Does market transparency matter?
A case study

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Abstract

We analyse a change in the degree of transparency of MTS, the electronic inter-dealer market for Italian Treasury bonds, namely the July 1997 move to the anonymity of quotes. Our evidence supports the hypothesis that a decrease in transparency makes liquidity traders worse-off, whereas large/informed traders find it less costly to execute block trades. The evidence is also consistent with the "waiting game" hypothesis of Foster and Viswanathan (1996): under anonymity, traders tend to delay their trades in an attempt to acquire information through the order flow. From a public welfare perspective, our results indicate that the move to anonymity has been accompanied by an increase in market liquidity and by a reduction in volatility, a phenomenon that is also partly explained by the growth in Italy's prospects for early participation in the EMU. The speed of information aggregation on MTS increases, as shown by an improvement of the MTS lead over the futures market. In a European perspective, the current organisation and performance of MTS place the market in a competitive position with respect to other sovereign bond markets and may contribute to their integration under the single currency.

1. Introduction[1]

The electronic inter-dealer market for Italian Treasury bonds, known as MTS (from *Mercato Telematico dei Titoli di Stato*), is characterised in international comparison by a high degree of transparency (Inoue, 1998). In July 1997, ten years after its inception, MTS switched to a new operating regime in which the names of market makers who post bid and ask quotes for each security are not revealed.

This switch seems worth investigating because it prompts a number of interesting questions for financial economists and regulatory authorities. What was the reason for the switch? Who benefited from it? How did it affect market performance, in terms of liquidity, efficiency and price volatility? Is market microstructure theory consistent with the evidence? Has the switch altered the way Italian T-bonds are traded on MTS as compared to the over-the-counter market? Can we derive any regulatory policy lessons from the experience of MTS? What are the implications for the development of an integrated sovereign bond market in the European single-currency area?

Market microstructure theory shows that the existence of information asymmetries among participants is a key element in understanding how a financial market is organised and works. If the market is populated by two types of agents with different information endowments and objective functions, the better-informed and the liquidity-motivated, then a given market set-up may be optimal for one group but, generally, not for the other. Similarly, a change in the set-up may benefit one group at the expense of the other. The dynamic relationship between the two groups has implications for the consolidation or fragmentation of trading in different marketplaces and for asset price volatility. It can be argued that in a bond market, like ours, the absence of "inside" information on an asset's fundamental value reduces the scope for heterogeneity of beliefs with respect to a stock market. However, we observe that the concept of private information must also include knowledge that dealers may acquire on the order flow and on the trading intentions of large customers, an argument which applies to the bond and foreign exchange markets as well as to the stock market. This knowledge causes an update of beliefs and may be profitably exploited at the expense of other market participants, according to a notion that is also at the basis of the literature on block trading and dual-trading. From an empirical viewpoint, some studies support this hypothesis in the forex market and in the bond market (see Lyons, 1995 and Scalia, 1998a), although there is also evidence to the contrary (Proudman, 1995).

The models of information asymmetry point to one conclusion: liquidity traders in general prefer more transparency, informed traders prefer less transparency. This notion was pioneered by the Grossman (1988) model of sunshine trading. Sunshine trading, i.e., disclosing pre-trade information on the direction of price-contingent orders, removes the possibility that those orders are information-based and thus eases the inference problem of market makers. This should lower execution costs for sunshine traders and possibly increase overall trading volume. Forster and George (1992) explore the effects of various degrees of traders' anonymity on the distribution of wealth within the two groups of market participants. They conclude that if monitoring who is trading in a centralised system gives information on liquidity trades, then disclosing the identity of current participants lowers execution costs for liquidity traders, provided that there is sufficient competition among privately informed agents. This clearly reduces the expected profit of informed traders. The analysis of Pagano and Röell (1996) provides similar results: in a comparison of alternative trading systems, it is shown that greater transparency, such as that provided by a centralised order execution system with full disclosure, reduces the average trading cost of liquidity traders. Madhavan (1995) examines the issue of post-trade information disclosure and market fragmentation *vs* consolidation in a two-period dynamic model. The model provides an unambiguous prediction on the implication of different disclosure rules

[1] We are grateful for many helpful comments to Masaaki Shirakawa, the co-ordinator of the BIS research project under which this paper was written, Carlo Santini, Michele Bagella, Marco Mazzucchelli and seminar participants at the Bank of Canada in Vancouver, the Banca d'Italia and the VII Financial Conference at the University of Rome - Tor Vergata. The usual disclaimer applies. The views expressed herein are those of the authors and do not involve the responsibility of the Banca d'Italia.

for informed traders and the “large” (or strategic) liquidity traders: they should prefer non-transparency because it facilitates dynamic trading strategies, like “working” a large order over time. Without mandatory disclosure, dealers also prefer not to disclose trades voluntarily because they profit from the reduction in price competition. Naik, Neuberger and Viswanathan (1994) investigate the relationship between delayed trade disclosure rules and execution costs in a dynamic market setting with risk averse dealers. If there are two stages of trading, first a public investor who trades with market maker A, and then A who trades with other competing market makers, a delayed disclosure rule of the first-round trade by A grants him the possibility in the second round to exploit the information conveyed by the trade itself. In turn, A passes on part of the associated profit to the public investor. The authors stress the fact that their conclusion has a more general bearing: any time less-than-full disclosure of large and informative orders is in place, the dealers who intermediate the orders and their customers should be better-off.

Our summary of models that explore the effects of information asymmetry and market transparency is far from exhaustive. However, theory provides an unambiguous prediction in our context: under the assumption that significant informational asymmetries exist, the switch that took place on MTS in July 1997 should have shifted the balance between liquidity traders’ and informed/large traders’ profits in favour of the latter. For the purpose of the tests to be conducted in the following sections, we set forth two hypotheses.

- *Hypothesis I*: liquidity traders have been made worse-off by the move to anonymity (we shall call this hypothesis the “liquidity trader’s curse”).
- *Hypothesis II* (the “large trader’s blessing”): large/informed traders have been made better-off.

Our brief survey also suggests a third implication, related to the previous ones. By not disclosing the names of market makers, the 1997 switch has made the structure of MTS more similar to that of the over-the-counter inter-dealer broker market, where dealers negotiate trades without revealing their identity. We should consider the possibility that dealers in the opaque over-the-counter market (trading either through a broker or *vis-à-vis*) benefit from the price discovery function of the highly transparent MTS, thus free-riding on the information disseminated by the latter (see also Madrigal, 1996). Hence, before the 1997 shift there would have been two types of free-riding. The first would have been among MTS members, and it is captured by Hypothesis I. The second would have been by the OTC market at the expense of MTS. If the switch to anonymity has reduced the second type of free-riding, making MTS more similar to the OTC market, then the incentives for informed/large dealers to trade over-the-counter rather than on the regulated market have declined. We have the following hypothesis.

- *Hypothesis III* (“decline of OTC free-riding”): trading volume on the OTC market has fallen since the MTS shift.

The events that preceded the market move seem broadly consistent with Hypotheses I-III. At the end of 1996 the proposal of anonymity was put forward by a group of MTS specialists (which we may assimilate to the informed/large traders of theory), led by one with foreign affiliation. The main argument advanced by the proponents was that the shift would increase the welfare of the most skilled market players, thus enhancing competition and market efficiency. In fact, the proponents’ complaint about the regime of full transparency was that it allowed small dealers to mirror the moves of the big players. Understandably, some small traders had reservations. The Treasury and the Banca d’Italia raised no objections. In the end the management board (in which small dealers are lowly represented) approved the proposal, which became effective on 14 July 1997.

The MTS switch of 1997 is also interesting for another reason. Foster and Viswanathan (1996) have explored the possibility that informed traders’ signals are different, giving an incentive to informed traders to forecast the price forecasts of others. This may induce each informed trader to delay his transactions and wait for the other traders’ moves to reveal more information. The Foster-Viswanathan model has the following prediction for intraday trading activity on MTS.

- *Hypothesis IV* (the "waiting game"): after the switch to anonymity, the increasing dispersion in traders' opinions reduced market turnover in the early stages of trading and increased it in the later stages.

The previous discussion explains the first objective of this paper. By analysing various market indicators before and after the switch to anonymity of MTS, we wish to conduct a test of the four above mentioned hypotheses: the liquidity trader's curse, the large trader's blessing, the decline of free-riding and the waiting game hypothesis. Another contribution of our test is that we use an original and extensive data set as compared to that of the existing literature.

Should the hypothesised worsening of terms for liquidity traders be the unique, or even the main concern for market regulators? This question raises the more general problem of which market design maximises public welfare, which brings us to the subject of normative economics and regulatory policy. O'Hara (1995) tries to qualify the three goals of a market set forth by Domowitz (1990). They are (i) reliable price discovery, (ii) broad-based price dissemination, and (iii) effective hedging against price risk. Concerning the first goal, O'Hara argues that the ability to find a market-clearing price is enhanced by scale and possibly by the existence of multiple settings which suit the needs of different types of traders. The achievement of broad-based price dissemination is a more contentious issue, because the free-riding problem discussed earlier sets up a trade-off between transparency and price discovery. While market transparency, broadly speaking, certainly improves public welfare, it is not clear where in the ideal market transparency scale the benefits of greater information dissemination fall below the costs of a reduction in informed trading (see e.g. Franks and Schaefer, 1995). This issue is clearly at the heart of our investigation. The third goal, namely hedging of price risk, reflects the concern for the market's ability to provide insurance to liquidity traders. The empirical counterpart of this goal is the minimisation of execution costs for liquidity trades and the improvement in general of market liquidity, defined as the property whereby the price impact of an order is small.

O'Hara introduces a fourth goal of optimal market design:

> *" (...) another, perhaps greater, function of the market that is not recognised in the working definitions given above (...) is the role of market efficiency. How well and how quickly a market aggregates and impounds information into the price must surely be a fundamental goal of market design."*

However, she also notes that the search for market efficiency presents two main problems. First, raising the speed of information aggregation may in principle increase price volatility, which is not desirable. Second, since market efficiency is positively related to the extent of information-based trading, which in turn generates losses for liquidity traders, the goal of efficiency may conflict with that of minimising execution costs for the uninformed. To summarise, although the issue of the optimal design of a financial market remains in O'Hara's words an open question, it seems safe to claim that, provided "sufficient" scale and transparency, the contribution of a market to public welfare should be measured along three dimensions: liquidity, volatility, efficiency (where the second variable clearly exerts a negative effect).

We observe that in the case of the government bond market the pursuit of public welfare along these lines is consistent with the objective of minimising the cost of public debt servicing and with the operating objectives of the monetary and regulatory authorities (Santini, 1997): to carry out liquidity management operations that do not affect the smooth functioning of the market, to obtain information about market expectations, to improve monetary policy implementation in general, to conduct macro-prudential policy.[2]

The second objective of our empirical investigation is therefore of a regulatory nature. Because normative economics in this area does not show unambiguously what is the welfare-maximising degree of market transparency, we wish to develop a case study based on the previously noted event.

[2] A detailed survey of market structure and regulation in government securities markets is provided by Dattels (1995).

We observe a change of regime in the arrangement of our market. By estimating the three performance variables defined earlier, both before and after the shift, we try to empirically assess whether it afforded a higher or lower level of welfare. We shall also try to keep into account an important macroeconomic factor that may have influenced the performance of MTS during our sample period, namely the fiscal consolidation process which brought about a sharp improvement in Italy's prospects for early participation in the European Monetary Union. To this extent, we shall provide estimates of the relative weight of the macroeconomic effect on our market performance measures, as distinct from the microeconomic effect related to the shift to anonymity.

The paper proceeds as follows. Section 2 describes the main features of the market. Section 3 presents evidence and tests on Hypotheses I-IV. Sections 4 to 6 provide estimates and tests on market liquidity, volatility and efficiency, respectively. Section 7 discusses the empirical evidence against the background of theory, the regulatory implications and the prospects for the development of an integrated securities market in the single currency area. Section 8 summarises and concludes. An Appendix table provides a brief history of the Italian government bond market during the last decade.

2. The market

The securities listed on MTS include all recent Italian Treasury issues: the 3, 6 and 12-month bills known as BOTs, the 18 and 24-month bills known as CTZs, the floating-rate notes with initial life of 7 years known as CCTs, and the fixed-coupon BTPs with initial life of 3, 5, 10 and 30 years. The minimum order size is 5 billion lire, which is by far the modal trade size. Market members are of three types: specialists, primary dealers and ordinary members.[3] Specialists and primary dealers are committed to quoting firm two-way quotes on a wide range of securities, to being competitive in terms of tightness of spreads, and to maintaining a share on the primary and secondary market above a certain threshold, with stricter requirements applying to specialists.[4] Both categories may apply for bond and cash lending with the Banca d'Italia. Ordinary members may trade at the quoted prices. Specialists and primary dealers may also trade at somebody else's quotes.[5] In practice over 60% of transactions take place between two market makers (specialists and primary dealers). In what follows we shall refer to the players who initiate a trade as "traders", without distinguishing whether they are market makers or ordinary members.

Trading hours are from 9 a.m. to 5.10 p.m. The market trading mechanism is fully integrated. Each member's video-terminal serves three functions: (i) publication of pre- and post-trade information, including the five best bid and ask quotes for each security,[6] (ii) trade execution at a key-press, and (iii) automatic clearing and settlement onto the centralised systems for bank reserves and government bonds managed by the central bank.[7]

In the Spring of 1997 the run-up to the annual review of the specialists' requisites, including a check of their market share, contributed to the growth in overall trading volume observed on MTS. Some specialists may have inflated their transactions on an intraday basis, without affecting their open

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3 Strictly speaking, specialists are included in the class of primary dealers. Upon demand and subject to the selection criteria set by the Treasury and the Banca d'Italia, a primary dealer may be upgraded to the status of specialist. Downgraded specialists maintain the status of primary dealers.

4 The requisites for specialists are a market share above 3% on the primary market and above 1.5% on MTS. Primary dealers must maintain a minimum share of 0.5% on MTS.

5 The July 1997 shift to anonymity was accompanied by a further innovation: all quotes at the same price made by different market makers are aggregated, leading to an aggregate volume figure associated with each outstanding quote.

6 Prices are quoted clean, as a percentage of par value.

7 Further details on the functioning of MTS can be found in Banca d'Italia (1994).

positions at the end of the day, in an attempt to improve their turnover score. After the June 1997 review, the Treasury and the Banca d'Italia decided to lengthen the observation period to two years and to hold the next review in January 2000.[8] Partly as a consequence of this process, daily trading volume changed from an average 36 trillion lire in the second half of 1996, to 45 trillion in the first half of 1997; since then, it has stabilised at around 33 trillion lire.

The data-set employed in the empirical analysis of the following sections includes all MTS transactions, and the identity of the traders, performed in the period from 1 September 1996 to 31 May 1998. The old regime data sample runs from 1 September 1996 to 13 July 1997 (period 1). The new regime sample goes from 14 July 1997 to 31 May 1998 (period 2). The two samples are approximately equal in length, about 10 and a half months each. To be precise, there are 213 working days in period 1 and 221 working days in period 2.

3. Evidence on theoretical predictions

3.1 Hypothesis I - The liquidity trader's curse

The first type of evidence we should like to gather is that concerning the change, if any, in the degree of market participation by the informed/large dealers and the liquidity/small traders. To this extent, Table 1 provides summary statistics on the average number of active traders on a daily basis, ranked according to their market share, before and after the switch to anonymity. If we consider the smallest traders (below 0.1% of trading volume) we note that they decrease in number from 15 in period 1 to 3 in period 2. The second smallest class of traders (between 0.1 and 0.25%) decreases from 110 to 84. The third class (between 0.25 and 0.5%) increases slightly from 59 to 65 traders. The fourth class (0.5 to 1%) increases from 34 to 41 traders. Overall, if we set a threshold for "small" traders at 1%, we note that their average number decreases from 218 to 193. The two classes of the largest traders, from 1 to 2.5% and above 2.5%, both increase, with their sum going from 42 to 48 traders. The reduction in the number of small traders is also evidenced by the data on market concentration, provided in the lower part of the table. The Herfindahl concentration index of traders increases from 3.2 to 3.8%. The degree of concentration measured on the market makers' side increases from 5.0 to 5.8% on average. The null hypothesis of equal means before and after anonymity is rejected. These results are consistent with Hypothesis I.

3.2 Hypothesis II - The large trader's blessing

The greater concentration among market makers seems consistent with the hypothesis that large traders have been made better-off. The category of informed and/or large traders can also be detected ex post based on the occurrence of large trades. On MTS a "block trade" as such hardly ever occurs. Due to the prudence of market makers who post firm quotes, also in terms of size, 99% of transactions occur at or below 5 times the minimum size of 5 billion lire. Traders wishing to exchange a large amount of bonds respond to this behaviour by working the order over time. This would suggest to proxy large trades by tracking down the continuations of trades made by the same trader on the same bond on each working day. Things are complicated, however, by the fact that during our sample period a "race for volume" took place (see the previous section), and many trades were inflated, i.e. offset by trades of opposite sign within the same day. To control for this phenomenon, we proxy large trades as follows. Within each working day, we compute the net daily change in each trader's holdings of each listed bond. When the net change in absolute terms is larger than a given threshold, we count

[8] The switch to anonymity was also viewed as a measure to avoid the inflation of trading volume.

one "large trade" for each continuation of trades above the same threshold. Our working variable is then defined as the ratio of large trades so defined to total daily volume.

The evidence is presented in Figure 1, Panel A, for a threshold of 50 billion lire, and Panel B, for a threshold of 100 billion lire. Each panel reports the daily series of the large trade ratio and an interpolating function. In the case of a threshold of 50 billion lire, the ratio generally lies between 10 and 20%. Panel A shows that the series increases from period 1 to period 2, and the tests of equal mean and of equal distribution across periods are rejected. The series obtained with a threshold of 100 billion lire generally lies between 0 and 10%. The evidence across periods is analogous: the ratio increases from period 1 to period 2, indicating that, under anonymity, it has become easier to build/unwind large positions on MTS, and the tests of equal mean and distribution are rejected. These findings support Hypothesis II.

Table 1

Dealers' participation to MTS

	Period 1	**Period 2**	**P-value > *t*[1]**
Number of traders with a market share of:[2]			
less than 0.1%	15	3	
0.1-0.25%	110	84	
0.25-0.5%	59	65	
0.5-1%	34	41	
1-2.5%	27	30	
2.5% or more	15	18	
Total	***260***	***241***	
Herfidahl concentration index			
(1) among all traders			
daily average (%)	3.2	3.8	0.00
(standard deviation)	*(0.7)*	*(1.0)*	
(2) among market makers			
daily average (%)	5.0	5.8	0.00
(standard deviation)	*(0.9)*	*(1.0)*	

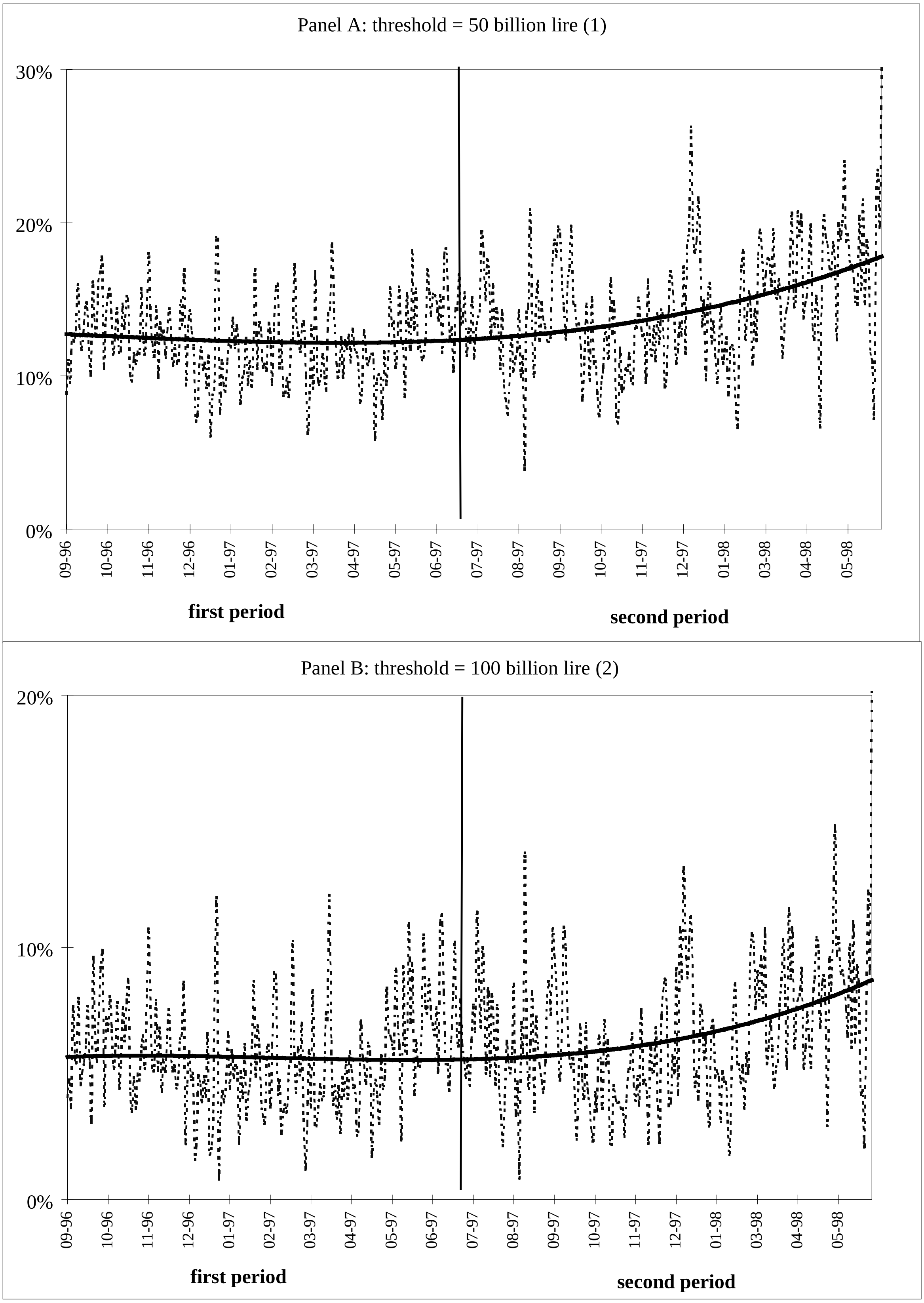
[1] A p-value at or below 0.05 implies rejection of the null hypothesis of identical means by the *t*-test. [2] The traders' shares are daily averages (213 days for period 1, 221 days for period 2).

3.3 Hypothesis III - The decline of OTC free-riding

In order to gather evidence on the hypothesised shift from OTC to MTS transactions, we used the information contained in the monthly statistical reports of MTS market makers to the Banca d'Italia. These reports include the OTC trading volume in government bonds of each dealer, with a breakdown for trades carried out with residents and non-residents. We corrected the residents' figures for the effect of double counting by scaling them down by the share of MTS turnover involving trades between two market makers. We thus obtained an estimate of the OTC volume that is comparable with the MTS exact figures that we possess. We then calculated the ratio of OTC volume over total inter-dealer volume (OTC plus MTS). The resulting figures are given in Table 2. It shows that the OTC share tends to increase from the end of 1996 onward. The highest OTC share figures are observed in July 1997 (37.3%) and in May 1998 (39.6%). The subdued OTC share in the Spring of 1997 may partly be explained by the race for volume that took place on MTS and that no longer occurred under anonymity. The evidence of Table 2 is at odds with Hypothesis III.

Figure 1

Block trades on MTS as a share of total trading volume



(1) A block trade is assumed whenever the net daily change in a trader's holding of an issue is worth at least 50 billion lire. (2) A block trade is assumed whenever the net daily change in a trader's holding of an issue is worth at least 100 billion lire.

3.4 Hypothesis IV - The waiting game

If the waiting game hypothesis holds, dealers should try to delay their trades on an intraday basis in the attempt to acquire more information through trade flow, and we would expect a shift of trading volume from the early stages of trading to the later stages. In order to analyse intraday turnover on MTS, we chose the benchmark 10-year BTP issue, which is generally the most heavily traded security. The evidence is given in Figure 2, which shows the intraday relative volume on the benchmark BTP, i.e., the share of trading volume observed in each half-hour interval of the day over the total daily volume of the bond. The key findings that emerge from Figure 2 are as follows. First, trading volume increases from the first half-hour of trading (9-9.30 a.m.) to the second half-hour. Second, like most financial markets, there is a decline in trading activity for a couple of hours after 12.30 p.m. Third, trading activity remains steady after 2.30 p.m. (we recall that the closing interval after 5 p.m. is just 10 minutes, i.e. one third of all other intervals). Finally, we note that from period 1 to period 2 there is a small decline in volume in the morning intervals and a corresponding increase in the intervals after 2.30 p.m. The share of trading volume that moves from before 2.30 p.m. to after that time is equal to 3.2%. The last finding seems consistent with Hypothesis IV.

4. Liquidity

Various definitions have been provided in the literature for the concept of market liquidity. Perhaps the most popular one is “a market is liquid if the impact of a trade on price is small”. However, the liquidity concept has several other dimensions (see e.g. O’Hara, 1995; Muranaga and Shimizu, 1997). The richness of our data-set allows us to conduct an empirical study of market liquidity along different definitions. The first and simplest indicator of market liquidity is turnover. For the reason explained in Section 2, namely that trading volume should have been biased by the dealers’ effort to maintain their status before the June 1997 review, we do not think that it is useful to compare total MTS trading volume before and after the market move to anonymity. Instead, we prefer to focus our attention on the number of bonds that were actively traded on each day. The second indicator of liquidity is the bid-ask spread. The (half-)spread is the reward paid by traders to market makers for their services, which provide immediacy to those wishing to buy or sell a security. The third indicator of liquidity is the market impact of a trade, which is related to the adverse selection problem faced by market makers and which varies directly with the perceived arrival of orders from informed traders. We present the evidence on each of the above mentioned indicators respectively in the three following subsections.

4.1 Active bonds

We choose two statistics to describe turnover on the active bonds. We first rank the bonds traded on each day by their volume of transactions. We then consider those bonds below the median and take (i) their number (i.e., one half of the total number of traded bonds) and (ii) their share over total daily trading volume. These statistics are plotted on a daily basis in Figure 3. It shows that the number of the 50% least-traded bonds remains almost the same in the two periods (63.6 and 65.1 on average in periods 1 and 2 respectively). On the other hand, the volume share of the least traded bonds shows an increasing trend, and it doubles on average from 6.9% before anonymity to 14.3% after anonymity. The tests of the hypotheses that the mean and distribution of market share by class do not change are rejected.

Table 2

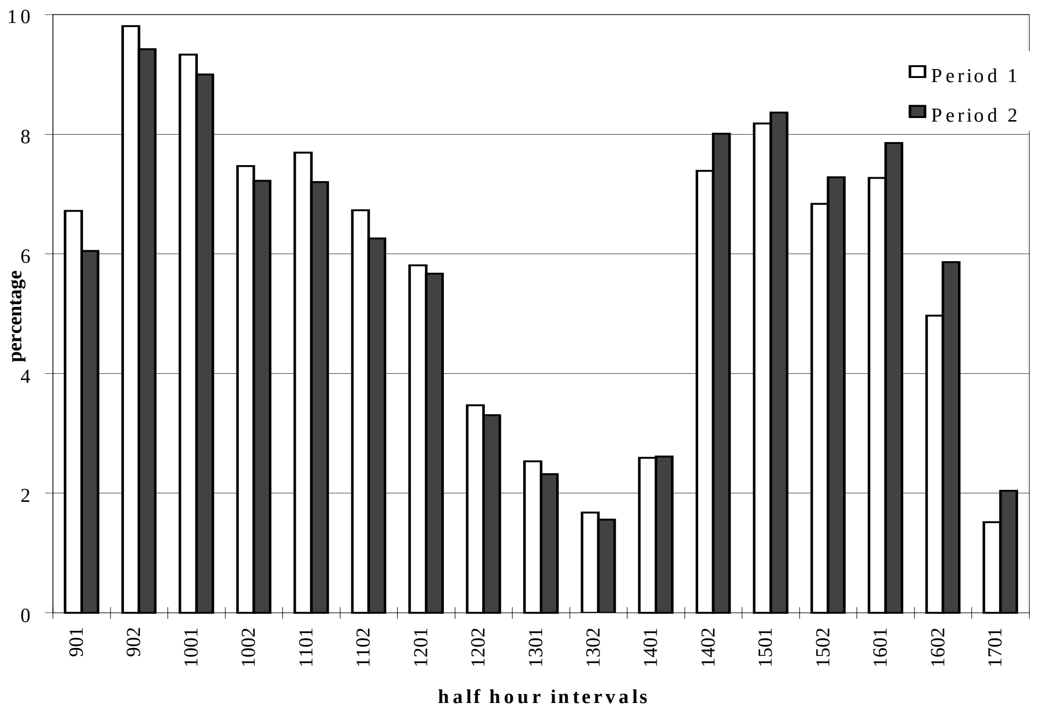
Monthly trading volume on OTC market and MTS

		OTC*	MTS	OTC share on total (%)
1996	September	310	812	27.6
	October	393	915	30.1
	November	326	892	26.7
	December	284	717	28.3
1997	January	343	1,136	23.2
	February	360	834	30.2
	March	356	735	32.6
	April	396	898	30.6
	May	463	1,048	30.6
	June	528	946	35.8
	July	508	854	37.3
	August	322	562	36.4
	September	455	898	33.6
	October	457	928	33.0
	November	363	730	33.2
	December	355	611	36.8
1998	January	297	658	31.1
	February	295	621	32.2
	March	379	726	34.3
	April	296	566	34.4
	May	315	481	39.6

Data in trillions lire, percentages. * Estimated values.

Figure 2

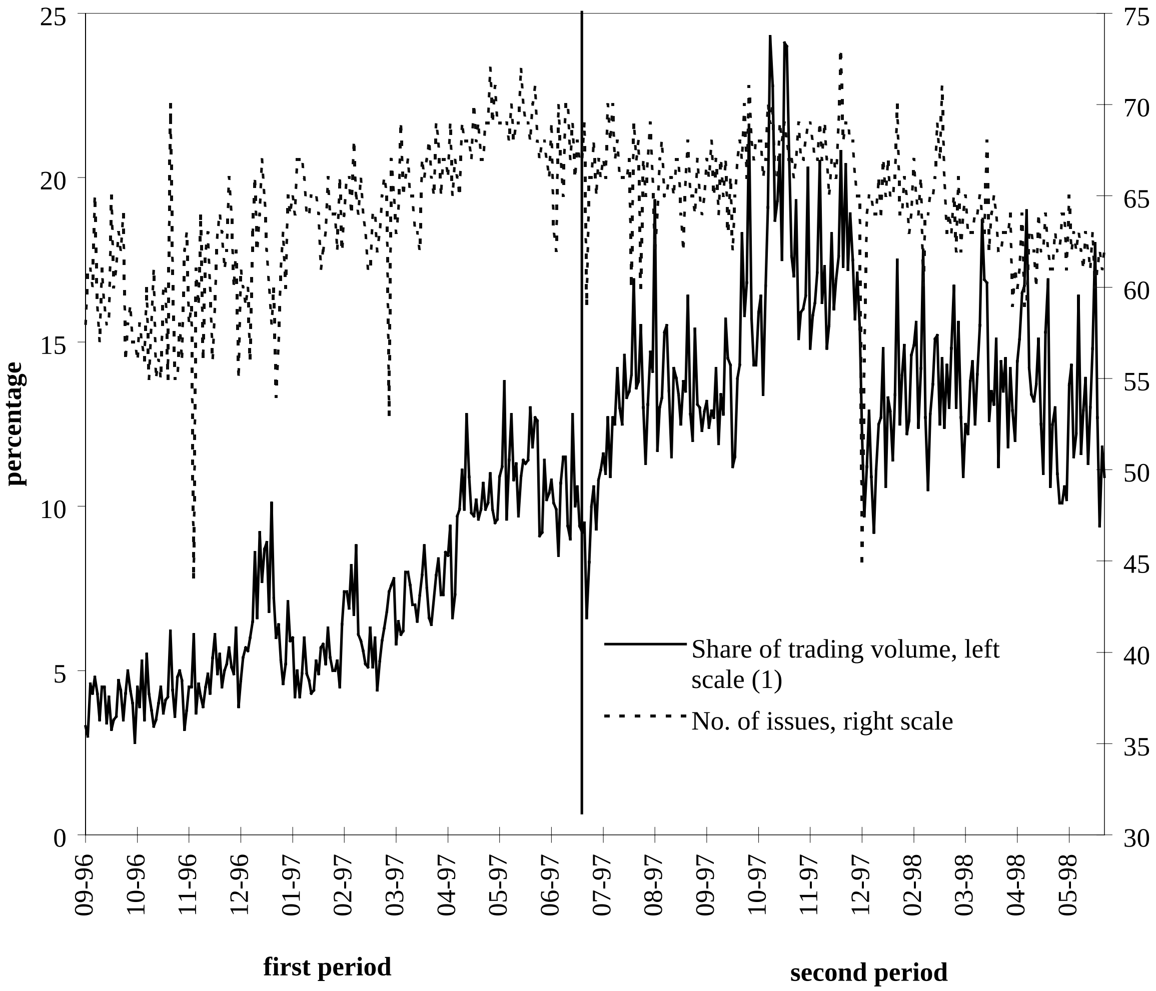
MTS: Intraday trading volume on 10-year benchmark BTP (1)



(1) Data are averages of shares of daily volume. The Kolmogorov-Smirnov test rejects the null hypothesis of identical distributions in period 1 and 2 for 9 out of 17 intervals, at 5% level. The *t*-test rejects the null hypothesis of identical means for 6 out of 17 intervals, at 5% level.

Figure 3

Least liquid bonds on MTS: Number of issues and share of trading volume



Daily data.

(1) The Kolmogorov-Smirnov test rejects the null hypothesis of identical distributions in period 1 and 2 at 5% level. The t-test rejects the null hypothesis of identical means at 5% level.

4.2 Bid-ask spread

Our intraday data-set does not include data on the bid-ask spread. In order to obtain estimates of the fixed-cost of trading associated with the existence of the spread, we use our intraday transactions data to fit the two-equation empirical model of trade and quote revision proposed by Foster and Viswanathan (1993) (see Hasbrouck, 1991 for a thorough discussion). The model is as follows:

$$q_t = \alpha + \sum_{i=2}^{N} \delta_i 1_{d_t=i} + \sum_{j=1}^{3} \beta_j dp_{t-j} + \sum_{k=1}^{3} \iota_k q_{t-k} + \tau_t \quad (1)$$

$$dp_t = 2c\left[1_{q_t>0} - 1_{q_{t-1}>0}\right] + \sum_{i=2}^{N} 2c_i \left[1_{q_t>0} - 1_{q_{t-1}>0}\right] 1_{d_t=i} + \lambda \tau_t + \sum_{j=2}^{N} \lambda_j 1_{d_t=j} \tau_t + v_t \quad (2)$$

where q_t is the signed trade size (e.g., –5 indicates a public sale of 5 billion lire at the current bid price) and dp_t is the price change that occurred between the previous trade and the current trade.

$1_{d_t = i}$ is an indicator variable equal to 1 if trade *t* occurs in the *I*-th half-hour interval of the day and 0 otherwise. $1_{q_t > 0}$ is an indicator variable equal to 1 if trade *t* is a public buy and 0 otherwise. Equation (1) tries to model the expected value of the incoming order conditional on the past record of orders and prices; the residual τ_t is the unexpected component, or the innovation brought about by the order and potentially related to informed trading.[9] This residual in turn becomes one of the explanatory variables of the price change caused by the order, given by equation (2). In it, the coefficient *c* is an estimate of the "fixed" component of transaction costs. Assuming that the "true" (and unobservable) value of the bond does not change, *c* measures the difference between the transaction price and the true price, corresponding to one half of the spread, i.e., to the compensation for the market making services provided by the dealer who posted the quote. In practice, since the true bond price *does* change over time, if we take 2*c* we do not obtain the actual spread but an unbiased (and noisy) estimate of it.[10] In equation (2) we allow for the possibility that 2c changes during the day, by introducing dummy variables for the half hour intervals $i = 2, \ldots, N$, where *N* is the last interval of the day (from 5 p.m. to the market close at 5.10 p.m.). In the same equation, the λ coefficient measures the adverse selection component of trading cost, or market impact of a trade, which enters the total cost of trading when the trade itself is not expected by the market makers on the basis of the past order flow. Again, we allow for the possibility that λ changes during the day, by introducing (*N*-1) interval dummies. This estimation approach, which recognises the dynamic nature of trading costs, is similar to those employed in a number of previous studies.

The evidence on the intraday spread estimates for the benchmark 10-year BTP is plotted in Figure 4. The first fact that we note is that 2*c* is roughly W-shaped during the day. The spread has three peaks: at the open, before 2.30 p.m. and at the close. The peak between 2 p.m. and 2.30 p.m. (8-8.30 a.m. US Eastern Standard Time) is related to the market's uncertainty concerning the opening prices of the United States financial markets. The peak may also be related on some days to the upcoming release of United States' macroeconomic indicators. This finding is analogous to previous evidence for MTS (Scalia, 1998a) and to the behaviour of the United States' T-bond market (Fleming and Remolona, 1997). The second fact that we note is that the spread in period 2 is uniformly lower than in period 1. In particular, the spread in the initial and final intervals of the day declines from 2 to 1.4 basis points of price.

It may be argued that the estimated reduction of the spread, which is positively related to the asset's expected volatility, may have been caused by the general improvement in the Italian Treasury bond market, brought about by the increase in Italy's prospects for early participation in the EMU. This poses the problem of distinguishing the effects that MTS anonymity and the macroeconomic change have had on our market performance variables. As a control variable for macroeconomic improvement, we chose the 10-year BTP-Bund yield differential.[11] Figure 5, Panel A shows the series of the estimated bid-ask spread and the BTP-Bund yield differential on a daily basis. The yield differential fell from around 3% in September 1996 to 1% in July 1997, and fell again to 0.25% in May 1998. The bid-ask spread series shows a declining trend in period 2. In that period the differential and the spread are clearly associated.[12]

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9 Equation (1) is run using the logit method.

10 In order to control for residual heteroskedasticity caused by the different length of time between subsequent trades, we weight each observation in equation (2) by the inverse square root of the time elapsed since the previous trade. We thus run equation (2) with the weighted least squares method.

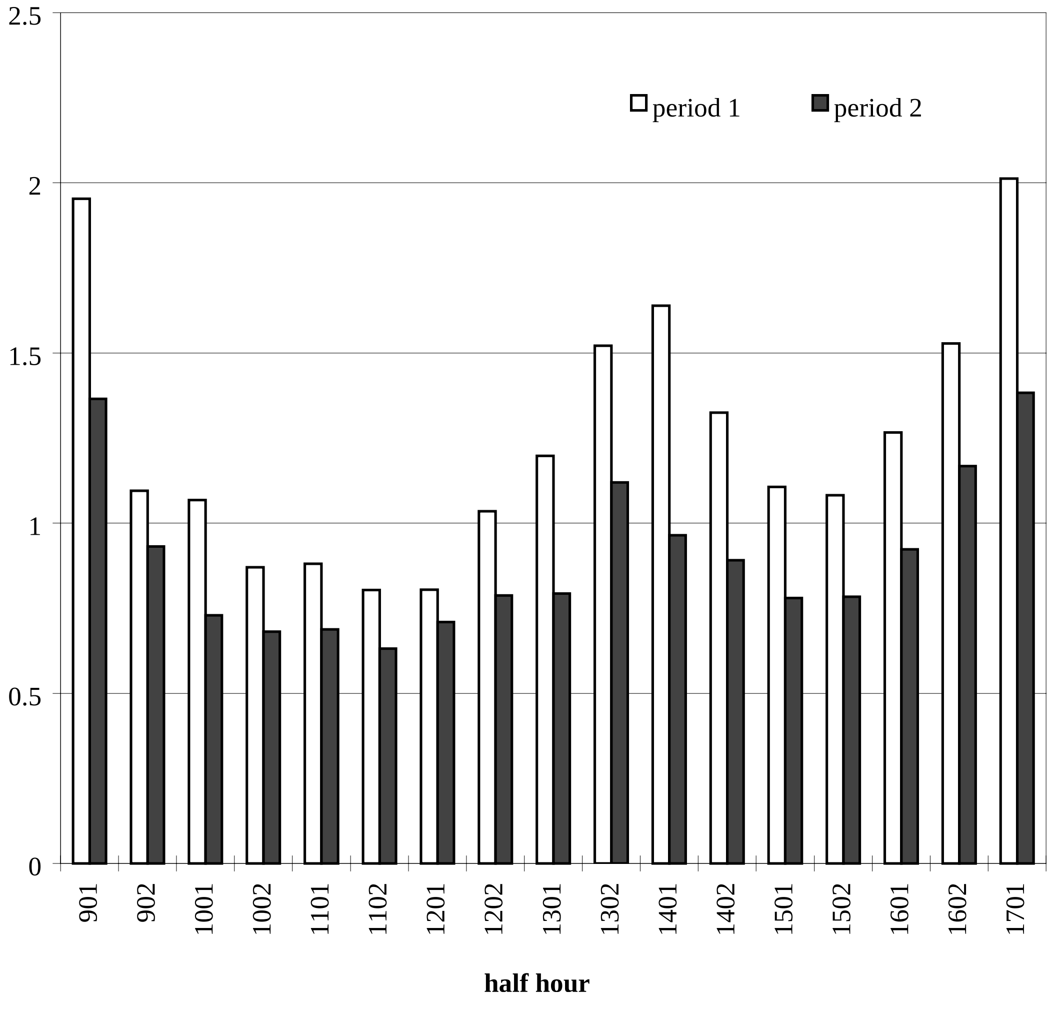
11 Another plausible proxy might be the market perceived probability of Italy's early participation in the EMU. This estimated probability measure and the BTP-Bund spread are strongly correlated.

12 This is confirmed by a simple regression of the spread over a constant and the differential (not reported for simplicity). We also perform a Chow stability test that the regression coefficients are identical between period 1 and period 2. The results show that the differential is directly related to the spread; however, this effect is limited to period 2, and the stability test is rejected.

What are the relative weights of the micro- and macroeconomic effects on the spread? In order to provide an answer, we run a regression of the spread estimate over a constant, the differential, a dummy equal to 1 in the second period, and the product of the previous two variables. The weights are obtained as the product of the estimated coefficients by the average value of each variable, as a percentage of total. These weights are reported in Figure 5, Panel B. The weight of the microeconomic effect, related to the dummy variable, is equal to 56%. The macroeconomic variable, i.e. the differential, accounts for 10%, and the third variable (the differential times the dummy) accounts for 34%. Adopting a cautious stance, and attributing the last estimate entirely to the macroeconomic effect, we observe that the microeconomic effect accounts for over one half of the total improvement in the bid-ask spread from period 1 to period 2.

Figure 4

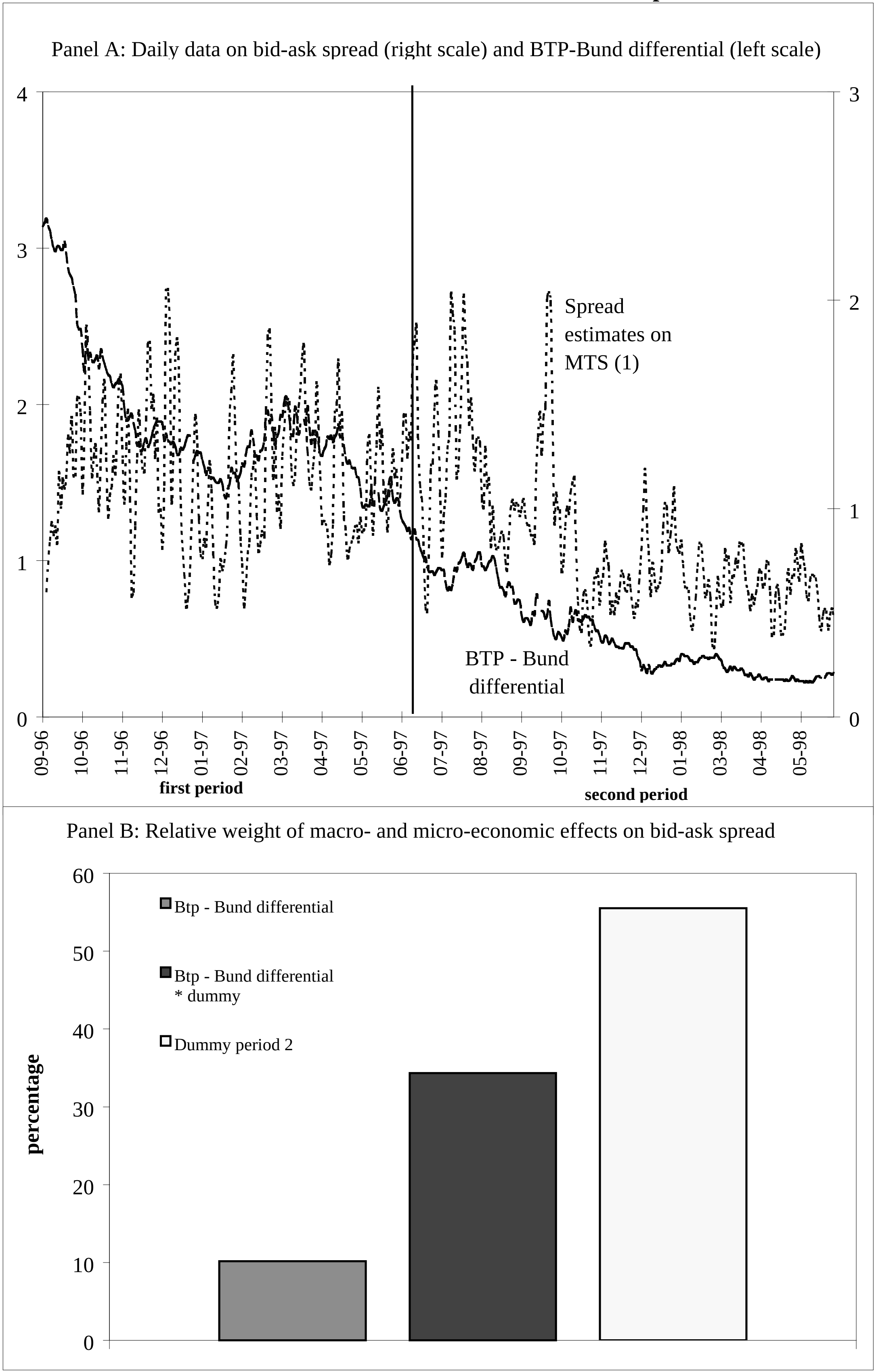
Intraday spread estimates on 10-year benchmark BTP (1)



(1) Data are in basis points. See equations *(1)* and *(2)* in the text. The Kolmogorov-Smirnov test rejects the null hypothesis of identical distributions in period 1 and 2 for 16 out of 17 intervals, at 5% level. The *t*-test rejects the null hypothesis of identical means for 16 out of 17 intervals, at 5% level.

Figure 5

Macro- and micro-economic effects on bid-ask spread



(1) Spread estimates on MTS, in basis points, are moving averages over three days.

4.3 Market impact

The intraday evidence on the estimates of the market impact λ is plotted in Figure 6. The first finding is that in period 1 there are minor variations of λ during the day, whereas in period 2 there is a tendency for market impact to increase in the early afternoon intervals. The second finding is that λ is uniformly lower in period 2 than in period 1.

Has λ been influenced by the general macroeconomic improvement of the market? Figure 7, Panel A shows the market impact series and the yield differential series. The evidence, again, is that the differential is positively related to the spread in period 2, but unrelated to it in the earlier period.[13]

The results on the weights of the micro- and macroeconomic effects are given in Panel B, obtained with the same methodology of the previous subsection. The microeconomic effect turns out to be extremely large, equal to around 69% of the total price impact. The macroeconomic effect accounts for the remaining 31%.

5. Volatility

We estimate volatility on an intraday basis as the squared log-difference of the benchmark 10-year BTP prices, taken at half-hourly intervals. The resulting evidence is presented in Figure 8. Intraday volatility displays a U-shape. Although its estimate declines in the last interval of the day, we recall that the different length of the interval itself does not make the corresponding value comparable to estimates for earlier intervals.[14] Volatility is largest in the initial interval of period 1, when it is equal to 0.03%. Throughout the rest of the day it is much lower, generally below 0.015%, and it rises after 2.30 p.m. The second fact that we note is that volatility in period 2 is uniformly lower than in period 1. In particular, volatility in the first half hour of trading declines from 0.030 to 0.011. Moreover, after 2.30 p.m. the increase in volatility is less pronounced.

Figure 9, Panel A provides evidence on the relationship between the BTP-Bund yield differential and volatility on a daily basis. The picture is slightly different from the case of the spread and market impact. A direct relationship between yield differential and volatility is found; this is significant in period 2 only; however, the Chow stability test between periods cannot be rejected. The evidence of Panel B is that the microeconomic effect has a weight of 37% on volatility, i.e. much smaller than in the case of the cost measures, whereas the macroeconomic effect accounts for the remaining 63%.

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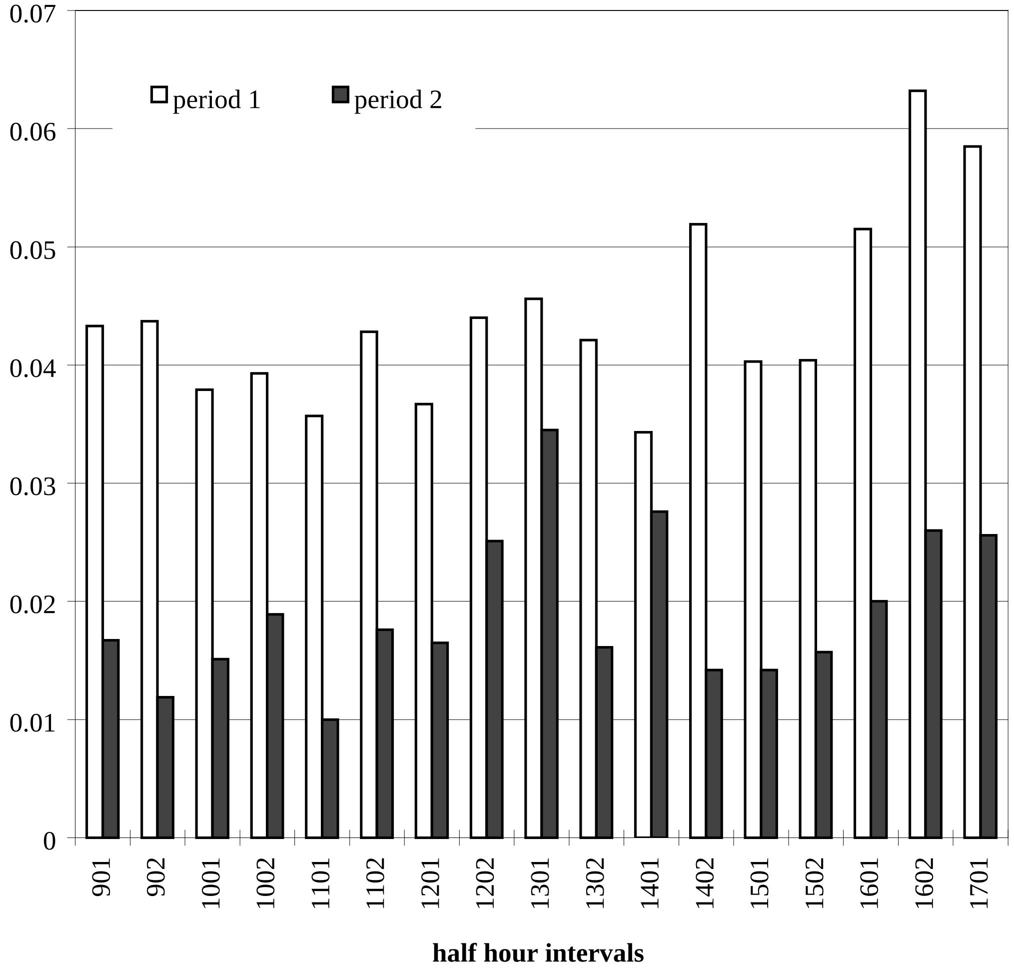
[13] The Chow stability test between period 1 and 2 is rejected.

[14] Under the hypothesis that bond prices follow a Brownian motion, our (squared) volatility proxy in the last interval should be multiplied by 30’/10’=3 in order to express it in half-hourly terms.

Figure 6

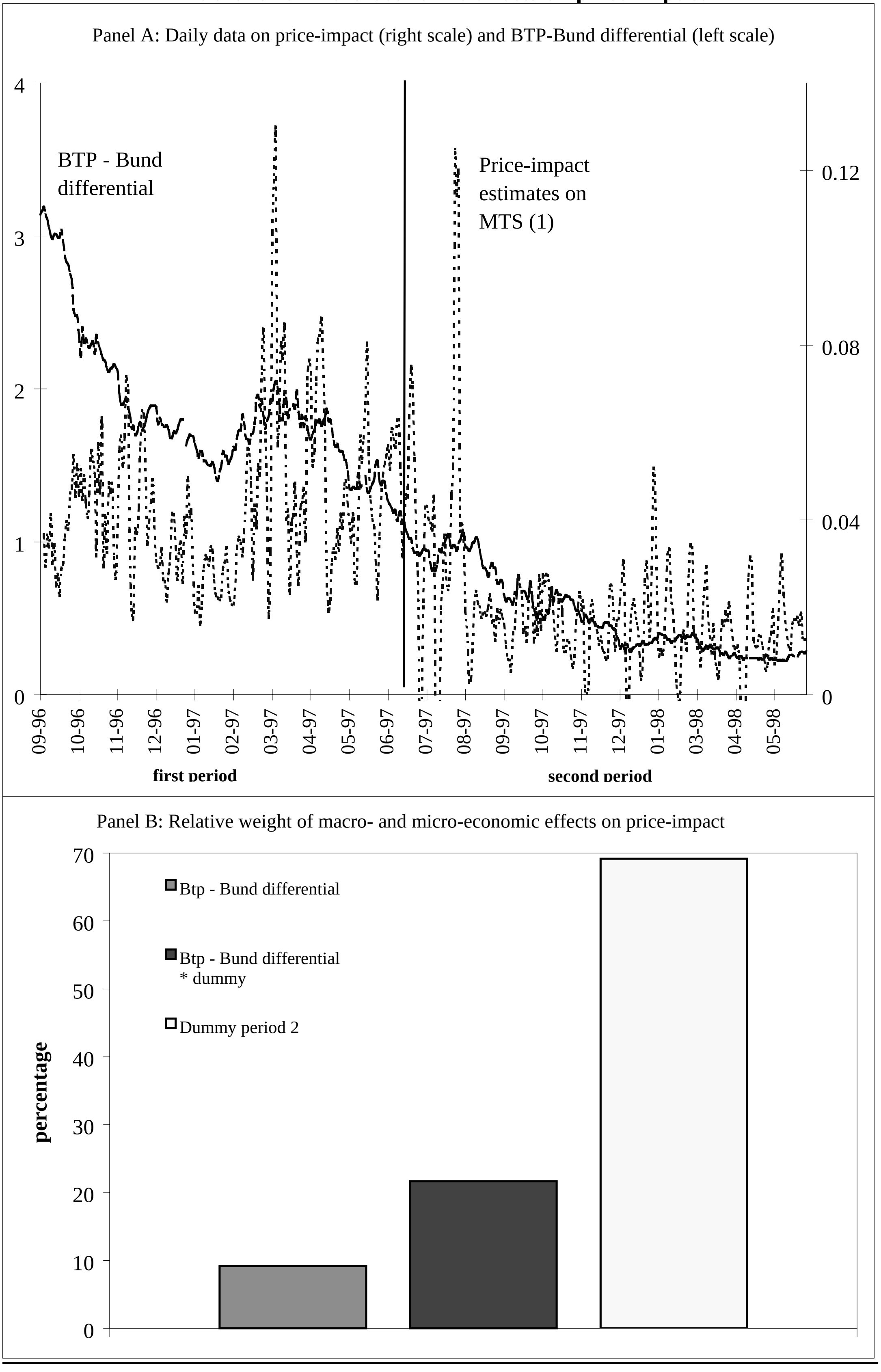
Intraday price impact estimates on 10-year benchmark BTP (1)



(1) Basis points per 1 billion lire order size. See equations *(1)* and *(2)* in the text. The Kolmogorov-Smirnov test rejects the null hypothesis of identical distributions in period 1 and 2 for 17 out of 17 intervals, at 5% level. The *t*-test rejects the null hypothesis of identical means for 15 out of 17 intervals, at 5% level.

Figure 7

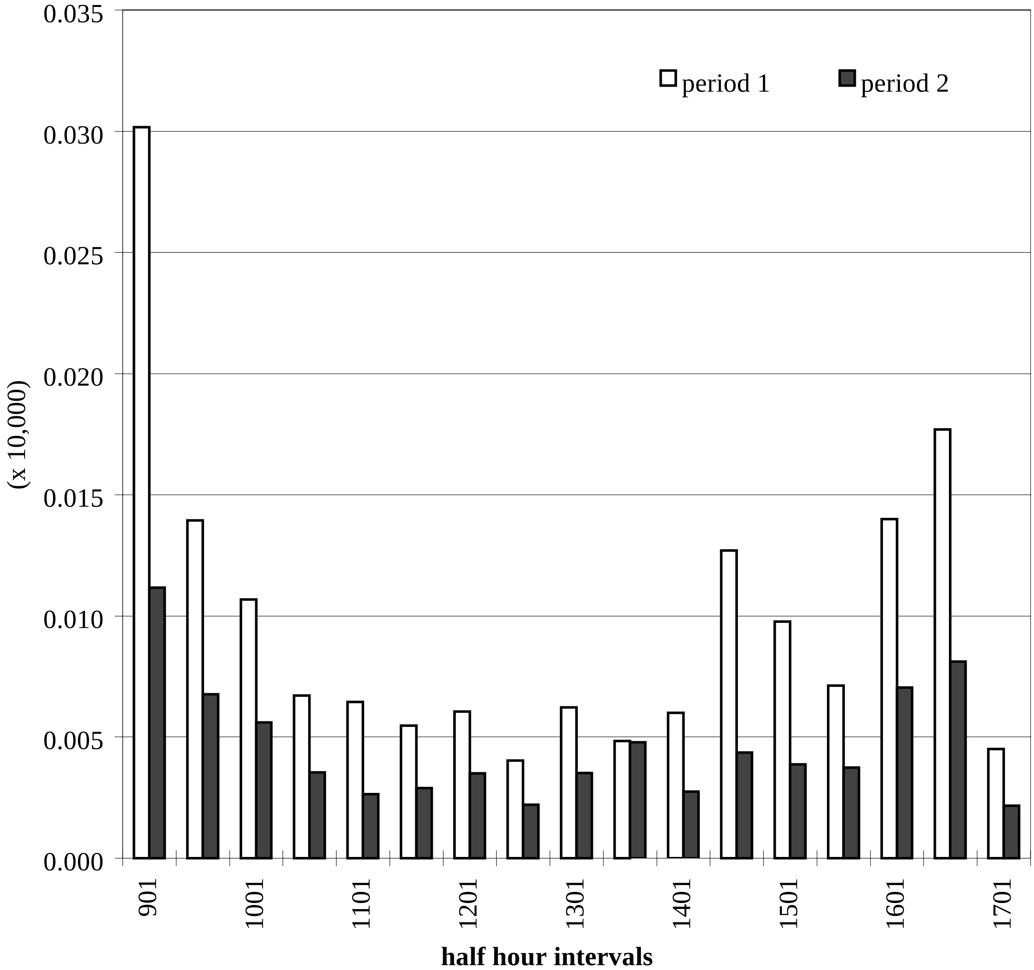
Macro- and micro-economic effects on price-impact



(1) Price-impact estimates on MTS, in basis points, are moving averages over three days.

Figure 8

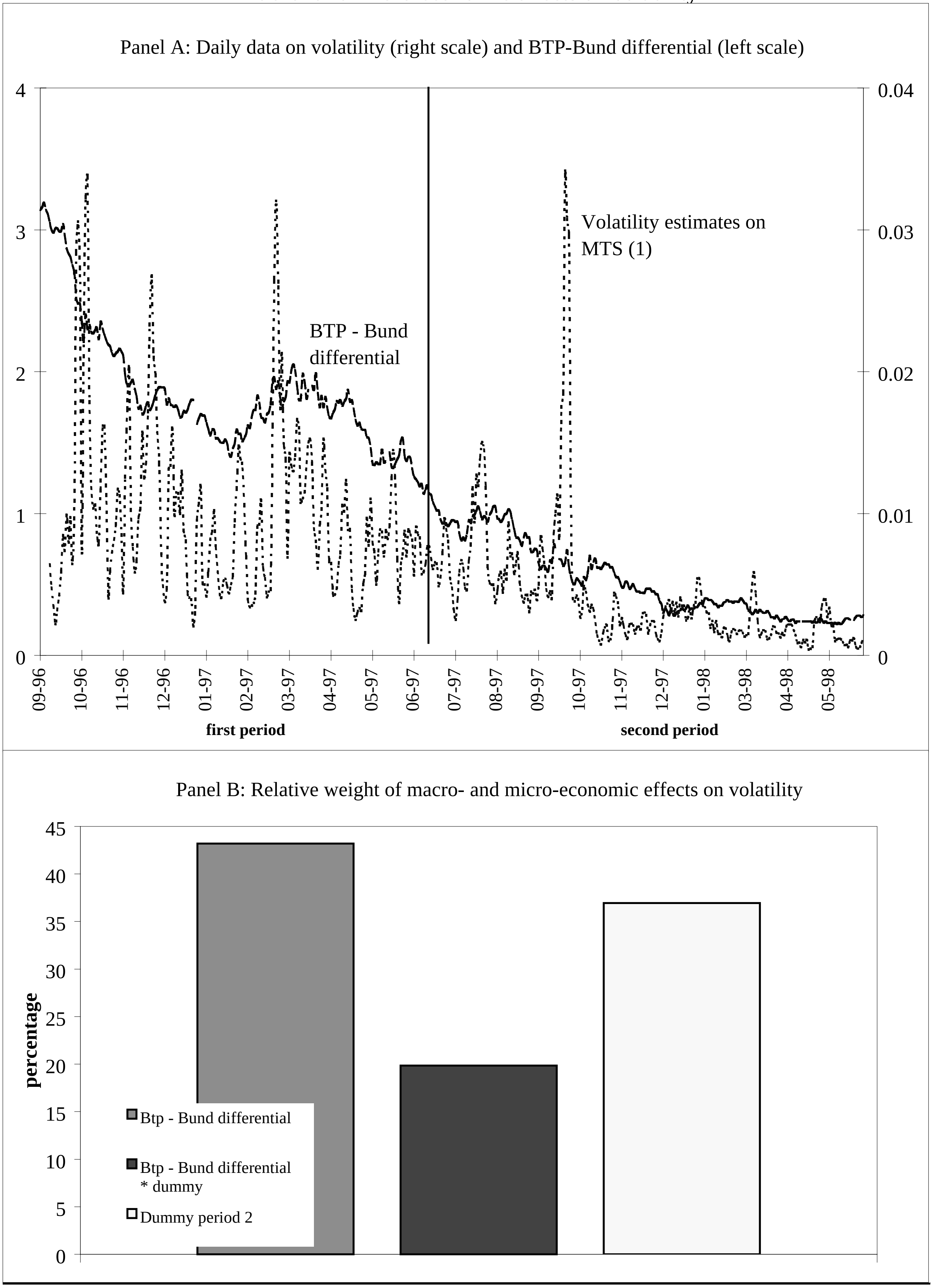
Intraday price volatility on 10-year benchmark BTP



(1) The Kolmogorov-Smirnov test rejects the null hypothesis of identical distributions in period 1 and 2 for 17 out of 17 intervals, at 5% level. The *t*-test rejects the null hypothesis of identical means for 16 out of 17 intervals, at 5% level.

Figure 9

Macro- and micro-economic effects on volatility



(1) Volatility estimates on MTS, in basis points, are moving averages over three days.

6. Efficiency

The notion of financial market efficiency implies that prices fully reflect all available information. As is well known, Fama (1970) distinguishes three types of efficiency: *weak-form efficiency*, which requires that no investor can earn excess returns based on historical price information; *semi-strong-form efficiency*, which implies that no investor can earn excess returns by applying trading rules based on any publicly available information; and *strong-form efficiency*, which implies that no investor can earn excess returns using any type of information, whether public or private. While strong-form efficiency is unachievable if one accepts the view that information asymmetries are a relevant factor in explaining dealers' behaviour, weak-form and semi-strong-form efficiency are in principle attainable by a financial market. In particular, the hypothesis of weak-form efficiency has been tested by empirical studies on leads and lags between cash and futures markets for the same security, in which prices are strictly correlated due to a no-arbitrage argument. The evidence in the case of bond markets is available for Japan and Italy. In Japan the JGS inter-dealer cash market is driven by the futures market, with cash prices lagging behind the price of the 10-year JGS contract traded on the Tokyo Stock Exchange by two minutes on average (Miyanoya, Inoue and Higo, 1997). In the case of the Italian BTPs there is evidence of reciprocal causality between the futures contract traded on LIFFE and the benchmark 10-year BTP traded on MTS in the years 1992-1993; furthermore, the futures lead cannot be exploited to earn excess returns on MTS, consistent with weak-form efficiency of MTS with respect to LIFFE (Scalia, 1998b; see also Angeloni et al., 1996).

Has MTS changed its record of efficiency with respect to LIFFE following its switch to anonymity? This question is relevant because traders in the two marketplaces are not fully integrated, particularly concerning their access to information on monetary policy implementation, the Treasury's issuing decisions and the order-flow. The empirical analysis that follows seeks to update previous evidence, while improving the type of data and the power of the causality test.

Our data sample includes all MTS transactions on the benchmark 10-year BTP and all BTP futures transactions at LIFFE in the period from September 1996 to May 1998.[15] We also employ an intraday data-set, obtained from the Reuters service, that contains market prices and quotes at 5-minute intervals on the following financial instruments: the 3-month eurolira futures contract at LIFFE (last trade price), the Deutsche Mark/US Dollar exchange rate (last bid), and the 10-year Bund futures contract traded at LIFFE (last trade price). The general motive for the inclusion of these variables in a VAR analysis of causality is to take into account the behaviour of the world financial markets that potentially may explain the behaviour of BTP prices, i.e., we should like to include in a parsimonious way all the relevant information set. We observe that, compared with previous studies, we take a step from the notion of weak-form efficiency to that of semi-strong-form efficiency, which involves the predictability of prices based on all publicly available information. The specific reasons for this set of variables are as follows. The short-term rate futures captures the attitude of domestic monetary policy. The DM/USD exchange rate is the reference exchange rate for Europe, reflecting the relative degree of monetary tightness between the United States and Germany. The Bund futures prices incorporate the attitude of investors towards the European fixed-income market.

After taking the log-differences of our intraday time series at 5-minute intervals (simple differences for the eurolira rate), for each day in our sample we ran a VAR system of equations in order to check if any pattern of causality emerges among the prices of our financial instruments, and in particular between BTP cash and futures prices.[16] The evidence on absolute contemporaneous correlation among variables is given in Table 3, Panel A. The evidence on the VAR estimates is contained in Panel B, which gives summary statistics (frequency and mean) on the coefficients that turned out to be significantly different from zero across all days. The maximum lag length with significant statistical

[15] The futures data-set was kindly made available by LIFFE.

[16] The VAR model is estimated in the interval 9 a.m.-5.10 p.m. (opening hours of MTS) on a daily basis. The number of lags is selected by minimising the Akaike information criterion.

power in both samples is 10 minutes (two lags). However, since the second lag of variables turns out to be significant in a negligible number of cases, for ease of presentation the table reports only the evidence for the first lag of variables.

The key facts that emerge from our estimates are as follows. First, as with previous evidence from many financial markets world-wide, all our series display substantial mean-reversion at 5-minute intervals. In particular, the average mean-reversion coefficient for the BTP cash price is -0.41 in period 1 and -0.35 in period 2; the averages for the BTP futures are -0.33 and -0.41, the averages for the eurolira rate are -0.33 and -0.31. Second, contemporaneous correlation of price changes between cash and futures BTP is extremely high (0.72 and 0.64 on average in periods 1 and 2)[17], as one would expect based on the no-arbitrage principle. Third, causality between cash and futures BTP runs in both directions. In particular, the 5-minute average lead of LIFFE declines from 0.39 to 0.34, while the average lead of MTS is almost unchanged, from 0.33 to 0.32. Furthermore, while the number of days in which LIFFE displays a significant lead on MTS declines from 30 in period 1 to 18 in period 2, the corresponding frequency for the MTS lead increases from 17 days in period 1 to 25 days in period 2. Finally, there is evidence of positive two-way causality between price changes of the Bund futures, on one side, and of the BTP cash and futures, on the other side. Interestingly, we observe that contemporaneous correlation increases over time (from 0.47 to 0.51 for the benchmark BTP, from 0.49 to 0.55 for the BTP futures) and that causality from the Bund to the BTP becomes positive in a number of cases in period 2. These phenomena are consistent with the hypothesis that, thanks to the improvement in the prospects of first-round participation of the lira in the EMU, in period 2 the Italian and German bond markets have become more integrated.

Compared with the evidence on causality for the years 1992-1993, when the LIFFE lead over MTS was of 15 to 30 minutes with an intensity of 0.25-0.30, in recent years the lead has become much shorter, and the frequency of cases in which it is longer than 5 minutes is just 4 days out of 309. The MTS lead has increased compared to 1992-1993.

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17 The fact that we use the benchmark BTP, which is not necessarily the cheapest-to-deliver bond for the futures contract, diminishes the power of the no-arbitrage principle in our case, thus reducing the correlation between cash and futures.

Table 3

Intraday evidence on price causality

Panel A: Contemporaneous correlations

	10-year benchmark BTP	**10-year BTP future**	**3-month eurolira**	**10-year Bund future**	**D-Mark/ US Dollar**
			Period 1		
10-year benchmark BTP	1.00	0.72	-0.37	0.47	0.08
10-year BTP future		1.00	-0.42	0.49	0.08
3-month eurolira			1.00	-0.29	-0.05
10-year Bund future				1.00	0.05
D-Mark/US Dollar					1.00
			Period 2		
10-year benchmark BTP	1.00	0.64	0.08	0.51	0.01
10-year BTP future		1.00	0.08	0.55	0.01
3-month eurolira			1.00	0.09	-0.01
10-year Bund future				1.00	0.01
D-Mark/US Dollar					1.00

Figures are averages of daily data.

Panel B: Lead-lag estimates[1]

	10-year benchmark BTP		**10-year BTP future**		**3-month eurolira**		**10-year Bund future**		**D-Mark/ US Dollar**	
	Aver-age[2]	No. days[3]	Aver-age[2]	No. days[3]	Aver-age[2]	No. days[3]	Aver-age[2]	No. days[3]	Aver-age[2]	No. days[3]
					Period 1					
10-year benchmark BTP	-0.41	38	0.39	30	-0.81	19	-0.10	20	0.18	12
10-year BTP future	0.33	17	-0.33	28	-1.37	11	-0.02	20	0.19	8
3-month eurolira	-0.03	18	-0.08	34	-0.33	85	-0.01	15	-0.03	10
10-year Bund future	0.17	11	0.27	22	-0.41	15	-0.32	36	0.09	10
D-Mark/US Dollar	0.08	13	0.00	11	-0.50	8	0.17	13	-0.27	37
					Period 2					
10-year benchmark BTP	-0.35	35	0.34	18	0.12	9	0.29	17	0.11	9
10-year BTP future	0.32	25	-0.41	39	0.10	8	0.32	21	0.13	7
3-month eurolira	0.04	12	0.08	14	-0.31	56	0.01	8	0.00	4
10-year Bund future	0.15	18	0.20	20	0.34	9	-0.34	27	-0.01	9
D-Mark/US Dollar	-0.07	9	0.31	6	0.11	5	0.30	21	-0.25	18

[1] Causality at 5-minute level runs from the variables along the top row to the variables along the first column on the left. Due to gaps in the intraday series, 159 days and 150 days were employed for the estimates respectively in period 1 and in period 2. [2] Average estimated causality over the days where the estimated causality is non-zero with 95% confidence. [3] Numbers of days where the estimated causality is non-zero with 95% confidence.

7. Discussion and regulatory policy implications

We summarise the main empirical findings of the previous sections.

A. *Small traders' participation on MTS decreases from period 1 to period 2.*

B. *Large traders' participation increases.*

C. *Large trades on MTS become more frequent in period 2.*

D. *The share of OTC transactions over total inter-dealer trading increases slightly from period 1 to period 2.*

E. *The shape of intraday trading volume on the benchmark bond is slightly displaced towards the late trading intervals of the day, from period 1 to period 2.*

F. *The share of trading volume of the 50% least traded bonds on MTS doubles from period 1 to period 2.*

G. *The intraday bid-ask spread is W-shaped, and the spread in period 2 is uniformly lower than in period 1.*

H. *The market impact λ is uniformly lower in period 2 than in period 1.*

I. *Volatility is U-shaped and uniformly lower in period 2.*[18]

J. *The increase in Italy's prospects for early participation in the EMU is correlated to the improvement in spread, market impact and volatility in period 2, but virtually uncorrelated to them in period 1. The macroeconomic effect explains between 31 and 63% of the improvement in market performance.*

K. *Causality between BTP cash prices on MTS and futures prices at LIFFE runs in both directions.*

L. *From period 1 to period 2 the intensity of causality from either market becomes similar, the frequency of the LIFFE lead declines, the frequency of the MTS lead increases.*

The first theoretical hypothesis that we made was that the smaller MTS traders, who are most likely to be liquidity motivated and uninformed, have been made worse-off by the market move to anonymity. Finding A is clearly consistent with the "liquidity trader's curse". Some small traders, although formally MTS members, may have withdrawn from active market participation because under anonymity they have less control on the "real game" played by the large traders, thus being unable to mirror their moves. It seems likely that either or both of the following phenomena may have occurred in period 2: (i) small players deal more frequently on an OTC basis through large dealers, and are prepared to pay a commission for the superior information possessed by the latter; (ii) small players participate more actively in the uniform-price auctions of Treasury securities. The counterpart to this are findings B and C, suggesting that the "large trader's blessing" has indeed occurred. Under anonymity large traders are better able to carry out big inventory adjustments, which in period 1 were presumably executed on the OTC market.

The estimated increase in the share of OTC trading volume (finding D), although a small amount, is somewhat puzzling. It is the opposite of Hypothesis III. The "decline of OTC free-riding" hypothesis is actually related to two considerations. First, anonymity makes MTS more similar to the OTC inter-dealer-broker market. This increases *ceteris paribus* the incentives to trade on MTS. Second, under anonymity it becomes more difficult for the OTC market to free-ride on price and order-flow

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[18] Concerning the findings G, H and I, for control purposes, we also ran the empirical tests on market liquidity and volatility using a different set of securities, namely the just-off-the-run 5-year BTPs. In a ranking of daily trading volume these bonds generally lie between the 5th and the 15th most traded issues. The evidence (available from the authors) confirms the findings for the 10-year benchmark bonds. However, finding E is no longer observed on 5-year BTPs.

information provided by MTS. This phenomenon may cause an increase in trading cost on the OTC market, and may induce some dealers to trade directly on MTS. Are there any other reasons for the observed increase in OTC turnover? It is possible that the OTC inter-dealer brokers have reacted to the 1997 MTS shift, which increased competition between the two markets, by reducing spreads. We note an interesting example concerning competition between the OTC market and MTS. Cantor Fitzgerald, one of the major brokers trading Italian bonds from London, had often used MTS through an intermediary in the past; at the end of 1997, he applied for membership with MTS and started trading large volumes directly on the Italian market in May 1998.

The fourth theoretical prediction that we investigated is the waiting game hypothesis of Foster and Viswanathan. Finding E is consistent with this hypothesis: under anonymity the order flow information of MTS has become less useful to dealers, and they tend to wait longer in order to extract more information. There is a further reason for the slight displacement of the intraday profile of trading volume in period 2. During our sample period the Italian market has become increasingly integrated with the other major financial markets. Among these, the US market is an important source of information and it has been a growing source of investment into the Italian market. Hence, the information and orders that start arriving on MTS from 2.30 p.m. onward, i.e. from the opening of the US market and the release time of most US macroeconomic indicators, have increased over time, and this clearly contributes to the observed shift in intraday trading volume on MTS.

Findings F to L represent in our opinion impressive evidence on the improvement in the performance of MTS in recent years. In interpreting these results, we face an attribution problem. As we argued earlier on, two distinct factors may have played a role, namely the switch to anonymity, a one-time event that took place in the middle of 1997, and the steady progress of public finance of 1996-1997. We tried to distinguish between these two factors, and obtained results that show that the macroeconomic effect accounts for 31 to 63% of the variation in the market performance variables. In the case of the two cost measures, the microeconomic effect is more important. In the case of volatility, the macroeconomic effect takes first place. This is not surprising, since market volatility may be expected to be more sensitive to macroeconomic conditions than trading costs.

An additional factor that may have played a role is the listing of repo contracts on MTS starting in December 1997. Repo contracts on Treasury bonds have been traded among dealers on the OTC market for long before that date. However, cash traders greatly benefited from the inception of repo trading directly on MTS, through a reduction in the cost of setting-up short positions. This may help explain why the speed of price discovery on MTS has increased with respect to the futures market (findings K and L).

From a regulatory point of view, the evidence presented in this paper has several implications. The first implication is domestic. The move to anonymity has furthered the reform process of the Treasury bond market that the Italian regulatory authorities initiated in 1994 (see the Appendix table). This reform was aimed at restoring the competitive role of MTS with respect to the OTC market, by opening up the former to foreign investors, lowering transaction costs and promoting competition among dealers. Since 1994 MTS has greatly increased efficiency and turnover relative to the OTC market. As we have shown, the 1997 shift helped to enhance this competition, affording higher levels of welfare for those who invest in Italian Treasury bonds. The improvement of the secondary market should also have benefited the issuer, through a reduction in the cost of debt servicing. We conclude that the 1997 innovation on MTS has proved successful.

The second regulatory implication follows from the first one. Looking at the Italian Treasury bond market from a more general perspective, we note that the market has made a remarkable progress in just one decade, from an opaque, lowly liquid market with negligible foreign participation to a highly transparent and liquid market with a large participation of international investors. This progress has been similar in nature to developments in other industrialised countries, but in the Italian case it has been more intense. To this extent, MTS has played a key role. The ideas that have underlain the MTS inception and development have proved successful in the medium-term. These ideas are: (i) full automation of the trading mechanism; (ii) transparency; (iii) large participation, (iv) inside and outside competition. We believe that the experience of MTS may be useful for those emerging countries wishing to establish a liquid and efficient financial market in a relatively short time horizon.

In 1998 the market was fully privatised. A major development took place in September 1998, namely the listing of a eurolira 10-year bond issued by the European Investment Bank and of a large group of German government bonds.[19] The listing of sovereign bonds from other countries is also planned. In the perspective of EMU, it has been argued that the likely integration of the European bond markets might imply either a strong cooperation among sovereign issuers, or a "race to benchmark status" (McCauley and White, 1997). In both cases, the role of each country's government bonds within the European market will be positively affected by the liquidity conditions of the domestic market and by the availability of the securities in the portfolios of international investors, even more than by the creditworthiness of the issuer. In this view, the improvement in the liquidity of MTS, along with the decision by the Italian Treasury to convert all outstanding debt in euros on 1 January 1999, places the Italian issues in a strong position among the partner countries' issues.

8. Conclusion

We analysed a change in the organisation of the electronic inter-dealer market for Italian Treasury bonds known as MTS, namely the shift to the anonymity of quotes in July 1997. The implications of this event were investigated in the light of market microstructure theory and from a public welfare perspective. We employed an extensive data-set which includes all transactions carried out on MTS with the identity of the traders, in the period from September 1996 to May 1998. In addition, we used intraday prices for the BTP futures contract traded at LIFFE and for a set of financial instruments that may be viewed as explanatory variables for the dynamics of BTP prices. Our evidence supports the hypothesis that the decrease in transparency makes liquidity traders worse-off, whereas large/informed traders find it less costly to execute block trades. The evidence is also consistent with the "waiting game" hypothesis of Foster and Viswanathan (1996) on intraday trading: under anonymity, traders tend to delay their trades in an attempt to acquire information through the order flow. From a public welfare perspective, our results indicate that the move to anonymity has been accompanied by an increase in market liquidity and by a reduction in volatility, a phenomenon that is also partly explained by the growth in Italy's prospects for early participation in the EMU. The speed of information aggregation on MTS increases, as shown by an improvement of the MTS lead over the futures market. From a regulatory policy perspective our evidence suggests that, despite the welfare loss suffered by small traders, the move to anonymity has afforded an overall improvement in market performance. In this respect, the experience of MTS may be useful for the development of market mechanisms in emerging countries. Finally, in a European perspective, the current organisation and performance of MTS place the market in a competitive position compared to other cash markets for government bonds, and may contribute to a closer integration of these markets under the EMU.

[19] Contracts on these bonds are cleared and settled through international depository entities (Euroclear and Cedel).

Appendix table

The development of the Italian Treasury Bond market in the last decade

	International integration	**Changes in microstructure**	**New instruments**
1988	– Liberalisation of capital flows (partial)	– Inception of MTS – Start of regular reopenings of Treasury auctions – Floor to bid prices abolished for T-bills, uniform price auction introduced for other bonds	
1990	– Liberalisation of capital flows (full)		– Real-time securities transferral at the central depository (Banca d’Italia)
1991	– 10-year BTP futures at LIFFE (London)		
1992			– Inception of the Italian futures market (MIF)
1993	– First US$ global bond issue by the Republic of Italy – Prohibition of direct financing of the Treasury by the Banca d’Italia		– First issuance of 30-year BTPs
1994	– Reform of MTS	– Treasury starts publishing timetable of auctions – Electronic bid submission at auctions – Reserved reopenings for “specialists in government securities” – Continuous trading on MOT, the electronic retail market	
1995			– First issuance of CTZs (2-year zero coupon bonds) – CCT indexation fully matched with contemporaneous 6-month bills
1996	– EU Investment Service Directive made effective		
1997	– Withholding tax abolished for foreign investors – Remote access to MTS for foreign primary dealers	– Monitoring functions to the MTS management board	– T-bond repos start trading on MTS
1998		– First ad hoc reopenings of Treasury auctions	– Book-entry system for all new Treasury issues – Coupon-strips traded on MTS

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