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Domestic vs. International Correlations of Interest Rate Maturities

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Abstract

The association between long and short interest rates is traditionally envisaged from a purely domestic perspective, where it is believed an empirical regularity. Hence, the weakening of this relationship in the first half of the 2000s has represented a conundrum, calling for a reassessment of the term structure and the conduct of monetary policy. Some commentators have called for investigations into the international dimension of this puzzle. Hence, in this paper we employ recent advances in panel data econometrics to investigate the co-movement of interest rate maturities both at the domestic and international levels for a sample of industrial countries. Specifically, we use the Ng (2006) spacings correlations approach to examine interest rates correlations between and within countries. Compared to alternatives, this method does not just estimate bivariate correlations, but also assesses the degree of panel correlation without being restricted by the assumption of either zero or complete panel correlation. We find very small correlations between the different maturities of domestic rates and much higher correlations of international rates. Moreover, international correlations between long rates are significantly higher than those between short rates. These findings suggest a scenario for national monetary policy, where financial globalization may have changed the transmission mechanism, advocating searches for the “missing” yield curve in its international dimension.

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1. Introduction

The empirical literature has traditionally investigated the term structure of interest rates from a purely domestic perspective and the co-movement between long rates and short rates is considered a "broad empirical regularity", as noticed by Rudebusch *et al.* (2006). However, more recently, and in particular from the end of 1990s and through the 2000s, changes in domestic short term interest rates seem to have become less potent at influencing the long end of the yield curve. This *conundrum*, as notably first defined by Greenspan (2005), has sparked an intensive debate in research and policy circles (see Rudebusch *et al.* 2006, and Atkenson and Kehoe, 2009) both on the relationship between short and long rates and on the implications for the conduct of monetary policy. According to Bernanke (2007) this phenomenon requires further investigation from an international perspective. Indeed, increasing international financial integration (see Lane and Milesi-Ferretti 2007, 2008) seems to have redefined the operating environment of domestic monetary policy, as also discussed by Rogoff (2007), Borio and Filardo (2007) and Spiegel (2008).

Hence, in this paper we employ recent advances in panel data econometrics to investigate the relationship between short and long term interest rates not only from the domestic, but also from the international perspective for four industrialized countries. In particular, we exploit the concordance between the null hypothesis of no correlation and uniformity of the probability integral transformations of the ordered correlations, following the spacings approach of Ng (2006). This approach was originally developed to overcome some of the limitations of traditional methods in testing the extent of cross-sectional correlation in panel data sets and represents a natural means for examining international and domestic interest rates correlations. Compared to other alternatives, this methodology not only does estimate bivariate correlations, but exploits the panel dimension of the data to provide an assessment of the overall panel cross-sectional correlation. Further, this approach does not assume that there is either no correlation or complete correlation in the panel, utilizing a break point test to identify which correlations are relatively large and which are small.

Our approach allows us to identify fresh empirical evidence on the domestic and international correlations between interest rates of different maturities, corroborating the view that further investigation is needed on the international dimension of the domestic conundrum.

The paper is set out as follows: section 2 presents our methodology. Section 3 presents the results. Section 4 concludes.

2. Empirical Strategy

We are interested in the domestic and international correlation structure of interest rates at different maturities. Specifically, we have investigated interest rate series of three maturities (3 months, 1 year and 10 years) and for four countries (United States, Germany, Canada and the United Kingdom). Three month T-Bills ($i_{j,t}^{3M}$) are from IMF *International Financial Statistics*, and one year ($i_{j,t}^{1Y}$) and 10 year yields on zero-coupon bonds ($i_{j,t}^{10Y}$) are provided by national central banks. Hence, there are twelve time series (N=12) and 66 potential correlations ($n = N\cdot(N-1)/2$). Data is monthly from 1999M1 to 2006M7.

In order to investigate the correlation between domestic and international interest rates, we employ a methodology that allows us to capture the overall correlation structure of the data. First, we perform the panel test for cross-sectional correlation proposed by Ng

(2006) and then we implement simple tests to investigate statistical differences between coefficients.

2.1 Ng (2006) Spacings

Most tests for cross-sectional correlation in panels of dimension $N \times T$ are based on the null of no correlation and an alternative of greater than zero correlation for some units. Unfortunately, such tests provide little guidance about the nature and pervasiveness of cross-sectional correlation in panels, making it unclear whether rejection or acceptance of the null is due to a large or small number of uncorrelated units. To investigate this issue, Ng (2006) introduces a panel test for cross-sectional correlation when some, but not necessarily all, units are correlated. The suggested *uniform spacing* methodology facilitates the estimation of the number of correlated pairs; the evaluation of the magnitude of the correlations; and the identification of the underlying series, which produce small or large correlations.

The panel cross-section correlation test of Ng (2006) is based on a probability integral transformation of ordered correlations. Transformed correlations are first ordered by size and then partitioned by means of a breakpoint analysis into two subsamples of small (*S*) and large (*L*) correlations, where the proportion of low correlations is represented by the parameter $\hat{\theta} \in [0,1]$. The variance ratio of the two subsamples is then evaluated. The spacings variance ratio (*svr*) test proposed by Ng is asymptotically standard normal in large samples and can be applied to the full set of correlations as well as subsets. As an example, if the hypothesis of no correlation is rejected for the *L* sample, but not the *S* sample, the fraction $\hat{\theta}$ of correlation coefficients is not statistically different from 0. A q-q plot of the probability integral of the transformed ordered correlations, $\bar{\phi}_j$, can also be used to uncover the extent of cross-sectional correlation in the data. Homogeneity in correlations implies that the q-q plot is flat over a subset. The test proposed by Ng allows us to test the overall significance of correlations in the sample. However, we are also interested to investigate the statistical difference between correlation coefficients.

2.2 Fisher's *z* Transformation

Given that correlation coefficients are constrained in the [-1, 1] space, in order to test hypotheses about specific values, we transform the Pearson's correlation coefficients, r_{ij}, into Fisher's *z* correlations, $r_{ij}(z)$:

$$r_{ij}(z) = \frac{1}{2}\ln\frac{(1+r_{ij})}{(1-r_{ij})}, \tag{1}$$

where $r_{ij}(z) \approx N\left(0, \frac{1}{T-3}\right)$, where T is the sample size, if the null hypothesis of zero correlation is true. Tests of equality of correlation coefficients for independent samples, N_1 and N_2, follow the test statistic:

$$z = \frac{r_{ij,1}(z) - r_{ij,2}(z)}{\sqrt{\frac{1}{(N_1-3)} + \frac{1}{(N_2-3)}}}, \tag{2}$$

which is distributed as N(0,1) under the null.

Table 1. Spacings Variance Ratio Test Statistics

	$\hat{\theta}$	*Number of small correlation pairings*	*Small svr*	*Large svr*
1999-2006	0.333	22 out of 66	-0.633	5.067*

Notes: $\hat{\theta}$ is the proportion of correlations that are small. *svr* is the Ng (2006) Spacings Variance Ratio test and gives an indication of whether correlation is significantly different from zero, distributed as standard normal, therefore the critical value is 1.65 (significant at 5% marked with asterisk). First order serial correlation is removed following Ng (2006). Since $N = 12$, there are $n = N \cdot (N-1)/2 = 66$ correlations.

3. Results

As mentioned above, the *svr* test partitions the series of correlations into subsets of small (S) and large (L) correlations, where the proportion of low correlations in the first set is given by $\hat{\theta}$. For our panel of interest rates we find $\hat{\theta}$=0.333, i.e. 22 out of 66 correlations are small. The q-q plot of $\bar{\phi}_j$ in Figure 1 deviates substantially from the 45% line, indicating highly heterogeneous correlations. The *svr* test statistics for the S and L samples are -0.633 and 5.067, respectively, indicating no evidence of correlated pairs in the S sample, but substantial correlations in the L sample. Table 2 presents a lower diagonal matrix of correlations.

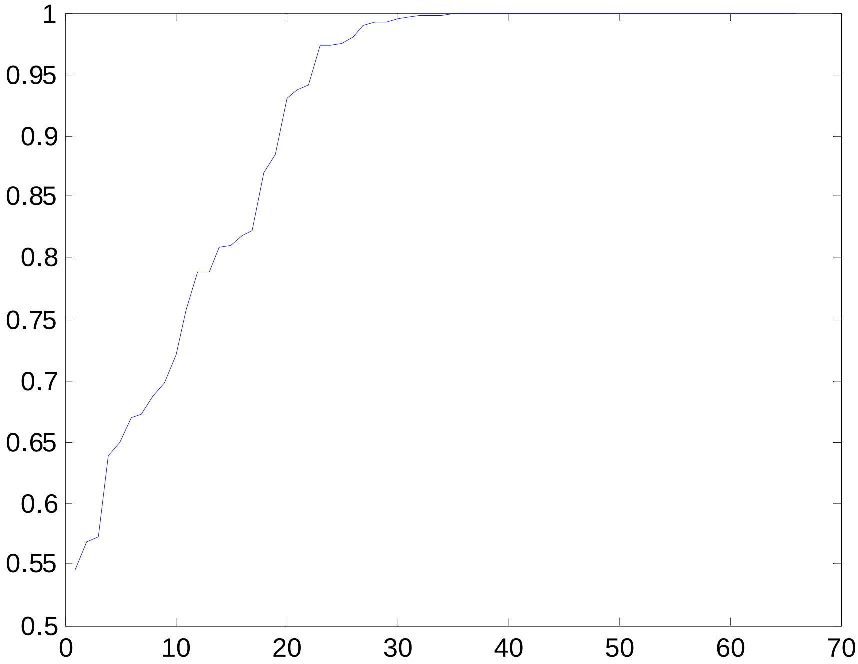

Figure 1. $\bar{\phi}_j$ **: 3M, 1Y and 10Y Interest Rates in 4 Countries**

Domestic correlations of short and long rates

We first turn our attention to the correlation between rates at different maturities within the same country, i.e. the domestic term structure. Interestingly, all within country correlations between 10 year bonds and three month rates are in the *Small* sample, denoted by superscript *S*, and, according to the *svr* test statistic and p-values, they are not significantly different from zero. For the US such low correlation of 10 year and three month rates (-0.097) is consistent with the Greenspan *conundrum* that long rates have recently failed to respond to policy-driven changes in the short term interest rate. Our findings suggest, however, that the *conundrum* is not just US-specific, but an international phenomenon, since in Germany, the UK and Canada the correlations between short and long interest rates are also low (-0.041, -0.062 and -0.085) and insignificantly different from zero. Furthermore, we find weak statistical correlation between three month rates and one year bond yields for the UK and Germany, but less so for Canada and the US, indicating that the Greenspan *conundrum* may apply more readily to the European countries even at short-end maturities. For the US and Canada the term structure seems to survive only between the 3 moths and 1 year rates.

Table 2. Correlations in Interest Rates for Four Industrial Countries

	$i^{3M}_{UK,t}$	$i^{3M}_{US,t}$	$i^{3M}_{CN,t}$	$i^{3M}_{GE,t}$	$i^{1Y}_{UK,t}$	$i^{1Y}_{US,t}$	$i^{1Y}_{CN,t}$	$i^{1Y}_{GE,t}$	$i^{10Y}_{UK,t}$	$i^{10Y}_{US,t}$	$i^{10Y}_{CN,t}$	$i^{10Y}_{GE,t}$
$i^{3M}_{UK,t}$	1.000											
$i^{3M}_{US,t}$	**0.448**^{L,*}	1.000										
$i^{3M}_{CN,t}$	**0.345**^{L,*}	**0.676**^{L,*}	1.000									
$i^{3M}_{GE,t}$	**0.317**^{L,*}	**0.371**^{L,*}	**0.432**^{L,*}	1.000								
$i^{1Y}_{UK,t}$	0.098^{S}	0.093^{S}	0.018^{S}	0.206^{L}	1.000							
$i^{1Y}_{US,t}$	**0.293**^{L,*}	**0.359**^{L,*}	0.206^{L}	0.092^{S}	**0.575**^{L,*}	1.000						
$i^{1Y}_{CN,t}$	**0.257**^{L,*}	**0.260**^{L,*}	**0.278**^{L,*}	0.119^{S}	**0.524**^{L,*}	**0.746**^{L,*}	1.000					
$i^{1Y}_{GE,t}$	**0.244**^{L,*}	0.162^{S}	0.127^{S}	0.208^{L}	**0.550**^{L,*}	**0.663**^{L,*}	**0.672**^{L,*}	1.000				
$i^{10Y}_{UK,t}$	-0.062^{S}	-0.052^{S}	-0.047^{S}	-0.019^{S}	**0.643**^{L,*}	**0.314**^{L,*}	**0.307**^{L,*}	**0.435**^{L,*}	1.000			
$i^{10Y}_{US,t}$	-0.047^{S}	-0.097^{S}	-0.085^{S}	-0.166^{S}	**0.519**^{L,*}	**0.549**^{L,*}	**0.421**^{L,*}	**0.565**^{L,*}	**0.659**^{L,*}	1.000		
$i^{10Y}_{CN,t}$	-0.012^{S}	-0.157^{S}	-0.085^{S}	**-0.218**^{L,*}	**0.503**^{L,*}	**0.431**^{L,*}	**0.532**^{L,*}	**0.505**^{L,*}	**0.689**^{L,*}	**0.818**^{L,*}	1.000	
$i^{10Y}_{GE,t}$	-0.055^{S}	-0.074^{S}	-0.037^{S}	-0.041^{S}	**0.510**^{L,*}	**0.348**^{L,*}	**0.380**^{L,*}	**0.592**^{L,*}	**0.807**^{L,*}	**0.735**^{L,*}	**0.743**^{L,*}	1.000

Notes: This table presents bivariate Pearson's correlation statistics for three month ($i^{3M}_{j,t}$), one year ($i^{1Y}_{j,t}$) and 10 year rates ($i^{10Y}_{j,t}$) for the UK, the US, Germany and Canada based on monthly data between 1999*M*1 and 2006*M*7. Correlation in the small group according Ng (2006) are denoted by superscript *S*. Large by superscript *L*. Correlations that are significantly different from zero are marked with an asterisk (*).

Table 3. Test of Equality of Correlation Coefficients

Country Pairings	$i^{3M}_{j,t}$	$i^{10Y}_{j,t}$	**Z**
Corr($i_{UK,t}, i_{US,t}$)	0.448	0.659	-2.051
Corr($i_{UK,t}, i_{CN,t}$)	0.345	0.689	-3.219
Corr($i_{UK,t}, i_{GE,t}$)	0.317	0.807	-5.251
Corr($i_{US,t}, i_{CN,t}$)	0.676	0.818	-2.179
Corr($i_{US,t}, i_{GE,t}$)	0.371	0.735	-3.649
Corr($i_{CN,t}, i_{GE,t}$)	0.432	0.743	-3.279
Joint test of: $\frac{1}{n}\sum r_{ij,short} - \frac{1}{m}\sum r_{ij,long} = 0$			-3.253

Notes: This table presents Pearson's correlation statistics for three month ($i^{3M}_{j,t}$) and 10 year rates ($i^{10Y}_{j,t}$) for the UK, the US, Germany and Canada. **Z** is the test statistic according to equation (2) which is based on the Fisher's *z* transformation. The two tailed 95% critical values are $\pm$ 1.96.

International correlations of short and long rates

A more refined picture emerges once we split cross-country correlations by maturity (3 month versus 10 year rate). International correlations between short interest rates are considerably larger than the domestic term structure correlations and range between corr($i^{3M}_{UK,t}, i^{3M}_{GE,t}$) = 0.317 and corr($i^{3M}_{US,t}, i^{3M}_{CN,t}$) = 0.676. This results is interesting, since the short rate can be considered mainly a policy variable, and these correlations seem to indicate that although monetary policies should be independent, they do exhibit some degree of international correlation.

Correlations are even more sizeable for long interest rates, ranging from corr($i^{10Y}_{UK,t}, i^{10Y}_{US,t}$) = 0.659 to corr($i^{10Y}_{UK,t}, i^{10Y}_{CN,t}$) = 0.818 (see Table 3). Further, individual and group tests of coefficients' equality are clearly rejected, indicating that long rates are indeed significantly more correlated than short rates.[1]

These results show that increasing financial integration is impacting long interest rates more than short interest rates. The finding of lower cross sectional correlation in short rates relative to long rates may depend on the fact that short rates should be more susceptible to idiosyncratic shocks and domestic policy actions. While on one side this could be the outcome of the attempt to pursue independent monetary policies on the part of domestic authorities, on the other it may suggest that due to international financial integration the long end of the maturity spectrum has become more tied to its international dimension, as suggested by Bernanke (2007), and less responsive to its domestic dimension.

[1] There is also evidence of a statistically significant difference in average correlation between three month and one year interest rates at 10% but less evidence of a statistical difference between one year and 10 year bond yields. These results are available upon request.

4. Conclusions

The relationship between short and long interest rates is typically envisaged from a purely domestic standpoint. Prompted by the recent increase in financial globalization, and its potential consequences for national economies, in this paper we have added an international dimension to the conventional analysis. In particular, we have investigated both the domestic and international relationships between interest rates at different maturities. Some important stylized facts have emerged. Within countries, long interest rates are not correlated with short interest rates. We take this as evidence that the term structure has “gone missing” in the period analyzed, not just in the US, where the problem was first highlighted by former Fed Chairman Greenspan, but also in the other three countries in our sample: Canada, Germany and the UK. Furthermore, there seems to be evidence of international cross-country correlations between short term rate, indicating some degree of monetary policy interdependence. However, and notably, these correlations are significantly smaller than the international correlations between long rates. We take this as evidence of financial globalization at the long end of the yield curve. Finally, this seems to suggest that searches for the “missing” yield curve could benefit from a deeper investigation into the international dimension of the term structure.

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