aggregate data is used, there is no evidence of the J-Curve in the short run or any significant relation between trade balance and effective exchange rate in the long run. However, when bilateral data are employed, he found evidence of the J-Curve between Japan and Germany as well as between Japan and Italy. In later studies he found mixed results between countries and the results differed also per industry. Hacker et al. (2004) use generalized impulse response functions to test for the J-curve in Czech Republic, Hungary, and Poland in their bilateral trade with respect to Germany. Their findings support the J-curve for each country.

The ARDL approach

Numerous studies use the ARDL model to find short and long run effects. The main advantage of this model is that it can include both stationary and nonstationary variables. The three papers that are taken as a basis use this approach and were discussed above. BO and Kara

(2003) use an ARDL model to measure the responsiveness of trade flows to relative prices and the nominal exchange rate for 9 industrial countries. The results were significant but country specific. The number of lags imposed were based on the Akaike Information Criterion (AIC). BO and Goswami (2004) test the exchange rate sensitivity of Japan's bilateral trade flows. The number of lags imposed on the real effective exchange rate are selected by AIC. They vary from 9 lags for Italy and Germany to 0 for Australia. They concluded that exchange rate changes do not have a significant impact on exports but they do on the value of imports. In a paper of BO and Wang from 2006 the same approach is used and this time the bilateral trade data of China is investigated. More papers of BO use the ARDL model and other economists have followed. Lane and Milesi-Ferretti (2002) investigate the relation between trade balance and real exchange rate using ARDL and include country and time fixed effects in a panel regression. The panel includes 20 OECD countries. It is mentioned that the country size can affect the relationship and this is why country fixed effects are included. Results are showed with and without time fixed effects. They have found a negative long run relationship between the trade balance and the real effective exchange rate. Improvement in the trade balance is associated with a depreciation.

As can be seen from the literature review, the results are very mixed. Looking at the papers using the ARDL approach, there is no strong evidence of the J-curve or a long run relationship between the exchange rate and the trade balance. In this paper we apply the ARDL model on European countries since there is not much empirical evidence for the Eurozone. The ARDL model is a dynamic model in which both short and long run effects can be interpreted. An important feature of the ARDL model is that it can be used with a mixture of I(0) and I(1) data.[5] Some studies have used the nominal exchange rate but we will use the real effective exchange rate to adjust for changes in price levels and all other variables are in real terms to be consistent. Some papers talk about the relationship between the exchange rate and the trade balance but do not mention anything about causality. We are only interested in the effect the exchange rate has on the trade balance and not the other way around. A Granger causality test will therefore be included. Since Europe is a monetary union we will not only look at countries separately and since data on the real effective exchange rate start in 1994, panel analysis will have more statistical power.

[5] See Pesaran and Shin (1999) and Pesaran et al. (2001) for an explanation on ARDL.

Section 3 – Data and methodology

In this section we formulate an empirical model and describe the data that is being used. This study attempts to find the impact of a currency depreciation on the trade balance for 12 Eurozone countries separately and as a panel. All series (exports, imports, income, exchange rate, and the long term interest rate) are obtained from Eurostat, the database of the European Commission. The data is quarterly and spans the time period 1994Q1-2015Q1. The trade balance is the ratio of the value of exports of goods and services (X) to the value of imports of goods and services (M). The X/M ratio is not sensitive to unit of measurement and can be interpreted as nominal or real trade balance (Bahmani-Oskooee, 1991). As for the exchange rate, the indicator used is the real effective exchange rate (REER). The REER for each country is calculated by using CPI as a deflator and is a weighted average of the country's currency relative to a panel of 37 countries' currencies, including all 28 European countries and 9 other industrial countries (Australia, Canada, United States, Japan, Norway, New Zealand, Mexico, Switzerland, and Turkey). For income real GDP is used which is calculated by using GDP at current prices divided by CPI. All variables are expressed in natural logarithm except for the long-term interest rate.

Beneath the ARDL model for the trade balance is specified. The transformation of the ARDL model from level into differences is known as the error correction transformation. As the name indicates, Δy_t corrects past deviation from the long run equilibrium relationships. Specifying in error correction form is useful since the error correction rate and the short term and the long term effects are readily available and the long run multipliers are easy to calculate. The other advantage of using this approach is that it allows for a combination of stationary and nonstationary variables, unlike the Johansen cointegration technique for example. This also means that pretesting the variable on the presence of a unit root is not necessary. The model is given as follows:

$$\Delta lnTB_{t,j} = \alpha_0 + \alpha_1 lnTB_{t-1,j} + \beta_0 \Delta lnREER_{t,j} + \beta_1 lnREER_{t-1,j} + \gamma_0 \Delta \ln Y_{t,j} + \gamma_1 lnY_{t-1,j} + \eta_0 \Delta i_{t,j} + \eta_1 i_{t-1,j} + \theta_j + \theta_t + \varepsilon_{t,j} \quad (1)$$

Where *t* is time and *j* represents country, TB_t is $\frac{X_t}{M_t}$, Y_t is domestic income, $REER_t$ is the real effective exchange rate, i_t is the long term interest rate, and ε_t is the error term. θ_j are country fixed effects and θ_t are time fixed effects. Equation one (1) is the panel regression. The following regression is run for each country separately:

$$\Delta lnTB_t = \alpha_0 + \alpha_1 lnTB_{t-1} + \beta_0 \Delta lnREER_t + \beta_1 lnREER_{t-1} + \gamma_0 \Delta \ln Y_t + \gamma_1 lnY_{t-1} + \delta_0 \Delta lnY_t^* + \delta_1 lnY_{t-1}^* + \eta_0 \Delta i_t + \eta_1 i_{t-1} + \varepsilon_t \quad (2)$$

In addition to the previous regression used, foreign GDP is added. This variable is often included in the trade balance regression in other papers. Foreign GDP is the sum of US, UK, and Swiss GDP and the GDP of the other 11 Eurozone countries.

Of particular interest are β_1 and β_2 since these two coefficients show the relationship between the exchange rate and the trade balance. A rise in REER means the domestic currency is appreciating. So in the long run we expect a negative sign and in the short run it can be either negative or positive. The long run coefficients are $-\frac{\beta_1}{\alpha_1}$, $-\frac{\gamma_1}{\alpha_1}$ and $-\frac{\eta_1}{\alpha_1}$. The paper of S. De Boef and L. Keele gives a more comprehensive explanation about dynamic models and their interpretation. The interpretation of the sign of η is ambiguous. A higher interest rate makes investing in the domestic currency more attractive, which leads to an appreciation and this might worsen the trade balance. The interest rate is negatively related to aggregate demand since a rise increases savings and decreases investments. A drop in aggregate demand could lead to less imports and therefore improve the balance of trade. A rise in domestic income leads to consumers spending more which means imports should go up. Therefore a negative relationship between domestic income and the trade balance is expected. There are also scenarios in which it can go either way. For example when the domestic production of import-substitute goods increases, a rise in domestic income may decrease imports. Naturally, a positive relationship is expected between foreign output and the trade balance.

The regressions are estimated using OLS. Because time series is used, it is possible that the error terms are correlated with the error terms in the previous period. It is important that the error terms are serially independent otherwise the t-statistics and standard errors of the OLS estimation are not valid. To test for autocorrelation the Durbin Watson statistic will be used and a correlogram of the error terms should also tell whether or not the data suffers from autocorrelation. To test for stationarity the Augmented Dickey Fuller (ADF) test and the Im, Pesaran and Shin test is used. If correlation is found to be significant, it is still not clear in which way causation runs. Real output can affect the trade balance or the other way around, or causation happens to be two-way. To make sure the independent variables cause changes in the dependent variable, a Granger causality test will be carried out.

If there are omitted variables that vary across countries but do not change over time, like geographical location or the size of a country, this could bias the estimation. To solve this type of misspecification, cross-section fixed effects are added to the model. One can use period fixed effects if there are omitted variables that are the same for each country in the sample but vary over time. It is possible that there were European laws and regulations that affected the trade balance across all countries. It is also likely that the crisis affected the trade balance of all Eurozone countries. Therefore the model also includes period fixed effects. A fixed effects model assigns every cross-sectional entity or each time period a dummy variable. The coefficients of the dummy variable (the thetas of equation 1 and 2) are different intercepts for each cross-sectional country or each time period. Including these effects could decrease the standard errors and improve the model.

A separate ARDL model will be used to detect the J-curve phenomenon. To detect the J-curve 10 lags of $\Delta \ln \mathrm{REER}$ will be included into the equation (like in BO and Brooks). Since quarterly data is used this corresponds to a time span of 2.5 years. The coefficients of the first lags of the exchange rate are expected to be positive and then turn negative.

Section 4 - Results

Prior to estimating the regression, unit root tests are conducted for each variable using the ADF test. The Im, Pesaran, and Shin (IPS) test is used for the variables of the panel regression. The ARDL framework does not require pre-testing the variables, but the test could convince to use the ARDL model and to make sure the data are not second order integrated. The null hypothesis of the IPS test is that all panels contain a unit root against the alternative hypothesis that a fraction of panels follow a stationary process. According to the IPS test, the interest rate, exchange rate, and the trade balance are found to be stationary and real GDP is integrated of order 1. In fact, the interest rate is stationary by definition and it is also logical that the exchange rate and the trade balance are. For the model where each country is analysed separately, the ADF test is used. None of the series is I(2). Since there is a mix of stationary and nonstationary data, the ARDL model is appropriate.

The next step is estimating the panel error correction model to examine the long and short run relationships between the trade balance and its regressors. The results are presented in Table 1.

Table 1. Panel error correction model

Error correction model							
	Independent variables						
	$\ln(X/M)_{t-1}$	$\Delta ln(REER)_t$	$ln(REER)_{t-1}$	$\Delta lnRY_t$	$lnRY_{t-1}$	Δi_t	i_{t-1}
Dependent variable	-0.0960***	-0.0252	0.0833***	0.2329***	-0.0205	0.0030	0.0028***
$\Delta\ln(X/M)_t$	(0.0143)	(0.1100)	(0.0312)	(0.0663)	(0.0158)	(0.0019)	(0.0007)
Test Statistics: DW: 2.466779 R2: 0.178463							
Long run coefficients							
$-(\beta_1/\alpha_1)$	0.8677						
$-(\gamma_1/\alpha_1)$	0.2135						
$-(\eta_1/\alpha_1)$	0.0292						

α_1 indicates speed of adjustment which is -0.0960 meaning that the trade balance moves back to its equilibrium at a rate of 10%, i.e. when a change of an independent variable causes the dependent variable to move in the long run, the change will take place at a rate of 10% each quarter until it reach its long term value. For the system to be stable (asymptotically) we need alpha to be <0. In this case, the dynamic process is correcting the initial shock between the initial level of y and its long run level. The long run multipliers are 0.8677 ($\frac{\beta_1}{\alpha_1}$), 0.2135 ($\frac{\gamma_1}{\alpha_1}$), and 0.0292 ($\frac{\eta_1}{\alpha_1}$) which can be used to calculate the total effect the independent variable has on the dependent variable distributed over future time periods. The difference between the old and new equilibrium values for Y is the long run multiplier effect of X on Y. When the exchange rate depreciates by one point, the total change in the trade balance is -1*0.8677 is -0.8677. The immediate effect of a change in the exchange rate indicated by β_0 is not significant meaning that the exchange rate does not affect the trade balance immediately. In the long run the REER has a small positive effect on TB (indicated by β_1) which is unexpected. We expect $ln(REER)_{t-1}$ to have a negative sign. It is consistent with Ogundipe et al. (2013), but most other studies found a negative relationship. The coefficient of GDP has a negative sign which support Keynesian theory that an increase in GDP increases imports and therefore worsens the trade balance though the long run coefficient is not significant. The short run effect of real GDP is positive and significant at the 1% level. The interest rate has a small positive significant effect on the trade balance in the long run. This might be because a higher interest rate decreases GDP and GDP is negatively correlated with the trade balance. Both panel fixed effects, time and cross section, significantly improve the model. To test if fixed effects should be included, an F-test is used which suggests that both effects are present. So there is indeed unobserved heterogeneity that needed to be controlled for. By default, all regression coefficients are restricted to be the same across all cross sections. The fixed effects estimates should be interpreted as deviations from an overall mean.

The exchange rate affecting the trade balance is more substantiated in theory and empirically than the other way around as we addressed in the theoretical framework. We can somewhat verify this by using the Granger causality test. Y is said to be Granger-caused by x if x helps in predicting y. The granger causality test examines whether lagged values of one variable help predict the other variable. Causality can also run two-way when y also affects x. The results of the Granger causality test are reported in table 2. The null hypothesis states that x does not granger cause y. We have chosen to include 8 lags which corresponds to two years. The null hypothesis is rejected in all cases except in the first test where we test if the trade balance granger causes the exchange rate when using a 5% significance level. So there is indeed causation taking place from the exchange rate to trade balance but not the other way around. This coincides with the theory. In the other two cases, there is two-way causation as can be seen in table 2. In the case of real GDP, this corresponds to theory since GDP affects the trade balance and the trade balance also affects GDP since it is a component of GDP. The interest rate can have an effect on the trade balance but there is little or no influence from the trade balance on the interest rate on the other hand. Interest rates are affected by supply and demand of credit and monetary policy.

Table 2. Granger causality tests

Sample: 1990Q1 2015Q1
Lags: 8

Null Hypothesis:	Obs	F-Statistic	Prob.
LEM does not Granger Cause LRE	887	1.88660	0.0589
LRE does not Granger Cause LEM		4.83570	8.E-06
LRG does not Granger Cause LEM	994	6.52965	3.E-08
LEM does not Granger Cause LRG		2.89456	0.0034
LR does not Granger Cause LEM	1022	5.99086	2.E-07
LEM does not Granger Cause LR		2.78303	0.0048

J-curve

To see if the J-curve effect is present in the Eurozone, lags of the real exchange rate are added to the equation one by one. The coefficients show the short term effects up to 10 quarters. Table 3 shows the results. If the J-curve would exists, the first coefficients should be positive and later on turn negative. As can be seen, the coefficients do not follow a specific pattern plus most of them are insignificant. Only the fifth, ninth, and tenth quarter show significance which might indicate there is a problem with the data since this is theoretically hard to substantiate. It seems the exchange rate does not have a significant effect on the trade balance in the short run. To analyse if the first four lags have any joint significance, a Wald test is conducted. Joint significance is also not found. BO and Brooks (1999) and Wilson (2001) who used the same type of model also did not found any evidence in support of the J-curve. In small countries it is common that both exports and imports are denominated in foreign currency. This could be a reason why the J-curve is not detected.

Table 3. Coefficient estimates of the lagged exchange rate

Lagged exchange rate	Coefficients	T-statistic
$\Delta lnREER_{t-1}$	-0.0243	-0.2208
$\Delta lnREER_{t-2}$	0.0565	0.5386
$\Delta lnREER_{t-3}$	0.1147	1.0654
$\Delta lnREER_{t-4}$	-0.0747	-0.6928
$\Delta lnREER_{t-5}$	-0.4238***	-4.0041
$\Delta lnREER_{t-6}$	-0.0093	-0.0874
$\Delta lnREER_{t-7}$	-0.0579	-0.5436
$\Delta lnREER_{t-8}$	-0.1277	-1.2012
$\Delta lnREER_{t-9}$	0.2149**	2.0189
$\Delta lnREER_{t-10}$	-0.1798*	-1.7038

Autocorrelation is a problem in this model as can be seen by the DW statistic and when we look at the correlogram of the residuals. When the first difference of the lagged dependent variable is added, autocorrelation disappears. Excluding this variable is what is causing autocorrelation in the error terms. Unfortunately, the model cannot be written in the current ECM form if this variable was to be included. That is why it is kept excluded and when interpreting the data one should take this into account. What one can conclude from the results of the panel error correction model does not change when including the first difference of the lagged dependent variable.

Country specific results

Next, regressions for each country separately are analysed. The results found in the panel regression may not apply to a specific Eurozone country. We also want to know if the exchange rate has a significant effect on the trade balance of a particular country. Results are likely to differ between countries because of trade relations, the size of the country, geographical location etc. In table 4 in the Appendix the statistics are shown for the country specific regressions. The exchange rate has a significant effect in 5 out of 12 countries, both in the short and long run. The signs of the coefficients are still not consistent with the theory that a depreciation improves the trade balance. Only in two cases foreign GDP has some significant effect on the trade balance immediately, but in the long run 7 countries show a significant effect and 5 of them are positive. As shown by the Durbin Watson test, some regressions suffer from autocorrelation. Some autocorrelation is solved when excluding insignificant variables. Another way to make autocorrelation disappear is to include a lagged dependent variable but as said before, the ECM form would not be valid anymore.

Robustness

In order to check the robustness of the results, a number of additional estimates were produced. First, more variables were included to see if this would improve the model. Money supply (M3) has been added, US GDP as a proxy for foreign GDP, and the bilateral exchange rate with US dollar instead of the REER. The results were robust to these changes and the additional variables were all insignificant. When bilateral exchange rate data is used, most often the US is used as the foreign country. The US is also Europe's biggest trading partner but when looking at countries separately, the biggest trading partners of Eurozone countries are neighbouring countries. The largest part of exports and imports is going to and coming from other EU countries. So it is important to also take into account the price levels of other EU countries. Eurostat offers different data on REER. Including the REER that is calculated using data from 18 countries instead of 37 did not affect the results. The problem with the effective exchange rate is that a country's currency could appreciate against one currency and depreciate against another. The weighted averaging could therefore smooth out the exchange rate fluctuations, causing an insignificant link between the effective exchange rate and the trade balance (BO and Brooks, 1999). Because Greece had the largest residuals, a panel was created excluding Greece to see if this would lead to improvement. Excluding Greece only degraded the model.

Section 5 - Conclusion

The purpose of this research is to discover if a depreciation of the Euro has a significant positive effect on the trade balance of 12 Eurozone countries over the period 1994-2015 using an ARDL model specified in error correction form. The results of previous papers are mixed and little research has focused on the Eurozone. Using panel data, no short run effect was found of the real effective exchange rate on the trade balance. Thereby support of the J-curve is not found. Empirically, the absence of short run effects is detected frequently. A small positive effect of the REER on the trade balance was found in the long run which is not consistent with the theory that in the long run a depreciation should improve the trade balance. Expected is that in the long run quantities have adjusted to the changes in prices and more will be exported and less will be imported. An explanation could be that imports are not price elastic so when imports become more expensive a country will not import less but expenditures will increase. This is a plausible explanation for the Eurozone since countries depend on imports i.e. there is a lack of domestically produced alternatives. Most countries have a current account surplus but some have a deficit and when the value of imports increase the value of exports, a depreciation can have a contractionary effect. The benefit of the increase in demand of exports is mitigated when input materials are imported from outside the EU because those will be more expensive. A depreciation thus can have a negative effect when the cost effect outweighs the quantity effect. Analysing countries separately did not lead to more evidence for a strong relationship between the effective exchange rate and the trade balance. The findings of this paper are in line with work using a similar approach.

Even though the Eurozone has a floating exchange rate regime, the central bank has tools to move the exchange rate in the desired direction. A policy implication which could be drawn is that the European Central Bank should not depend on the exchange rate channel when increasing money supply. The exchange rate is dependent on many factors and the effect is has on trade balances is weak according to this study. To stimulate economic growth and to reach inflation of 2%, it might be better to focus on consumption and investments.

Shortcomings

Using the OLS estimation procedure for a dynamic fixed effects model could create biased estimates of coefficients. The bias approaches zero as T approaches infinity so OLS only performs well when T is large (Kiviet, 1995). But the biases can be sizeable even when t is 20 according to Judson and Owen (1999). Solution might be using GMM (generalized method of moments) or a corrected LSDV (least-squares dummy variables) estimation procedure. For further research this is something to look into. OLS might also not be the best estimation procedure because of autocorrelation and/or omitted variables. A possible solution is to use maximum likelihood or instrumental variables techniques. Since the exchange rate was significant in the 5^{th}, 9^{th}, and 10^{th} quarter which is uncommon, there might be a measurement error. This problem is hard to solve even with different estimation techniques since finding suitable instruments is a problem.

Appendix

Figure 1. The trade balance and real effective exchange rate of 12 Eurozone countries

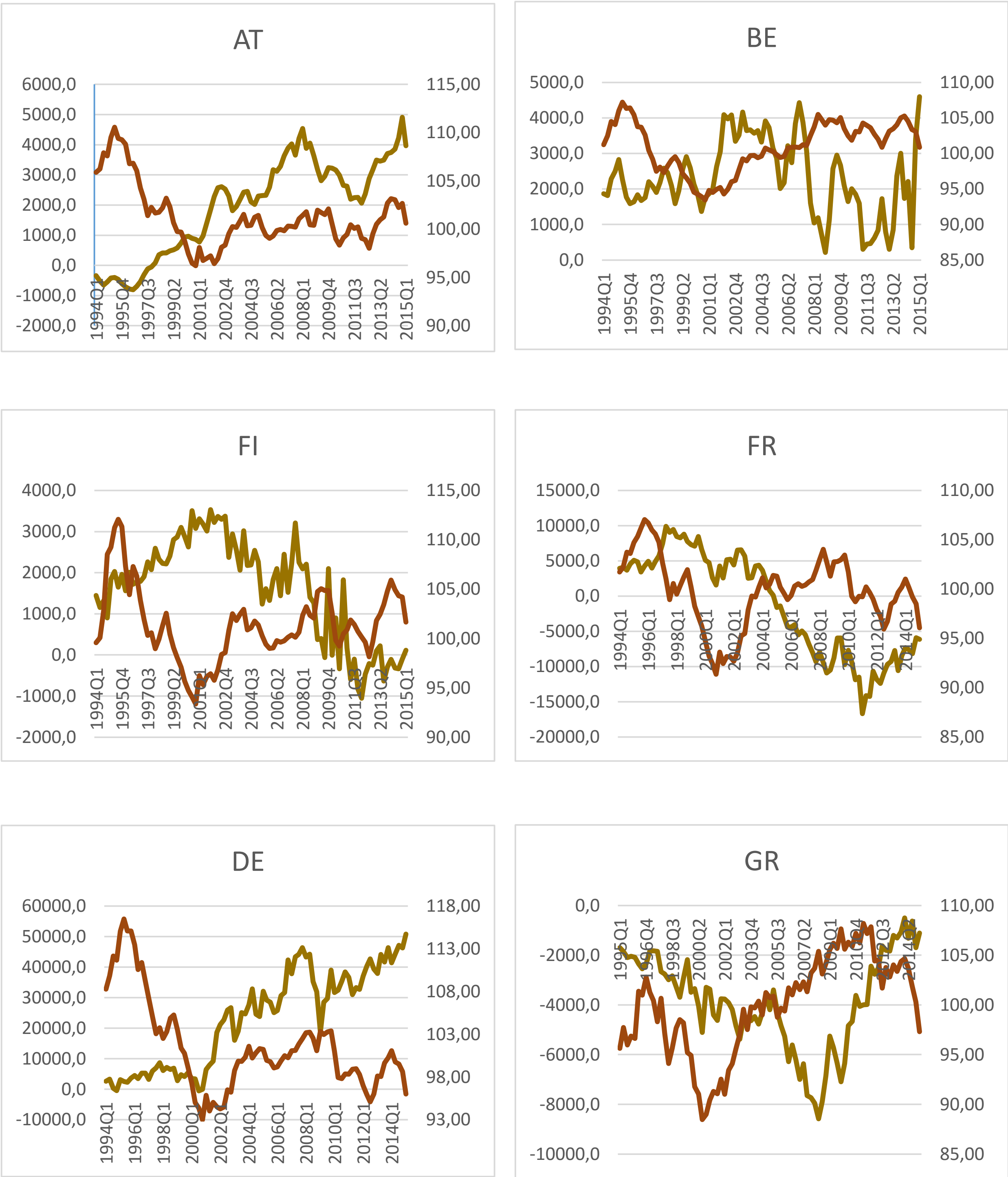
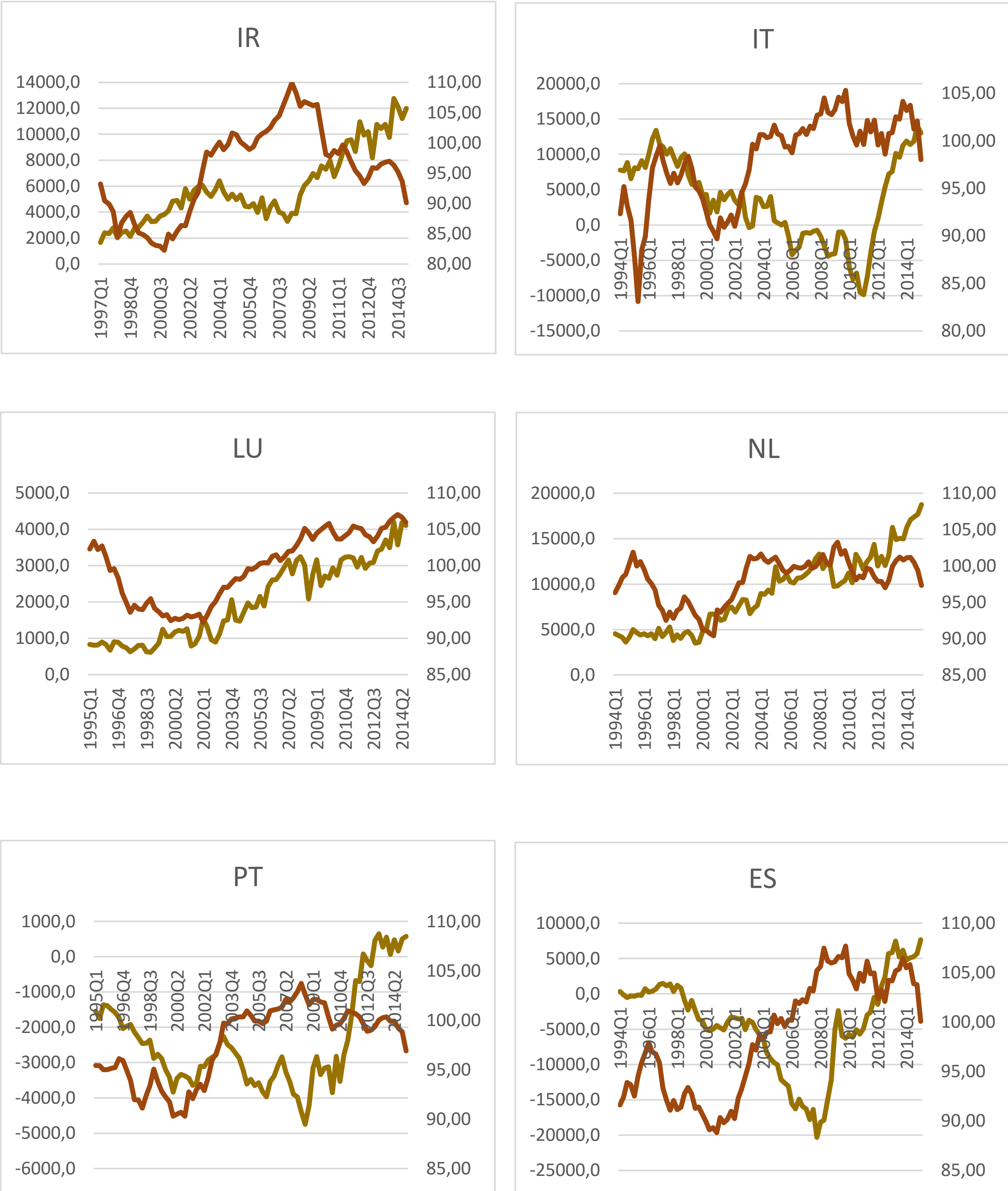


Figure 1. (continued)



Note: The red line represents the real effective exchange rate and the yellow line represents the trade balance. rise in the REER means a real appreciation of the currency.

Table 4. Country specific regression estimates

	ECM per country											
	Trade balance $\Delta\ln(X/M)_t$											
Independent variables	Austria	Belgium	Finland	France	Germany	Greece	Ireland	Italy	Luxembourg	Netherlands	Portugal	Spain
$\ln(X/M)_{t-1}$	-0.1221**	-0.2570***	-0.4454***	-0.2586***	-0.2375***	-0.4330***	-0.2271***	-0.1676***	-0.6427***	-0.5303***	-0.0421	-0.2013***
	(0.0497)	(0.0862)	(0.0873)	(0.0766)	0.0764	(0.0921)	(0.0838)	(0.0524)	(0.1220)	(0.0997)	(0.0368)	(0.0673)
$\Delta ln(REER)_t$	0.3681*	-0.1366	-1.6346***	-0.5207	-0.7700**	0.2554	0.0901	0.2469	-1.2566*	0.1078	0.5566	-0.6567*
	(0.1934)	(0.3105)	(0.5687)	(0.6080)	0.3051	(0.5992)	(0.4386)	(0.1750)	(0.5811)	(0.1952)	(0.6726)	(0.3820)
$ln(REER)_{t-1}$	-0.1016	-0.0952	-0.2622	-0.2705	-0.3272*	0.9776***	-0.0515	0.2454*	-0.1055	0.2943***	0.1111	0.7175**
	(0.0997)	(0.1467)	(0.3681)	(0.3147)	0.1649	(0.2815)	(0.1362)	(0.1301)	(0.2567)	(0.0866)	(0.2702)	(0.2856)
$\Delta lnRY_t$	-0.0770	-0.0053	0.2452	-0.3263	0.7847***	-0.5627	0.3793***	0.0250	0.3274***	0.2339**	-0.0233	-0.8065***
	(0.1028)	(0.1249)	(0.3027)	(0.2140)	0.1967	(0.3814)	(0.1229)	(0.1514)	(0.1207)	(0.0921)	(0.3008)	(0.2280)
$lnRY_{t-1}$	-0.0083	-0.0701**	-0.2777**	-0.3109***	0.0447	-0.3026***	0.0318	-0.2084**	0.0975*	0.0341	0.0523	-0.2457**
	(0.0232)	(0.0271)	(0.1087)	(0.0780)	0.0902	(0.1014)	(0.0290)	(0.0826)	(0.0508)	(0.0216)	(0.1114)	(0.1080)
Δi_t	0.0007	0.0023	-0.0089	-0.0022	0.0041	-0.0050	0.0029	0.0042	0.0103	-0.0098**	7.47E-05	-0.0114**
	(0.0029)	(0.0038)	(0.0137)	(0.0046)	0.0070	(0.0044)	(0.0056)	(0.0058)	(0.0089)	(0.0038)	(0.0047)	(0.0054)
i_{t-1}	-0.0003	-0.0015	0.0166***	-0.0010	0.0041	-0.0014	0.0058**	0.0049*	0.0014	-0.0024*	0.0048**	0.0028
	(0.0011)	(0.0017)	(0.0055)	(0.0022)	0.0035	(0.0021)	(0.0022)	(0.0029)	(0.0030)	(0.0014)	(0.0019)	(0.0023)
$\Delta lnRY^*_t$	0.0661**	0.0032	0.1797	-0.0120	-0.1076	0.4448	-0.1644	0.0215	-0.2793*	-0.0307	0.1004	-0.0136
	(0.0313)	(0.0458)	(0.1671)	(0.0535)	0.0882	(0.2850)	(0.1416)	(0.0841)	(0.1197)	(0.0428)	(0.1259)	(0.0852)
$lnRY^*_{t-1}$	0.0358***	0.0129	0.3621***	0.0630**	-0.0033	0.2342**	-0.0400	0.0416	-0.1390*	-0.0403**	0.0442	0.0829**
	(0.0115)	(0.0158)	(0.0955)	(0.0257)	0.0288	(0.0960)	(0.0611)	(0.0346)	(0.0560)	(0.0174)	(0.0491)	(0.0328)
R^2	0.26	0.18	0.31	0.24	0.34	0.29	0.29	0.19	0.47	0.36	0.16	0.34
DW	1.48	1.65	2.54	2.18	2.00	2.11	2.18	2.12	2.03	2.31	2.36	2.25

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