The Euro and Cointegration Analysis of Long-Term Bond Yields

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Abstract

This paper studies the long-term equilibrium of the bond yields for the six European Union countries, and Japan and the US before and after the introduction of the euro. This paper analyzes long-term government bond yields for three groups. First is the treatment group: these are the European Union (EU) member states which adopted the euro. The other two are the control group countries, which did not adopt the euro. The first control group consist of the EU member states and the second are non-EU countries. I find empirical evidence supporting that the introduction of the euro caused convergence in the bond markets of the countries that adopted the euro. On the other hand, there is no significant long-run relationship for the two control group countries.

1 Introduction:

The European Community's integration of economic affairs made major progress starting from the beginning of the 1990s. The integration started with the Single, "Common", Market which was formally completed for the existing member countries at the end of 1992. The Common market aimed to remove all the barriers to trade and to achieve free movement of goods, services, people and capital amongst the European Union (EU) member states. In the same year, the EU furthered this integration by forming the Economic and Monetary Union (EMU), which involved the introduction of a single European currency. On January 1, 1999 the euro became the new currency for eleven Member States [1] of the European Union. By the introduction of the euro, the EMU countries re-denominated their outstanding stock of debt into euro and also started issuing new debt in euro. In this perspective, the EMU countries can be considered as one big economy.

The European Union established a formal entry criteria to the EMU by the Maastricht Treaty of 1992. This treaty underlined five monetary and fiscal convergence criterion[2] in order to qualify for participation in the EMU. One of the convergence criterion requires a candidate state to move its long-term interest rates towards the

[1] The eleven member states are Austria, Belgium, Germany, Spain, France, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Finland. By January 2001 Greece had fulfilled the convergence criteria and join the euro area.

[2] The Maastricht convergence criterion are:

1. Inflation rate no more than 1.5 percent greater than the average of the three countries with the lowest inflation rates.
2. The long-term interest rates not in excess of 2 percent above the average of the three countries with the lowest inflation rates.
3. No deviation of the currency from EUR by more then 15 percent in the two years preceding the entrance into the monetary union
4. The fiscal deficit of no more than 3 percent of GDP.
5. The ratio of general government debt to GDP of not more than 60 percent.

level prevailing in the three best performing EU member states. The historical data for the long-term government bond yields present that there existed a high discrepancy in EU member state bond yields in late 1980s and early 1990s. However, this gap started to fall by the second half of the 1990. The participation criteria in EMU may describe these converging patterns in cross-country yield differences of the EMU countries.

In this paper I will study the long-run relationship of the 10-year government bond yields for the three EMU countries: France, Germany and Italy. In order to differentiate the euro effect from other effects, I will hold two control groups which did not adopt the euro. The first control group consist of the EU member states -Denmark, Sweden and UK- and the second are non-EU countries -Japan and USA. I find empirical evidence supporting that the introduction of the euro caused convergence in the bond yields of the countries that adopted the euro. On the other hand, there is no significant long-run relationship for the two control group countries.

This paper has the following structure. Next section describes the data and features of the long-term government bond yields. Empirical Analysis section describes the models applied and provides the regression results. Last section concludes.

2 Data:

In this paper I study long-term government bond yields for the six European Union countries, Japan and the US. The data is monthly and all government bonds have ten year maturity. I obtained the data from "eurostat": the official webpage for European Union statistical information. The data range is from January 1987 to October 2005 for all the bond yields.

Amongst these six EU countries, three of them are in the European Economic and Monetary Union (EMU), and these countries are France Germany and Italy. The other three EU member states did not launch the euro, they will be referred as the non-EMU countries. I will study the long-run relationship of the bond yields for three

groups. The first group is the treatment group, these are EMU countries. The second group is one of the control groups, these are EU member states outside the EMU. The third is the other treatment group, this consists of non-EU and non-EMU countries; and they are Japan and the US.

Figures 1, 2 and 3 plot the bond yields for these three groups respectively. In Figure 1, one can see the plot of the historical bond yield data for France, Germany and Italy. These are the three EMU countries. Looking at the figure, one can see that Italy has the highest bond yield and Germany has the lowest. The spread between these two bond yields was around four percent in the earlier days of the data. As the time passed all the countries encountered lower yields, and interestingly the spread between three government bonds vanished by the end of 1998. Figure 1 depicts two important observations for this study. First is the downward time trend in the bond yields signalling possibility for nonstationary data. Second is the convergence of the long-term government bond yields for the EMU economies.

Figure 2 plots the bond yields for Denmark, UK and Sweden, and Figure 3 shows for Japan and the US. The downward trend in bond yields are also observed in these two figures. The spread between the bond yields are smaller for the European countries, around 2 percent at the highest, whereas the spread between Japan and US is much larger -around 4 percent on average.

Figures 4 and 5 plot the average spread and the average absolute spreads of long-term government bond yields. Figures indicate that the yield spread for the EMU countries was larger in late 1980s, however it fell gradually over time. In particular by 1998, the average spread approached to zero, and stayed at that level there on. For UK, Denmark and Sweden, average spread was the lowest, around one percent, compared to the other two groups in late 1980s. This spread further reduced almost down to zero percent during January 1999 to the end of 2002. However, it started increasing by 2003 and reached to 50 basis points by the end of 2005. Last, yield spread between Japan and USA is generally high. Excluding the period from January 1990 to January 1994, yield spread remained on average around 3 percent.

3 Empirical Analysis

In this section I will analyze the long-run relationship between the long-term government bonds for the three groups. In the data section, I determined that there is a downward trend in the 10-year government bond yields. This is an indicator for nonstationary data. Therefore, I test each bond yield separately for unit root behavior. I apply the conventional Augmented Dickey-Fuller (ADF) test with an intercept. Tables 1, 2 and 3 provide the ADF test results for the whole sample, for the data set ranging from January 1987 to December 1998, and for the data set from January 1999 to December 2005 respectively. Looking at these tables, one can see that all bond yields have one unit root in all sample ranges.

Next, I study the data for the the possibility of a long-run equilibrium of the bond yields in each group. Before applying the cointegration test, I estimate the Vector Autoregression Models (VARs) for each group for the whole sample. I construct three-variable VARs for the groups consisting of EU member states, and a two-variable VAR for non-EU countries. I determine lag-length in each model by considering the Schwarz and Akaike Information Criteria. Table 4 present the VAR lag-lengths for the three groups for different sample sizes. The optimal lag-lengths are two for all three groups in the data set covering the whole range. After determining the lag-length, next I apply Johansen cointegration test, which can be considered as a multivariate generalization of the Dickey-Fuller test. Now consider the n-variable VAR(2) case:

$$x_t = A_1 x_{t-1} + A_2 x_{t-2} + \epsilon_t \tag{1}$$

$$\begin{aligned} \textit{where} \qquad x_t &= (n \times 1)\textit{government bond yield vector} \\ \epsilon_t &= (n \times 1)\textit{error term vector} \\ A_i &= (n \times n)\ \textit{matrix of parameters, for } i = 1, 2. \end{aligned}$$

so that

$$\begin{aligned}\Delta x_t &= A_1 x_{t-1} - x_{t-1} + A_2 x_{t-2} + \epsilon_t \\ &= (A_1 - I)x_{t-1} + A_2 x_{t-2} + \epsilon_t \\ &= \Pi_1 x_{t-1} + A_2 x_{t-2} + \epsilon_t \end{aligned} \tag{2}$$

Now, add and subtract $(A_1 - I)x_{t-2}$ to obtain

$$\begin{aligned}\Delta x_t &= (A_1 - I)\Delta x_{t-1} + (A_2 + A_1 - I)x_{t-2} + \epsilon_t \\ &= \Pi_1 \Delta x_{t-1} + \Pi x_{t-2} + \epsilon_t \end{aligned} \tag{3}$$

Equation (3) provides the Johansen test for a VAR(2) model. Because all the three groups have lag length 2, I illustrated the Johansen test for a VAR(2) model. The more generalized version of this test for VAR(p) can be obtained as:

$$\Delta x_t = \sum_{i=1}^{p-1} \Pi_i \Delta x_{t-i} + \Pi x_{t-p} + \epsilon_t \tag{4}$$

$$\begin{aligned} where \qquad \Pi &= -\left(I - \sum_{i=1}^{p} A_i\right) \\ \Pi_i &= -\left(I - \sum_{j=1}^{i} A_j\right) \end{aligned}$$

The key feature in this representation is that the rank of Π matrix is equal the number of independent cointegrating vectors. If $rank(\Pi) = 0$, matrix is null and the process is nonstationary. Table 5 provides the Johansen cointegration test results for the three groups covering the entire data set with an intercept term in the cointegrating vectors. The table suggests that there is no long-run relationship amongst the variables of each group when we consider the whole sample.

Next I divide the data range into two samples. The first sample is from January 1987 to December 1998, and this is the pre-euro sample. The second sample is from January 1999 to October 2005, and this is the post-euro sample. Similarly, I run the ADF unit root test for each government bond yield for the two subsamples. Tables 2 and 3 provide the unit root test results for the pre-euro and post-euro samples respectively. Studying these tables, one can see that all the government bonds are non-stationary in the considered subsections as well. After determining the non-stationary relationship, I will determine the lag lengths of each VAR equation for the corresponding subsamples. Table 4 presents that the the optimal lag-length is equal to one for the "EMU" group and the "non-EMU but EU" group for both subsamples. The VAR equation for the "non-EMU and non-EU" group has lag length 2 for both subsamples.

After determining the appropriate lag-lengths, I apply the Johansen cointegration test, again with an intercept in the cointegrating vectors. Tables 6 and 7 provide the test results for the pre-euro and post-euro samples respectively. Looking at these statistics, one can see that there is only one long-run relationship amongst all the possibilities, and that is observed only for the EMU members after the introduction of the euro. This is the key feature of this article: the introduction of the euro caused a long-run equilibrium for the countries that launched the euro in January 1999. Since we do not observe any other cointegration relationship elsewhere, this indicates that the euro is significant in a long-run comovement of EMU government bond yields.

4 Conclusion:

In this study, I looked at the long-term government bond-yield relationship for three groups. The first group consists of the EMU members of the EU member states. The empirical analysis shows that there is a convergence in the 10-year government bond yields of the countries included in this group. The other two groups are the control groups, these are non-EMU member states of the EU and non-EU countries.

These countries did not exhibit any long-run relationship.

I employed the Johansen cointegration test in determining the long-run equilibrium amongst the bond yields. I applied the testing procedure first for the whole sample. This did not generate any equilibrium in the long-run. Next, I split the data into two groups: first covers the sample before the introduction of the euro and second after the launch of the euro. The empirical results shows that only the EMU members of the European Union achieved long-run equilibrium after the introduction of the euro.

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