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Price Formation on the EuroMTS Platform

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Abstract

This paper examines the process of price discovery in the MTS system, which builds on the parallel quoting of euro-denominated government securities on a number of (relatively large) domestic markets and on a (relatively small) European marketplace (EuroMTS). Using twenty-seven months of daily data for 107 pairs of bonds, we present unambiguous evidence that trades on EuroMTS have a sizeable informational content.

Keywords: MTS system, price discovery.

JEL Classification: C32, G10.

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1 Introduction

The recent availability of high-quality transaction data has led to a number of empirical studies aimed at shedding light on how European government bond markets work (see Menkveld et al., 2004; Cheung et al., 2005; Dunne et al., 2007; Beber et al., 2008, among others).

The present paper contributes to this growing body of research by investigating the process of price discovery (i.e. the timely incorporation of information arrivals into market prices through trading), in the most relevant electronic platform for euro-denominated government bonds, i.e. the duplicated market setting of the MTS (Mercato Telematico dei Titoli di Stato) system, which builds on a number of domestic markets and a centralized European marketplace (EuroMTS).

The extent to which the institutional architecture of the MTS system can create an efficient environment to trade Treasury securities is being debated in academic and policy circles. A number of observers subscribe to “the redundancy hypothesis” of Cheung et al. (2005) for a centralized European marketplace as bonds being traded on EuroMTS are a fraction of the portfolio of securities traded on the domestic MTS platforms. Given this criticism, this paper aims at quantifying the degree of price discovery on the EuroMTS market by using an original and extensive dataset of daily transaction prices for 107 euro-denominated government bonds over a 27-month horizon.

2 A duplicated market setting: *E pluribus unum?*

The main electronic dealer-to-dealer platforms to trade euro-denominated Treasury securieties are MTS, Icap/BrokerTec Eurex Bonds and eSpeed, with the MTS system accounting for 40% of government bond transactions (Galati and Tsatsaronis, 2003) and 72% volume of electronic trading (Persaud, 2006).

All government marketable bonds issued by euro area Member States are listed on their respective domestic MTS platforms. Only benchmark securities, or on-the-run bonds with an outstanding value of at least 5 billion euro and satisfying a number of listing requirements are admitted, instead, to trading on EuroMTS. For benchmark securities, thus, dealers are allowed to post their quotes on both market simultaneously (parallel quoting).

As a background to the discussion, Figure 1 shows (the logarithm of) daily transaction prices of a benchmark bond, over the period January 2004 - March 2006.

[Figure 1]

As can be seen, the series overlap very closely. This is not surprising since the prices of the same bond recorded in multiple markets are not independent of one another. The process of price formation, however, may occur entirely in one market or, more typically, may be split among marketplaces.

As benchmark bond trading takes place for the most part in the domestic MTS markets (Cheung et al., 2005), the informational content of prices recorded on the EuroMTS is doubtful. In the MTS system, indeed, EuroMTS seems to be a prototype of a "satellite market" (in the sense of Hasbrouck, 1995), competing with a number of large domestic markets.

3 Econometric framework

Consider a bond traded on EuroMTS (E) and on its domestic MTS market (D). Its (log-) price in market $j = E, D$ at time t, p_t^j, can be represented as the sum of a common permanent component (capturing information arrivals cumulating over time), ϕ_t, and an idiosyncratic transitory part (capturing market-specific characteristics), υ_t^j:

$$p_t^j = \phi_t + \upsilon_t^j \qquad (1)$$

The law of motion of the permanent part is $\phi_t = \phi_{t-1} + \mu_t^\phi = \phi_0 + \sum_{i=1}^{t} \mu_i^\phi$, with initial conditions ϕ_0 and μ_t^ϕ such that $E(\mu_t^\phi) = 0$, $E(\mu_t^\phi)^2 = \sigma_\phi^2$, $E(\mu_t^\phi \mu_s^\phi) = 0$ for $s \neq t$. The υ_t^j term is a covariance stationary process $\upsilon_t^j = \sum_{i=1}^{\infty} \delta_i^j \xi_{t-i}^j = \delta^j(L)\xi_t^j$, where ξ_t^j's are independently distributed with mean zero and constant variance. Under these assumptions, the two log-price series, albeit individually non-stationary, are linked to one another by a stationary equilibrium condition:

$$p_t^E - p_t^D = \delta^E(L)\xi_t^E - \delta^D(L)\xi_t^D = \varepsilon_t \tag{2}$$

The empirical implications of equation (2) can be suitably captured by specifying, for each pair (p_t^E , p_t^D), a Vector Error Correction model (Johansen, 1995), which constitutes the basis to construct price discovery statistics as suggested by Harris et al. (1995) and Hasbrouck (1995):

$$\begin{bmatrix} \Delta p_t^E \\ \Delta p_t^D \end{bmatrix} = \Pi \cdot \begin{bmatrix} p_{t-1}^E \\ p_{t-1}^D \end{bmatrix} + \sum_{j=1}^{k-1} A_j \cdot \begin{bmatrix} \Delta p_{t-j}^E \\ \Delta p_{t-j}^D \end{bmatrix} + \begin{bmatrix} u_t^E \\ u_t^D \end{bmatrix}, \; E\left(u_t \cdot u_t'\right) = \Sigma = \begin{bmatrix} \sigma_E^2 & \rho\sigma_E\sigma_D \\ \rho\sigma_E\sigma_D & \sigma_D^2 \end{bmatrix} \tag{3}$$

where Δ is the first difference operator, A's are matrices of autoregressive coefficients, u's are residuals, ρ is the correlation coefficient and σ's are standard deviations. If condition (2) holds, the long-run matrix Π can be factored as:

$$\Pi = \begin{bmatrix} \alpha^E \\ \alpha^D \end{bmatrix} \cdot \begin{bmatrix} 1 & -1 \end{bmatrix} \tag{4}$$

with feedback parameters such that $\alpha^E < 0$ and $\alpha^D > 0$.

Harris et al. (1995) attribute superior price discovery to the market that adjusts the least to price movements in the other market:

$$\gamma_E = \frac{\alpha^D}{\alpha^D - \alpha^E}, \; \gamma_D = \frac{\alpha^E}{\alpha^E - \alpha^D} \tag{5}$$

so that EuroMTS (domestic MTS) market's contribution to price discovery, γ_E (γ_D), depends on both α's. Hasbrouck's model defines markets' contribution to price discovery as their contribution in explaining the variance of the innovations to the common factor. With price innovations correlated across markets, Hasbrouck's approach can only provide upper and lower bounds. Using condition (5), they can be written for the EuroMTS market as:

$$S_E^{ub}=\frac{(\gamma_E\sigma_E+\rho\gamma_D\sigma_D)^2}{(\gamma_E\sigma_E+\rho\gamma_D\sigma_D)^2+\gamma_D^2\sigma_D^2(1-\rho^2)}\ ,\ S_E^{lb}=\frac{\gamma_E^2\sigma_E^2(1-\rho^2)}{\gamma_E^2\sigma_E^2(1-\rho^2)+(\rho\gamma_E\sigma_E+\gamma_D\sigma_D)^2}$$

respectively. However, Baillie et al. (2002) argue that the average of the bounds:

$$\zeta_E=\frac{1}{2}(S_E^{ub}+S_E^{lb}) \qquad (6)$$

provides a sensible estimate of markets' contribution in determining the efficient price. Both γ_E and ζ_E can range in the [0,1] interval, with $\gamma_E+\gamma_D=\zeta_E+\zeta_D=1$. High (low) values of the statistics indicate sizeable EuroMTS (domestic MTS) market's contribution to price discovery.[1]

4 Empirical results

4.1 Data and preliminary analyses

Daily data over the period 02/01/2004 to 31/03/2006 for the last transaction prices (reference prices) recorded before market close are extracted from the MTS Time series database. All euro-denominated government securities traded in January 2004 maturing after the end of our estimation horizon are included: a total of 107 bonds, whose codes are listed below.

[Table 1]

The estimation horizon ranges from 557 to 585 observations, with an average of 580 datapoints.[2] Standard ADF test results for each of 214 individual log-price series lead to reject the null hypothesis of a unit root at conventional levels of significance. On the other hand, differencing the series appears to

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1 See Ballie et al. (2002) for a detailed discussion of the two price discovery measures.

2 Following Upper and Werner (2002), in the case of missing observations (owing to lack of transactions) we use the last available transaction price ("fill-in" method).

induce stationarity.[3]

The trace test suggests choosing rank 1 for Π in 104 models.[4] The symmetry and proportionality assumption implied by condition (2) is tested through a standard χ^2-distributed LR test. In 94 models, the over-identifying restriction is not rejected by the data at (least at) the 5% level of significance. For the remaining 10 cases, the evidence is less conclusive, even though the existence of a $[1 \quad -1]'$ cointegration vector is strongly supported by the Horvath and Watson (1995) test. As for the feedback parameters, both α's are correctly signed, implying direct convergence towards the long-run relationship in all but six models.

4.2 The EuroMTS market's contribution to price discovery

Discarding the cases with wrongly signed α's, Figure 2 presents the scatter plot (γ_E versus ζ_E) of price discovery measures for the (107-3-6=98) remaining models.

[Figure 2]

Even though estimated values for γ_E and ζ_E reveal that the process of price discovery takes place mainly in the domestic markets for all but two models (those in quadrant I), their averages values (roughly 0.2) are significantly different from zero, according to asymptotic and a number of bootstrap (with 1000 replicates) 95% confidence intervals (Table 2, Panel A).[5] Moreover, when testing for the equivalence of the mean (γ_E minus ζ_E) the null cannot be rejected, suggesting that considering γ_E or ζ_E leads to the same conclusions, as also confirmed by their strong correlation (0.81).[6] Finally, with

[3] Complete results of this Section are available upon request.

[4] In three models, the rank of Π turns out to be two, which is not consistent with the conclusions from the unit root tests but confirms that condition (2) holds in these cases too.

[5] Although asymptotic intervals are not very sensitive to the assumption of normality, QQ-plots and normality tests indicate clear departures from this assumption for γ_E and ζ_E in the two samples.

[6] The "fill-in" method may influence the short-term information flow for the less frequent trading marketplace (EuroMTS, in the

wrongly signed α^D's replaced by zero (as in Blanco et al., 2005), the two price discovery measures in the larger sample of 107-3=104 models (Table 2, Panel B) are highly correlated, with their average values not statistically different and quite close in magnitude to their counteparts in Panel A.[7]

[Table 2]

5 Conclusions

This paper documents that the duplicated market setting of the MTS system is able to eliminate persistent price discrepancies for the same bond traded on the domestic MTS and the EuroMTS platforms, with about 20% of price discovery occurring in the European marketplace. Our results clearly suggest that trades on EuroMTS have a sizeable informational content, in contrast to the “redundancy hypothesis”.

It is widely recognized that markets’ contribution to price discovery may be influenced by market-specific characteristics as well as by institutional arrangements. Addressing this issue is of relevance for policy makers, as the degree of price discovery might be entirely due to liquidity conditions, institutional features or possibly both, with different implications for developing a more efficient regulatory framework. This topic is left for future research.

References

Baillie R.T., G.G. Booth, Y. Tse, T. Zabotina (2002), Price Discovery and Common Factor Models, Journal of Financial Markets, 5, 309-321.

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present case) even if the trades taking place on that market do contain information (Lehmann, 2002). Accordingly, our estimated values for γ_E and ζ_E can be considered as *lower* bounds.

[7] By comparing the mean value of γ_E (ζ_E) in Panel A to its counterpart in Panel B, the null of equivalence is not rejected according to asymptotic and bootstrap-based tests. Furthermore, replicating these computations for weighted quantities by traded volumes or by average number of trades over the 27-month horizon considered gives quantitatively similar results (not reported) to those in Table 2.

Beber A., M.W. Brandt, K.A. Kavajecz (2008), Flight-to-Quality or Flight-to-Liquidity? Evidence from the Euro-Area Bond Market, Review of Financial Studies, forthcoming.

Blanco R., S. Brennan, I. Marsh (2005), An Empirical Analysis of the Dynamic Relation between Investment-Grade Bonds and Credit Default Swaps, Journal of Finance, 60, 2255-2281.

Chakravarty S., H. Gulen, S. Mayhew (2004), Informed Trading in Stock and Option Markets, Journal of Finance, 59, 1235-1258.

Cheung C., F. de Jong, B. Rindi (2005), Trading European Sovereign Bonds: The Microstructure of the MTS Trading Platforms, ECB Working Paper, 432.

Dunne P.G., M.J. Moore, R. Portes (2007), Benchmark Status in Fixed-Income Asset Markets, Journal of Business Finance and Accounting, 34, 1615-1634.

Galati G., K. Tsatsaronis (2003), The Impact of the Euro on Europe's Financial Markets, *Financial Markets, Institutions and Instruments*, 12, 165-221.

Harris F., T. McInish, G. Shoesmith, R. Wood (1995), Cointegration, Error Correction, and Price Discovery on Informationally Linked Security Markets, Journal of Financial and Quantitative Analysis, 30, 563-579.

Hasbrouck J. (1995), One Security, Many Markets: Determining the Contributions to Price Discovery, Journal of Finance, 50, 1175-1199.

Horvath M.T.K., M.W. Watson (1995), Testing for Cointegration when Some of the Cointegrating Vectors Are Prespecified, Econometric Theory, 11, 984-1014.

Johansen S. (1995), Likelihood-Based Inference in Cointegrated Vector Autoregressive Models, Oxford University Press.

Lehmann B.N. (2002), Some Desiderata for the Measurement of Price Discovery across Markets, Journal of Financial Markets, 5, 259-276.

Menkveld A.J., Y.C. Cheung, F. de Jong (2004), Euro Area Sovereign Yield Dynamics: The Role of Order Imbalance, ECB Working Paper, 385.

Persaud A.D. (2006), Improving Efficiency in the European Government Bond Market, Discussion Paper ICAP plc.

Upper C., T. Werner (2002), How Resilient Are Financial Markets to Stress? Bund Futures and Bonds during the 1998 Turbulence, BIS Papers, 12, 110-123.

Table 1. Bond codes

Austria	Belgium	Finland	France	Germany	Greece	Ireland	Italy	Netherlands	Portugal	Spain
AT0000383518	BE0000286923	FI0001004822	FR0000187361	DE0001135176	GR0110014165	IE0006857530	IT0001448619	NL0000102101	PTOTECOE0011	ES0000012239
AT0000383864	BE0000291972	FI0001005167	FR0000187635	DE0001135192	GR0114012371	IE0031256211	IT0003080402	NL0000102317	PTOTEGOE0009	ES0000012387
AT0000384227	BE0000296054	FI0001005332	FR0000187874	DE0001135200	GR0114015408	IE0031256328	IT0003171946	NL0000102606	PTOTEJOE0006	ES0000012411
AT0000384821	BE0000297060	FI0001005407	FR0000188328	DE0001135218	GR0124006405	IE0032584868	IT0003190912	NL0000102671	PTOTEKOE0003	ES0000012445
AT0000384938	BE0000298076	FI0001005514	FR0000188690	DE0001135226	GR0124011454	.	IT0003242747	NL0000102689	PTOTEWOE0009	ES0000012452
AT0000384953	BE0000300096	FI0001005522	FR0000188989	DE0001135234	GR0124015497	.	IT0003256820	NL0000102697	PTOTEXOE0016	ES0000012783
AT0000385067	BE0000301102	.	FR0000189151	DE0001135242	GR0124018525	.	IT0003271019	.	.	ES0000012791
AT0000385356	BE0000302118	.	FR0010011130	DE0001141380	GR0124021552	.	IT0003357982	.	.	ES0000012825
AT0000385745	BE0000303124	.	FR0103230423	DE0001141398	GR0124024580	.	IT0003413892	.	.	ES0000012866
AT0000385992	.	.	FR0103840098	DE0001141406	GR0128002590	.	IT0003472336	.	.	ES0000012882
.	.	.	FR0104446556	DE0001141414	GR0133001140	.	IT0003477111	.	.	.
.	.	.	FR0105427795	DE0001141422	GR0133002155	.	IT0003493258	.	.	.
.	.	.	FR0105760112	DE0001141430	.	.	IT0003522254	.	.	.
.	.	.	FR0106589437	.	.	.	IT0003532097	.	.	.
.	.	.	.	.	.	.	IT0003535157	.	.	.
.	.	.	.	.	.	.	IT0003611156	.	.	.
.	.	.	.	.	.	.	IT0003618383	.	.	.

Table 2. Tests for the mean values of γ_E and ζ_E

	Panel A: 98 bonds		Panel B: 104 bonds	
	γ_E	ζ_E	γ_E	ζ_E
Mean	0.1966	0.2064	0.1853	0.2031
Correlation (95% confidence interval)	0.8116 (0.7309 , 0.8699)		0.7820 (0.6940 , 0.8471)	
	Test for the significance of the means (95% confidence intervals)			
Asymptotic interval	(0.1704 , 0.2228)	(0.1832 , 0.2296)	(0.1590 , 0.2115)	(0.1807 , 0.2256)
Bootstrap: normal approximation interval	(0.1665 , 0.2152)	(0.1870 , 0.2353)	(0.1525 , 0.1993)	(0.1882 , 0.2359)
Bootstrap: percentile interval	(0.1804 , 0.2253)	(0.1782 , 0.2252)	(0.1717 , 0.2182)	(0.1714 , 0.2178)
Bootstrap: adjusted percentile interval	(0.1706 , 0.2170)	(0.1875 , 0.2388)	(0.1610 , 0.1994)	(0.1883 , 0.2295)
Bootstrap: studentized interval	(0.1736 , 0.2252)	(0.1835 , 0.2316)	(0.1603 , 0.2131)	(0.1801 , 0.2271)
	Test for the equivalence of the means (95% confidence intervals)			
Asymptotic interval	(-0.0446 , 0.0250)		(-0.0522 , 0.0165)	
Bootstrap: normal approximation interval	(-0.0443 , 0.0266)		(-0.0522 , 0.0167)	
Bootstrap: percentile interval	(-0.0470 , 0.0241)		(-0.0537 , 0.0156)	
Bootstrap: adjusted percentile interval	(-0.0449 , 0.0259)		(-0.0547 , 0.0148)	
Bootstrap: studentized interval	(-0.0452 , 0.0275)		(-0.0526 , 0.0170)	

Figure 1. Daily transaction prices (in logs) on the MTS system (bond code: IT0003242747)

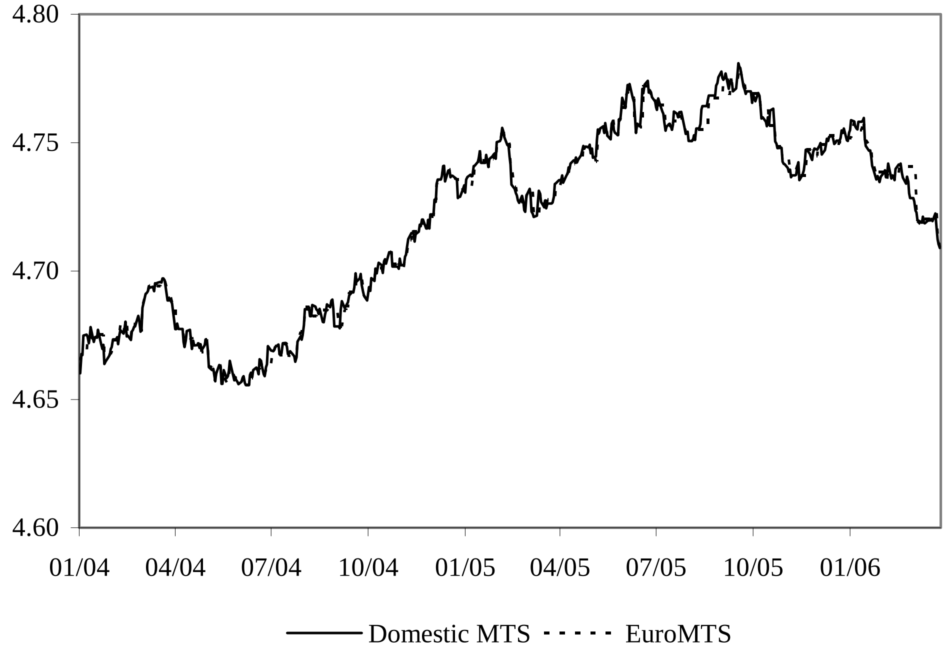

Figure 2. Scatter plot: γ_E *versus* ζ_E