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Conference Paper

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Beiträge zur Jahrestagung des Vereins für Socialpolitik 2012: Neue Wege und Herausforderungen für den Arbeitsmarkt des 21. Jahrhunderts - Session: Monetary Unions, No. F17-V1

Provided in Cooperation with:

Verein für Socialpolitik / German Economic Association

Suggested Citation: Kolev, Galina (2012) : Quo vadis Eurozone? A reappraisal of the real exchange rate criterion, Beiträge zur Jahrestagung des Vereins für Socialpolitik 2012: Neue Wege und Herausforderungen für den Arbeitsmarkt des 21. Jahrhunderts - Session: Monetary Unions, No. F17-V1, ZBW - Deutsche Zentralbibliothek für Wirtschaftswissenschaften, Leibniz-Informationszentrum Wirtschaft

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Quo vadis Eurozone?

A reappraisal of the real exchange rate criterion

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May 3, 2012

Abstract

In 1976 Vaubel suggested using the variation of real exchange rates when evaluating the desirability of a monetary union within a group of countries (Vaubel 1976). Currency unification is less desirable, the more often real exchange rate adjustments are needed. Ten years later, Mussa reconsidered the high correlation between nominal and real exchange rate movements and presumed predominant influence of transitory factors on the development of real exchange rates (Mussa 1986). The implementation of the real exchange rate criterion for the viability of countries to form a monetary union affords therefore to isolate the real exchange rate variation which is not caused by short-lived shocks to nominal exchange rates. Using the methodology introduced by Blanchard and Quah (1989), the present analysis examines the contribution of temporary and permanent shocks to the variation of real and nominal exchange rates among European countries. Imposing the restriction that temporary shocks should not affect the real exchange rate in the long run, the analysis indicates that in most of the EU-15 countries the nominal exchange rate flexibility was used as a means to effect real exchange rate adjustments before 1999. Based on the results the most viable monetary union of eight members is among Germany, Austria, Belgium, Denmark, France, Luxembourg, the Netherlands and Sweden. Further on, the empirical analysis applies the real exchange rate criterion to the Eastern enlargement of EMU and shows that giving up the nominal exchange rate flexibility would be the most painful for Hungary and Poland.

Keywords: Real exchange rate, SVAR, Monetary integration, European Union.

JEL Classification Numbers: F15, F33, F41, F53.

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1 Introduction

The variation of real exchange rates (RER) as a criterion for the desirability of currency unification was introduced by Vaubel in the 1970s as the idea of creating a monetary union was launched within the structures of the European Community (see Vaubel 1976, 1978). As Vaubel has pointed out, the flexibility of nominal exchange rates is an effective means of carrying out equilibrium real exchange rate adjustments. In inflationary situations the continuous adjustment of the nominal exchange rate (NER) can avoid real exchange rate instability and economic distortions. Furthermore, the largest fraction of real exchange rate variations takes place through nominal exchange rate changes, if permitted. This stylized fact has also been confirmed in a range of studies, of which Mussa (1986) has gained the most popularity. Therefore, joining a monetary union is more costly for countries in need of large real exchange rate adjustments.

In his analyses Vaubel (1976, 1978) compares RER changes among Community countries with those among regions or cities of three existing currency areas, Germany, Italy, and USA. The results show that the variation of RER is significantly larger among Community countries. He refers to at least seven reasons for suspecting that the larger variance of Community RER is partly due to institutional factors which hamper the comparison of cross-country and within-country RER movements. However, Vaubel's analysis shows that RER changes are likely to be systematically correlated with the magnitude of the benefits stemming from currency unification.

Von Hagen and Neumann (1994) take up the results by Vaubel (1976, 1978) and compare the conditional variance and the persistence of RER shocks between Germany and eight European countries with those of RER shocks within the existing German monetary union. Using monthly series of consumer prices and nominal exchange rates over the time span of 1973-1989, they evaluate the RER criterion for desirability of currency unions, and show that "Europe of Two Speeds" existed at the time of their research with Germany, France, and the small neighbors of Germany being a viable monetary union, whereas further reduction

of RER variability was needed in order to include Denmark, Italy, and the United Kingdom. The methodology proposed by Von Hagen and Neumann (1994) has been also applied for the case of the Countries of Central and Eastern Europe (CCEE). Kutan and Zhou (2008) investigate the conditional variance and persistence of RER between Germany as representing the EU standards and EU-27. They extend the time span used by Von Hagen and Neumann (1994) through 2004, and evaluate the desirability of monetary union between EU-15 and the CCEE who joined the EU in 2004 and 2007. Their analysis also highlights the need for RER adjustment as an important criterion for the viability of the common currency area: the larger and more persistent RER changes are needed between the member states, the higher are the costs associated with the enlargement of the monetary union. Comparing five periods of different exchange rate arrangements, they find that the variability and the persistence of RER shocks have declined significantly between the EU founding member states. Although the introduction of the common currency has reduced the variability of RER, Kutan and Zhou show that it is too early to enlarge the monetary union by including the new EU-member states. In the jargon of Von Hagen and Neumann (1994), they refer to “EU of three speeds”. At the time of their research Cyprus, Malta, Estonia, and Slovenia had already met the imposed desirability conditions for entering the Eurozone, including low variability and persistence of RER shocks, as well as high degree of monetary policy coordination.

The publication of these research results has been of considerable political significance in the context of EMU enlargement. Furthermore, the current discussion about the most appropriate way out of the economic crisis can benefit from this comprehensive methodology for analysing the costs of being a member of monetary union. The aim of the present paper is to contribute to the discussion about the desirability of monetary unification within the European Union by reconsidering the real exchange rate criterion as proposed by Vaubel (1976, 1978). First, the empirical analysis investigates the persistence of real exchange rate movements vis-a-vis Germany using a range of different measures. The results point toward

a substantial mean reverting component in some countries. Therefore, the observed high correlation between nominal and real exchange rate movements can result from transitory influences on the development of real exchange rates (see e.g. Mussa 1986). In such a case, the variability of real exchange rates is less conclusive with regard to the disadvantages stemming from currency unification. If the high RER variability is caused by short-lived shocks to the nominal exchange rate, then it could be argued that nominal exchange rate flexibility is less desirable since it causes movements away from the equilibrium path. However, in case that the variability of real exchange rates is caused mainly by permanent shocks, the real exchange rate criterion can be applied as proposed by Vaubel (1976, 1978).¹ Using the methodology introduced by Blanchard and Quah (1989), the present analysis contributes to the discussion of the desirability of monetary unification among the EU member states by examining the influence of temporary and permanent shocks on the variation of real and nominal exchange rates among European countries. Imposing the restriction that temporary shocks should not affect the real exchange rate in the long run, the analysis indicates that in most of the EU-15 countries nominal exchange rate flexibility has been used as a means to effect real exchange rate adjustments before 1999. Based on the results, the most viable monetary union of eight member states should be between Germany, Austria, Belgium, Denmark, France, Luxembourg, the Netherlands and Sweden. Further on, the empirical analysis applies the real exchange rate criterion to the Eastern enlargement of EMU and shows that giving up the nominal exchange rate flexibility would be the most painful for Hungary and Poland.

This paper is organized as follows. The next section analyses the persistence of real exchange rates between Germany and the other EU countries. Section 3 presents the methodology of the empirical approach for the decomposition of RER and NER variation into a transitory and a permanent component. Section 4 contains the results of the empirical analysis. Concluding remarks are offered in Section 5.

¹The importance of the decomposition of real exchange rate variation into a component due to monetary or temporary causes and a component due to real causes has been also stressed by Vaubel in a later publication (see Vaubel 2003, footnote 34).

2 Real exchange rate persistence

Before proceeding with the analysis of RER persistence a closer look at the data provides valuable insights about its time series features. A plot of all real and nominal exchange rates against Germany as representing the standards of the EU is provided in Figure A1 in the Appendix. The data are taken from the IMF International Financial statistics database. It includes monthly, seasonally unadjusted observations on nominal exchange rates and consumer prices from January 1973 to September 2011². The nominal exchange rate vis-a-vis Germany is defined as the price of the Deutsche Mark in terms of the particular home currency. Both, nominal and real exchange rates are expressed as indices with January 2005 serving as a base.

Aside from the overall trend of the series, the nominal exchange rate exhibits a pattern similar to that of the real exchange rate in most of the current EMU member states before the adoption of the Euro. However, some notable exceptions are apparent from Figure A1. Austria and the Netherlands, for instance, exhibit real exchange rate adjustment without significant nominal exchange rate movements, since they chose to stabilize their exchange rates against the Deutsche Mark since the early 1980s. A similar development has been observed in Estonia due to the currency board arrangement adopted almost immediately after introducing the Estonian Kroon.

The common overall pattern of real and nominal exchange rate movements can also be observed in the remaining member states which (still) have not joined the EMU. Besides countries like Bulgaria, Latvia, and Lithuania, where fixed exchange rate regimes do not allow for nominal exchange rate adjustment, much of the real exchange rate variation is reflected by the development of the nominal exchange rates, or vice versa.

The launch of the common European currency has marked the beginning of a period characterized by minor real exchange rate variation in most of the countries. Nevertheless, many

²However, producer prices were used in the case of Ireland and the United Kingdom, since comparable consumer prices were not available for these countries over the whole time period.

of the currencies have experienced continuous real appreciation vis-a-vis the Deutsche Mark which occurred through inflation rates in excess of the German inflation rate. As stated above, real exchange rate adjustments can be achieved in a less painful way if nominal exchange rate flexibility is granted. Therefore, estimation of the costs of giving up the national currency should consider the extent to which nominal exchange rate flexibility has effectively been used as an adjustment mechanism, as well as the actual need for real exchange rate adjustment.

The calculation of RER persistence serves as a suitable starting point of the analysis since it can be used as a rough approximation for the need of real exchange rate adjustments. Considering that the RER persistence is inversely proportional to the speed of mean reversion after a particular shock, it delivers valuable information about the kind of shocks driving the overall real exchange rate movements. For instance, high persistence values, respectively high values for the half life of RER disturbances, are likely to be observed if the development of the real exchange rate is mainly driven by permanent shocks. In terms of the real exchange rate criterion for the desirability of currency unification, the costs of giving up the national currency are higher, the higher the RER persistence between the particular countries.

The majority of PPP studies calculate the RER persistence assuming that real exchange rate dynamics can be best described as an AR(1) process, as represented by the following equation (see e.g. Imbs et al. 2005, Choi et al. 2004):

$$z_t = c + \rho z_{t-1} + \epsilon_t. \quad (1)$$

The estimated autoregression coefficient $\hat{\rho}$ can then be used to calculate the half-life of deviations from Purchasing Power Parity. The half-life $T_{1/2}$ is defined as the number of periods needed for half the effect of a particular shock to dissipate. The half-life can be

derived using the following standard formula:

$$T_{1/2} = \frac{\ln(0.5)}{\ln(\hat{\rho})}. \quad (2)$$

This conventional procedure is also applied in the present analysis. Columns (1) and (2) of Table 1 report the estimated values of $\hat{\rho}$ and $T_{1/2}$ for the EU countries vis-a-vis Germany. The half-life was calculated, using monthly observations of the real exchange rates in logarithms and then transformed into years needed for half of the given shock to dissipate.

The overall results presented in columns (1) and (2) of Table 1 can be summarized as follows. The half-life of shocks to the real exchange rate ranges from about one year in Bulgaria to 192.5 years in Estonia. As a whole, the higher AR(1) coefficients, implying high RER persistence and therefore little reversion, are observed in the transition economies (the only exceptions being Romania, Bulgaria, and Slovenia). This is an expected outcome, since these countries have experienced substantial real appreciations in recent years. Although the fixed exchange rate arrangements in some of these countries have dampened the short-term variability of real exchange rates, the real appreciation due to productivity growth as in the framework of Balassa (1964) and Samuelson (1964) and other real factors is expected to bring about higher autoregression coefficients than e.g. in Luxembourg.³ The RER persistence in Slovenia is similar to that of many EU-15 countries. The low half-life values in Bulgaria and Romania are probably due to the economic turbulences at the beginning of the transition process.⁴ Within the EU-15 countries the half-life of RER shocks is relatively low, with Austria as an exception.⁵ Somewhat higher values of about ten years have been estimated for countries like Denmark, Portugal, and Spain.

The measurement of RER persistence by the half-life of shocks to the real exchange rate derived from the coefficient of an AR(1) process has become a standard in the literature

³For a discussion about the possible explanations for the real appreciation in CCEE see among others Boeva (2009) and Egert et al. (2005).

⁴The RER persistence increased substantially in these countries in the last years. See below.

⁵The high RER persistence in Austria is not surprising, since it is the result of continuous real appreciation vis-a-vis Germany.

Table 1: Real exchange rate persistence in the EU vis-a-vis Germany

Country	N	ρ (1)	half life (2)	β $k = 12$ (3)	β $k = 24$ (4)	β $k = 36$ (5)	β $k = 48$ (6)	β $k = 60$ (7)
Austria	464	.9993***	82.5	.228***	.217***	.259***	.425***	.440***
Belgium	464	.9854***	3.9	-.042	-.243***	-.318***	-.420***	-.606***
Bulgaria	248	.9364***	.9	.052	.144***	.209***	.289***	.301***
Cyprus	464	.9890***	5.2	-.002	.071*	-.183***	.009	-.175***
Czech Rep.	224	.9992***	72.2	-.062	.367***	.232**	.060	.072
Denmark	464	.9949***	11.3	-.079***	-.144***	-.148***	-.147***	-.178***
Estonia	231	.9997***	192.5	.637***	.423***	.228***	.142***	.112***
Finland	464	.9919***	7.1	.076**	-.337***	-.371***	-.211***	-.191***
France	464	.9692***	1.8	-.129***	-.570***	-.479***	-.252***	-.358***
Greece	464	.9911***	6.5	-.279***	-.143***	-.143***	-.244***	-.349***
Hungary	428	.9977***	25.1	.125**	-.010	.130***	-.008	-.142***
Ireland	446	.9774***	2.5	-.165***	-.079*	.101**	-.066	-.193***
Italy	464	.9885***	5.0	.052	.041	-.172***	-.192***	-.192***
Latvia	235	.9992***	72.2	.482***	.297***	.260***	.203***	.086***
Lithuania	225	.9995***	115.5	.332***	.434***	.270***	.198***	.136***
Luxembourg	464	.9853***	3.9	.001	-.259***	-.293***	-.265***	-.166***
Malta	463	.9908***	6.2	.153***	.110**	-.095*	-.329***	-.410***
Netherlands	464	.9845***	3.7	-.083***	-.238***	-.316***	-.278***	-.267***
Poland	284	.9943***	10.1	-.367***	-.018	.236***	.292***	.365***
Portugal	464	.9951***	11.8	-.071**	-.371***	-.262***	-.010	.015
Romania	251	.9665***	1.7	-.255***	-.218***	.279***	.408***	.339***
Slovak Rep.	224	.9995***	115.5	.391***	.691***	.922***	1.002***	1.127***
Slovenia	237	.9945***	10.5	-.044	.123	-.348***	-.570***	-.494***
Spain	464	.9938***	9.3	-.068**	-.192***	-.167***	-.259***	-.380***
Sweden	464	.9855***	4.0	-.189***	-.594***	-.350***	-.275***	-.224***
UK	463	.9907***	6.2	-.057	-.056	.000	-.255***	-.392***

ρ denotes the first order autoregression coefficient.

β represents the persistence of RER changes as in Huizinga (1987).

The reported half life is in years.

*/**/** indicate respectively 1%/5%/10% significance level of the coefficients.

examining the validity of Purchasing Power Parity. In addition, further extensions of the autoregressive process have been proposed to estimate the longevity of shocks to the real exchange rate, including the estimation of AR(p) models (e.g. Mark 2001) and the utilization of impulse response functions (see among others Cheung and Lai 2000, Kilian and Zha 2002, Murray and Papell 2002). A slightly different application of the autoregressive process in the context of RER persistence has been proposed by Huizinga (1987). He suggests to estimate the share of the shocks that can be expected to be reversed in a given period. The

methodology involves estimating the regression model:

$$z_{t+k} - z_t = \beta_k(z_t - z_{t-k}) + e_t, \quad (3)$$

the interpretation being as presented below. A coefficient β would imply that $\beta \cdot 100\%$ of any real appreciation or depreciation over the last k years can be expected to be reversed in the following k years. In his analysis Huizinga estimates β for different k values and shows that the mean-reverting component in RER becomes weaker with decreasing time interval. Columns (3)-(7) of Table 1 (page 8) present the estimated values of β for the case of EU countries for $k = 12, 24, 36, 48, 60$ months. In some countries like France, Belgium, the Netherlands, and Slovenia the relatively low half-life of shocks to the real exchange rate are also confirmed by the negative β coefficients, regardless of the horizon for which they were estimated. In Poland the low RER persistence based on the AR(1) process estimates for the levels can be observed for small k as well. However, as the time interval increases the β values become positive, indicating that shocks are more persistent than the calculated half-life suggests. In Bulgaria and Romania, where extremely low half-life values were observed, in spite of trend real appreciation, the β values suggest RER persistence far exceeding that calculated from the AR(1) estimation of the levels. For large k the β values become positive and highly significant. In the other transition economies the estimated β values are positive and significant, therefore confirming the high RER persistence in these countries.

To sum up, the analysis indicates significantly higher levels of RER persistence in CCEE than the average (with Slovenia being a notable exception) with the lowest levels in Belgium, France, Luxembourg, and the Netherlands. Based on these results the costs of currency unification are the lowest in the latter countries, implying that according to this methodology they form more desirable monetary union with Germany than most CCEE countries. The results indicate that most transition economies will have to accept high costs by adopting

the common European currency in the near future. They should wait until their real appreciation slows down considerably. Moreover, the results show that in many current EMU member states nominal exchange rate flexibility would have been a valuable instrument for real exchange rate adjustment. For instance, Portugal, Spain and Austria exhibit relatively high AR(1) coefficients and the analysis of the β values indicate that less than one-fifth of a shock to the real exchange rate over the last five years is expected to be reversed in the next five years. Concerning the high persistence in these countries, the question about the source of these long lasting shocks to real exchange rates has arisen. If nominal shocks have been the main cause of real exchange rate movements, then it would be misleading to deduce the costs of giving up the national currency from the calculated persistence measures.

3 The Empirical Model

The high levels of real exchange rate persistence in many countries have led to a large body of literature trying to explain the slow mean reversion process. Attempts to investigate the so called PPP Puzzle, i.e. the extremely slow rate at which shocks to the real exchange rate seem to cancel out, consider for instance sticky price models as explanation. As a result of monetary shocks, immediate adjustments of nominal exchange rates are associated with large real exchange rate movements since national price levels adjust slowly. The main reason is the binding character of long-lasting contracts. In his influential paper Mussa (1986) has pointed out that sluggish price adjustment must be the main explanation for the short-term movements in real and nominal exchange rates. However, Bergin and Feenstra (2001), Chari et al. (2002), Kollmann (2001), and Tille (1998) among others have shown that only extremely long-ranging contracts can explain the observed persistence. Chari et al. (2002) investigate the effect of monetary shocks on real exchange rates in a two-country sticky price model with price-discriminating monopolists. Their analysis

reproduces the observed volatility in RER, assuming one-year contracts, but it cannot generate the high persistence observed in the data. Bergin and Feenstra (2001) use a model with translog preferences, which amplify the effect of price stickiness in generating persistence. However, their analysis also points out the duration of contracts should be at least 2-3 years in order to generate the very high persistence of real exchange rates. As further explanation Benigno (2004) proposes to reinterpret the way monetary policy is conducted in order to reproduce the deviations from PPP. Endogenous monetary policy designed in a way to smooth disturbances in the real economy can interact with nominal price stickiness in a complementary way to generate RER persistence as observed in the data.

Regardless of the source of real exchange rate persistence, it is a well accepted fact that monetary policy brings about substantial real exchange movements. Bergin and Feenstra (2001) and Chari et al. (2002) estimate an average one quarter autocorrelation of the real exchange rate amounting to about 0.8, with a standard deviation between four and five times that of real output. Although some part of the real exchange rate persistence is brought about by real factors, there is a substantial part which can be ascribed solely to monetary policy.

Clarida and Gali (1994) examine the role of monetary policy for four countries vis-a-vis the US dollar. Using the approach pioneered by Blanchard and Quah (1989) they estimate a three-equations open macro model in the spirit of Dornbusch (1976) and Obstfeld (1985). Especially for the case of Germany and Japan they show that monetary shocks explain a substantial amount of the variance of the US dollar RER: more than 41% of the variance of the USD/DM RER and more than 35% for the USD/YEN can be ascribed to monetary shocks at a twelve-month horizon. The main core of their results has been confirmed by Rogers (1999) and Faust and Rogers (2003). In several alternative VAR specifications with five variables Rogers (1999) analyses the GBP-USD real exchange rate using over a hundred years of data. Depending on the specification, the real exchange rate variability in

the short run (twelve months) ascribed to monetary shocks ranges between 19% and 60%, with a median contribution of 40.6%. Faust and Rogers (2003) estimate a seven-variables model as in Eichenbaum and Evans (1995) and analyse the effect of monetary shocks over a 48-months horizon. The results point toward a variance share of over 50% that can be attributed to monetary shocks. Even in a further specification with fourteen variables the variance share of monetary shocks remains substantial, about one-third.

The examination of sources for RER movements using the Blanchard/Quah methodology within a multivariate framework requires imposing a wide range of constraints, many of which are questionable. In the present analysis the methodology is applied in a bivariate framework using only the real and nominal exchange rates in order to investigate the sources of real exchange rate movements and the costs of giving up the national currencies in Europe by placing only one restriction, namely that, in the long run, the real exchange rate is not affected by nominal and temporary real shocks.

The objective of the following sections is to determine empirically the sources of real and nominal exchange rate fluctuations in current EMU member states and candidate countries. More specifically, the empirical approach focuses on decomposition of real exchange rate variation into two components, permanent and transitory. The methodology goes back to the seminal paper of Blanchard and Quah (1989), in which they propose a method to identify the dynamic effects of supply and demand shocks on real GNP and unemployment. In their work Blanchard and Quah apply a bivariate structural vector autoregressive model (SVAR) imposing a long-term restriction as strategy for identification. Lastrapes (1992) introduces a natural extension of the estimation technique applied by Blanchard and Quah (1989) to the study of exchange rate behavior. Using monthly IMF data between 1973 and 1989, Lastrapes investigates the driving sources of nominal and real exchange rates between the United States on the one hand and Germany, Japan, Italy, and Canada on the other.⁶ His

⁶Originally the data set used by Lastrapes included the United Kingdom too. However these series were dropped from further consideration after investigating the stationarity of the exchange rates. See below.

findings indicate that nominal and real exchange rate fluctuations were mainly caused by real shocks between 1973 and 1989. Therefore Lastrapes concludes that nominal exchange rate flexibility is required to facilitate the changes in relative prices across borders and an efficient allocation of resources.

In the following, a brief overview of the estimation procedure is presented before proceeding to the empirical results regarding the EU countries.

Consider the following bivariate stable vector autoregressive process

$$\Delta y_t = A_0 \Delta y_t + A_1 \Delta y_{t-1} + A_2 \Delta y_{t-2} + \dots + A_q \Delta y_{t-q} + u_t, \quad (4)$$

where

$$\Delta y_t = \begin{bmatrix} \Delta z_t \\ \Delta s_t \end{bmatrix}$$

represents the vector of the endogenous variables in first differences. s_t is the logarithm of the nominal exchange rate defined as the price of the foreign currency in home currency units. z_t is the log of the real exchange rate, $z_t = s_t + p_t^* - p_t$, with p_t and p_t^* denoting the price levels in the home and in the foreign country, respectively. $A_0, A_1 \dots A_q$ represent matrices of parameters with the only ex ante restriction being

$$A_0 = \begin{bmatrix} 0 & a_{02} \\ a_{03} & 0 \end{bmatrix}.$$

The contemporaneous covariance matrix of disturbances is given by Ω , with

$$\Omega = E[u_t u_t'] = \begin{bmatrix} \omega_{11} & 0 \\ 0 & \omega_{22} \end{bmatrix}.^7$$

The disturbances contained in the vector u_t are assumed to be white noise and represent two fundamental structural shocks as pointed out in the discussion below. The reduced form of

⁷Placing the zero restrictions in A_0 and Σ is convenient normalization in the VAR literature. For further discussion of VAR and SVAR models see among others Amisano and Giannini (1997), Luetkepohl (2005), Stock and Watson (2001) and Watson (1994).

the linear dynamic structural model can be represented as follows:

$$\begin{aligned}
\Delta y_t &= (I - A_0)^{-1} A_1 \Delta y_{t-1} + (I - A_0)^{-1} A_2 \Delta y_{t-2} \\
&\quad + \dots + (I - A_0)^{-1} A_q \Delta y_{t-q} + (I - A_0)^{-1} u_t \\
&= \Pi_1 \Delta y_{t-1} + \Pi_2 \Delta y_{t-2} + \dots + \Pi_q \Delta y_{t-q} + \epsilon_t,
\end{aligned} \tag{5}$$

with

$$\Sigma = E[\epsilon_t \epsilon_t'] = \begin{bmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{12} & \omega_{22} \end{bmatrix}.$$

The moving average representation of the derived VAR model can be obtained by solving for the final form of Δy_t ,

$$\Delta y_t = (I - \Pi_1 L - \Pi_2 L^2 - \dots - \Pi_q L^q)^{-1} \epsilon_t = \begin{bmatrix} C_1(L) & C_2(L) \\ C_3(L) & C_4(L) \end{bmatrix} \begin{bmatrix} \epsilon_{1t} \\ \epsilon_{2t} \end{bmatrix} = C(L) \epsilon_t. \tag{6}$$

$C(L)$ is the matrix of long-run responses of Δy to exogenous shocks, whereas each element of the matrix is an infinite order lag polynomial.

Although reduced form VAR can be used to estimate the coefficients in Π_1, \dots, Π_q , the information delivered by the VAR estimations is not sufficient to investigate the effect of the structural shocks contained in the vector u_t on the levels of the variables. A further restriction is needed and it can be derived from the long-run neutrality of transitory shocks on the real exchange rate. Under the assumption that u_1 represents permanent shocks and u_2 transitory shocks, this restriction implies that

$$\lim_{k \rightarrow \infty} \frac{\partial z_t}{\partial u_{2,t-k}} = 0. \tag{7}$$

This restriction is equivalent to setting the accumulated effect of the transitory shock on Δz_t equal to zero. It should, however, be kept in mind that the imposed restriction is not testable,

since it does not overidentify the structural model. Thus, the methodology introduced by Blanchard and Quah (1989) decomposes the variation of real and nominal exchange rates within a SVAR framework into a transitory and a permanent component.⁸

4 Estimation Results

For the purpose of the empirical analysis, the time series calculated from IMF data as described in section 2 have been converted into logs and expressed as first differences. Preconditions for the estimation of the SVAR model are a stationary vector process Δy_t and no cointegrating relationship between z_t and s_t . In most of the cases nonstationarity of Δy_t and cointegration of the exchange rates in levels appeared nonproblematic.⁹ However, the null of nonstationarity can be rejected in some countries for the levels of nominal or real exchange rates. In particular in Austria, France, and Luxembourg the results should be interpreted with caution, since overdifferencing of the exchange rates makes the application of the Blanchard-Quah approach less appropriate for these countries.

In the following the dynamic effects of transitory and permanent shocks on exchange rates have been analyzed. The unrestricted VAR has been estimated for $q = 12$.¹⁰ Besides the constant and a deterministic trend, seasonal dummies have been included in some cases, since the time series exhibit strong seasonal patterns in some countries. Afterwards, SVAR has been estimated placing the neutrality long-term restriction in the equation of the real exchange rate.¹¹

Figures A2 in the Appendix depicts the responses of real and nominal exchange rates to per-

⁸The application of the Blanchard/Quah framework has led in the literature to the interpretation of the transitory (permanent) component as nominal (real) shock. However, there are some potential problems with this interpretation. For further details see Lastrapes (1992).

⁹The results of the modified ADF test for nonstationarity as well as those of the Engle-Granger test procedure for cointegration are reported in Tables 8 and 9 in the Appendix.

¹⁰The optimum lag-length according to the Schwarz's Bayesian information criterion turned out to be 1 in most of the cases. However, the implementation of the Lagrange-multiplier test showed considerable autocorrelation of the residuals. Therefore the number of lags included has been increased in order to account for remaining autocorrelation and set uniformly to 12 to assure comparability of the results.

¹¹The Blanchard-Quah methodology was implemented using the JMulTi software package.

manent and transitory shocks in the EU-15 countries.¹² The long-term effect of transitory shocks on RER approaches zero due to the neutrality restriction imposed. In the short run, both, real and nominal exchange rates, exhibit in many countries a pattern consistent with the overshooting hypothesis of the 1970s.¹³ The peak is reached after about 6-12 months in Austria, Belgium, Finland, France, and Spain and much sooner in the remaining countries. It is followed by gradual decline of the nominal exchange rate towards the long-term value. Remarkable exceptions from this pattern can be observed in Greece, Luxembourg, and Portugal, where the response increases steadily until the long-term value is reached. In all countries the long-term response of nominal exchange rates to transitory shocks is strongly positive, indicating that nominal shocks are absorbed also by the nominal exchange rate over time and not solely by the price levels. The real exchange rate returns to its initial value after approximately 1.5-3.5 years.

Of great relevance for the implementation of the real exchange rate criterion is further the response of nominal and real exchange rates to permanent shocks. In most of the countries the pattern of the dynamic response of nominal exchange rates to permanent shocks is very similar to that of the real exchange rate. Therefore nominal exchange rate flexibility has indeed been used as an adjustment mechanism for permanent changes in the real exchange rate. The long-term responses to the different shocks are also presented in Table 3. In order to investigate the challenges associated with the adaptation to the situations with common currency, the last column of Table 3 reports the share of long-term response of real exchange rates, which has been carried out by nominal rate adjustments. The results indicate that over the period from 1973 to 1998 the nominal exchange rate flexibility was utilized to a lesser extent in countries like Austria and the Netherlands, where only 43%, respectively 70% of real exchange rate changes occur through nominal exchange rate movements.¹⁴ At the

¹²The dashed lines represent the 95% confidence interval from a bootstrap simulation with 500 replications.

¹³See e.g. Dornbusch (1976).

¹⁴In Ireland the calculated number of 70.2% is relatively small as well. However, this result is mainly due to the fact, that producer prices were used for this country. Therefore, the comparability is not granted for the case of Ireland and the results should be interpreted with caution.

Table 2: Long-term responses of real and nominal exchange rates in EU-15 to permanent and transitory shocks (1973-1998)

Country	Response of RER to a		Response of NER to a		share of permanent shock to RER accounted for by NER (3)/(1)·100%
	permanent shock (1)	transitory shock (2)	permanent shock (3)	transitory shock (4)	
Austria	.0051 (.0012)	.0000	.0022 (.0008)	.0023 (.0006)	43.1
Belgium	.0093 (.0020)	.0000	.0076 (.0028)	.0066 (.0022)	81.7
Finland	.0382 (.0114)	.0000	.0321 (.0093)	.0057 (.0016)	84.0
France	.0121 (.0022)	.0000	.0108 (.0027)	.0073 (.0025)	89.3
Greece	.0139 (.0034)	.0000	.0222 (.0113)	.0229 (.0089)	159.7
Ireland	.0159 (.0036)	.0000	.0112 (.0045)	.0116 (.0027)	70.4
Italy	.0216 (.0053)	.0000	.0184 (.0047)	.0056 (.0011)	85.2
Luxembourg	.0082 (.0018)	.0000	.0095 (.0037)	.0067 (.0023)	115.9
Netherlands	.0235 (.0050)	.0000	.0165 (.0046)	.0096 (.0025)	70.2
Portugal	.0345 (.0106)	.0000	.0414 (.0146)	.0130 (.0032)	120.0
Spain	.0230 (.0048)	.0000	.0230 (.0057)	.0093 (.0026)	100.0
Denmark	.0092 (.0020)	.0000	.0049 (.0023)	.0069 (.0018)	53.3
Sweden	.0298 (.0073)	.0000	.0262 (.0066)	.0087 (.0022)	87.9
UK	.0256 (.0053)	.0000	.0269 (.0064)	.0090 (.0023)	105.1

Standard errors from the bootstrapping procedure are presented in parentheses. All coefficients are highly significant, except for the cases indicated by *ns*.

other extreme are countries like Greece, Portugal, and Spain, in which the response of the nominal exchange rate has even outpaced that of the real rate. The remaining countries can be placed in between. Considering the EU-15 countries which are not part of the EMU, the results indicate that in Denmark the adjustment to the common currency would have been comparable to that in Austria and the Netherlands. However, in the UK nominal exchange rate flexibility is still a valuable instrument for carrying out real exchange rate changes.

Figure A3 and Table 4 present the results of the estimation with regard to the new EU member states with flexible exchange rate arrangements.¹⁵ The responses of nominal and

¹⁵Transition economies with fixed exchange rate arrangements have been excluded from the analysis since the methodology presupposes a minimum of exchange rate flexibility. However, as regards the utilization of the nominal exchange rate as an adjustment mechanism they can be classified as countries, in which the challenge of adaptation to the situation with common currency is not that pronounced, since they do not use the nominal rate flexibility at all.

Table 3: Long-term responses of real and nominal exchange rates in CCEE (1993-2006) and Cyprus and Malta (1973-2006) to permanent and transitory shocks

Country	Response of RER to a		Response of NER to a		share of permanent shock to RER accounted for by NER (III)/(I)·100%
	permanent shock (I)	transitory shock (II)	permanent shock (III)	transitory shock (IV)	
Czech Rep.	.0113 (.0034)	.0000	.0078 (.0029)	.0054 (.0019)	69.0
Hungary	.0133 (.0035)	.0000	.0184 (.0065)	.0095 (.0035)	138.3
Poland	.0228 (.0054)	.0000	.0221 (.0124)	.0318 (.0157)	96.9
Romania	.0306 (.0081)	.0000	.0072 ^{ns} (.0121)	.0444 (.0125)	23.5
Slovak Rep.	.0453 (.0131)	.0000	.0080 (.0045)	.0105 (.0032)	17.7
Slovenia	.0165 (.0052)	.0000	.0000 ^{ns} (.0231)	.0058 (.0013)	0.0
Cyprus	.0173 (.0035)	.0000	.0129 (.0029)	.0052 (.0009)	74.6
Malta	.0087 (.0025)	.0000	.0008 ^{ns} (.0007)	.0023 (.0004)	9.2

Standard errors from the bootstrapping procedure are presented in parentheses. All coefficients are highly significant, except for the cases indicated by *ns*.

real exchange rates to transitory shocks have been similar to those in the EU-15. Concerning the response to permanent shocks, the results indicate that in Slovakia, Slovenia, and most notably Romania only a small amount of the real exchange rate adjustment has been brought about through nominal exchange rate changes. However, Hungary and Poland, where permanent shocks to the real exchange rate are carried out mainly by nominal rate adjustments, would lose much when joining the common currency.

The examination of the nominal exchange rate as an adjustment mechanism reveals valuable insights about the behavior of the real exchange rate in some member states since the adoption of the Euro. Greece, Portugal and Spain, for instance, experienced a considerable real appreciation vis-a-vis Germany, which exceeded the long-term trend and the pace determined by real factors. In these countries the adaptation to the common currency has been especially challenging, since before 1999 they had extensively used nominal exchange rate flexibility as an adjustment mechanism. Moreover, depreciation had served to accomodate high inflation rates. It would have been better to allow for a more gradual adaptation to the common currency in these countries by stepwise decrease

of nominal exchange rate flexibility (if at all). This would have permitted adaptation of the process of expectation formation as well.

Further information contained in the SVAR estimates can be summarized using the variance decomposition of the forecast errors (FEVD). FEVD is a measure for the relative importance of the shocks under consideration to the system. Tables 5 and 6 report the relative contribution of permanent and transitory shocks to the real and nominal exchange rates. The left block of the tables reveals that even at short time horizons real exchange rate movements are mainly driven by permanent shocks. Only in Italy, the Netherlands, Romania, Slovakia, and the Czech Republic more than 25% of the variance at 1-month horizon is attributed to transitory shocks. Considering the right hand panel of the tables showing the relative contribution of permanent shocks to the nominal exchange rate, the results confirm by and large the outcome of the impulse-response functions. Especially in Denmark and the Netherlands the nominal exchange rate is mainly driven by transitory factors. However, in other countries like Finland, Greece, Portugal, and Spain over 70% of the nominal exchange rate movements are due to permanent adjustments. In CCEE the nominal rate flexibility seems to be of great importance especially for Hungary and Poland, where the relative contribution of permanent shocks to the nominal exchange rate amounts to 91% and 69% respectively.

The variance decomposition achieved by estimating the SVAR can be further used to approximate the share of RER variance caused by transitory and permanent shocks. In the next step the variance of the real exchange rate over time was computed for the annual observations and weighted by the contribution of permanent shocks to the forecast error at a 12-month horizon in the SVAR framework. The calculated values for each country can then be used to evaluate the extent to which real exchange rate adjustments are needed with regard to Germany. The results presented in Table 7 indicate that there is a

Table 4: Forecast error variance decomposition of real and nominal exchange rates in EU-15 (1973-1998)

Country	Relative contribution of permanent shocks to RER (in %)			Relative contribution of permanent shocks to NER (in %)		
	$k = 1$	$k = 12$	$k = 60$	$k = 1$	$k = 12$	$k = 60$
	(1)	(2)	(3)	(4)	(5)	(6)
Austria	93	90	88	55	54	55
Belgium	86	81	79	45	45	44
Finland	94	89	88	75	74	73
France	94	87	85	74	71	70
Greece	99	96	95	78	74	74
Ireland	91	86	86	49	50	50
Italy	72	71	71	46	47	49
Luxembourg	100	93	93	87	83	82
Netherlands	71	71	70	27	28	29
Portugal	94	90	89	86	83	83
Spain	95	94	91	75	75	74
Denmark	86	83	81	24	25	26
Sweden	93	88	88	69	68	67
UK	85	80	81	65	66	65

Table 5: Forecast error variance decomposition of real and nominal exchange rates in CCEE (1993-2006) and Cyprus and Malta (1973-2006)

Country	Relative contribution of permanent shocks to RER (in %)			Relative contribution of permanent shocks to NER (in %)		
	$k = 1$	$k = 12$	$k = 60$	$k = 1$	$k = 12$	$k = 60$
	(1)	(2)	(3)	(4)	(5)	(6)
Czech Rep.	63	56	56	26	26	28
Hungary	100	96	90	94	93	91
Poland	87	86	83	70	70	69
Romania	63	60	60	16	17	21
Slovak Rep.	72	70	70	34	37	39
Slovenia	99	95	95	0	2	5
Cyprus	100	98	97	61	60	60
Malta	85	76	76	7	9	10

Table 6: Variance of RER due to permanent shocks in EU-15, Cyprus and Malta (1973-1998) and CCEE (1993-2006)

Country	Annual variance of RER (1)	Share of perm. shocks in % ($k = 12$) (2)	Variance due to perm. shocks (3)=(1)*(2)
Austria	56.6	90	51.0
Belgium	23.0	81	18.7
Finland	137.6	89	122.5
France	20.8	87	18.1
Greece	130.4	96	125.1
Ireland	29.6	86	25.5
Italy	162.4	71	115.3
Luxembourg	24.0	93	22.3
Netherlands	14.5	71	10.3
Portugal	223.8	90	201.4
Spain	189.2	94	177.9
Denmark	33.7	83	28.0
Sweden	56.7	88	49.9
UK	342.5	80	274.0
Czech Rep.	618.9	56	346.6
Hungary	482.2	96	462.9
Poland	496.6	86	427.1
Romania	1631.7	60	979.0
Slovak Rep.	1172.3	70	820.6
Slovenia	63.0	95	59.9
Cyprus	100	98	83.4
Malta	85	76	106.5

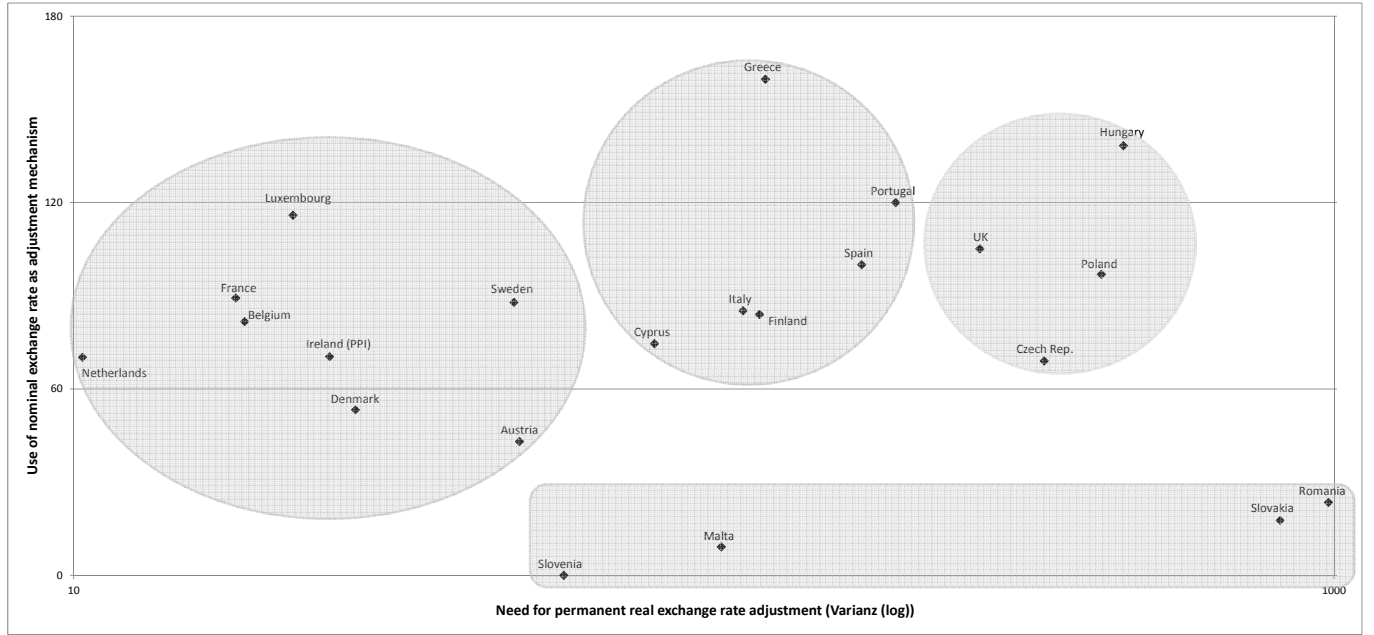
range of countries with relatively low variance of real exchange rates vis-a-vis Germany. The calculated values show that a monetary union between Germany on the one hand and Austria, Belgium, France, Luxembourg, Netherlands and most notably Denmark and Sweden would be a more desirable currency area than with the other countries.¹⁶ However, the inclusion of countries like Greece, Portugal, Spain is associated with increasing costs of monetary unification. Among the new member states Slovenia exhibits variance comparable to Austria and Sweden and can therefore be considered an adequate member of the currency area. On the other hand, the variance of the remaining CCEE is extremely high, even in Slovakia, where the Euro has already been introduced as official currency. The accession of these countries is less desirable as long as they are in need of large real exchange rate adjustment.

¹⁶The value for Ireland is relatively low too. However, this is again due to the fact that consumer prices were not available for this country and producer prices were used instead. Therefore, the result is not really comparable to the others.

Combining the results of the variance analysis and the impulse response functions, four main groups of countries can be identified (see Figure 1). The first group includes Austria, Belgium, Denmark, France, Luxembourg, the Netherlands and Sweden. In these countries the nominal exchange rate has been used as an adjustment mechanism, but the need for real exchange rate adjustment vis-a-vis Germany has been relatively low. These countries would form a desirable monetary union with Germany. The second group consists of Greece, Finland, Italy, Portugal, Spain and probably Cyprus, where the need for real exchange rate adjustment has been pronounced and the nominal exchange rate has indeed been used as valuable adjustment mechanism. These countries are less suitable to form desirable currency area with Germany and it is not surprising that they faced considerable difficulties in the last years including loss of competitiveness. The third group includes the Czech Republic, Hungary, Poland and the UK. These countries use the exchange rate flexibility and they should do so in the future, since the need for permanent real exchange rate adjustment with respect to Germany is very high there. They should not join the monetary union, at least not in the near future. The last group includes countries, where the nominal exchange rate has not been extensively used as an adjustment mechanism, but the permanent component of the RER variance has been high to very high. This group includes Slovenia, Malta, Romania and Slovakia. Although these countries are in need of real exchange rate adjustments, they are not expected to face the difficulties of the second group since the nominal exchange rate has not been appropriately used to achieve the real adjustment. Nevertheless, probably besides Slovenia, these countries (still) do not form desirable monetary union with Germany.¹⁷

¹⁷This group can be reasonably extended by the countries excluded from the analysis due to lacking nominal exchange rate flexibility. Bulgaria and the Baltic states are not expected to face significant difficulties by introducing the Euro in place of the currency board either. However they do not form desirable monetary union with Germany since their real exchange rates exhibited high variability in the last decades.

Figure 1: Classification of EU member states due to the real exchange rate criterion



5 Concluding remarks

This paper has examined the dynamics and sources of real and nominal exchange rate changes in EU countries prior to their accession to the monetary union. In first place, the real exchange rate persistence turned out to vary widely among the different countries, indicating that RER shocks, as well as the adjustment path of the real exchange rate, differ across member states. In the second part of the analysis, an attempt was made to decompose the variance of nominal and real exchange rates. The results indicate that real exchange rates are driven mainly by permanent shocks and these have been carried out through nominal exchange rate changes, especially in countries like Hungary, Poland, Finland, Greece, Portugal, and Spain. Reappraising the real exchange rate criterion proposed by Vaubel (1976, 1978), this outcome implicates that these countries benefit, or would have benefited from retaining the nominal exchange rate flexibility. Austria, Belgium, Denmark, France, Luxembourg, the Netherlands and Sweden, on the other hand, are more likely to fulfill the real exchange rate criterion and could thus form more desirable monetary union with Germany.

These results are relevant not only as regards the future accession of CCEE to the monetary union. Moreover, they indicate that a possible way out of the currency union would be less costly for current member states like Greece, Portugal, and Spain, since they will regain the nominal exchange rate flexibility, which they have extensively used before the Euro introduction.

The examination of the real exchange rate criterion can be extended in several ways. For instance, the analysis of the driving forces of the RER appreciation during the transition process can benefit from separating the transitory component from the overall real exchange rate development. The real exchange rate criterion can be further developed by introducing a more accurate measure for the costs of currency unification which entails both the need for permanent real exchange rate adjustment and the degree to which these adjustments have been indeed carried out over nominal exchange rate changes. Furthermore, it could be interesting to apply the real exchange rate criterion for different groups of countries and to test for instance if the Southeuropean countries could form a desirable monetary union. The aforementioned issues can serve as topics for further research.

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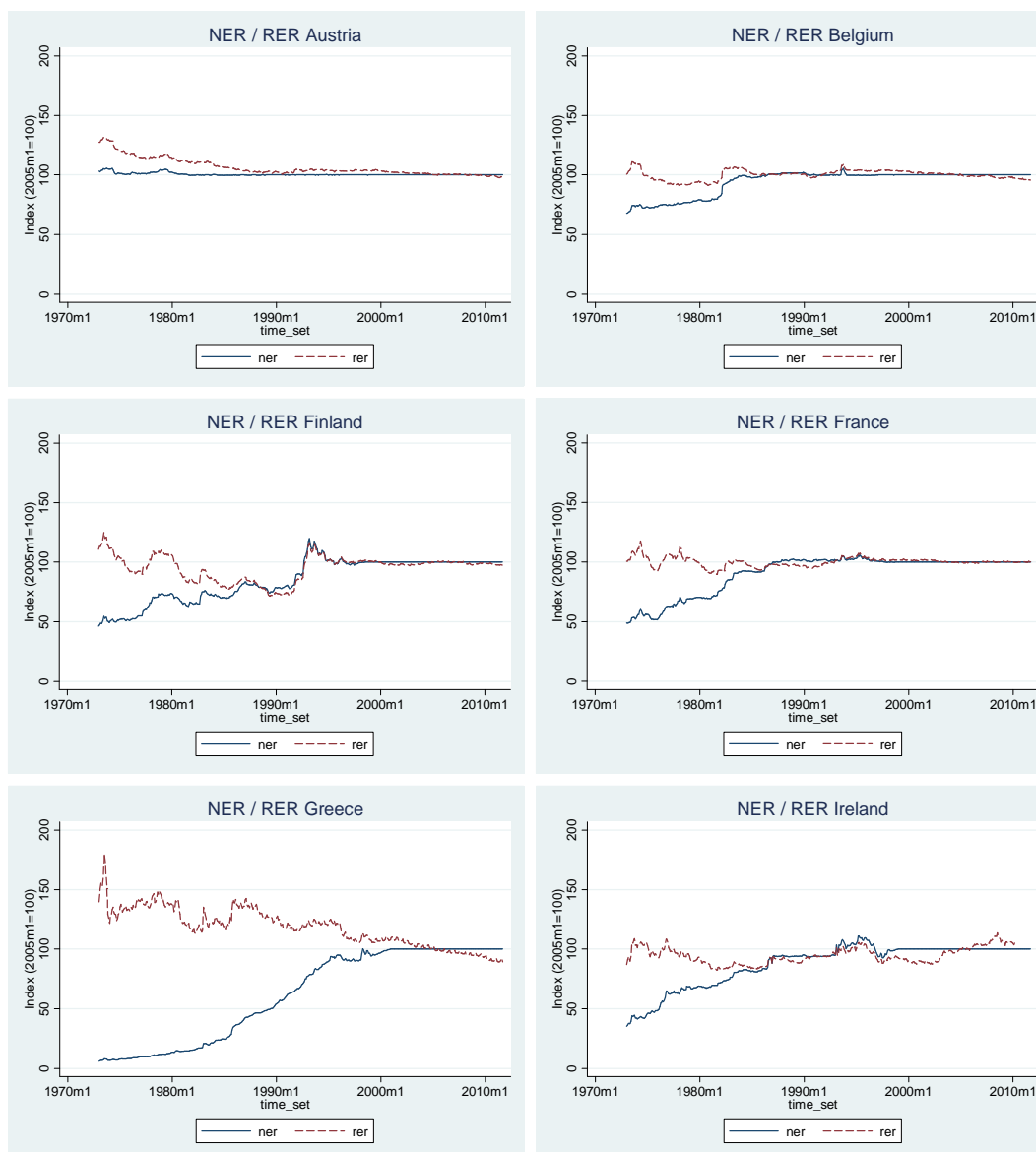
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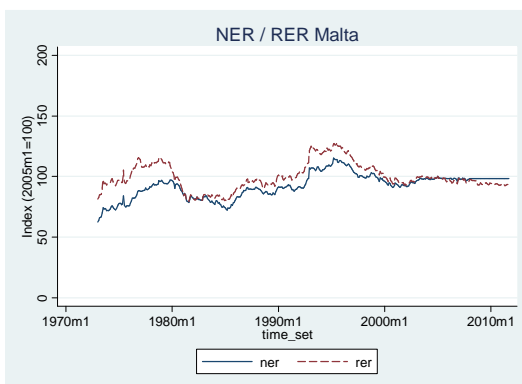
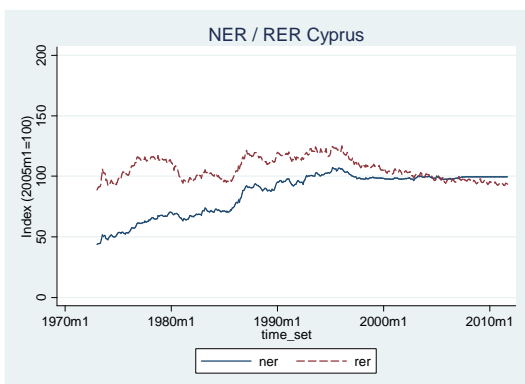
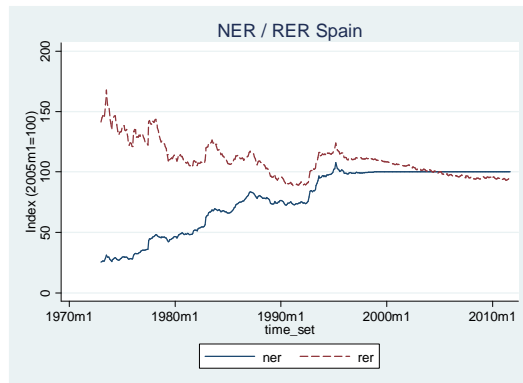
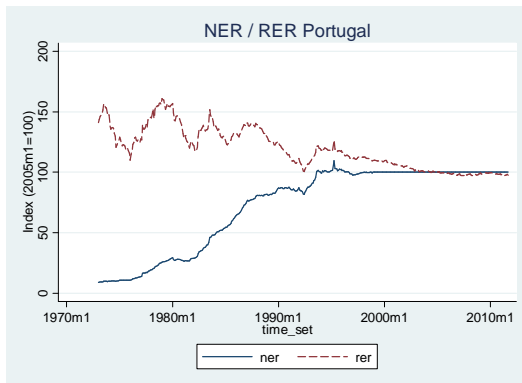
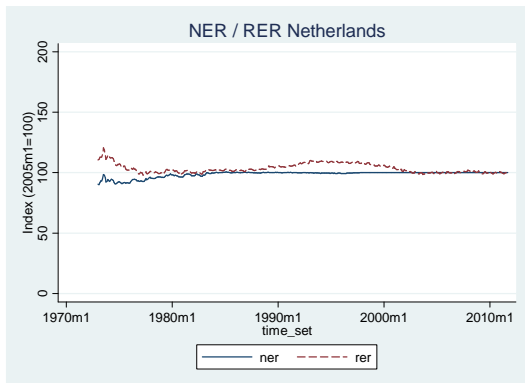
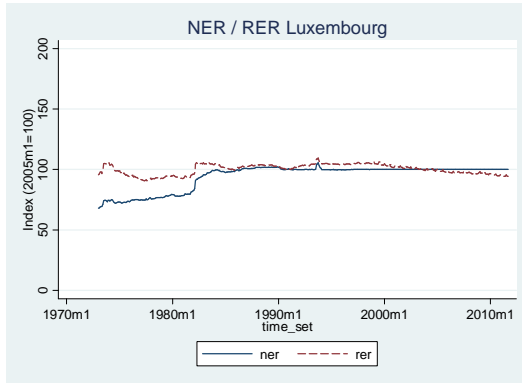
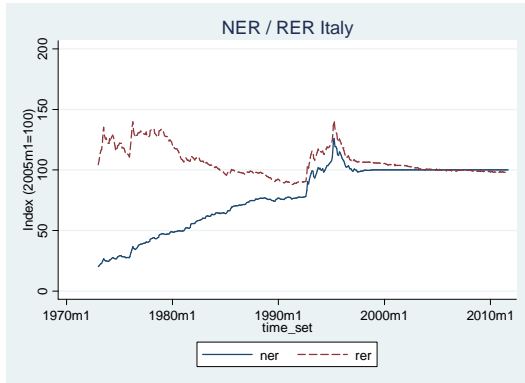
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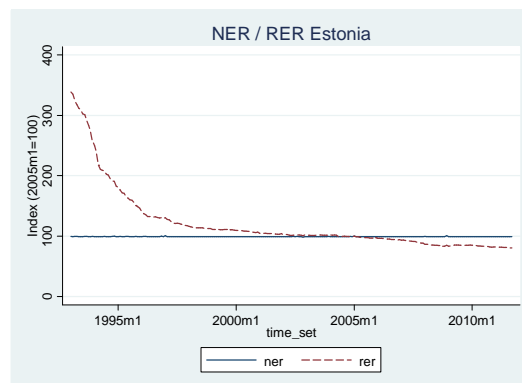
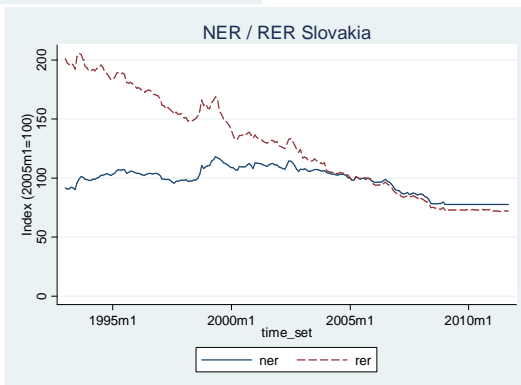
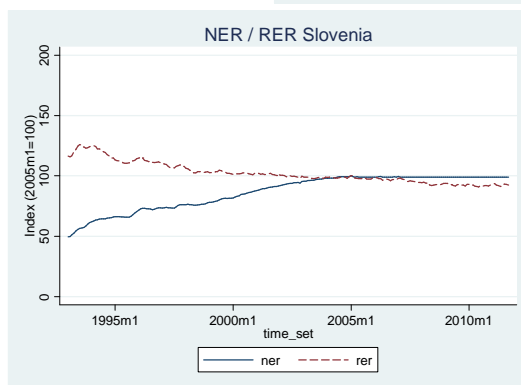
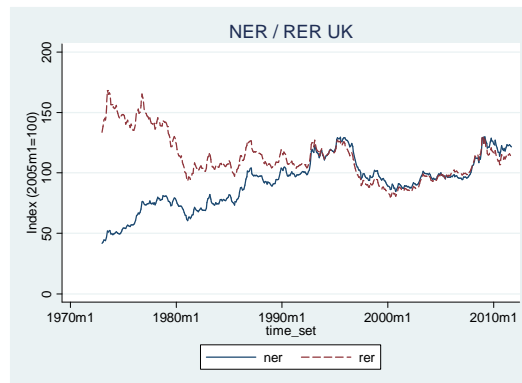
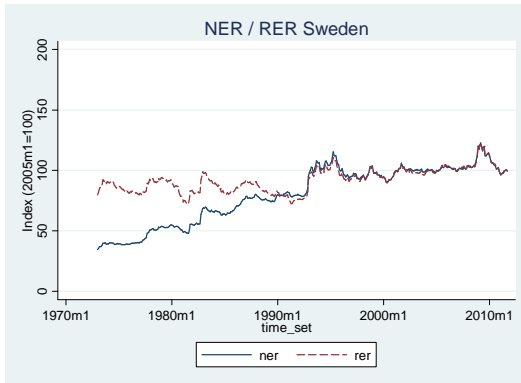
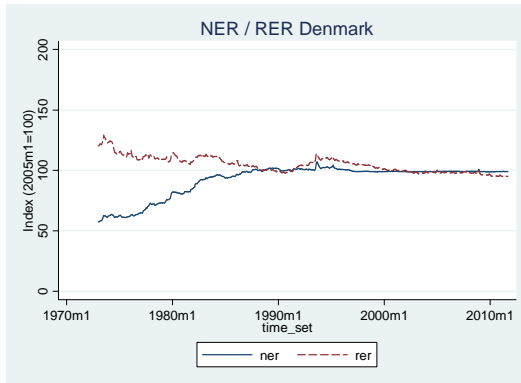
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Appendix

Figure A1: Nominal and real exchange rates of EU member states vis-a-vis Germany
(Attention should be paid to the different scaling in the case of CCEE, especially in the case of Lithuania.)







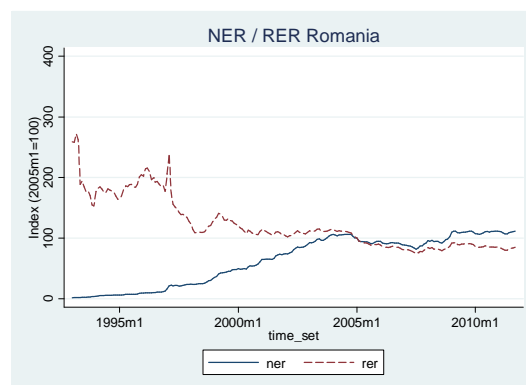
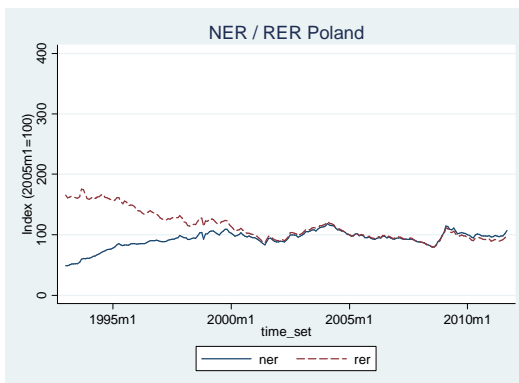
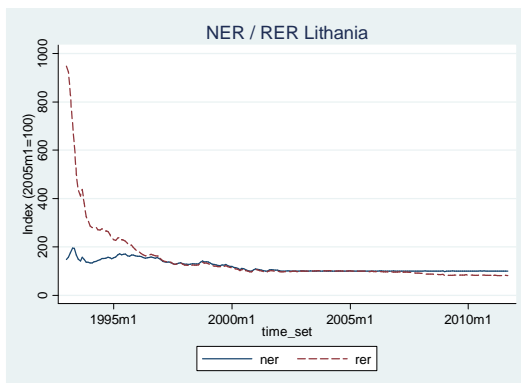
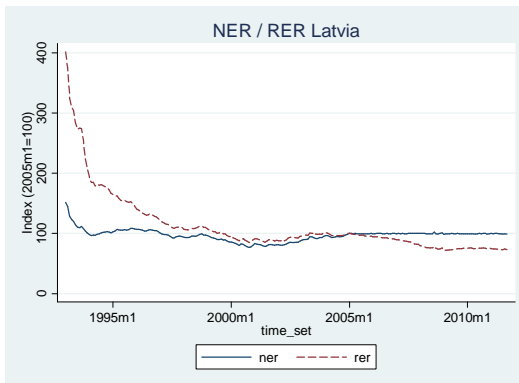
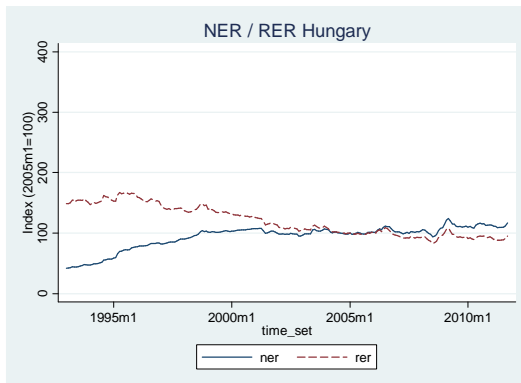
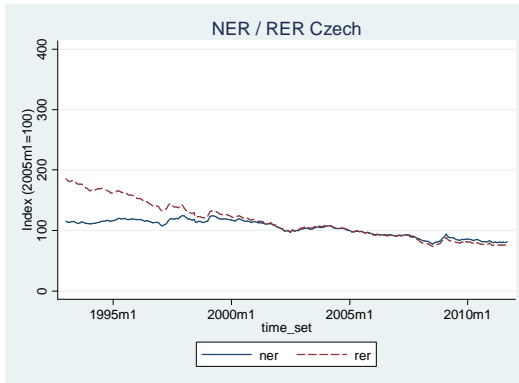
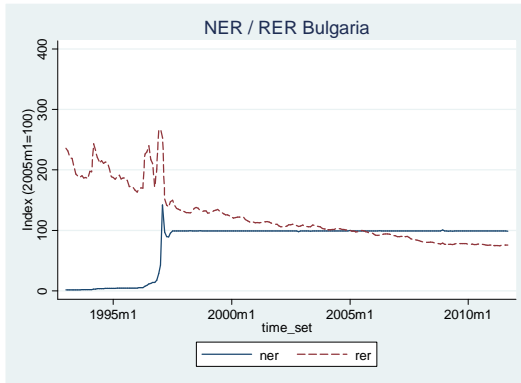
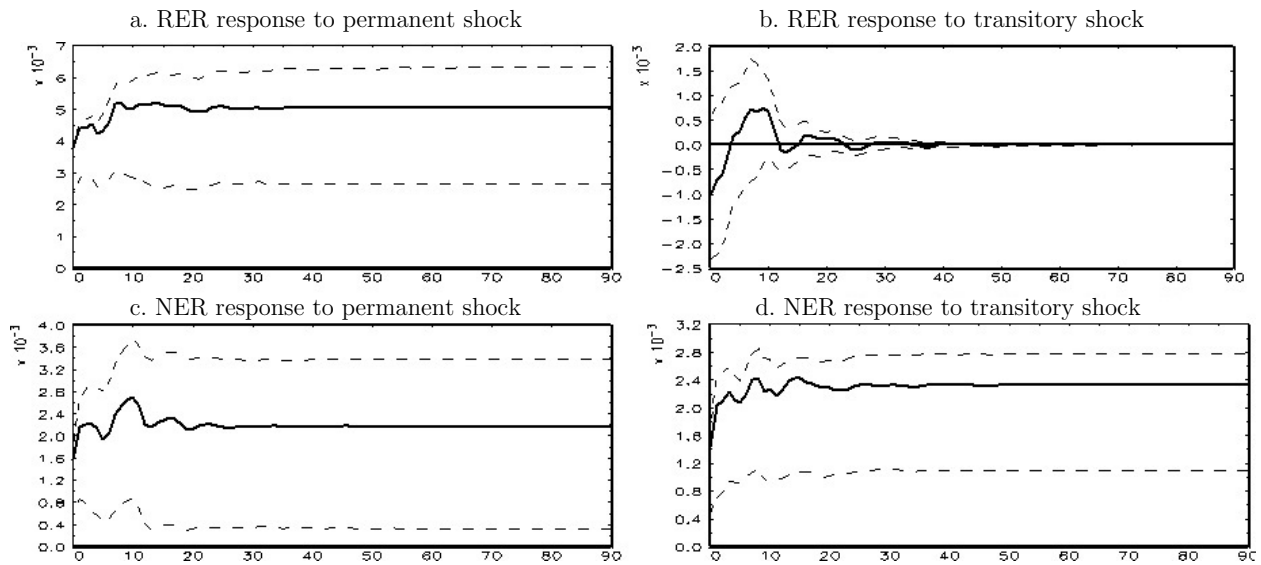
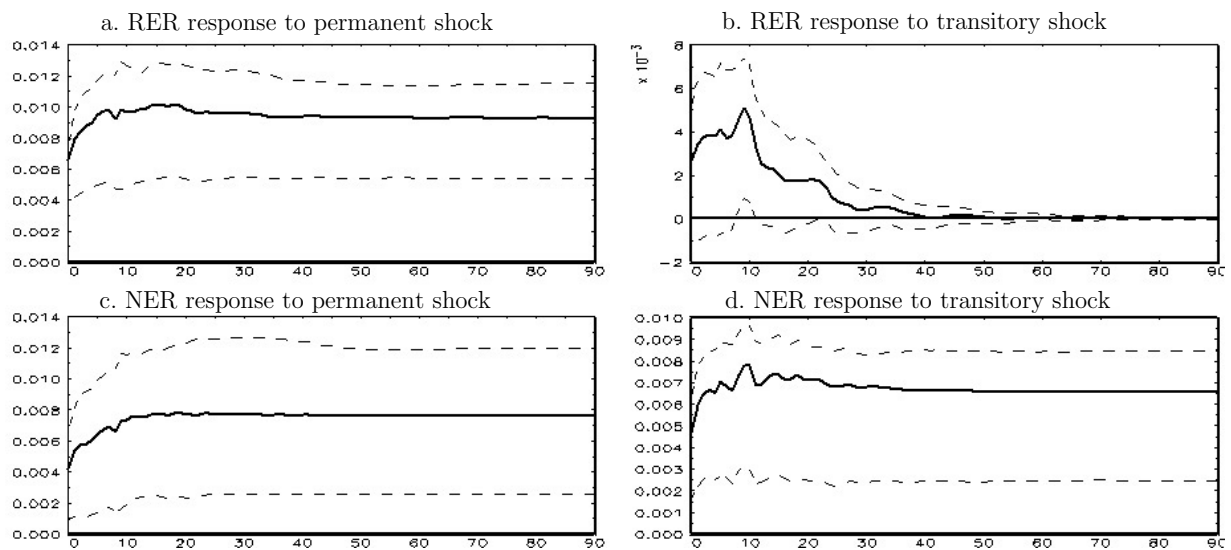


Figure A2: Dynamic responses of real and nominal exchange rates in EU-15 to permanent and transitory shocks (1973-1998)

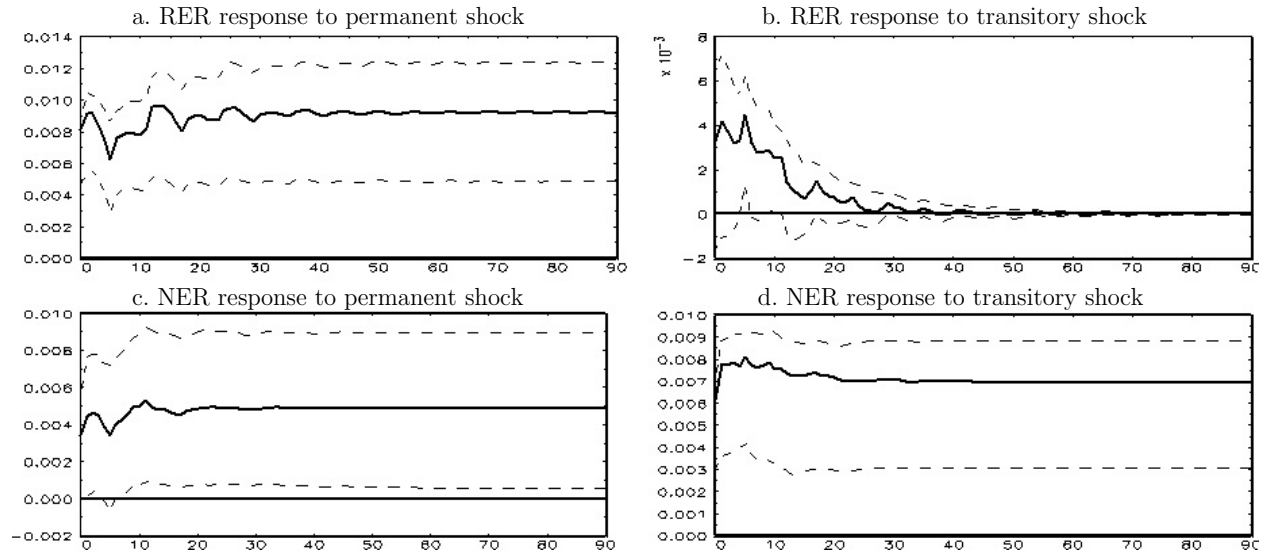
A. Austria



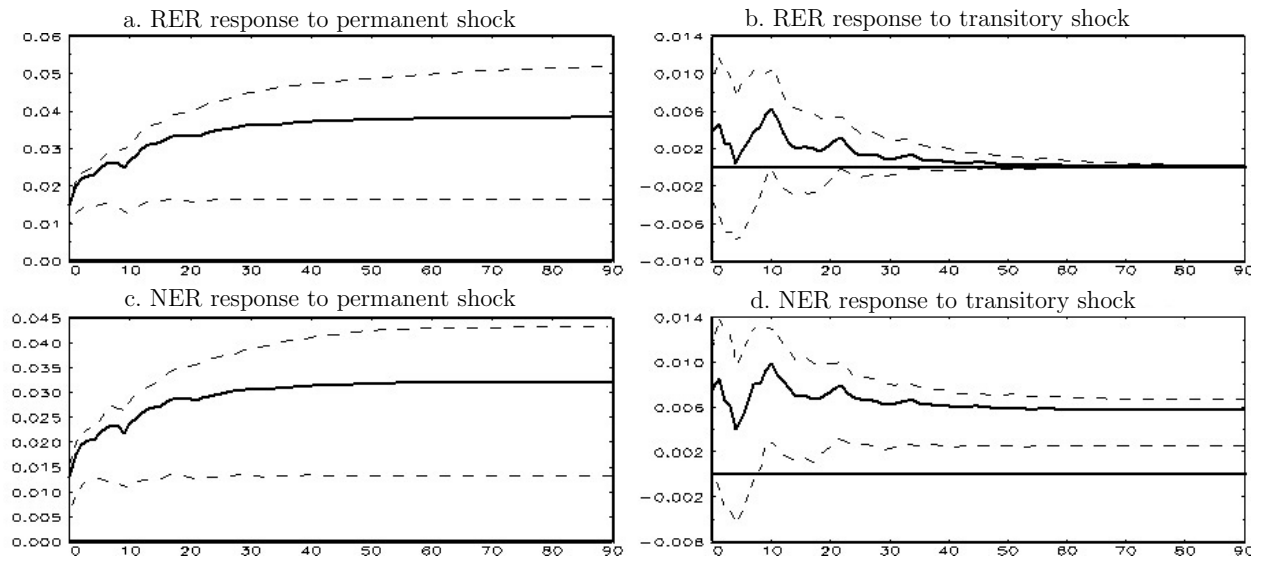
B. Belgium



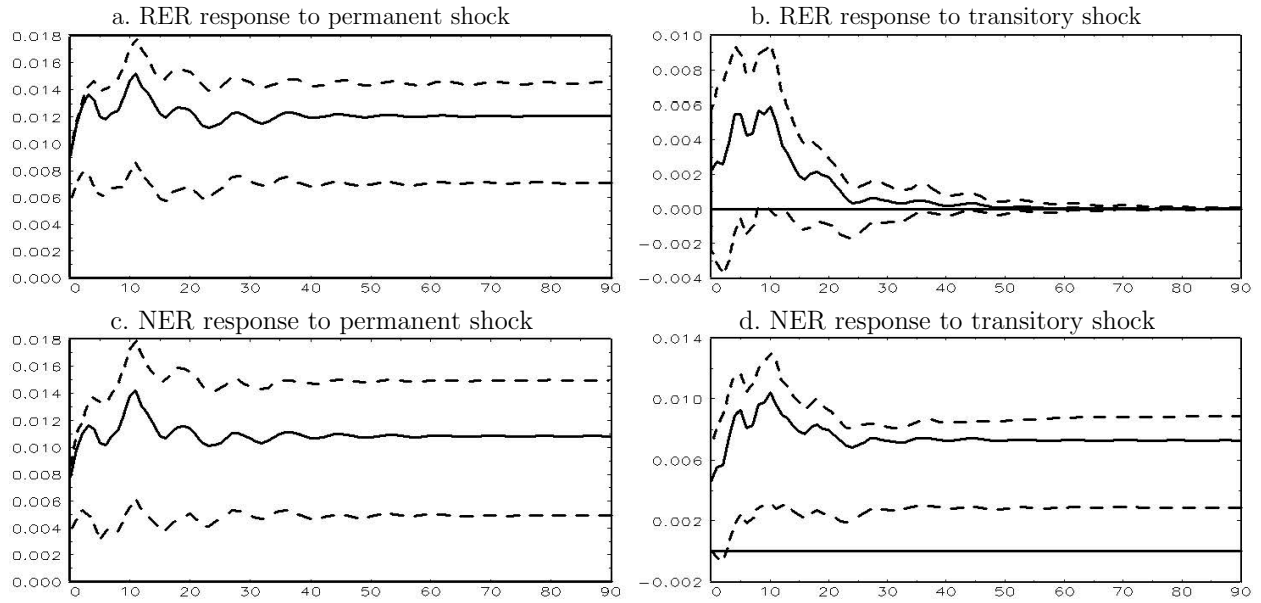
C. Denmark



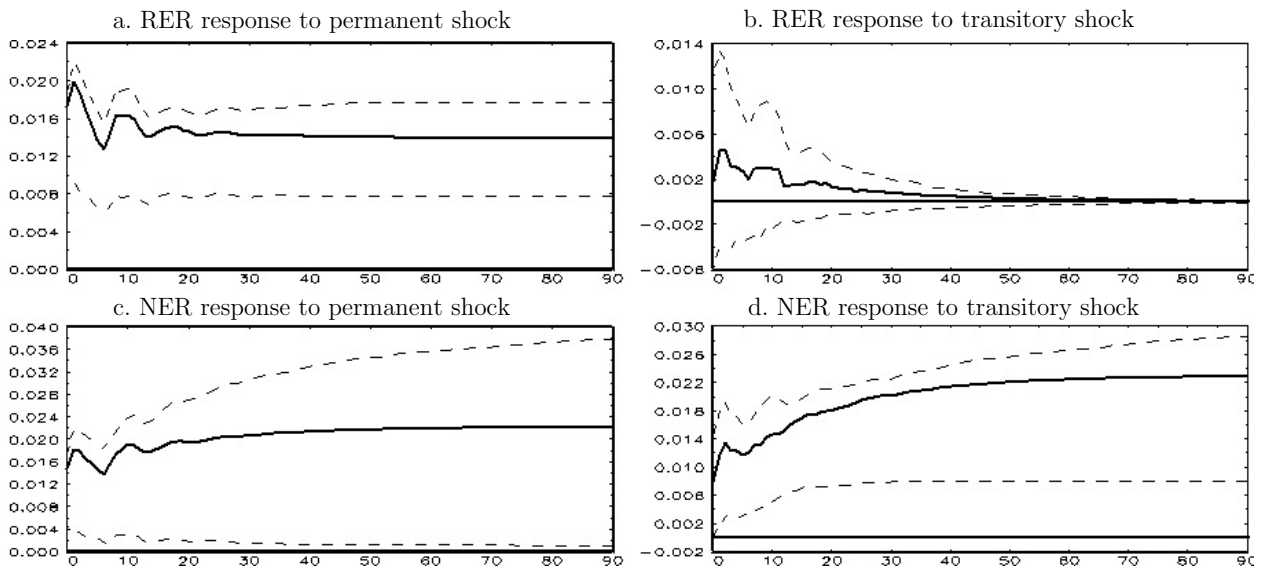
D. Finland



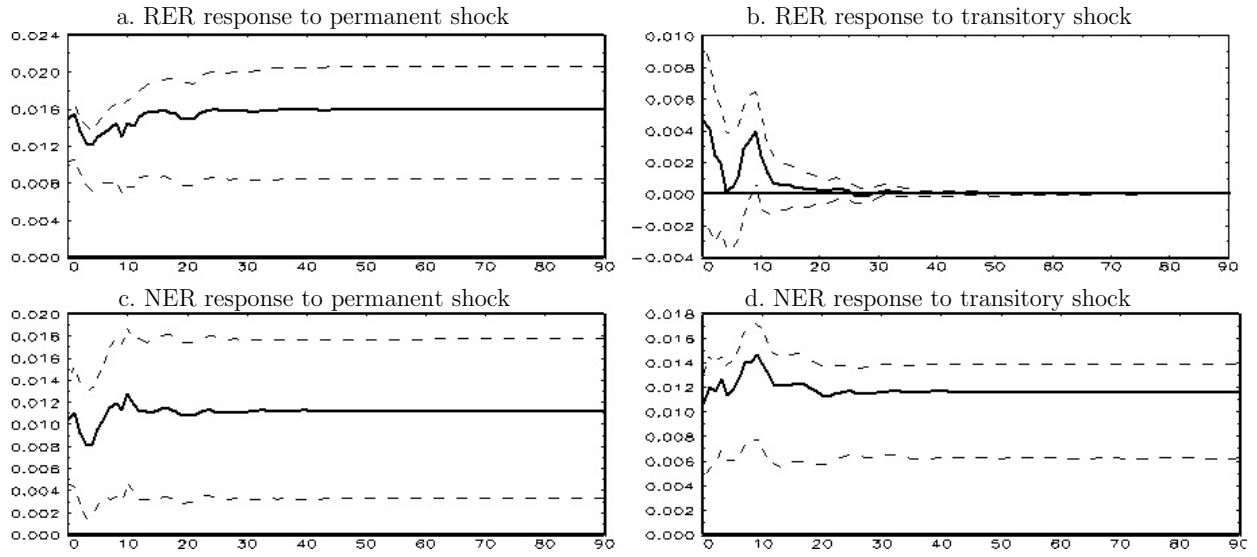
E. France



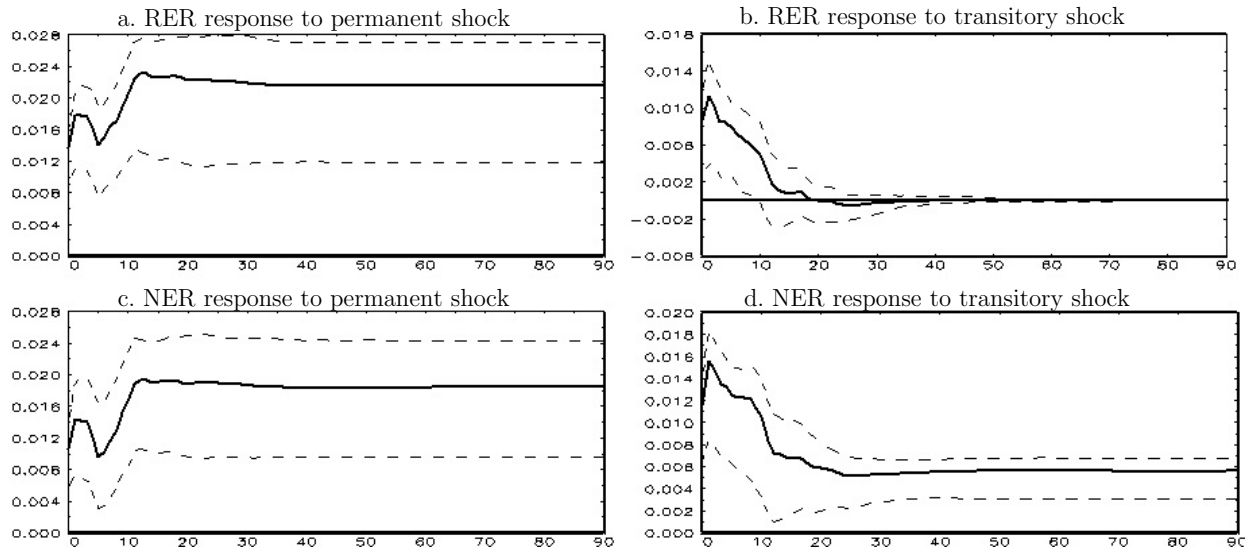
F. Greece



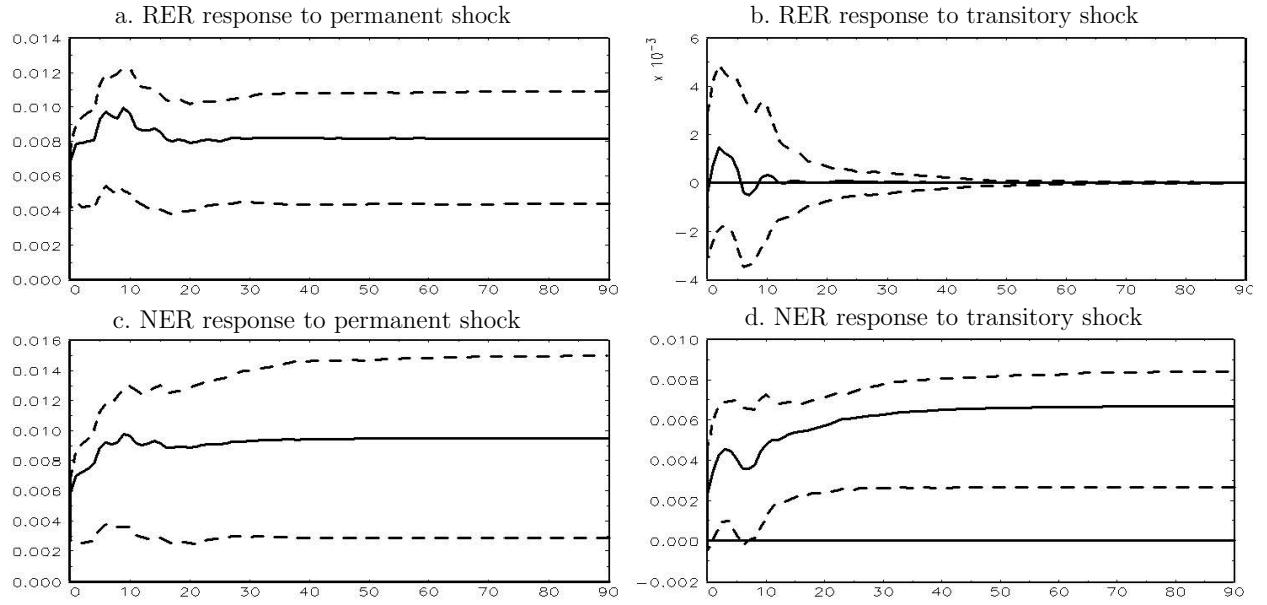
G. Ireland



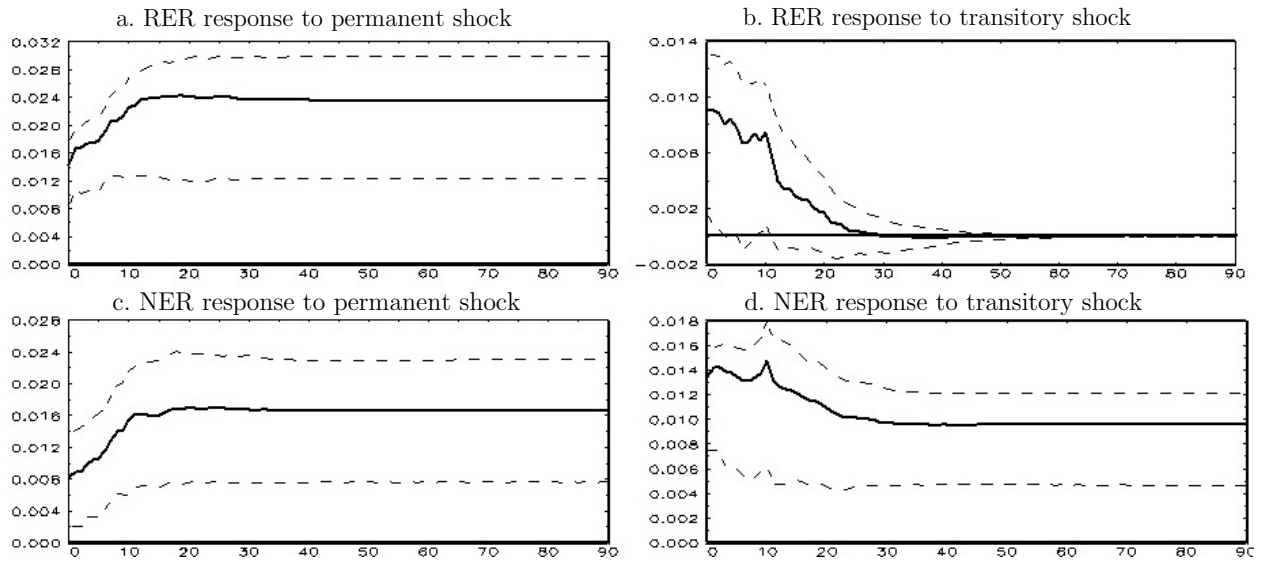
H. Italy



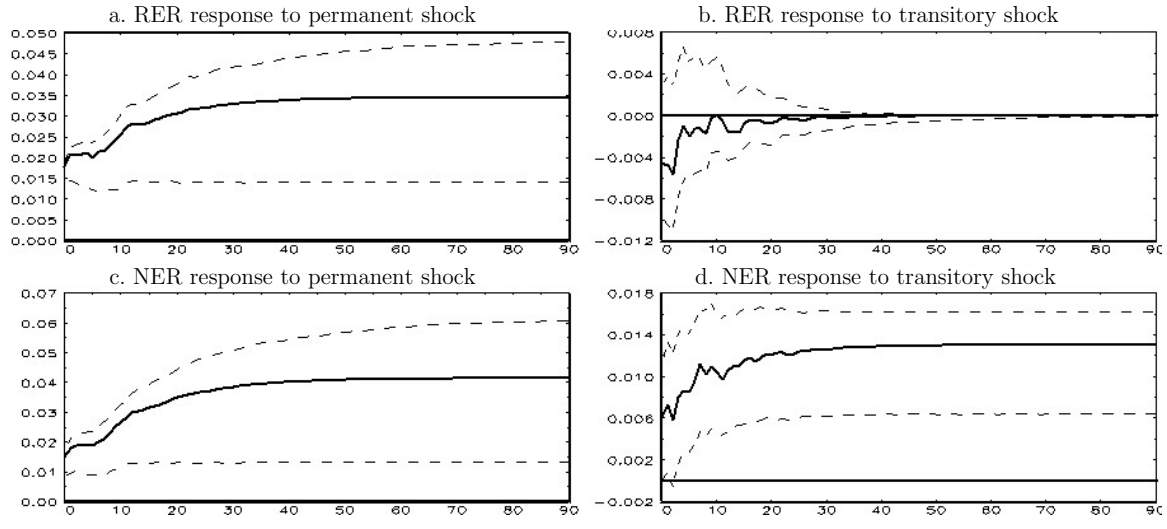
I. Luxembourg



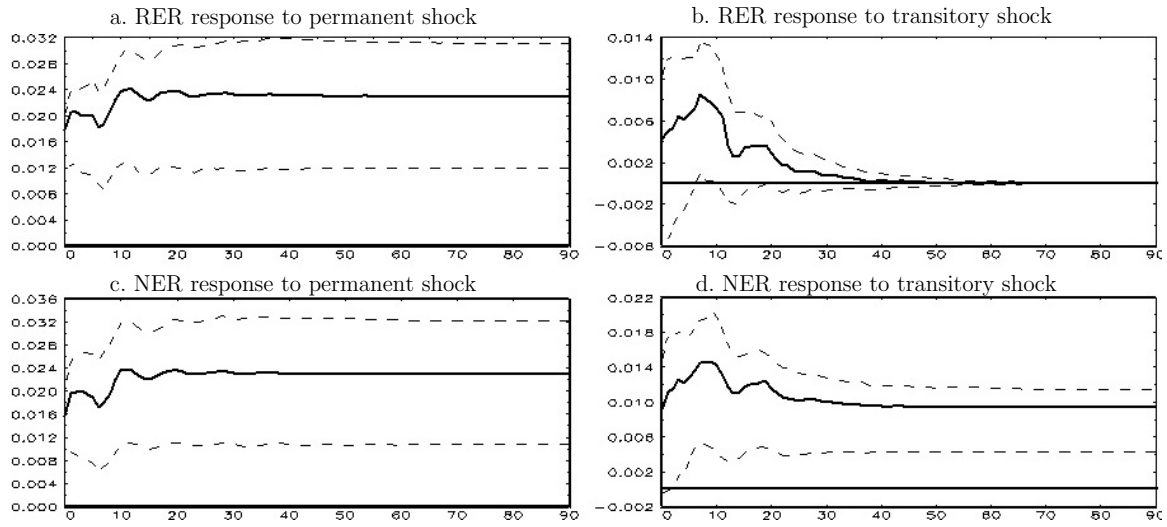
J. Netherlands



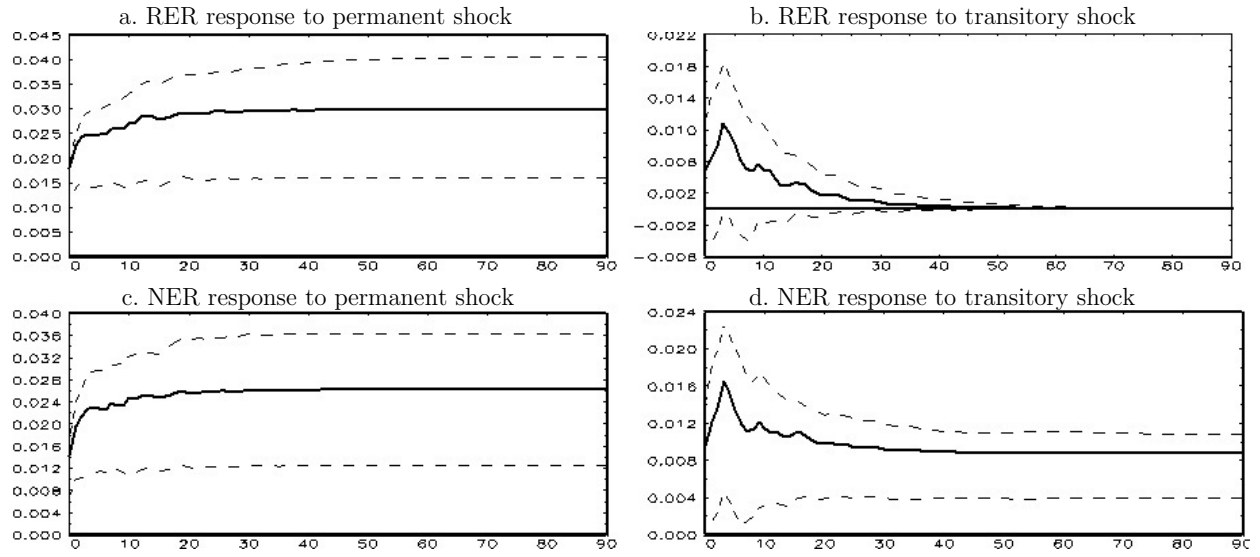
K. Portugal



L. Spain



M. Sweden



N. UK

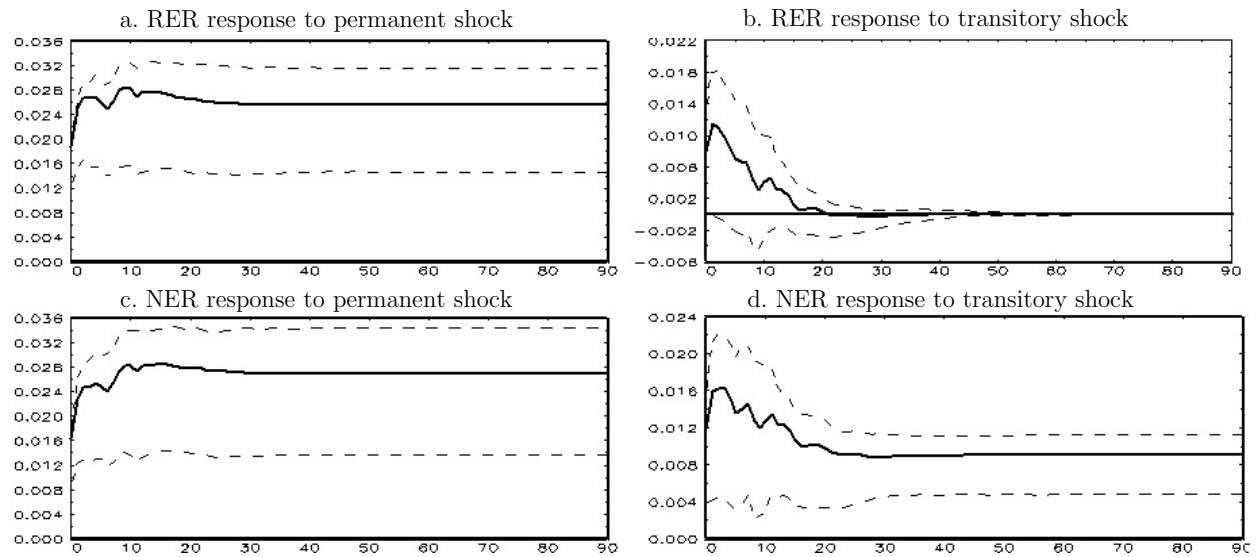
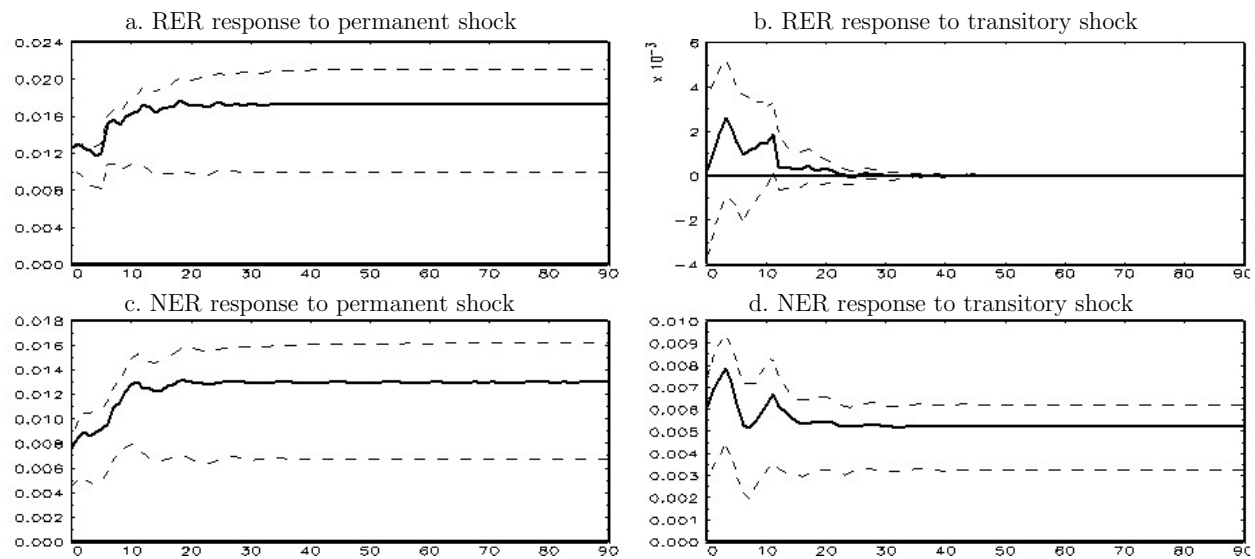
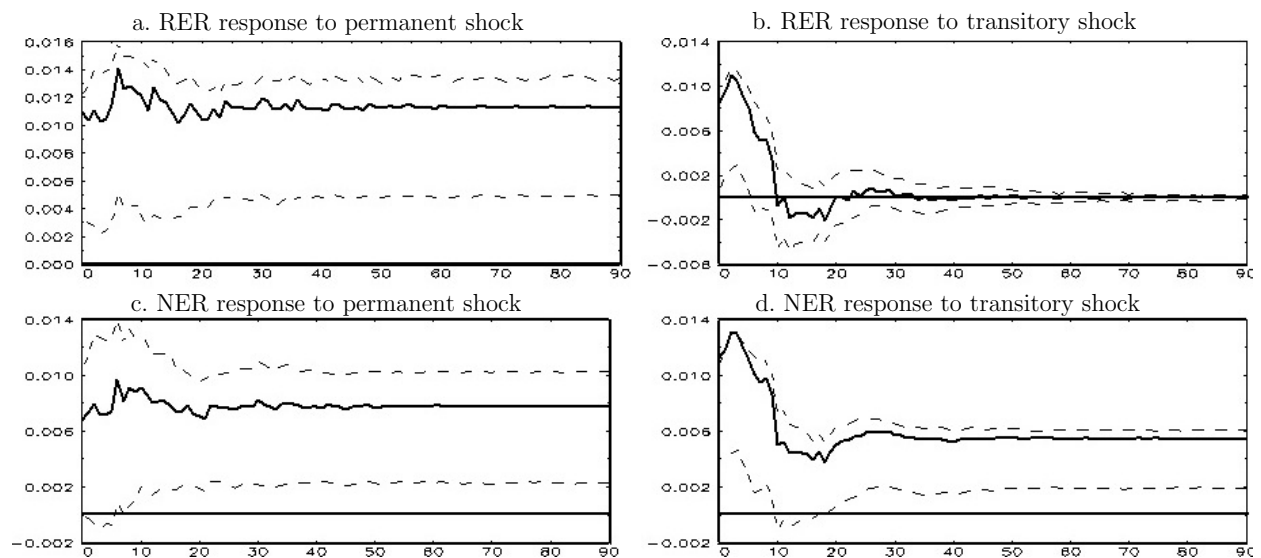


Figure A3: Dynamic responses of real and nominal exchange rates in the new EU member states to permanent and transitory shocks

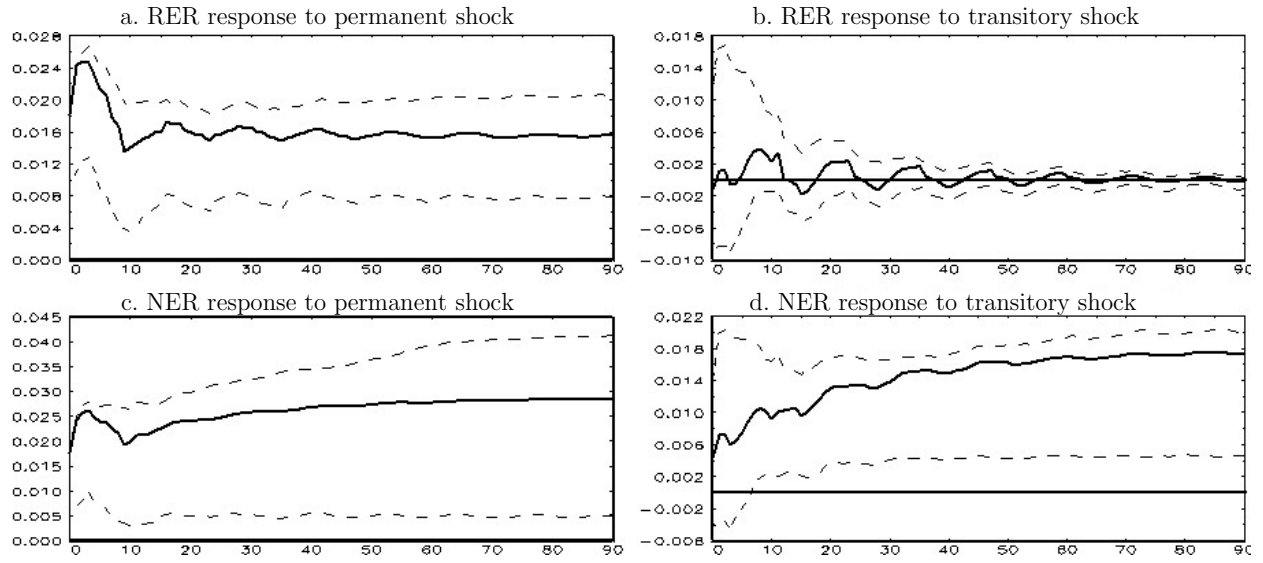
A. Cyprus



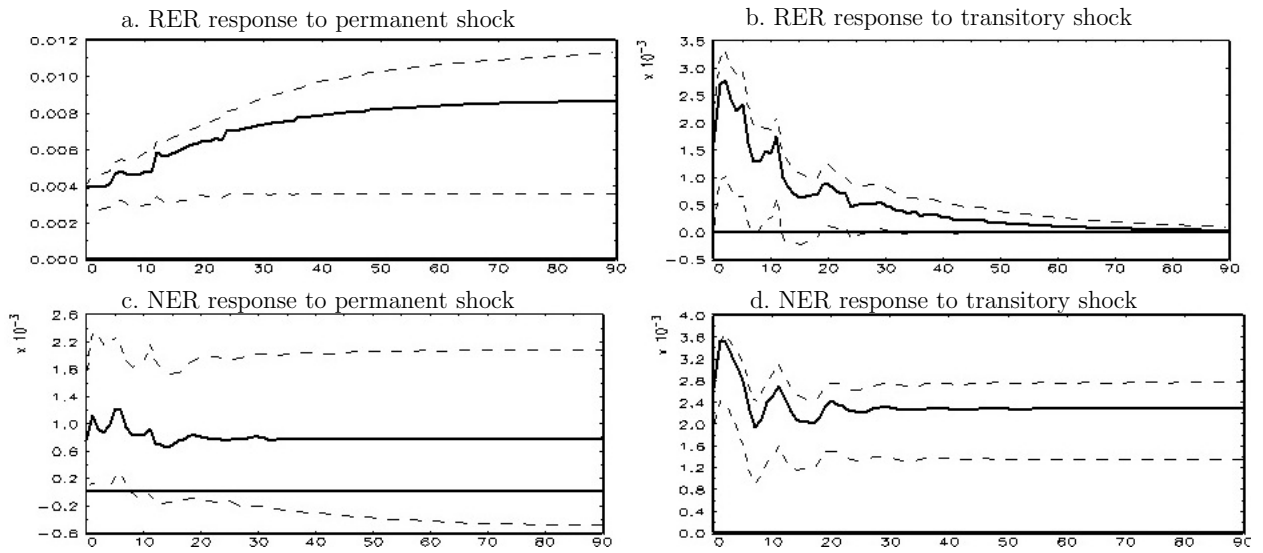
B. Czech Republic



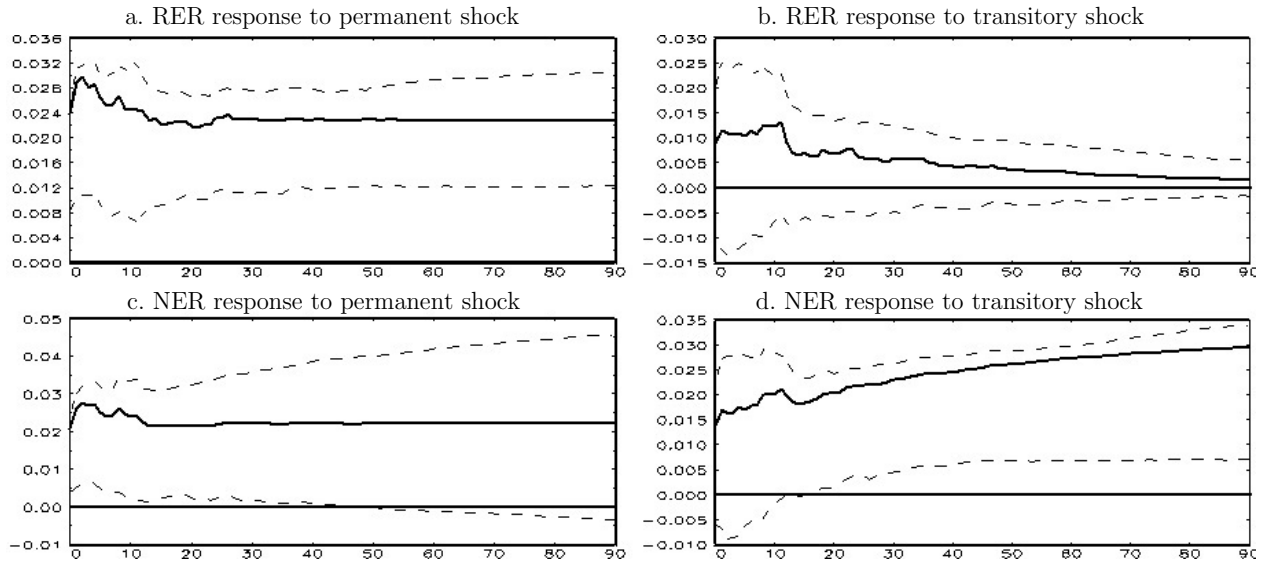
E. Hungary



F. Malta



G. Poland



H. Romania

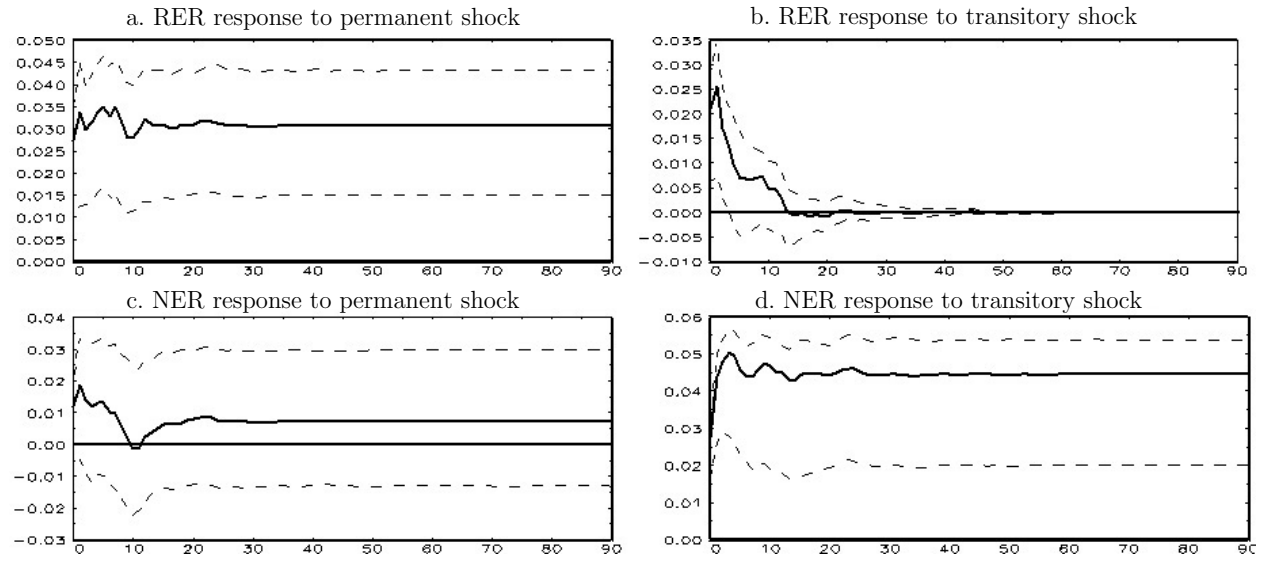


Table 7: Test statistics from the modified ADF test for cointegration and nonstationarity of NER and RER in levels and first differences: EU-15 (1973-1998)

Country	NER		RER		Cointegration test (Engel-Granger) (V)
	levels (I)	Δ (II)	levels (III)	Δ (IV)	
Austria	-3.478(1)**	-8.986(1)***	-9.902(1)	-7.393(4)***	-4.286(1)***
Belgium	-.635(1)	-9.868(1)***	-2.347(1)	-8.772(1)***	-.288(1)
Finland	-1.793(1)	-4.915(4)***	-1.223(1)	-4.238(4)***	-1.668(1)
France	-.511(1)	-9.880(1)***	-3.885(1)***	-10.440(1)***	-1.475(1)
Greece	-.770(1)	-6.145(1)***	-2.659(6)*	-2.233(11)	-1.976(4)
Ireland	-.158(1)	-3.093(6)**	-2.885(1)*	-5.934(1)***	-.793(1)
Italy	-.530(1)	-3.628(5)***	-2.045(1)	-6.482(1)***	-1.691(1)
Luxembourg	-.635(1)	-9.868(1)***	-2.974(1)**	-4.775(4)***	-2.974(1)**
Netherlands	-1.517(2)	-10.598(1)***	-1.522(1)	-9.511(1)***	-1.023(1)
Portugal	.442(1)	-7.219(2)***	-2.277(1)	-9.621(1)***	-1.424(1)
Spain	-.959(1)	-9.861(1)***	-1.717(1)	-7.970(1)***	-2.626(1)*
Denmark	-.020(1)	-11.035(1)***	-2.086(1)	-11.807(1)***	-3.120(1)
Sweden	-2.325(1)	-8.136(1)***	-2.672(1)*	-7.777(1)***	-.556(1)
UK	-1.194(1)	-8.956(1)***	-2.542(1)	-7.428(1)***	-1.921(1)

*/**/*** indicate respectively 1%/5%/10% significance level for rejecting the null hypothesis of non-stationarity.

Table 8: Test statistics from the modified ADF test for cointegration and nonstationarity of NER and RER in levels and first differences: CCEE (1993-2006) and Cyprus and Malta (1973-2006)

Country	NER		RER		Cointegration test (Engel-Granger) (V)
	levels (I)	Δ (II)	levels (III)	Δ (IV)	
Czech Rep.	-1.478(1)	-6.428(1)***	-2.104(1)	-7.323(1)***	-.676(1)
Hungary	-.109(1)	-6.197(1)***	-1.843(1)	-3.944(1)***	-.728(1)
Poland	-.394(1)	-7.512(1)***	-1.903(1)	-8.347(1)***	-1.207(1)
Romania	.084(1)	-8.129(1)***	-2.031(2)	-6.253(2)***	-2.004(1)
Slovak Rep.	-.620(1)	-7.049(1)***	-2.031(2)	-6.253(2)***	-.711(1)
Slovenia	.547	-5.719(1)***	-2.528(1)	-6.886(1)***	-.405(1)
Cyprus	-1.743(1)	-8.170(1)***	-2.418(12)	-1.526(11)	-2.049(1)
Malta	-1.594(5)	-1.004(1)	-1.649(12)	-2.515(11)	-1.593(5)

*/**/*** indicate respectively 1%/5%/10% significance level for rejecting the null hypothesis of non-stationarity.