Is the European debt crisis a mere balance of payments crisis?

David Guerreiro*

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Abstract

This paper is interested in linking formally external disequilibriums to the sovereign debt crisis the EMU is experiencing since 2009. Relying on the CHEER approach that connects the goods market to the capital market, we show that when a country belonging to a monetary union faces external disequilibrium relative to its main partner, the corresponding interest rate differential increases. Moreover, when these imbalances are persistent, it may trigger a balance of payments crisis. Our findings indicate that this phenomenon seems to be at play for the European countries under international assistance.

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1 Introduction

Despite the vast literature on Optimum Currency Areas (OCA) that emerged in the line of Mundell's (1961) seminal paper, there is still a long way to go in order to fully understand all the mechanisms, and apprehend all the stakes, raised by the formation of a currency union. The current European debt crisis constitutes an example of such complexity. What was seen at the very beginning as a mere slippage in public finances due to the lack of stringency from peripheral countries accounting for less than 10% of the Eurozone GDP, is turning now into a severe sovereign crisis challenging the grounds of a political and economical construction that took more than half a century to build.

Since it is always difficult to analyze a crisis on the spot, the likely roots of interest rates differentials in EMU are still an open question. On the one hand, structural economic factors, such as the high debt ratios relative to GDP, the large deficits and the low growth expectations, have triggered the mistrust of markets. On the other hand, political factors, like the fuzzy management of EMU, have strengthen this mistrust. One may however wonder to which extent these former economic factors are not second round effects traducing more global structural imbalances in the specific context of currency areas. In other words, the sovereign crisis may actually be a typical form of balance of payments crisis when parities are irrevocably fixed.

*EconomiX-CNRS, University of Paris Ouest, 200 Avenue de la République, 92001 Nanterre-Cedex, France. E-mail: david.guerreiro@u-paris10.fr. Phone +33 (0)1 40 97 56 63.

Much before the general model developed by Krugman (1979) that defines the balance of payments crisis as the inability for a government to defend a fixed parity due to the constrains of its actions, the pioneering theorists of OCA (Mundell, 1961; McKinnon, 1963; Kenen, 1969; Fleming, 1971) have widely discussed the problem inside the single currency framework. According to them, money is an economic tool that plays a central part in the absorption of economic disequilibria (such as loss of competitiveness, unemployment) for an independent nation. However, when several countries decide to relinquish their own currency in order to form a monetary union, they also drop the chance to carry discretionary monetary policies to solve possible internal but also external imbalances. This strand of literature highlights that there is a "trade-off" between the homogeneity of the participating countries and the existence of real adjustment mechanisms inside the zone. Whether the union is made of highly similar members so that asymmetric shocks (such as imbalances between members) are avoided, either there are enough real adjustments mechanisms between members that allow to cope with asymmetric shocks.

When there is a lack of homogeneity and real adjustments, monetary union is non-optimal: the fixed exchange rate regime that also implies a "one-size-fits-all" monetary policy is not the adequate regime to ensure both internal and external equilibrium. EMU seems suffering these two shortcomings. First, there is a strong heterogeneity in terms of income per capita, specialization patterns, or economic institutions (Carlin, 2011). Second, labor mobility between participants, that constitutes the principal mechanism of real adjustment, is very low, lower than in long-lived currency unions such the United States (OECD, 1999). Hence EMU members may be subject to the occurrence of external disequilibriums relative to their currency partners (*i.e.* EMU may experience internal disequilibriums).

While there exists a wide literature dealing with external imbalances, especially concerning the US (Cline, 2005 and 2009), very few studies pay a special attention to the phenomenon inside EMU. Relying on the approach introduced by Chinn and Prasad (2003), that consists in estimating current accounts through a set of economic fundamentals, Barnes et al. (2010) evidence that the surpluses as well as the deficits respectively exhibited by Germany and the Netherlands on one hand, and Greece, Portugal and Spain on the other hand, are greater than those suggested by their model during the period 2004-2008. This supports the existence of external imbalances relative to the fundamental equilibrium. Based on the same methodology, Jaumotte and Sdosriwiboon (2010) reach similar results for Southern periphery in 2008.

In the context of price convergence inside EMU, Guerreiro and Mignon (2011), and Guerreiro et al. (2012) adopt a different approach: they apprehend the issue of external equilibriums by testing the PPP hypothesis for EMU countries with Germany as numeraire. As stated by Juselius (2003), a violation of PPP (Purchasing Power Parity) "*signals an imbalance in the goods market, which in the absence of trade barriers is likely to results in trade deficits*". Hence in a monetary union framework, a non respect of PPP can be assimilated to an external imbalance. Relying on the estimation of nonlinear threshold models, Guerreiro and Mignon (2011) find evidences of price convergence (PPP validation) for each member, except Finland, during the period 1970-2011. The convergence speeds, when controlled for a set of competitiveness indicators, appear however too high for Greece and Portugal, suggesting a loss of competitiveness for these two countries relative to Germany. Guerreiro et al. (2012) tackle the problem by using panels. They constitute four groups – EMU as a whole, its core,

its Northern periphery, its Southern periphery – and test the PPP hypothesis on three subperiods (1970-1987, 1987-1998, 1999-2011). If PPP is validated for the whole EMU and for the core countries for each period, it is violated for Northern periphery regardless the period, and for Southern periphery during the last period. Here again some asymmetries concerning external imbalances are pointed out.

The aim of this paper is to go further than the previous literature by linking the external disequilibrium to the surge of the interest rates differentials, demonstrating that i) the sovereign debt crisis finds its deep roots in real imbalances, and ii) this debt crisis is the special form taken by a balance of payments crisis when parities are irrevocably fixed. To this end, we rely on the **CHEER** (**C**apital en**H**anced **E**quilibrium **E**xchange **R**ate) approach introduced by Juselius (1991, 1995), Johansen and Juselius (1992), Camarero and Tamarit (1996), and MacDonald and Marsh (1997, 2004), that allows to test jointly the international parities, PPP and UIP (Uncovered Interest Parity), through a cointegrated VAR.

The remainder of the paper is organized as follows: section 2 presents the theoretical framework. Section 3, describes the economic methodology and the data. Section 4 is dedicated to results and their corresponding comments. Finally, section 5 concludes the article.

2 Theoretical backgrounds

2.1 Identifying external imbalances and linking them to interest rates differentials

To emphasize how external disequilibriums may induce a raise in the interest rates differentials, we adopt the CHEER approach that links the goods market, modeled by PPP, to the capital market, modeled by UIP. This method has been introduced by Juselius (1991, 1995) in order to face the poor empirical support for PPP as well as for UIP. According to her, supplementing PPP by UIP extends the analysis because statistically, it improves the specification of the sampling distribution of the data, and theoretically, it takes into account the eventual interactions between the goods and the capital markets. MacDonald and Marsh (1997) reinforce the theoretical background by showing that such a framework captures the Casselian view of PPP.

Following Guerreiro and Mignon (2011), and Guerreiro et al. (2012), we consider that PPP theory is a fair concept to identify external imbalances. For Breuer (1994), the PPP concept developed by Cassel (1922) implies that there are some restoring forces driving the nominal exchange rate between two countries to a ratio that ensures the equalization of their real exchange rates. This ratio warrants the same purchasing power of the two currencies when these last are converted into the same measure unit. Formally we get (in the absolute form of PPP):

$$e_t = p_t - p_t^* \tag{1}$$

where e_t is the log of the spot exchange rate, and p_t and p_t^* respectively denote the log of the domestic and foreign price levels. However, and excluding the assumptions relative to the

similarity of tastes and technologies, strong restrictions are required for PPP being validated. The most important are surely the absence of trade barriers preventing international market clearing, and also the external balance of economies.[1] Indeed when there are trade deficits or fiscal imbalances, deviations to PPP occur. Reversing the reasoning, a violation of PPP indicates that one or both these conditions are not fulfilled.

UIP is the interplay of PPP on the capital market. This theory is often used by monetary models to determine the exchange rates, but, unlike PPP, it is a forward rather than a backward market clearing mechanism, and adjustments are thought to be much faster than in goods market (Camarero and Tamarit, 1996). UIP states that the interest differential between two countries is equal to the change in parities expected between two countries as described in Equation (2):

$$E_t(\Delta e_{t+1}) = i_t - i_t^* \tag{2}$$

where $E_t(\Delta e_{t+1})$ is the expected exchange-rate change for $t+1$, i_t and i_t^* are respectively the domestic and foreign interest rates. According to Juselius (1995), PPP and UIP can be linked through the expected exchange rate. Turning back to PPP, when the forecast horizon grows, the principal determinant of exchange rates expectation is the PPP deviation:

$$E_t(e_{t+1}) = p_t - p_t^* \tag{3}$$

with $E_t(e_{t+1})$ the expected exchange rate. Then, plugging (3) into (2) it comes:

$$i_t - i_t^* = p_t - p_t^* - e_t \tag{4}$$

Equation (4), which links the capital market to the goods market, is an enhanced version of PPP and UIP because it allows disequilibriums on goods market to be balanced by disequilibriums on capital market and *vise versa*.

2.2 The special case of monetary unions

If we assume now that the two countries under study form a monetary union, two new aspects affecting the form and the interpretation of our relations have to be highlighted. The first one is the absence of trade barriers. As theorized by Balassa (1961), a monetary union is the final stage of an economic integration. As such it intervenes when trade barriers are removed. It is important when interpreting PPP: inside a currency area, a violation of PPP traduces in fact the presence of external imbalances between two participating members. The second feature is the fixity of parities. It implies that the nominal exchange rate (in log) e_t is equal to 0, which will modify both PPP and UIP relations.

[1] Note that Cassel advances other conditions as the absence of speculation or the non intervention of Central Banks.

If we look at PPP, Equation (1) becomes:

$$p_t = p_t^* \tag{5}$$

Moreover, a first interesting insight concerning PPP and monetary unions comes from Equation (3). In a currency area, the expected exchange rate $E_t(e_{t+1})$ has to be equal to zero, because of the fixed regime. Nonetheless, when PPP is not validated, $E_t(e_{t+1})$ is different from zero, which indicates that the survival of monetary union is questioned: the external disequilibriums between the two countries are pushing the nominal exchange rate away from the value determined by the monetary commitment.

The UIP relation is also amended. Within a monetary union, short-term interest rates are the same for all members since they are set by a federal Central Bank. However, long-term interest rates may differ as long as the monetary union is not supplemented by a fiscal union, as in EMU. The absence of mutual bonds (*i.e.*"federal" bonds) forces the members to borrow in their own name, allowing long-run differentials to diverge. We can then rewrite UIP as:

$$E_t(\Delta e_{t+1}) = i_t^l - i_t^{l^*} \tag{6}$$

where $i_t^l - i_t^{l^*}$ is the long-term interest rate differential. Here, a second interesting insight appears. As for PPP, a non null interest differential induces that the expected change of the nominal exchange rate $E_t(\Delta e_{t+1})$ is also non null. This indicates that the sustainability of monetary commitment is challenged, and that monetary union is likely to break up. Indeed, when parities are irrevocably fixed, $E_t(\Delta e_{t+1})$, that represents the confidence of investors in currency union survival, has to be equal to zero.

Accounting simultaneously for goods and capital markets allows to mitigate the outcomes of separate PPP and UIP predictions. When linking both theories inside a monetary union framework, we get:

$$i_t^l - i_t^{l^*} = (p_t - p_t^*) \tag{7}$$

Equation (7) shows that the adjustments in a currency union that can not be made through exchange rates are realized thanks to interactions between goods and capital markets. Goods market imbalances (external imbalances) are compensated by the raise of interest differentials in order to keep the nominal exchange rate constant and equal to zero. Hence, theoretically a currency union can be perpetual even if there are imbalances between its members, providing that a raise in the interest differentials is accepted. This situation is not likely because the raise of interest rates will aggravate the imbalances (the snowball effect) until one or more members run into bankrupt. Two main results are pointed out by our modified CHEER model. First, booms of interest differentials inside a monetary area can be assimilated to a balance of payments crisis because they are due to external imbalances between members, which goes in our direction. Second, these latter are not sustainable on the long run: whether a resorption is achieved inside the zone through real adjustments (Mundell, 1961), whether it takes place outside the union by a break of parities.

3 Econometrics of the CHEER

3.1 Econometric transcription of the theoretical model

Despite the useful theoretical information carried by Equations (1) to (7), these latter are not directly tractable to test separately or simultaneously PPP and UIP. The most popular (and surely the most reliable) way of assessing the validity of international parities is to rely on the cointegrating approach, which is particularly suitable regarding the time horizon at play (long run).

Paying attention to Equation (5), the transcription of PPP becomes:

$$p_t - p_t^* \sim I(0) \tag{8}$$

A stationary price differential indicates that domestic, p, and foreign, p^* prices are cointegrated, and hence that absolute PPP holds. On the short run, some deviations between the two prices may occur, however, on the long run the prices follow the same behavior. When price differentials are integrated at the first order, purchasing power of money does not hold anymore. *Ceteris paribus*, it signals that the country where purchasing power deteriorates faces a loss of competitiveness. The latter results, in absence of trade impediments, in trade deficits and external imbalances. Turning to Equation (6), UIP is apprehended through:

$$i_t^l - i_t^{l^*} \sim I(0) \tag{9}$$

Again, stationary interest rates differentials mean that it might be divergences in interest rates on short run, nonetheless there also are restoring forces on the long run that push interest rates to converge.

As already emphasized, the CHEER modeling allows to relax the individual assumptions of PPP and UIP holding in favor of joint validity. Formally, we get:

$$p_t - p_t^* \sim I(1) \text{ and } i_t^l - i_t^{l^*} \sim I(1)$$

$$\text{but, } i_t^l - i_t^{l^*} - p_t + p_t^* \sim I(0) \tag{10}$$

Equation (10) is central to our analysis, because it illustrates that international parities deviations might be linked through a long-run (cointegrating) relationship. It is an interesting characteristic since it offers the possibility of establishing the nature of interactions, especially the direction of causality. Thus it enables us to ascertain if interest differentials are produced by a non-respect of PPP, in other words, if the European debt crisis is a balance of payments crisis.

3.2 Econometric methods and restrictions formulation

We tackle the possible relationships stated by Equation (10) thanks to the vector autoregressive (VAR) model, as suggested by the former literature on CHEER. Since non stationarity of our variables is likely[2], as underlined in section 3.1, we rely on the cointegrated VAR (CVAR)

[2]Integration rank of variables will be tested in section 4.1

Table 1: Restrictions, economic interpretation and sensitivity implications

Hypothesis	Restrictions on β	Economic interpretation	Sensitivity
A	β=[1,-1,-1,1]	Unitary UIP and PPP	Strong sensitivity since elasticity is equal to 1
B	β=[γ,-γ,-1,1]	Parity UIP and unitary PPP	Semi-strong sensitivity if $\|\gamma\|>1$, elasticity is lower than 1
C	β=[δ,-σ,-1,1]	Non-parity UIP and unitary PPP	Non proportional relation, weak sensitivity

Note: $\beta = [i_t^l, i_t^{l^*}, p_t, p_t^*]$. Causality is assumed to run from goods market to the capital market.

specified as follows:

$$\Delta x_t = \sum_{i=1}^{s+1} \Gamma_i \Delta x_{t-i} + \Pi x_{t-1} + \Psi D_t + \epsilon_t \tag{11}$$

where x_t is the vector containing our variables, $x_t = (i_t^l, i_t^{l^*}, p_t, p_t^*)'$, D_t contains the deterministic components (constant, trend, and dummies), and ϵ_t is an error term whose mean is zero, and that is homoscedastic and non-autocorrelated. Given that $\Delta x_t \sim I(0)$ and $x_{t-1} \sim I(1)$, Π is a rank reduced parameter matrix ($rank(\Pi) = r$ and $r < n$, n denoting the number of variables) that allows to balance the system. It represents the long-run responses matrix (MacDonald and Marsh, 2004). More formally, $\Pi = \alpha\beta'$, where β' is the matrix containing the cointegrating vectors, and α that containing the loading parameters associated to each cointegrating vector (in other words, the adjustment matrix).

A valuable ability of the cointegrated VAR models lies in the possibility of implementing a battery of tests. In addition to rank and causality tests that respectively provide answers to the number of relationships and their directions, CVARs grant the fulfillment of significance tests through restrictions imposition on the cointegrating space, Π. When applied on β, the restrictions are intended to check the conformity of the results found with the theoretical predictions. In our case, they not only license to appraise the theory, but also the essence of interplay between PPP and UIP: significance tests enable to investigate the values of cointegrating vectors, and hence the sensitiveness existing between the international parities. In Equation (10), we restricted all the coefficients to 1, which perfectly frames with pure (or unitary) PPP and UIP. However, this hypothesis may be too strong, which leads us to construct a typology of weaker assumptions. Since we are interested in demonstrating that interest differentials are caused in a monetary union by PPP deviations, we keep pure form of PPP in all the hypotheses. We report them on Table 1 with their corresponding theoretical meaning and the implication on sensitivity. These three models constitute the basis on which we draw our empirical analysis on the linkage of international parities.

Restrictions may also be placed on the loading parameters, α. Doing so amounts to examine the weak exogeneity of variables. They are also useful to determine short-run dynamics of stationary relationships. After ensuring that likelihood ratio tests validate the β restrictions, imposing restrictions on α permit to discover the channel(s) through which deviations of PPP

and UIP are reduced.[3]

3.3 Data

Literature dealing with PPP and CHEER has largely used CPIs as proxies of price levels, mainly because of the lack of available data. However, CPIs are unusable since they do not account for price level differentials between countries: they only depict the evolution of prices. To overcome this issue, we take over the methodology introduced by Allington et al. (2005) and improved by Guerreiro and Mignon (2011) and Guerreiro et al. (2012). It relies on the International Comparison Program (ICP) carried by the World Bank that aims at providing comparable international prices. Based on this framework, Eurostat and OECD have computed Comparative Price Level (CPL) series for each European country. These CPLs are defined by the OECD as the ratio between purchasing power parity conversion factor for private consumption[4] and the nominal exchange rate. This ratio measures price level differences between two countries (in our case between a European country and the United States) and can be expressed as follows:

$$CPL_{i,t} = \frac{PPP_{i,t}}{NER_{i,t}} \times 100 \tag{12}$$

where $PPP_{i,t}$ stands for the PPP conversion factor for private final consumption of country i relative to the United States at time t, expressed in euros per US dollar, and $NER_{i,t}$ is the euro/dollar exchange rate at time t. Turning to data availability, CPLs are computed by Eurostat and OECD for each European country annually only since 1995. It is however possible to recover monthly observations using the price evolution relative to the US in each European country—i.e. using the relative CPIs corrected by the exchange rate variations. More specifically, we construct the monthly domestic price level series of country i on the period from January 1999 to July 2011 as follows:[5]

$$P_{i,t} = \frac{PPP_{i,2005}}{NER_{i,2005}} \times \frac{\frac{CPI_{i,t}}{CPI_{i,2005}}}{\frac{NER_{i,t}}{NER_{i,2005}} \times \frac{CPI_{US,t}}{CPI_{US,2005}}} \times 100 \tag{13}$$

where $i = 1, ..., 12$ denotes the European country. $PPP_{i,2005}$ is the PPP for private consumption for country i relative to the US in 2005 (euros per US dollar). $CPI_{i,t}$, $CPI_{i,2005}$, $CPI_{US,t}$ and $CPI_{US,2005}$ are respectively the country i's CPI at time t and at year 2005, and the US CPI at time t and at year 2005. $NER_{i,2005}$ is the euro/dollar exchange rate in year 2005. 2005 has been chosen as the basis year because it corresponds to the year of the last ICP survey realized by the World Bank.[6] From Equation (13), we thus obtain 12 series of price levels that

[3] As similar approach is handled by Akram (2006) for PPP in the case of Norway.

[4] Following the World Bank definition, the PPP conversion factor for private consumption is the number of units of a country's currency required to buy the same amount of goods and services in the domestic market as a US dollar would buy in the United States, the conversion factor being applicable to private consumption.

[5] See Guerreiro and Mignon (2011), and Guerreiro et al. (2012).

[6] PPP series are extracted from the OECD database. NER and CPI series are from IFS, except the German and the Irish CPIs that come from Datastream.

can be used to test absolute PPP.

So as to test the UIP side of the CHEER, we employ the bond rate at ten years coming from Datastream. Given the importance of Germany in the Eurozone, we retain this country as the benchmark. Thereby, we investigate UIP and PPP between each member of the EMU and Germany.

4 Results

4.1 Specifying the VARs and testing causality

Completing the study of CHEER between each Eurozone member and Germany involves the specification and the estimation of eleven bivariate VARs. The first concern when considering the VAR specification is to evaluate the integration order of each variable entering the system. To this end, we execute, for each of the twelve countries belonging to Euroland, the tests proposed by Ng and Perron (2001) and by Lee and Strazicich (2003) on the long interest rates (i_t^l) and on price levels (p_t) series. Compared with usual unit-root tests as Dickey-Fuller (1979) or Phillips-Perron (1988), Ng and Perron (2001) supply a better size and power by selecting more precisely the lag length thanks to a modified AIC (MAIC) sample dependent penalty, while Lee and Strazicich (2003) account for possible breaks in the series. Regardless the tests, results point to the same direction: for all the countries, the two series are integrated at the first order.[7]

Before testing the cointegration rank in CVARs, we have to secure that the model presents the desired statistical properties to get reliable cointegrating estimates. That is why we notify in Table 2 the results of misspecification tests on the eleven unrestricted VARs.

Relating to autocorrelation, we notice that properties are broadly respected even if the VARs of Ireland on one hand, and Spain on the other, display first order autocorrelation of residuals. About normality, we deliver skewness and kurtosis separately, because as evidenced by Gonzalo (1994) cointegration results are relatively robust to excess of kurtosis but not to skewness deviation. The likelihood ratio tests decide in favor of centered residuals in all the cases, authorizing us to go forward by performing the cointegration tests.

4.2 Testing rank integration and causality

Table 3 reports the results of max-eigenvalue and trace cointegration tests proposed by Johansen. The estimation of associated cointegrating vectors is reported in Table A.1 in the Appendix. .

The outcomes illustrate that a sole cointegrating relationship between interest rates and price levels differentials relative to Germany exists for each European country except Finland. It implies that parities deviations relative to Germany are effectively connected for all the Eurozone members, Finland apart. This connexion partly supports the view we developed whereby

[7] To save space, results are not reported but are available upon request to the author.

Table 2: Misspecification tests of the 11 unrestricted VARs

Domestic country	$LM_{(1)}$	$LM_{(4)}$	Skewness	Kurtosis	Dummy variables	Lag
Austria	$\chi^2(16) = 21.61$ $p = 0.156$	$\chi^2(16) = 20.69$ $p = 0.19$	$\chi^2(4) = 6.11$ $p = 0.19$	$\chi^2(4) = 34.13$ $p = 0$	99:11 03:05 07:06	4
Belgium	$\chi^2(16) = 20.19$ $p = 0.21$	$\chi^2(16) = 19.59$ $p = 0.24$	$\chi^2(4) = 3.61$ $p = 0.46$	$\chi^2(4) = 59.37$ $p = 0$	none	5
Finland	$\chi^2(16) = 25.9$ $p = 0.05$	$\chi^2(16) = 17.2$ $p = 0.37$	$\chi^2(4) = 7.75$ $p = 0.10$	$\chi^2(4) = 28.67$ $p = 0$	03:05 08:12	3
France	$\chi^2(16) = 12.53$ $p = 0.71$	$\chi^2(16) = 12$ $p = 0.74$	$\chi^2(4) = 3.6$ $p = 0.46$	$\chi^2(4) = 73.74$ $p = 0$	08:03 08:10	4
Greece	$\chi^2(16) = 19.5$ $p = 0.46$	$\chi^2(16) = 22.32$ $p = 0.13$	$\chi^2(4) = 0.98$ $p = 0.91$	$\chi^2(4) = 69.23$ $p = 0$	none	7
Ireland	$\chi^2(16) = 36.83$ $p = 0.01$	$\chi^2(16) = 10.02$ $p = 0.86$	$\chi^2(4) = 0.99$ $p = 0.91$	$\chi^2(4) = 33.41$ $p = 0$	none	7
Italy	$\chi^2(16) = 17.62$ $p = 0.34$	$\chi^2(16) = 21.21$ $p = 0.17$	$\chi^2(4) = 4.34$ $p = 0.36$	$\chi^2(4) = 35.9$ $p = 0$	99:04 11:07	2
Luxembourg	$\chi^2(16) = 19.08$ $p = 0.26$	$\chi^2(16) = 18.86$ $p = 0.27$	$\chi^2(4) = 1.41$ $p = 0.84$	$\chi^2(4) = 26.71$ $p = 0$	none	7
Netherlands	$\chi^2(16) = 10.55$ $p = 0.83$	$\chi^2(16) = 19.94$ $p = 0.22$	$\chi^2(4) = 2$ $p = 0.73$	$\chi^2(4) = 14.75$ $p = 0.01$	none	7
Portugal	$\chi^2(16) = 23.10$ $p = 0.11$	$\chi^2(16) = 15.7$ $p = 0.47$	$\chi^2(4) = 2.2$ $p = 0.7$	$\chi^2(4) = 19.92$ $p = 0$	none	7
Spain	$\chi^2(16) = 31.78$ $p = 0.01$	$\chi^2(16) = 9.85$ $p = 0.87$	$\chi^2(4) = 6.07$ $p = 0.19$	$\chi^2(4) = 21.87$ $p = 0$	99:11 03:05 08:06 10:05	7

Note: Foreign country in each unrestricted VAR is Germany. $LM_{(1)}$ and $LM_{(4)}$ are respectively the statistics of the first and the fourth order LM autocorrelation tests. p stands for p-value.

Table 3: Johansen cointegration tests

	Austria		Belgium		Finland		France	
	λ_{max}	Trace	λ_{max}	Trace	λ_{max}	Trace	λ_{max}	Trace
$r \leq 3$	0.17	0.17	0.01	0.01	1.04	1.04	0.02	0.02
$r \leq 2$	9.25	9.42	3.45	3.47	5.39	6.44	2.19	2.22
$r \leq 1$	10.62	20.05	8.39	11.86	9.94	16.39	12.17	14.39
$r = 0$	35.62***	55.68***	29.64**	41.51	19.13	35.52	35.55***	49.94**
	Greece		Ireland		Italy		Luxembourg	
	λ_{max}	Trace	λ_{max}	Trace	λ_{max}	Trace	λ_{max}	Trace
$r \leq 3$	1.34	1.35	1.45	1.45	0.12	0.12	0.03	0.03
$r \leq 2$	7.24	8.59	8.99	10.44	6.22	6.34	3.94	3.97
$r \leq 1$	16.42	25.02	18.89	30	9.29	15.63	9.27	13.24
$r = 0$	33.81***	58.83***	46.55***	75.88***	30.51**	46.14*	33.67***	46.91*

	Netherlands		Portugal		Spain	
	λ_{max}	Trace	λ_{max}	Trace	λ_{max}	Trace
$r \leq 3$	7.46	7.46	5.47	5.47	0.25	0.25
$r \leq 2$	12.47	20.11	15.42	20.89	14.26	9
$r \leq 1$	21.62	41.73	21.03	41.93	21.13	21.72
$r = 0$	33.74**	75.48**	41.42****	83.55***	27.58***	54.46**

Note: * (resp. **, ***) denotes rejection of the null hypothesis of no cointegration with Germany at the 10% (resp. 5%, 1%) level.

external disequilibriums may be at roots of the sovereign crisis. Nevertheless, to fully confirm this statement, we have to make sure about the direction of causal links by testing if causality runs from the prices to the interest rates. This may be achieved throughout weak exogeneity tests. If in general, weak exogeneity is used to determine which are the driving variables of the system by identifying the possible feedbacks of the long-run levels (McDonald and Juselius, 2003), Hall and Milne (1994) argue that it can also be employed to test a form of long-run causality they call weak causality (Table 4). According so, weak exogenous prices suggest that causality runs from goods to capital market (*i.e.* PPP disequilibriums entail UIP disequilibriums).

As shown in Table 4 for the majority of countries (Austria, Belgium, Greece, Ireland, Italy Luxembourg and Portugal), the assumption of weak exogeneity is rejected for joint interest rates and not rejected for joint prices, denoting that the increase of interest differentials can be assigned to non stationary price differentials. These findings corroborate that sovereign debt crisis is due to a balance of payments crisis for these countries. For France and Spain the causality direction is not challenged, but it is more restricted since prices are weakly exogenous only when they are tested individually. Finally, the Netherlands exhibit a two-way causal relationship given that only the domestic price is weakly exogenous, which goes against the balance of payments crisis theory.

Table 4: Weak exogeneity

	Austria		Belgium		France		Greece		Ireland	
	$\chi^2(\nu)$	p-val	$\chi^2(\nu)$	p-val	$\chi^2(\nu)$	p-val	$\chi^2(\nu)$	p-val	$\chi^2(\nu)$	p-val
i^l	12.15	0	10.12	0.001	18.86	0	17.1	0	4.82	0.03
i^{l^*}	19.53	0	15.85	0	16.18	0	0.75	0.385	10.33	0.001
p	0.01	0.92	0.6	0.43	2.76	0.1	0.09	0.758	0.094	0.76
p^*	0.001	0.97	0.92	0.335	3.64	0.056	0.33	0.564	0.172	0.67
i^l and i^{l^*}	21.57	0	16.89	0	20.21	0	18.47	0	28.86	0
p and p^*	1.66	0.43	5.48	0.07	10.56	0.005	2.26	0.322	0.765	0.68
	Italy		Luxembourg		Netherlands		Portugal		Spain	
	$\chi^2(\nu)$	p-val	$\chi^2(\nu)$	p-val	$\chi^2(\nu)$	p-val	$\chi^2(\nu)$	p-val	$\chi^2(\nu)$	p-val
i^l	14.94	0	0.419	0.51	10.28	0.001	9.78	0.001	6.96	0.008
i^{l^*}	15.37	0	13.64	0	10.97	0	0.713	0.398	17.7	0
p	4.59	0.032	0.64	0.423	3.54	0.06	0.104	0.746	0.001	0.97
p^*	4.79	0.028	1.05	0.3	4.51	0.033	0.263	0.607	0.093	0.76
i^l and i^{l^*}	15.89	0	22.87	0	11.17	0.003	20.02	0	19.18	0
p and p^*	5.07	0.08	5.26	0.07	11.19	0.003	2.27	0.249	8.85	0.012

Note: $\nu = 1$ for individual and $\nu = 2$ for joint test.

4.3 Long-run relationships

As evidenced in section 3.2, long-term structure of the CVAR can be compared to the theoretical predictions by imposing restrictions on the cointegrating vector β. Resting on Table 1, we investigate the sensitivity of interest differentials to price differentials in each country relative to Germany.

Results in Table 5 show that for each country, the strongest version of CHEER is discarded with a p-value of 0. Even if PPP deviations entail UIP departures (according to weak exogeneity tests), the elasticity between these to components is lower than 1. The semi-strong sensitivity (elasticity ranging from]0;1[) is accepted for Greece, Ireland and Portugal, but rejected for the rest of the countries panel. Finally, weak sensitivity is accepted for our entire panel except France and Italy that display very small p-values (0.01 and 0.02). Overall, these results attest that the countries that appealed to international assistance are the most sensitive to external imbalances in the Eurozone: in order to stay in the monetary union (*i.e.* keep their nominal exchange rate equal to zero relative to Germany), they have to face a greater increase of their domestic rates than the rest of the European countries. On the opposite, France and Italy are the countries that disclose the weakest sensitivity since any constrained model is accepted. Between these two groups lie Austria, Belgium, Luxembourg and Spain, where restrictions on PPP are respected, but UIP is unrestricted.

Drawing a parallel with the sovereign debt crisis, these findings (supplemented by those of causality tests reported in section 4.2) are very informative on the causes and the form of the crisis. Indeed, they support the idea that Greece, Ireland and Portugal have experienced a balance of payment crisis as described in section 2.2. The irrevocably fixed parity relative to Germany prevents these countries from solving their external disequilibrium by devaluating

Table 5: Restrictions tests

Hypothesis	Austria		Belgium		France		Greece		Ireland	
	$\chi^2(\nu)$	p-val	$\chi^2(\nu)$	p-val	$\chi^2(\nu)$	p-val	$\chi^2(\nu)$	p-val	$\chi^2(\nu)$	p-val
A	31.24	0	21.73	0	31.03	0	12.75	0	33.24	0
B	23.94	0	20.07	0	31.02	0	1.22	0.54	1.8	0.40
C	0.47	0.49	0.458	0.5	6.66	0.01	2.53	0.11	0.139	0.71
	Italy		Luxembourg		Netherlands		Portugal		Spain	
	$\chi^2(\nu)$	p-val	$\chi^2(\nu)$	p-val	$\chi^2(\nu)$	p-val	$\chi^2(\nu)$	p-val	$\chi^2(\nu)$	p-val
A	21.99	0	30.89	0	11.7	0	24.43	0	27.2	0
B	20.22	0	24.2	0	11.40	0	2.54	0.28	24.48	0
C	5.57	0.02	0.03	0.86	0.058	0.81	2.16	0.14	0.93	0.33

Note: In hypothesis B, $|\gamma|$ is equal to 5.82 in Greece, 12.72 in Ireland, and 5.9 in Portugal. $\nu = 3$ for hypothesis A, $\nu = 2$ for hypothesis B, $\nu = 1$ for hypothesis C.

their currency. In the absence of real adjustments, deficits have been financed thanks to borrowing, pressuring upward interest rates until the financing costs were unsustainable, which forced these countries to ask for international relief. Regarding the rest of the Euroland, there is no manifest proof of such eventuality. Two-way causality challenges the view that PPP deviations are at the roots of interest rates differentials increase for the Netherlands. Any meaningful economic restrictions have been found relevant for France and Italy, and only weak restrictions are accepted for the remaining countries, suggesting that price differentials explain only a small part of interest differentials dynamics. Results are somewhat surprising for Spain and Italy, since only a small part of the increase in their interest differentials relative to Germany is due to external disequilibriums, whilst they are considered as "weak links" of the EMU. A likely reason for these differentials may lie in the threat of a contagion effect. This is supported by the weak exogeneity tests: unlike the other countries individual and joint prices are not both weakly exogenous for these two economies, which may indicate a certain disconnection between prices and interest rates.

4.4 Short-run adjustments

When restrictions on cointegrating vectors β are significant as it is the case for our entire panel except France and Italy, we can detect the short-run drivers as well as their adjustment speed towards the equilibrium state by imposing additional restrictions on α. These are simple tests of weak exogeneity implemented on restricted, rather than on unrestricted vectors, that aim at finding out which variables are unresponsive to restore equilibrium. Table 6 provides the loading parameters of the restricted β, and the unresponsive variables.

As expected, (domestic and foreign) prices are unresponsive in all countries but the Netherlands, substantiating that adjustment towards joint stationarity of PPP and UIP is made through interest rates. However, there are some disparities between countries regarding drivers and their importance. While for Greece and Portugal, only domestic interest rates are at play, for Austria, Belgium, Ireland, and Spain, both domestic and German interest rates participate to adjustments. For Austria, Belgium and Spain, the main driver is the German rate, whereas

Table 6: Short-run adjustments

Domestic country			Δi^l	Δi^{l^*}	Δp	Δp^*
Austria	loading parameters	*coeff*	0.09	0.121	-0.031	-0.08
		s.e.	(0.021)	(0.022)	(0.41)	(0.401)
	unresponsiveness	$\chi^2(2)$	15.73	23.57	0.47	0.51
		p-value	0	0	0.79	0.77
Belgium	loading parameters	*coeff*	0.044	0.06	-0.12	-0.16
		s.e.	(0.013)	(0.013)	(0.131)	(0.232)
	unresponsiveness	$\chi^2(2)$	10.95	18.97	0.76	1.01
		p-value	0	0	0.68	0.6
Greece	loading parameters	*coeff*	-0.017	-0.002	-0.002	-0.009
		s.e.	(0.003)	(0.001)	(0.025)	(0.024)
	unresponsiveness	$\chi^2(3)$	25.46	3.2	1.23	1.38
		p-value	0	0.36	0.74	0.71
Ireland	loading parameters	*coeff*	-0.005	0.004	-0.012	-0.014
		s.e.	(0.002)	(0.001)	(0.026)	(0.026)
	unresponsiveness	$\chi^2(3)$	9.037	10.81	2.07	2.16
		p-value	0.03	0.01	0.55	0.53
Luxembourg	loading parameters	*coeff*	0.008	0.043	-0.15	-0.202
		s.e.	(0.013)	(0.012)	(0.21)	(0.207)
	unresponsiveness	$\chi^2(2)$	0.43	13.77	0.69	1.17
		p-value	0.8	0.001	0.708	0.55
Netherlands	loading parameters	*coeff*	0.042	0.043	-0.46	-0.53
		s.e.	(0.011)	(0.011)	(0.193)	(0.194)
	unresponsiveness	$\chi^2(2)$	10.31	12.44	5.91	7.58
		p-value	0.05	0.002	0.052	0.022
Portugal	loading parameters	*coeff*	-0.024	0.003	-0.118	-0.129
		s.e.	(0.007)	(0.005)	(0.083)	(0.082)
	unresponsiveness	$\chi^2(3)$	14.77	2.97	4.58	4.95
		p-value	0.002	0.396	0.205	0.176
Spain	loading parameters	*coeff*	0.015	0.021	-0.025	-0.059
		s.e.	(0.007)	(0.005)	(0.083)	(0.082)
	unresponsiveness	$\chi^2(2)$	7.59	17.8	0.36	0.81
		p-value	0.022	0	0.836	0.668

Note: For Greece, Ireland and Portugal we retain the restricted vector coming from hypothesis B, while for Austria, Belgium, Luxembourg, the Netherlands an Spain, we keep that of hypothesis C.

for Ireland, domestic and German rates are equivalent. Finally, only the German interests restore the equilibrium for Luxembourg.

5 Conclusion

In this article, we investigate whether the sovereign debt crisis experienced by some EMU countries is actually a balance of payments crisis generated by the occurrence of large external disequilibriums relative to main partners. If the latter have largely been pointed out to explain the sources of the debt crisis, there is no study establishing formal relationships between external imbalances and the sharp increase of interest rates inside Eurozone. To overcome this shortcoming we rely on the equilibrium exchange rate model initiated by Juselius (1991, 1995), the CHEER approach.

Theoretically, we show that in a currency union, external imbalances of a country *vis-à-vis* a partner (that is a violation of PPP between these two countries) may traduce into a balance of payments crisis if real adjustments are too difficult to implement. Indeed, we evidence that external disequilibriums entail a raise in interest differential in order to keep fixed parities between members. In a monetary union, since real imbalances cannot be mitigated by monetary instruments (as the nominal exchange rate), only real adjustments that reduce these imbalances are available. Then, persistence of large external disequilibriums (that traduces an inability to implement structural adjustments) challenges on the long run the monetary commitments: the deficits aggravate the net foreign asset position raising the amount needed for servicing the debt, that in turns fuels the external imbalances. This snowball effect is likely to force the deficit country to exit the monetary union in order to recover competitiveness by devaluating its currency.

Empirically, we carry out a cointegration analysis between each EMU country and Germany to ascertain our theoretical predictions. We find that a cointegrating long-run relationship exists between goods market and capital market (relative to Germany) for each country except Finland. Moreover, causality tests indicate that, among the sample of countries for which cointegration is found, causality is unidirectional and runs from PPP to UIP, except in the Netherlands, where it is bidirectional. Finally, we show that the countries under assistance (Greece, Ireland and Portugal) exhibit the greatest sensitivity to external disequilibrium, whilst France and Italy seem relatively immune.

Generally speaking, our results attest that Greece, Ireland and Portugal are experiencing a balance of payments crisis. The sky-high interest rates they faced forced them to ask for Troïka assistance in order to not withdraw from Euro and have some extra time to implement structural adjustment policies. Notwithstanding, the former hypothesis cannot be discarded, since, as illustrated by Greece, structural adjustment is obviously socially costly and poorly accepted by people. For Spain and Italy disequilibriums seem to play a limited role, a result than can be explained by the fact that part of their interest differential increase relative to Germany is due to the so-called contagion effect. Finally, even if Austria, Belgium, France, Luxembourg and the Netherlands have undergone some (moderated) pressures on their interest rates, there is no evidence of a beginning balance of payments crisis. On the whole, our

findings put forward important differences between peripheral and core countries regarding the interpretation of the current debt crisis.

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Appendix

Table A.1: Cointegrating space

	Austria	Belgium	France	Greece	Ireland
	Standardized Eigenvectors β				
i^l	1	1	1	1	1
i^{l^*}	-3.76	-2.95	-0.74	-0.07	-0.65
p	-1.91	-1.03	0.29	0.41	0.09
p^*	1.92	1.05	-0.3	-0.45	-0.08
$trend$	-	-	-	-	-
	Adjustment coefficients α				
Δi^l	0.0527	0.0456	-0.5447	0.0889	0.0595
Δi^{l^*}	0.0679	0.0614	-0.5245	0.0068	-0.0635
Δp	-0.0771	-0.1893	3.6286	0.0481	0.118
Δp^*	-0.1106	-0.2389	4.205	0.0851	0.1633
	Italy	Luxembourg	Netherlands	Portugal	Spain
	Standardized Eigenvectors β				
i^l	1	1	1	1	1
i^{l^*}	11.64	-3.53	1.21	-0.82	0.5
p	6.81	-0.88	0.91	0.13	0.26
p^*	-7.24	0.89	-0.92	-0.11	0.25
$trend$	-	-	0.0002	-0.0001	-
	Adjustment coefficients α				
Δi^l	-0.0069	0.0096	-0.046	0.1508	-0.0524
Δi^{l^*}	-0.0077	0.049	-0.0473	-0.0284	-0.0729
Δp	0.0677	-0.1964	0.553	0.02091	0.018
Δp^*	0.0689	-0.2514	0.629	0.3254	0.1047