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**Working Paper**

## Price formation on the EuroMTS platform

DIW Discussion Papers, No. 977

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*Suggested Citation:* Caporale, Guglielmo Maria; Girardi, Alessandro (2010) : Price formation on the EuroMTS platform, DIW Discussion Papers, No. 977, Deutsches Institut für Wirtschaftsforschung (DIW), Berlin

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# Discussion Papers

# 977

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Berlin, February 2010

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#### IMPRESSUM

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<http://www.diw.de>

ISSN print edition 1433-0210  
ISSN electronic edition 1619-4535

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# **Price Formation on the EuroMTS Platform**

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February 2010

## **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 securities 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),  $\phi_t$ , and an idiosyncratic transitory part (capturing market-specific characteristics),  $v_t^j$ :

$$p_t^j = \phi_t + v_t^j \quad (1)$$

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  $\phi_0$  and  $\mu_t^\phi$  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  $v_t^j$  term is a covariance

stationary process  $v_t^j = \sum_{i=1}^{\infty} \delta_i^j \xi_{t-i}^j = \delta^j(L) \xi_t^j$ , where  $\xi_t^j$ '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:

$$p_t^E - p_t^D = \delta^E(L) \xi_t^E - \delta^D(L) \xi_t^D = \varepsilon_t \quad (2)$$

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):

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

where  $\Delta$  is the first difference operator,  $A$ 's are matrices of autoregressive coefficients,  $u$ 's are residuals,  $\rho$  is the correlation coefficient and  $\sigma$ 's are standard deviations. If condition (2) holds, the long-run matrix  $\Pi$  can be factored as:

$$\Pi = \begin{bmatrix} \alpha^E \\ \alpha^D \end{bmatrix} \cdot [1 \quad -1] \quad (4)$$

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:

$$\gamma_E = \frac{\alpha^D}{\alpha^D - \alpha^E}, \quad \gamma_D = \frac{\alpha^E}{\alpha^E - \alpha^D} \quad (5)$$

so that EuroMTS (domestic MTS) market's contribution to price discovery,  $\gamma_E$  ( $\gamma_D$ ), depends on both  $\alpha$ '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:

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

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

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

provides a sensible estimate of markets' contribution in determining the efficient price. Both  $\gamma_E$  and  $\zeta_E$  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.<sup>1</sup>

## 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.<sup>2</sup> 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

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

<sup>2</sup> 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.<sup>3</sup>

The trace test suggests choosing rank 1 for  $\Pi$  in 104 models.<sup>4</sup> The symmetry and proportionality assumption implied by condition (2) is tested through a standard  $\chi^2$ -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  $[1 \ -1]'$  cointegration vector is strongly supported by the Horvath and Watson (1995) test. As for the feedback parameters, both  $\alpha$ '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  $\alpha$ 's, Figure 2 presents the scatter plot ( $\gamma_E$  versus  $\zeta_E$ ) of price discovery measures for the (107-3-6=98) remaining models.

[Figure 2]

Even though estimated values for  $\gamma_E$  and  $\zeta_E$  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).<sup>5</sup> Moreover, when testing for the equivalence of the mean ( $\gamma_E$  minus  $\zeta_E$ ) the null cannot be rejected, suggesting that considering  $\gamma_E$  or  $\zeta_E$  leads to the same conclusions, as also confirmed by their strong correlation (0.81).<sup>6</sup> Finally, with

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<sup>3</sup> Complete results of this Section are available upon request.

<sup>4</sup> In three models, the rank of  $\Pi$  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.

<sup>5</sup> Although asymptotic intervals are not very sensitive to the assumption of normality, QQ-plots and normality tests indicate clear departures from this assumption for  $\gamma_E$  and  $\zeta_E$  in the two samples.

<sup>6</sup> The "fill-in" method may influence the short-term information flow for the less frequent trading marketplace (EuroMTS, in the

wrongly signed  $\alpha^D$ '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 counterparts in Panel A.<sup>7</sup>

[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.

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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  $\gamma_E$  and  $\zeta_E$  can be considered as *lower* bounds.

<sup>7</sup> By comparing the mean value of  $\gamma_E$  ( $\zeta_E$ ) 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.

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Table 1. Bond codes

| Austria      | Belgium      | Finland      | France        | Germany      | Greece       | Ireland      | Italy        | Netherlands  | Portugal      | Spain        |
|--------------|--------------|--------------|---------------|--------------|--------------|--------------|--------------|--------------|---------------|--------------|
| AT0000383318 | BE0000286923 | FI0001004822 | FR00000187361 | DE0001135176 | GR0110014165 | IE0006857530 | IT0001448619 | NL0000102101 | PTOTECOE0011  | ES0000012239 |
| AT0000383864 | BE0000291972 | FI0001005167 | FR00000187635 | DE0001135192 | GR0114012371 | IE0031256211 | IT0003080402 | NL0000102317 | PTOTEGOE0009  | ES0000012387 |
| AT0000384227 | BE0000296054 | FI0001005332 | FR00000187874 | DE0001135200 | GR0114015408 | IE0031256328 | IT0003171946 | NL0000102606 | PTOTEJOE0006  | ES0000012411 |
| AT0000384821 | BE0000297060 | FI0001005407 | FR00000188328 | DE0001135218 | GR0124006405 | IE0032384868 | IT0003190912 | NL0000102671 | PTOTEKOE0003  | ES0000012445 |
| AT0000384938 | BE0000298076 | FI0001005514 | FR00000188690 | DE0001135226 | GR0124011454 | .            | IT0003242747 | NL0000102689 | PTOTENWOE0009 | ES0000012452 |
| AT0000384953 | BE0000300096 | FI0001005522 | FR00000188989 | DE0001135234 | GR0124015497 | .            | IT0003256820 | NL0000102697 | PTOTEKOE0016  | ES0000012783 |
| AT0000385067 | BE0000301102 | .            | FR00000189151 | DE0001135242 | GR0124018525 | .            | IT0003271019 | .            | .             | ES0000012791 |
| AT0000385356 | BE0000302118 | .            | FR00100111130 | DE0001141380 | GR0124021552 | .            | IT0003357982 | .            | .             | ES0000012825 |
| AT0000385745 | BE0000303124 | .            | FR0103230423  | DE0001141398 | GR0124024580 | .            | IT0003413892 | .            | .             | ES0000012866 |
| AT0000385992 | .            | .            | FR0103840098  | DE0001141406 | GR0128002590 | .            | IT0003472336 | .            | .             | ES0000012882 |
| .            | .            | .            | FR0104446556  | DE0001141414 | GR0133001140 | .            | IT0003477111 | .            | .             | .            |
| .            | .            | .            | FR0105427795  | DE0001141422 | GR0133002155 | .            | IT0003492358 | .            | .             | .            |
| .            | .            | .            | FR0105760112  | DE0001141430 | .            | .            | IT0003522254 | .            | .             | .            |
| .            | .            | .            | FR0106589437  | .            | .            | .            | IT0003532097 | .            | .             | .            |
| .            | .            | .            | .             | .            | .            | .            | IT0003535157 | .            | .             | .            |
| .            | .            | .            | .             | .            | .            | .            | IT0003611156 | .            | .             | .            |
| .            | .            | .            | .             | .            | .            | .            | IT0003618383 | .            | .             | .            |

Table 2. Tests for the mean values of  $\gamma_E$  and  $\zeta_E$

|  | Panel A: 98 bonds        |                   | Panel B: 104 bonds        |                   |
|--|--------------------------|-------------------|---------------------------|-------------------|
|  | $\gamma_E$               | $\zeta_E$         | $\gamma_E$                | $\zeta_E$         |
| 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) |                   |
| <i>Test for the significance of the means (95% confidence intervals)</i> |                          |                   |                           |                   |
| 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) |
| <i>Test for the equivalence of the means (95% confidence intervals)</i>  |                          |                   |                           |                   |
| 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)

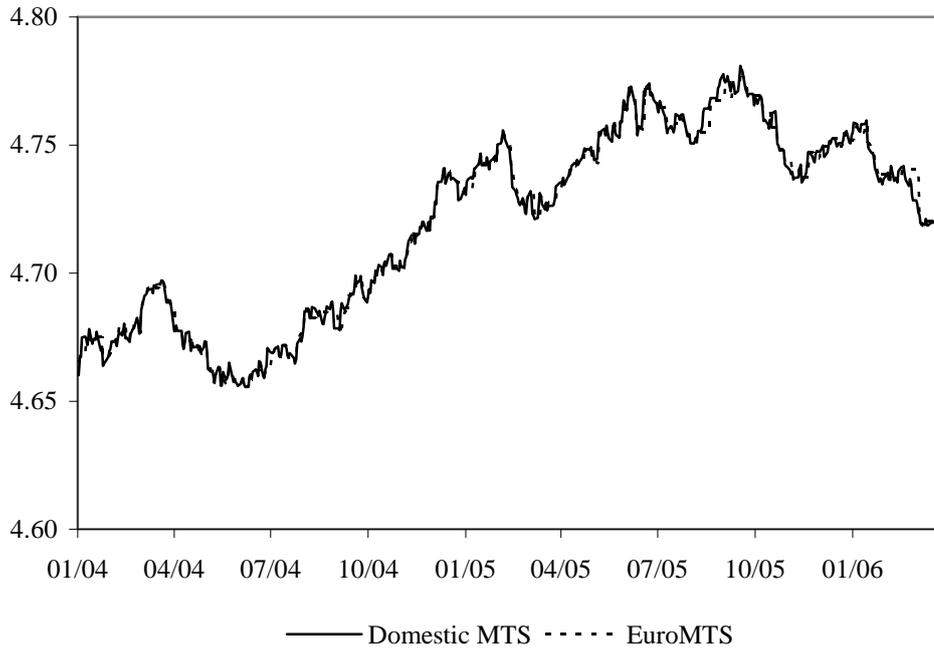


Figure 2. Scatter plot:  $\gamma_E$  versus  $\zeta_E$

