Money factors and EMU government bond markets' convergence

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Abstract

Purpose – The authors aim to investigate the cointegrating relationship of the government bond yields, driven by the common money factors in European Monetary Union (EMU).

Design/methodology/approach – By adopting a dynamic ARDL transformation, the paper provides short-/long-term estimates of bond yields convergence before the burst of the current debt crisis. It also investigates how the degree of convergence between bond yields, driven by money factors, is affected in short/long runs.

Findings – The findings indicate that the introduction of the common currency has not a uniform effect on the bond yields, and there is a nominal convergence between EMU bond yields based on money market determinants.

Originality/value – The current financial crisis indicates that the EMU bond market convergence was temporary and it can be highly affected by an exogenous shocks and the sentiment of international investors. The findings imply the necessity for a common monetary and fiscal policy in Euro zone countries.

Keywords Convergence, ARDL model, Euribor interest rates, Euro exchange rate, Government bond yields, European monetary union

Paper type Research paper

1. Introduction

This paper is concerned with the effect of money factors after the introduction of euro currency in European monetary union (EMU) sovereign bond markets. We adopt a dynamic parameterized approach that accounts for the specificity of cointegrating relationship based on the common currency, the euro money short-term rates and the interrelation of the yields of bonds. This approach of cointegrating effect among government bond yields is flexible enough to both incorporate the adjustment trend to equilibrium values and the stabilization that the common currency brought, over a short and long-run dynamics at EMU country-level.

Government bond markets play a crucial role in the transmission mechanism of monetary policy in EMU. Since 1999, the adoption of the common currency by 11 countries became the vehicle to exercise common effective monetary and fiscal policies, avoiding the consequences of asymmetrical shocks. Over the first years of Euro-zone life, previous studies provide evidence that the adoption of euro currency

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leads to government bond yields convergence. This convergence was driven by expectations of the euro introduction, by the consequent elimination of the global risk and asymmetrical shocks, by allowing cheaper access to debt financing with less uncertainty in financial markets and by fulfilling the vision of European integration (Kim *et al.*, 2006; Christiansen, 2007; Abad *et al.*, 2010).

Previous literature also indicates that EMU government bonds are imperfect substitutes that are affected by domestic macroeconomic policies, liquidity risk and global risk. In an earlier study, Codogno *et al.* (2003) examine the determinant factors that influence the EMU bond yield spreads. They examine the role of macroeconomic fundamentals and liquidity indicators on the movements in yield spreads fluctuations, providing new evidence on the relative importance of the credit risk and liquidity risk. Moreover, Geyer *et al.* (2004) explore the joined dynamics of yield spreads of EMU government bonds and find strong evidence for the presence of a global factor that captures the level of long-term yield spreads whereas the domestic factors and shocks are not significant. The authors find strong evidence that government bond spreads are related to the evolution of alternative euro area asset markets, as a sign of increased market integration, and much less so, to macroeconomic or liquidity variables.

On a similar study, Favero *et al.* (2005) examine the reasons behind the bond yield differentials in EMU bond markets using various factors. They find that the international risk factor is consistently priced, while liquidity differentials are priced only for a subset of countries and their interaction with the risk factor is crucial to detect their effect. Liquidity premia also play an important role regarding the driving spreads in the EMU. Bond spreads depend significantly on a range of indicators of fiscal performance, although the nature and magnitude of sovereign risk premia has changed concomitant to the adoption of the euro currency (Pagano and von Thadden, 2004; Schuknecht *et al.,* 2009; Manganelli and Wolswijk, 2009; Favero *et al.,* 2010).

However, there is limited evidence that the introduction of euro currency alone does not result in a full convergence of bond yields and prevent the bubbles in the debt bond market. Recent empirical studies stated to argue that the introduction of euro currency is associated with great imbalances and an unsustainable external debt accumulation, between countries of the EMU (Berger and Nitsch, 2010). These imbalances led to significant rise of external borrowing in some EMU countries and the current bursting of government bond bubbles. On the other hand, the latest European debt crisis raises fundamental questions about the influence of the euro currency introduction in bond markets and its role to the real convergence. The impact of international and sovereign risk factors has significantly affected the spreads of bond yields (versus Germany yields) during the latest crisis, while international investors started to discriminate more between countries because the combination of high risk aversion and large current account deficits tend to magnify the incidence of deteriorated public finances on government bond yield spreads (Barrios *et al.,* 2009; Longstaff *et al.,* 2011).

As it is recently revealed, the structure of EMU is undermined by political or financial differences, among its members. Thus, some important questions that arise are whether the introduction of euro currency led to convergence in the EMU bond markets in the past years and how this might affect yields in turmoil periods, and on the other hand, if the euro introduction was enough to convince investors about the real economic convergence of Euro-zone members. As we see nowadays, the current crisis created by the bursting of government bond bubbles in some EMU members can be extremely disruptive to the real economy of all EMU countries. The policy of "leaning against" potential bubbles appears to dominate versus the European Central Bank's neutrality, the elimination of business risk and the cointegrating relationship in bond markets, where the introduction of euro currency brought.

This paper provides short/long-term estimates of bond yields convergence before the burst of current debt crisis, starting in 2010. It investigates how the degree of convergence between bond yields, driven by money market factors is affected in short/long runs, during the pre-turmoil years. The empirical results indicate that some EMU economies have been benefited by the existence of the common currency and the financial conditions in the interbank market and they present a cointegrating relationship. On the other hand, other EMU economies with no funding imbalances, like Germany and The Netherlands, show a completely different short/long-run behaviour compared to the rest of countries. Our analysis indicates that before the beginning of the latest European crisis, there was a nominal convergence in bond markets introduced by the adoption of the common currency. However, the appearance of any exogenous shock led investors to price differently the cost of borrowing of each country, without taking into account the common money factors and the EMU common monetary or fiscal policies. Therefore, the presence of common currency was not enough to convince investors about the real economic convergence of Euro-zone members.

The structure of the paper is organized as follows. Section 2 discusses the proposed methodology; Section 3 presents the data while Section 4 shows the empirical analysis. Finally, Section 5 provides a discussion of the empirical findings and Section 6 summarizes the conclusions.

2. Methodology

We consider an autoregressive distributed lag specification of order p and q (Pesaran *et al.* (1999) for a short/long-run cointegration analysis) for EMU (1999) members. Based on the model, bond yields are explained by their own lags as well as by the lags of their common determinants in order to capture persistence effects and the benefits of including dynamic terms. Thus, the ARDL(p,q) model is given by:

$$(Bond)_t = c + \sum_{i=1,2,\ldots,p} a_i L^i (Bond)_t + \sum_{j=0,1,2,\ldots,q} \beta_j L^j X_t + \varepsilon_t$$

The term $(Bond)_t$ represents the dependent variable of EMU government bond yields, the term L represents the lag operator and the term X_t represents the common money market's determinant variable. The coefficient c is the fixed effect which varies across countries, the parameter a_i is the country's coefficient of the dependent's variable lag terms, the parameter β_j represents the country's coefficient of common determinants lag terms and finally, the term ε_t is the error term.

The ARDL model can be re-parameterized to yield an error correction model (ECM). However, the ECM form is not convenient when the cointegrating parameters are unknown. We use a transformation for the ARDL model which allows a valid inference on the long-run coefficients asymptotically and likely to yield improved estimators (extending the model of Inder (1993)). Thus, the model specification is re-parameterized, as follows (the Appendix):

$$(Bond)_t = \frac{c}{1-A_1} + \frac{B_0}{1-A_1} X_t - \frac{\sum_{j=1,2,\ldots,q} B_j}{1-A_1} \Delta X_{t-j+1}$$

$$-\frac{\sum_{i=1,2,\ldots,p} A_i}{1-A_1} \Delta(Bond)_{t-i+1} + \frac{\varepsilon_t}{1-A_1}, \quad (2.1)$$

where; $(1-A_1) \neq 0$, $B_0 = \sum_{j=0}^{q} \beta_j$, $B_1 = \sum_{j=1}^{q} \beta_j$, $B_q = \beta_q$, $A_1 = \sum_{i=1}^{p} a_i$, $A_2 = \sum_{i=2}^{p} a_i$, and $A_p = a_p$.

We can rewrite equation (2.1) in order to isolate the long-run coefficients C^* and $B_0^* X_t$ as follows:

$$(Bond)_t = c* + B_0^* X_t - B_j^* \Delta X_{t-j+1} - A_i^* \Delta(Bond)_{t-i+1} + \varepsilon_t^*, \quad (2.2)$$

The term $(1-A_1)$ denotes the error correction coefficient that is differentiated across EMU countries. The ARDL(1,1) model takes the form:

$$(Bond)_t = \frac{c}{1-a_1} + \frac{\beta_0 + \beta_1}{1-a_1} X_t - \frac{\beta_1}{1-a_1} \Delta X_t - \frac{a_1}{1-a_1} \Delta(Bond)_t + \frac{\varepsilon_t}{1-a_1}, \quad (2.3)$$

3. The data

In 1999, the EMU had contained 11 members that had qualified the agreed convergence criteria. Thus, our data set consists from the monthly ten-years government bond yields, derived by the average weekly yields, for 11 EMU countries namely Spain, Italy, Austria, France, Germany, Finland, The Netherlands, Luxembourg, Portugal, Belgium, and Ireland. The sample covers the period from January of 1986 to August of 2010 and it refers at the period before the introduction of common currency until the time point when Greece had to withdraw from international bond markets.

Previous studies indicate that one of the major money market's factors driving government bond yields before the adoption of the common currency is the currency exchange rates (Favero *et al.,* 1997). In line with this research, we consider the exchange currency rate of euro versus the US dollar in order to measure the exchange rate stability and the diversification against the global risk factor in terms of money market conditions. The euro exchange rate variation is driven by permanent (productivity, income per capita, etc.) or transitory factors (fiscal shocks). We expect that the more stable the exchange rate (low variance) the stronger the stability. Overall, changes in the exchange rate and government bond variation as pronounced volatility and depreciation in the value of the exchange rate can lead to higher spreads and higher volatility.

A significant money market factor related to government bond yields is the Euribor rate (three-months). The differentials between euro area government bond yields are related to short-term interest rates, which are in turn related to market liquidity, cyclical conditions and to investors' incentives to take risk (Manganelli and Wolswijk, 2009). In this respect, we include the euro inter-banking rates as a proxy for domestic money market liquidity. This proxy also provides information on the liquidity conditions in the long-term segment (Beber *et al.*, 2008).

Finally, we use a multiplicative dummy variable that restricts the analysis of the effects of common currency's introduction on European bond markets for the introduction date. Thus, by dividing the pre and post period of euro currency introduction, we set the dummy variable, mapping the explanatory variables:

$$[I_t = 0, \text{ before the euro introduction in 1999 vs } I_t = 1, \text{ after the euro introduction}]$$

By looking all government bond yields presented in Figure I, we can draw some interesting conclusions. Since the introduction of euro currency in 1999, all bond yield series have a similar co-movement with a similar value level, because of the global formal prospects (i.e. liquidity conditions, common EMU policies, low investors' risk aversion and positive economic activity).

To provide some perspective on the data, Table I reports the summary statistics of the bond yields.

The statistical analysis reveals that the monthly returns fall within a range (from 5.46 to 7.85 per cent) and the variability of the indices varies from 1.62 to 4.59 per cent. The bond yields distributions are skewed to the right whereas both the explanatory variables are skewed to the left. Finally, the hypothesis of normality (Jarque-Bera test) is not accepted for all the cases.

4. Empirical analysis

In this section, we estimate the dynamic panel ARDL(1,1) model in order to examine the cointegrating relationship of EMU (1999) bond yields. First, we examine the relation between the euro vs dollar exchange rate and Euribor (three-months) series regarding causality, using the Granger causality test specification. The results

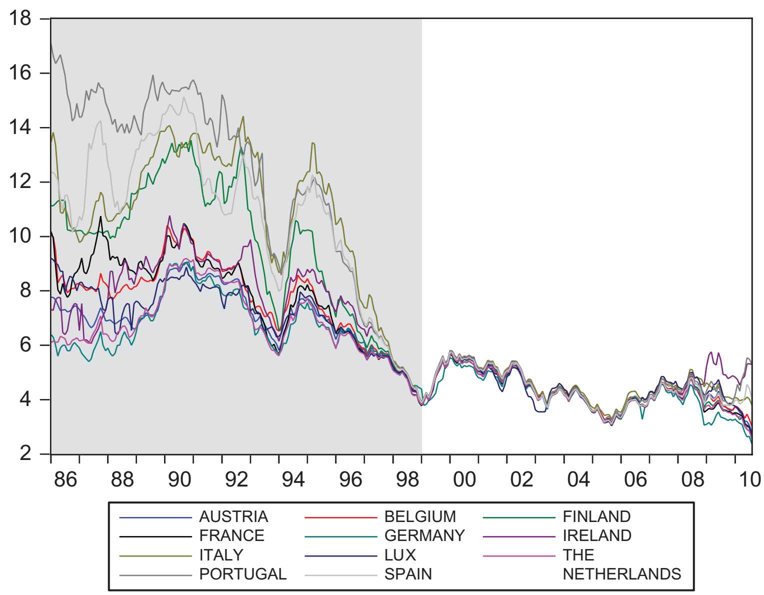

Figure 1.
Bond yields (ten years) – EMU (1999)

Notes: This figure presents the yields of EMU (1999) government bonds (10Y) from 1986M01 to 2010M08; the shadow area represents the time before the introduction of common currency

Table I. Descriptive statistics

	Government bond yields											Money factors	
	AUS	BEL	FIN	FRA	GER	IRE	IT	LUX	NED	POR	SPA	E3M	EUR
Mean	5.75	6.15	7.1	6.12	5.46	6.27	7.85	5.86	5.59	8.48	7.73	3.06	1.18
SD	1.64	2.04	3.28	2.18	1.59	2.01	3.71	1.72	1.62	4.59	3.8	1.26	0.19
Skewness	0.23	0.32	0.50	0.40	0.41	0.34	0.36	0.18	0.45	0.47	0.43	−0.11	−0.07
Kurtosis	1.85	1.74	1.72	1.71	2.34	1.81	1.45	1.66	2.31	1.51	1.59	2.17	2.01
J-B	18.99	24.80	32.63	28.21	13.37	23.39	36.06	23.81	16.11	38.12	33.77	14.31	15.72

Notes: *The null hypothesis of normality (J-B test) of the series is accepted at the 1 per cent level of significance; the table presents the summary statistics of the euro/$ exchange rate, the Euribor rate (three-months) and the government bond yields, derived from 11 EMU countries: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Spain, The Netherlands and Portugal; it shows the mean, standard deviation, skewness, kurtosis and the Jarque-Bera (J-B) test

are presented on Table II and show that there is no evidence for Granger causality between the two series. This means that any potential variation of the determinant factors will affect the patterns of the bond yields, but without influencing one factor the other.

Afterwards, we estimate the dynamic panel ARDL(1,1) model with respect to the money factors, using the quasi-maximum likelihood method with Gaussian likelihood functions. The results of dynamic ARDL(1,1) models are presented in Table III (panels I-III) and Table IV for the short and long-term, respectively. The empirical findings provide novel insights. Overall, the findings in the panels indicate that the majority of EMU government bond yields are significantly influenced from the variations of money factors but these variations do not determine the cointegrating patterns of bond yields.

Panel I reports the short-term results of the empirical analysis for the bond yields from estimating the dynamic ARDL(1,1), driven by the euro vs dollar exchange rate. The error correction coefficient a_1 is statistical significant and it appears to have a similar value in all the cases, thereby rejecting the null hypothesis of equality with zero [H_0:$a_1 = 0$] according to the Newey-West test. This indicates that the lag terms are consistently steady among the government's bond yields for each country. Therefore, there is a significant existence of strong cointegrating relationship for the government bond yield. This is very attractive issue from the vantage point of active bond trading in EMU. On the other hand, the effect from the exchange rate to all countries (coefficient β_0) is significant and negative, with minor importance for Germany, The Netherlands and Luxembourg. The variations of exchange rate seem to be absorbed on the European bond market.

Table II. Granger causality test (lags: 1)

Null hypothesis: (Fc = 3.84)	F-statistic
Euribor does not Granger cause euro/$ exchange rate	0.01
Euro/$ exchange rate does not Granger cause Euribor	0.41

Notes: The null hypothesis of the Granger causality test is: *Ho*: euro/$ or Euribor does not cause Granger causality to each other; the table shows the null hypothesis, the F-stat. critical value (Fc = 3.84) and the results of Granger causality test (the F-statistics)

Panel I – the euro/\$ exchange rate as a determinant factor				
EMU gov. bond yields	*100c*	a_1	β_0	β_1
Austria	-0.23	0.49^{*}	-0.83^{**}	0.63^{*}
Finland	-0.15	0.50^{*}	-0.75^{***}	0.46^{***}
Spain	-0.23	0.51^{*}	-1.36^{*}	0.83^{*}
Italy	-0.12	0.48^{*}	-0.89^{**}	0.66^{*}
The Netherlands	-0.21	0.46^{*}	-0.60	0.48
Lux	-0.21	0.44^{*}	-0.24	0.11
Belgium	-0.21	0.49^{*}	-1.08^{*}	0.75^{*}
France	-0.20	0.54^{*}	-0.85^{**}	0.70^{*}
Portugal	-0.15	0.58^{*}	-1.47^{*}	0.86^{*}
Ireland	-0.14	0.49^{*}	-1.00^{***}	0.58^{***}
Germany	0.11	0.49^{*}	-0.59	0.36

Panel II – the Euribor (three-months) interbank rate as a determinant factor				
EMU gov. bond yields	*100c*	a_1	β_0	β_1
Austria	-0.20	0.50^{*}	0.18^{*}	-0.05
Finland	-0.22	0.50^{*}	0.23^{*}	-0.07^{***}
Spain	-0.32	0.49^{*}	0.22^{*}	-0.06
Italy	-0.26	0.48^{*}	0.20^{*}	-0.07^{***}
The Netherlands	-0.31	0.42^{*}	0.21	-0.06
Lux	-0.20	0.40^{*}	0.20^{*}	-0.05
Belgium	-0.31	0.51^{*}	0.20^{*}	-0.06
France	-0.24	0.58^{*}	0.23^{*}	-0.07^{***}
Portugal	-0.14	0.50^{*}	0.20^{*}	-0.07
Ireland	-0.12	0.50^{*}	0.16^{***}	-0.04
Germany	0.11	0.44^{*}	0.13	-0.05

Panel III – the euro/\$ and the Euribor rates as determinant factors						
EMU gov. bond yields	*100c*	a_1	$\beta_0^{e/\$}$	$\beta_1^{e/\$}$	β_0^{E3m}	β_1^{E3m}
Austria	-0.21	0.42^{*}	-0.62	0.54^{***}	0.16^{**}	-0.04
Finland	-0.24	0.46^{*}	-0.49	0.34	0.21^{*}	-0.06
Spain	-0.24	0.51^{*}	-1.14^{*}	0.74^{*}	0.17^{*}	-0.04
Italy	-0.22	0.44^{*}	-0.67^{**}	0.56^{**}	0.17^{**}	-0.06
The Netherlands	-0.22	0.41^{*}	-0.35	0.36	0.19	-0.06
Lux	-0.23	0.39^{*}	-0.01	0.01	0.20^{*}	-0.06
Belgium	-0.25	0.45^{*}	-0.87^{**}	0.66^{**}	0.16^{**}	-0.05
France	-0.21	0.51^{*}	-0.58	0.59^{**}	0.20^{*}	-0.06
Portugal	-0.10	0.55^{*}	-1.27^{*}	0.78^{*}	0.15^{**}	-0.04
Ireland	-0.11	0.47^{*}	-0.83	0.51	0.13	-0.02
Germany	0.11	0.48^{*}	-0.44	0.29	0.11	-0.05

Notes: Coefficient is significant at the *1, **5 and ***10 per cent significance levels of confidence, according to the Newey-West test; the table reports the results of the dynamic ARDL(1,1) for the 11 EMU countries; the ARDL(1,1) model is given by:

$$(Bond)_t = \frac{c}{1-a_1} + \frac{\beta_0+\beta_1}{1-a_1} I_t X_t - \frac{\beta_1}{1-a_1} I_t \Delta X_t - \frac{a_1}{1-a_1} \Delta (Bond)_t + \frac{\varepsilon_t}{1-a_1}$$

Table III.
The dynamic ARDL(1,1) model-short term coefficients

Panel II reports the short-term results of the empirical analysis for the bond yields from estimating the dynamic ARDL(1,1), driven by the Euribor (three-months) inter-banking interest rate. Similar to the previous results, the error correction coefficient a_1 is statistical significant and it appears to have a similar value in all the cases, thereby rejecting the null hypothesis of equality with zero [H_0:$a_1 = 0$] according to the Newey-West test. This indicates again that the government bond yields are consistent,

EMU gov. bonds yields	Panel I B_0^*	Panel II B_0^*	Panel III $B_{0,e/\$}^*$	$B_{0,E3m}^*$
Austria	−0.39	0.36	−0.16	0.32
Finland	−0.58	0.32	−0.30	*0.42*
Spain	−0.68	0.43	−0.80	0.34
Italy	−0.44	0.26	−0.22	0.34
The Netherlands	*−0.24*	0.42	*0.12*	*0.26*
Lux	*−0.26*	0.40	*−0.13*	*0.40*
Belgium	−0.64	0.40	−0.54	0.32
France	−0.30	0.32	*0.12*	0.40
Portugal	−0.74	0.40	−0.98	0.30
Ireland	−0.82	0.32	−0.62	0.25
Germany	*−0.44*	*0.25*	*−0.28*	*0.21*

Notes: Coefficients indicate with italic, denote that the underlying coefficient is not statistically significant at any level of confidence (1, 5 and 10 per cent), according to the Newey-West test; the table reports the results of the long-term dynamic ARDL(1,1) for 11 EMU countries; the ARDL(1,1) model is given by:

$$(Bond)_t = c^* + B_0^* I_t X_t - B_j^* I_t \Delta X_{t-j+1} - A_i^* \Delta(Bond)_{t-i+1} + \varepsilon_t^*$$

Table IV. The dynamic ARDL(1,1) model-long term coefficients

depending by their lag term. On the other hand, the effect from the Euribor (three-months) rate to all countries (coefficient β_0) is significant and positive, with minor importance for Germany and The Netherlands. Liquidity conditions in the money market as reflected from the positive and statistical significant coefficient of the Euribor, are related with the short-run dynamics of bond yields at the majority of EMU yields with importance to countries that need liquidity and counterparty risk in the inter-bank market.

Panel III reports the short-term results of the empirical analysis for the bond yields from estimating the dynamic ARDL(1,1), driven both by the euro vs dollar exchange rate and the Euribor (three-months) inter-banking interest rate. The error correction coefficient is statistical significant and it appears to have a similar value in all the cases, thereby rejecting the null hypothesis of equality with zero $[H_0{:}a_1 = 0]$ according to the Newey-West test. On the other hand, the effect from both money factors to all countries (coefficient β_0^f) is significant, with minor importance for Germany, Luxembourg, The Netherlands and France (except the Euribor). The results in this panel combines the estimations of the previous panels and it indicates clearly that capital inflows to the European bond market seems to be responsible for the bond yields due to increased demand and a corresponding fall in the yield to maturity, without take into account the variations of the common currency and the inter-banking rates for countries that are not facing high financing or fiscal imbalances.

Finally, Table IV reports the long-term results of the empirical analysis for the bond yields from estimating the dynamic ARDL(1,1), driven both by the euro vs dollar exchange rate and the Euribor (three-months) inter-banking interest rate. The effect from both money factors to all countries (coefficient β_0^f) is significant in long-term, with minor importance for Germany, Luxembourg, The Netherlands and France, thereby rejecting the null hypothesis of equality with zero $[H_0 : \beta_0^f = 0]$ according to the Newey-West test.

5. Discussion

The above empirical findings provide novel insights. The results indicate that there is a distinction between EMU members concerning the cointegrating relationships. Some countries do not appear to be present a long-term cointegrating relationship between bond yields and the money factors, even before the burst of the current European debt crisis. On the other hand, EMU members with lower growth and higher debts have been benefited in long-run by the existence of the common currency and the use of interbank interest rate and they present a cointegrating relationship with the presence of the common currency.

This differentiation occurs because of the strong cross-market linkages and the Euro area's inability to fully adjust to common monetary policies through EMU market integration. This is in contrast to the common belief of policymakers that traditional liquidity indices (such as bid-ask spreads, trading volumes and outstanding amounts) as well as the presence of liquid futures contracts have explained a substantial proportion of yield differentials since the beginning of the Euro-zone. Thus, the introduction of the common currency has significantly changed the overall perception of risk aversion in some of the EMU bond markets; however, the results and the latest events in EMU bond markets shown that there was a nominal convergence among the EMU bond markets.

Nevertheless, the following question arises: if the general perceptual of risk on EMU bond markets had changed the last years, what went wrong? Within the latest crisis, it is now accepted that the presence of euro currency did not change significantly the general perceptual about risk. The Euro-zone interior discrepancies, such as the internal impact and instability of every member-state financial and economic sector and the general perceptual for risk, play the crucial negative influence to government bond yield spreads and macroeconomic indices.

The nominal cointegrating relationship in EMU members has multiple effects. Within the latest crisis, international investors, hedge funds and markets start to discriminate the Euro-zone countries according to their credit score ratings without take into consideration the common currency environment and the common monetary policy. This has a potential grinding feedback effect to other member-states through Euro-zone.

The combination of high degree of risk aversion and large domestic government deficit, particularly within the beginning of the current debt crisis in Europe, has a different impact for each member-state country, affecting their financial sectors and, hence, the macroeconomic indicators. The nominal convergence of bond yields underestimates risks that can be revealed over a crisis period. The latter implies that the great moderation policy is not enough to solve a debt crisis. Therefore, European Central Bank may play a more activate role over that periods. Moreover, the convergence of fiscal policies is necessary in order to convince investors of an economic convergence of Eurozone countries. The results present significant conclusions about the role of the common currency in EMU members. The introduction of common currency points out to a significant nominal convergence in the government bond yields in EMU but it seems to fail to functioned as a bulwark with the current unpredictable adverse effects on the EMU members.

Overall, the results suggest that an improvement in global risk perception will lead to a narrowing of intra-euro area bond yield differentials. However, the differing impact of the crisis on EMU's public finances and the expected higher risk awareness of investors after the crisis could keep government bond yield spreads at a higher level than in the pre-crisis period. Our analysis also suggests that yield differentials mainly reflect the market assessment about the creditworthiness of borrowers and those premiums are a function of international risk-related factors. Therefore, further convergence in fundamentals, and especially in debt-to-GDP ratios, would be required to reduce current yield differentials.

6. Conclusions

We herein examine the impact of money market factors conditions on EMU government bond yields through a dynamic ARDL model. The empirical results indicate that countries with EMU small economies are more affected by the movements of the euro exchange rates versus US dollar and the short-term rates in the interbank market. By looking long run coefficients, some EMU members such as Germany and The Netherlands, show a different cointegrating behaviour compared to the rest of countries. Our analysis indicates that there is a nominal convergence in sovereign EMU bond markets introduced by the adoption of common currency but is not enough to convince investors about the real economic convergence of Euro-zone members. The convergence of EMU fiscal policies is necessary in order to convince investors of an economic convergence of member countries. Moreover, common monetary policy must be accompanied with political and financial convergence or else; it is only a neutral change in real economy with occasional expectations' shifts. A major effort has to be made to fall down the barriers regarding regulatory regimes, various market practices and heterogeneity of domestic markets.

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Appendix

The ARDL(p,q) transformation

Consider an autoregressive distributed lag specification of order p and q, note as ARDL(p,q) specification (Pesaran *et al.,* 1999), for EMU (1999) members. Bond yields are explained by their own lags and by the lags of their common determinants:

$$(Bond)_t = c + \sum_{i=1,2,\dots,p} a_i L^i (Bond)_t + \sum_{j=0,1,2,\dots,q} \beta_j L^j X_t + \varepsilon_t$$

Thus, the model specification is re-parameterized by writing it in first differences, as follows:

$$\left(1 - \sum_{i=1,2,\dots,p} a_i L^i\right)(Bond)_t = c + \sum_{j=0,1,2,\dots,q} \beta_j L^j X_t + \varepsilon_t$$

The left hand of equation is written as:

$$\left(1 - \sum_{i=1,2,\dots,p} a_i L^i\right)(Bond)_t = (Bond)_t - \sum_{i=1,2,\dots,p} a_i L^i (Bond)_t \Rightarrow$$

$$\left(1 - \sum_{i=1,2,\dots,p} a_i L^i\right)(Bond)_t = (Bond)_t - \sum_{i=1,2,\dots,p} a_i (Bond)_t + \sum_{i=1,2,\dots,p} a_i (Bond)_t - \sum_{i=1,2,\dots,p} a_i (Bond)_{t-1}$$
$$+ \sum_{i=2,\dots,p} a_i (Bond)_{t-1} - \sum_{i=2,\dots,p} a_i (Bond)_{t-2} + \cdots + a_p (Bond)_{t-p} \Rightarrow$$

$$\left(1 - \sum_{i=1,2,\dots,p} a_i L^i\right)(Bond)_t = \left(1 - \sum_{i=1,2,\dots,p} a_i\right)(Bond)_t + \sum_{i=1,2,\dots,p} a_i \Delta(Bond)_t + \sum_{i=2,\dots,p} a_i \Delta(Bond)_{t-1}$$
$$+ \cdots + a_p \Delta(Bond)_{t-p+1} \Rightarrow$$

$$\left(1 - \sum_{i=1,2,\dots,p} a_i L^i\right)(Bond)_t = (1 - A_1)(Bond)_t + \sum_{i=1,2,\dots,p} A_i \Delta(Bond)_{t-i+1}$$

where; $A_1 = \sum_{i=1}^{p} a_i$, $A_2 = \sum_{i=2}^{p} a_i$, and $A_p = a_p$.

The right hand of equation is written as:

$$\sum_{j=0,1,2,\ldots,q} \beta_j L^j X_t = \sum_{j=0,1,2,\ldots,q} \beta_j X_t - \sum_{j=1,2,\ldots,q} \beta_j X_t + \sum_{j=1,2,\ldots,q} \beta_j X_t - \sum_{j=2,\ldots,q} \beta_j X_t + \cdots - \beta_q X_{t-q+1} \Rightarrow$$

$$\sum_{j=0,1,2,\ldots,q} \beta_j L^j X_t = \sum_{j=0,1,2,\ldots,q} \beta_j X_t - \sum_{j=1,2,\ldots,q} \beta_j X_t - \sum_{j=2,\ldots,q} \beta_j X_t + \cdots - \beta_q X_{t-q+1} \Rightarrow$$

$$\sum_{j=0,1,2,\ldots,q} \beta_j L^j X_t = B_0 X_t - \sum_{j=0,1,2,\ldots,q} \beta_j \Delta X_{t-j+1}$$

where, $B_0 = \sum_{j=0}^{q} \beta_j$, $B_1 = \sum_{j=1}^{q} \beta_j$ and $B_q = \beta_q$.

Thus, we conclude that the ARDL(p,q) model can be rewritten as:

$$(Bond)_t = \frac{c}{1-A_1} + \frac{B_0}{1-A_1} X_t - \frac{\sum_{j=1,2,\ldots,q} B_j}{1-A_1} \Delta X_{t-j+1} - \frac{\sum_{i=1,2,\ldots,p} A_i}{1-A_1} \Delta (Bond)_{t-i+1} + \frac{\varepsilon_t}{1-A_1}$$

The long-term coefficient form is written then as:

$$(Bond)_t = c^* + B_0^* X_t - B_j^* \Delta X_{t-j+1} - A_i^* \Delta (Bond)_{t-i+1} + \varepsilon_t^*$$

where; $(1 - A_1) \neq 0$.

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