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Order to trade ratios and their impact on Italian stock market quality

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Contents

Order to trade ratios and their impact on Italian stock market quality

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Abstract

Order-to-Trade Ratios (OTRs) are currently being actively considered as a means to reduce the order message traffic generated by High-Frequency Traders without harming liquidity supply. In this short paper, we attempt to supply a guide to the issues involved in the design of OTR schemes for the intention of policy-makers, as well as a preliminary assessment of the impact that the OTR scheme recently implemented by the Italian stock exchange has had on activity and liquidity. We report empirical evidence of liquidity worsening somewhat after the imposition of the OTR constraint.

Remit of this study

This is a pilot study. We first review the policy discussions surrounding order-to-trade ratios (OTRs) as a means to reduce some of the perceived negative aspects of High-Frequency Trading strategies. We then give preliminary empirical evidence on the effects of the implementation of such an OTR on the Italian stock exchange in April 2012.

At the time of writing, the Italian scheme has only been in place for a few weeks. We conducted the empirical part of our analysis under strict time constraints for this study to be part of the body of evidence generated by the Foresight project on "*The Future of Computer-based Trading in Financial Markets*" as it reaches completion. Our aim is to present evidence of whether the Italian change has had obvious effects on simple measures of market quality and activity.

1. Introduction

Order-to-trade (or order-to-execution) ratios involve financially penalising individual financial firms if the orders to buy or sell they enter do not lead to a 'sufficient' number of trades.

OTRs currently attract much interest as a way to curb some of the perceived negative aspects of HFT. Mary Schapiro, head of the US Securities and Exchange Commission, has pronounced herself in favour of OTRs and the EU Parliament has taken a similar position: *"(...) the European Parliament has requested order-to-trade ratios for all trading venues to be included [in current regulatory drafts]. (...) The Parliament's Economic and Monetary Affairs Committee (ECON) (...) has suggested that operators of trading venues ensure a fee is in place for members which exceed an order-to-trade ratio of 250:1, with the charge to be determined by the markets themselves." (The Trade News, 3 April 2012)*

Several exchanges have also announced their intention to limit message traffic by implementing OTRs since the start of 2012. Among them was the Italian exchange (Borsa Italiana, part of the London Stock Exchange Group), which just revised its fee structure to discourage 'excessive' order messages though an OTR. This scheme is the focus of the empirical part of our study.

We first discuss the reasons behind the current widespread appeal of OTRs in the next Section. We then describe the key features of OTR schemes in Section 3, and proceed to the predictions that can be made regarding the impact of the Italian scheme. Section 5 describes

the data we use, Section 6 presents graphical analysis for the treated and control samples and Section 7 gives regression estimation of the event's impact on liquidity and activity. Section 8 presents analysis of cross-sectional aspects.

2. OTR schemes: rationale

OTR schemes seem to enjoy a form of across-the-board support at present. Legislators, exchanges and their regulators and even HFT firms have expressed a keen interest in them. Article 51(3) of the proposed Markets in Financial Instruments (MifiD) II draft states that "Member States shall require a regulated market to have in place effective systems, procedures and arrangements to ensure that algorithmic trading systems cannot create or contribute to disorderly trading conditions on the market including systems to limit the ratio of unexecuted orders to transactions that may be entered into the system by a member or participant (...)".[1] Closer to our study, the Italian OTR scheme was reported to have been adopted by the Milan exchange after they were "prompted" to do so by their regulators.[2]

OTRs appeal to regulators because they target HFT firms in aspects of their liquidity *supply* activity that may both cause "message overload" issues and be used as part of manipulative attempts based on temporary outbursts of order entries and cancellations. Under an OTR constraint, HF traders are expected to enter fewer orders and/or to enter orders having a higher likelihood of execution because they are closer to current traded prices. In American parlance, OTRs are expected to reduce the frequency of "non bona fide" orders. Presumably, proponents of OTRs hope or expect that the schemes would not erode true market liquidity significantly (i.e. buy and sell liquidity close to the best bid-offer).

Note also that the HF liquidity supply that is under focus here is that which is mostly proprietary. OTRs are expected not to significantly constrain traders that execute orders on behalf of large investors, as due to the existence of a pre-determined underlying trade that must be filled, they will consume enough liquidity to keep their ratios low.

Regulators also seem to consider OTRs preferable to the other levers that are available to curtail HFT, such as transactions taxes, minimum order resting times, exchange fee structures, coarser tick sizes, the imposition of continuous market-maker obligations or minimum order sizes. All of these measures can only indirectly attempt to slow down markets.[3] As such, they have likely drawbacks: taxes can be passed on to end investors by liquidity suppliers widening their spreads. Increasing the tick size is a blunt tool that simultaneously affects spreads and depth in opposite ways. Minimum order resting times are difficult to set without risking a

[1] Proposal for a Directive of the European Parliament and of the Council on markets in financial instruments repealing Directive 2004/39/EC of the European Parliament and of the Council, COM(2011) 656 final, 20.10.2011, p. 116.

[2] "Italy to limit high-frequency orders", *Financial Times*, 20 Feb 2012.

[3] This is a reflection of the nature of HFT: it is neither a class of assets that can be regulated separately (like e.g. OTC derivatives), nor a specific trading strategy or market practice (like e.g. program trading in the 1980s, or short selling more recently), nor still a feature of market design that can be directly controlled (like e.g. the degree of order flow transparency).

significant reduction in market liquidity and efficiency, and imposing formal market-making commitments may cause HFT liquidity suppliers to withdraw from liquidity supply altogether.

Finally, from a regulatory standpoint, OTRs may appear less imposed "top down" than some other measures, since they are part of a trading venue's fee structure. They are in a sense related to the 'maker-taker' schemes that have long been heavily criticised by the buy side, as both reward liquidity supply behaviour that leads to an execution. But OTRs attempt to place bounds on the proportion of unexecuted orders and do not create incentives for HF traders to behave as "rebate hogs", potentially elbowing out slower liquidity suppliers. As such they may be better for market diversity.

More surprisingly perhaps, the part of the industry that is targeted by OTRs seems to agree on their value. The European Principal Traders Association, a trade body that represents many HFT firms, recently stated: "FIA EPTA supports well calibrated order-to-trade ratios determined by trading venues to ensure orderly trading on their platforms."[4] The key term here would appear to be "well calibrated".

Such unanimity should have a suspicious ring to it. In fact, regulators and HFTs have very different agendas. Regulators (and institutional investors) are more and more of the view that the unchecked message traffic generated by High-Frequency Trading (HFT) may be imposing costs on other investors with few benefits in terms of liquidity and pricing efficiency. This view is based on the following arguments, amongst others:

- Allowing order flow, especially liquidity supply, to be overly dominated by high-speed traders may harm market quality by reducing the diversity of trading strategies and trading motives that is required for markets to operate well.

- Allowing ever higher order-to-trade ratios may allow certain participants to engage in manipulative behaviour that relies on concentrated order entries and cancellations. Examples are 'quote stuffing', whereby a firm overloads the systems of other participants with messages to delay their access to order flow information, or order book 'layering'. The latter involves a manipulator attempting to lure other traders to one side of the market by supplying fleeting liquidity that is withdrawn before it can be consumed, and then hitting the traders who have been lured on to the book.

- From a public policy perspective, the suspicion is growing that the increase in message traffic forces participants to engage in a socially wasteful "arms race" involving ever more investment in hardware and software. It also likely leads to increases in the costs of monitoring and regulating markets.

HFT agents and some exchanges, on the other hand, see OTRs as disciplining devices to prevent sloppily written computer code from generating pointless order entries and revisions and using excessive bandwidth. This was recently called "Capacity abuse" by Deutsche Börse, which mentioned "stupid algos" that needed to be reined in.[5] The Head of the association of

[4] FIA/EPTA Position on Revised Proposals for Markets in Financial Instruments Directive (MiFID II), May 2012.

[5] Cited in Financial Times, 28 February 2012.

principal traders mentioned above concurs: “In the past, we have seen thousands of 'nonsense' messages and have told exchanges they need to act, (...) We think the more formal and stringent rules coming into force are an excellent step.”[6]

This goal is thus very different to the previous one. It views a high OTR as akin to email spam – irritating more than harmful. OTR schemes have actually been in place for years on some exchanges with specifically that goal in mind. The EU Commission's “Impact Assessment” paper that accompanies the proposed MiFiD II legislation reviews some existing OTR schemes and notes that “The driving force behind these [OTR] fee structures appears to be the additional bandwidth requirements that are associated with high levels of cancelled orders rather than specific concerns about the potential adverse impact on the market and other market participants of high order-to execution ratios.”[7]

3. OTR schemes: key features

In this Section, we highlight the main features of OTR schemes and compare the new Italian scheme with other recently proposed ones on the exchanges operated by Direct Edge and Nasdaq OMX in the US.

The first series of choices involves determining exactly which activity the threshold ratios between orders and trades will apply to. The constraint must apply at the firm level. But beyond this, choices must be made:

- Should OTRs be defined by taking into account a firm’s order flow across trading venues or by individual venue (with, in the latter case, risks of inconsistency across venues and regulatory arbitrage by firms)? The EU Parliament has expressed the view that OTRs should be defined across all venues available but for now, the proposed or actual changes have been implemented by individual venues.

- At the level of a firm, should OTRs be calculated for each of the assets it trades, by class of assets or aggregating the orders and trades of a firm across all the assets it trades? Here, the Italian exchange considers all activity across its main segment called MTA, something similar to the Daily Official List of the London exchange. The OTR will thus be calculated over a cross-section of over 250 stocks, which represent 78% of all listed companies and very close to 100% of total market capitalization and turnover by value. Nasdaq adds the condition that only individual firms sending over one million orders a day in aggregate will be subject to the ratio.

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[6] Mark Spanbroek, cited in "Prop traders call for engagement on message fees", *The Trade*, 16 March 2012.

7 EU Commission Staff Working Paper, “Impact Assessment accompanying the documents ‘Proposal for a Directive of the European Parliament and of the Council on Markets in Financial Instruments [Recast]’ and the ‘Proposal for a Regulation of the European Parliament and of the Council on Markets in Financial Instruments’” SEC(2011) 1226 final, 20.10.2011, p. 165.

- Should OTRs apply to all order events (entries, revisions and cancellations)? Borsa Italiana include all order entries, Direct Edge is targeting all order messages (entries, revisions, cancellations).[8]

- Should the order type matter (e.g. marketable and non-marketable)? Direct Edge and the Borsa include all, whilst Nasdaq focusses only on non-marketable orders, or any order posted outside the National Best Bid and Offer, using a weighting scheme based on order price distance from the NBBA.

- Should the proprietary activity of the firm be separated from its agency business too (if any) for the purposes of OTR calculation? Currently, the exchanges cited would include all business.

Then, a crucial parameter to set is the *time horizon* over which the OTR will be calculated. The longer the time window over which the OTR must hold, the weaker the constraint. At one extreme, the ratio could conceivably be enforced continuously: a small penalty could be slapped any time a firm entered over a set number of orders without a single realized trade. This would obviously be very constraining. Direct Edge want to calculate the OTR and possible penalties by month, while Nasdaq and the Italian exchange compute them on a daily basis, thus reducing the degrees of freedom for a firm to engage in outbursts of quoting activity on some days and make up for those bursts on quieter days.

Then, the value of the order-to-trade ratio itself must be defined. Should a single ratio apply to all assets or should the OTRs be entirely asset specific? Here, the three recent proposals have selected a single ratio of 100:1.[9] Some financial firms have voiced disagreement with this wholesale approach and have argued that ratios should be determined from the level of activity and liquidity in the assets.

Finally, the choice of the *financial penalty* will determine how constraining the scheme will be. Direct Edge intends to cut the rebate it offers to liquidity suppliers, whilst Nasdaq and the Italian exchange are levying a fee. Specifically for our purposes, the Italian scheme defines three thresholds (1, 5 and 10 OTRs) with associated fees (€0.01, €0.02 and €0.025 respectively), and the added condition that fees may not exceed €1,000 per member firm and day.

The upshot of the previous two sections is that an OTR scheme may have two very different goals depending on one's view of HFT activity, leading to very different choices of parameters. Even if the goal is clearly specified and agreed upon, selecting a set of parameters is not likely to be easy. The view expressed in the MiFiD impact assessment paper considers that "This measure would in all likelihood, provided that the ratio is suitably calibrated, only affect the high frequency traders or algorithmic trading activity it is targeted at. Market liquidity and efficiency and the quality of price discovery should not be adversely affected. Assuming that the ratio and the system of penalties is effectively calibrated then risks would be effectively addressed while

8 This can be a function of the order events available. For example, some exchanges don't allow for orders to be revised, they must be deleted and replaced by new ones.

9 Except for very thinly traded stocks in Italy, where the ratio is 40:1. These stocks make up less than 0.5% of all trading interest.

minimising the adverse effect on spreads." This gives no hints as to how the crucial "calibration" should be performed. The concern was expressed during the MiFiD consultation that: "a majority [of Exchanges and market operators] pointed out that this measure was impractical as it would be difficult to prescribe a ratio for all instruments."[10]

4. Predicted impact on activity and liquidity in the Italian case

The flavour of extant empirical evidence very broadly suggests that limitations placed on the ability of HF traders to revise their order entries may be harmful to liquidity. Empirical work has generally found that an increase in HFT has been associated with increased liquidity.[11]

However, it is not easy to determine what impact an OTR scheme will have on activity and liquidity in the cross-section given the difficulties involved in parameterising it. Once implemented, it is likely to require regular fine tuning.

Doubts have been expressed in the financial press as to whether any of the proposed schemes would be more than public relations. Some representatives of the buy side doubt that there are incentives on the part of exchanges to implement measures that genuinely reduce HFT. In the Italian case, the question is whether the combination of an OTR of 100 to 1 and a maximum penalty of €1000 a day will act as a significant financial constraint on firms.

Second, assuming the financial constraint bites, how many stocks will the selected ratio affect in the cross-section? Will firms tidy up their HF trading code so that they generate fewer pointless quote changes, with no impact on liquidity? Or will the OTR cause an HFT liquidity supplier to charge higher spreads as the limits to order revision flexibility it entails makes them more exposed to adverse selection?

How quickly should we expect the new fee structure to impact order submission strategies? It seems that Italian market participants had less time to adapt to the new fee structure than in the US (where it requires regulatory approval). First mentions of the fee structure in the UK financial press appear on 20 February 2012 and the document uploaded to the Borsa Italiana website detailing the new OTR policy is dated 23 February 2012 (effective from 2 April).[12,13] The view has been expressed in the financial press that these fee changes may take time to have an effect on actual trading practices because HF trading code is only modified piecemeal and then thoroughly tested.

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[10] Proposal for a Directive of the European Parliament and of the Council on markets in financial instruments repealing Directive 2004/39/EC of the European Parliament and of the Council, COM(2011) 656 final, 20.10.2011, Annex 13, Summary of the replies to the public consultation, p. 308.

[11] Examples are Hasbrouck and Saar (2010), Hendershott, Jones, and Menkveld (2011) and Menkveld (2011). Similar evidence generated by the Foresight project includes DR1 by Linton and DR5 by Friederich and Payne.

[12] See e.g. "Italy to limit high-frequency orders", FT, 20 Feb 2012; "Sweden plots HFT surveillance as Italy plans penalty", *The Trade*, 21 February 2012.

[13] Borsa Italiana, *Price list for trading services*, version dated 23 February 2012, in force as of April 2nd, 2012.

We also note that HFT behaviour may have adapted ahead of the change. The FT has just reported evidence suggestive of this occurring in the US, even though a US constraint on Order to Trade Ratios is only at a discussion stage, and requires regulatory approval:

> "Fewer messages are being blasted at US stock exchanges by high-speed traders ahead of pending rule changes that penalise some automated trading activities. (...) 'Since the Securities and Exchange Commission and many exchanges have announced their intention to more closely scrutinise such practices in early March, this has had a dramatic and very noticeable change in quote traffic'" (Financial Times, 10 April 2012)

Similar spontaneous adjustment may have occurred pre-event in Italy. Depending on one's view of HFT, it could be consistent with either HF players switching to cleaner and less noisy quoting practices or consistent with the fact that a number of order entries were used for inappropriate purposes.

Finally, there may be easy ways for some firms to get around the constraint by generating small trades to increase the denominator of the ratio, as it is not defined in terms of quantities traded but just number of trades. This concern was voiced by some trading venues during the MiFiD consultation: "Some argued that limiting ratios of orders could also have some unintended negative effects. For example, it may encourage participants to generate additional trades for the purpose of reducing the ratio." [14]

The arguments reviewed in the previous three sections suggest to us that strong priors regarding the effect of the OTR scheme are difficult to form. The effect of the proposed OTR is essentially an empirical matter.

5. Data

We construct a treated and a control sample of stocks. The treatment sample consists of over 60 of the most liquid shares listed on the Italian stock exchange (Borsa Italiana, part of the London Stock Exchange Group). This sample comprises the 40 stocks that are components of the leading FTSE MIB index. The bulk of trading interest in Italian shares is very concentrated in a few names. The top five stocks make up more than 50% of total turnover by value, with a single bank (Unicredit) representing 20%. The 40 components of the FTSE MIB index represent over 90% of all trading action.[15] Therefore, taken together, the 64 stocks in our sample represent at least 95% of Euro turnover in all listed Italian shares.

Our second sample covers the Eurostoxx 50 index constituents that are not Italian (44 stocks), and serves as a control sample allowing us to separate any effects occurring in Italian stocks from changes that might impact European stocks more broadly.

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[14] Proposal for a Directive of the European Parliament and of the Council on markets in financial instruments repealing Directive 2004/39/EC of the European Parliament and of the Council, COM(2011) 656 final, 20.10.2011, Annex 13, Summary of the replies to the public consultation, p. 308.

[15] Source: Borsa Italiana monthly statistics bulletin, April 2012.

We collected data covering the period February 1st 2012 till April 23rd 2012. As the OTR penalty regime was introduced on April 2nd 2012, this gives us as many as two calendar months of data before the event and around three calendar week of data after the event (some post-event days of data are lost though, as Easter falls in this period).

For each stock-day we collected data sampled on a minute-by-minute frequency during normal trading hours and have averaged these data (with equal weighting) to give daily figures. We have data for the following variables:

- Bid-ask spreads (in basis points)
- Depth (within a minute bin, we take all observations on bid depth, measured as shares multiplied by price, and all observations on ask depth and compute an average equally-weighted across the bid and ask.)
- Number of trades
- Number of quotes (where a quote is defined as a change in either the best bid or ask, or in the sizes at the best bid or ask)[16]

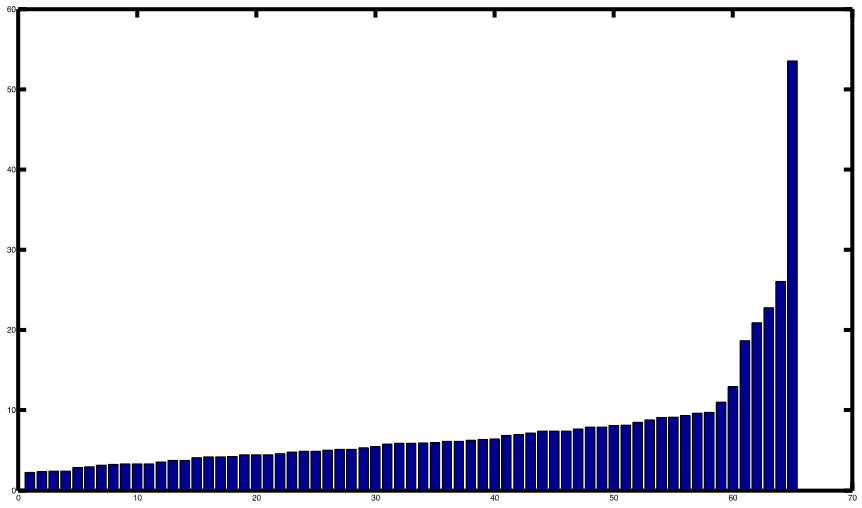
Note that our proxy for order entries and revisions is different to the definition of an order event used in the computation of the OTR by Borsa Italiana. However, we use "quote-to-trade" ratios (QTRs) to proxy OTRs in our analysis. This will serve as a good proxy for most purposes except that it prevents us from determining whether the OTR policy represents a biting constraint in our stocks.

For each stock we normalize the scale of the data by dividing each series by its mean value in February. Thus, all of our scaled data points are roughly around a unit level.

In the Appendix, we present in Table A1 some descriptive statistics for the individual securities comprised in both the main and the control samples. From the mean values of spreads, depth, number of quote revisions and trades, it is clearly the case that the main sample (Italian) stocks exhibit significant cross-sectional heterogeneity. To present further cross-sectional evidence for our Italian sample stocks, we break the entire sample into three non-overlapping subsets of QTRs. Figure 1 shows a plot of the sorted cross-sectional distribution of QTRs for our sample stocks in the month of February 2012;

16 We also require that the bid is less than the ask quote, that there has been at least one trade in the day and that the bid and ask sizes are both positive.

Figure 1



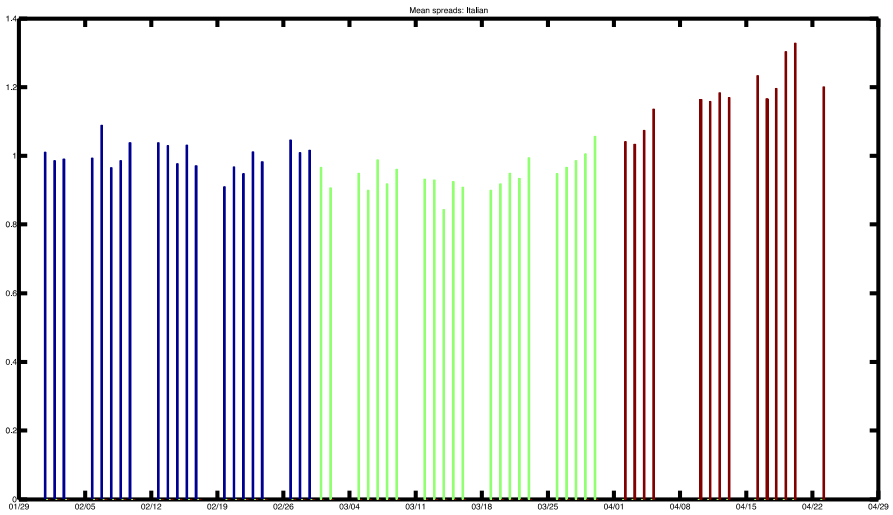
The QTRs increase relatively smoothly until we reach the 7 largest stocks, reflecting the highly skewed distribution of trading volume mentioned above. We create a high QTR subset from this group of 7 stocks and split the rest of the cross-section into two equally-sized subsets containing low and medium QTRs respectively.

6. Graphical analysis

6.1. Treatment sample stocks

Figure 2 shows a plot showing the evolution of cross-sectional mean bid-ask spreads throughout our sample period. Dates corresponding to February, March and the post-OTR period are coloured differently to enable easy identification of relevant sub-periods. Blue bars represent data points from February, green bars are data points in March and red bars are data points in the post-OTR period.

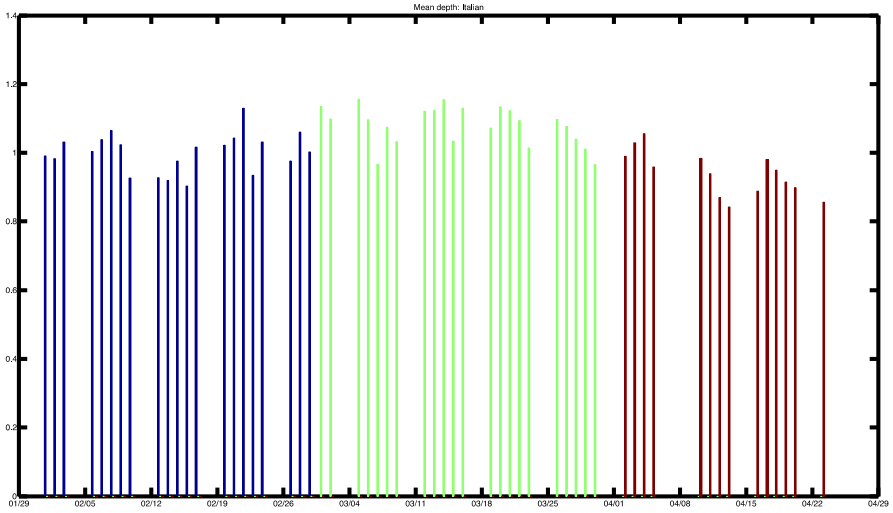
Figure 2



While the time-series variation in cross-sectional mean spreads is slight, there is a notable rise in spreads in the post-OTR period, of the order 10 to 20%. This is suggestive of the OTR regime making liquidity supply less attractive. However, note that we have made no attempt at controlling for market conditions here. Perhaps the post-OTR period is characterized by larger market volatility, which could generate wider spreads.

Conversely, if anything Italian stock depth seems to drop during the post-OTR period by around 10% (Figure 3). Again, this suggests that liquidity supply activity is curtailed after the introduction of the OTR.

Figure 3



Similar plots for the number of trades and the number of quotes (Figures 4 and 5) yield the following conclusions. The level of trading activity seems pretty much constant across the sample while, if anything, quoting intensity seems to *increase* in the post-OTR period. It is unlikely that this latter result is in line with the wishes of regulators and it is not clear how it squares with the introduction of OTR-based penalties.

Figure 4

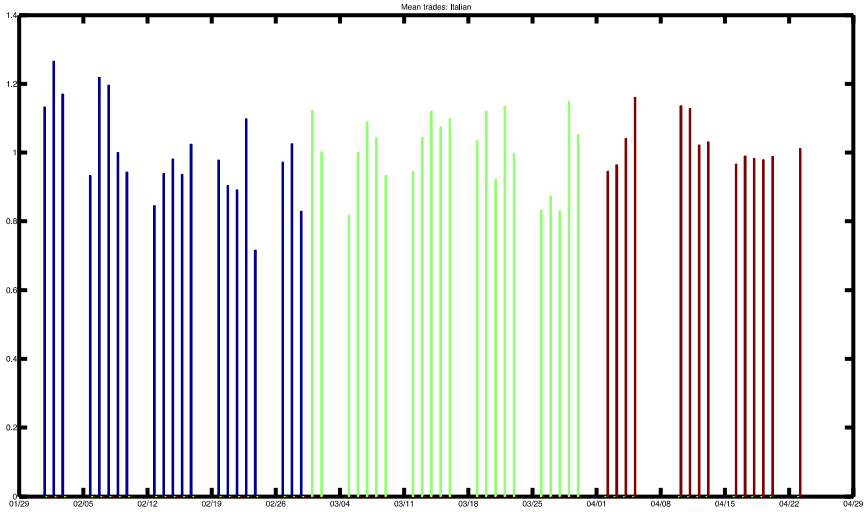
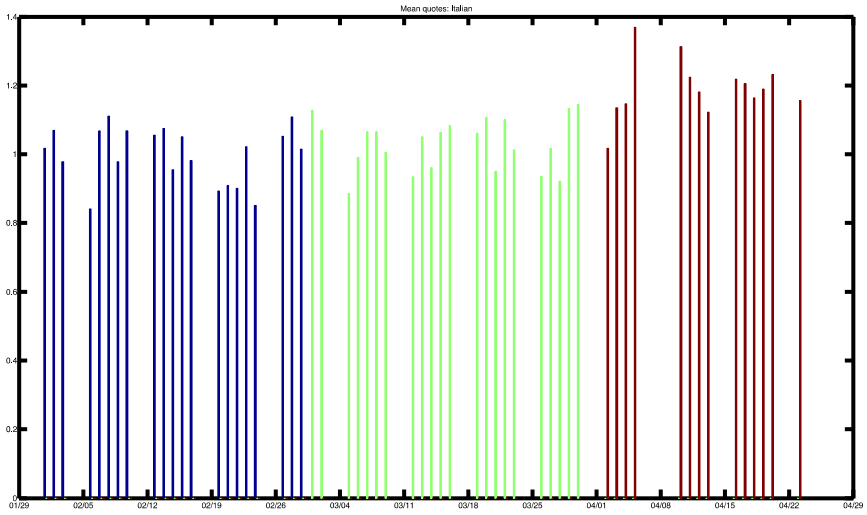


Figure 5



6.2. Control sample stocks

Figures 6 to 9 present identical data for our control sample. It is worth noting that the control sample stocks are in general much more liquid than the Italian sample stocks as they consist of the constituent stocks of the EuroStoxx 50 index, which are (roughly speaking) the 50 largest market caps stocks in Europe.

Figure 6

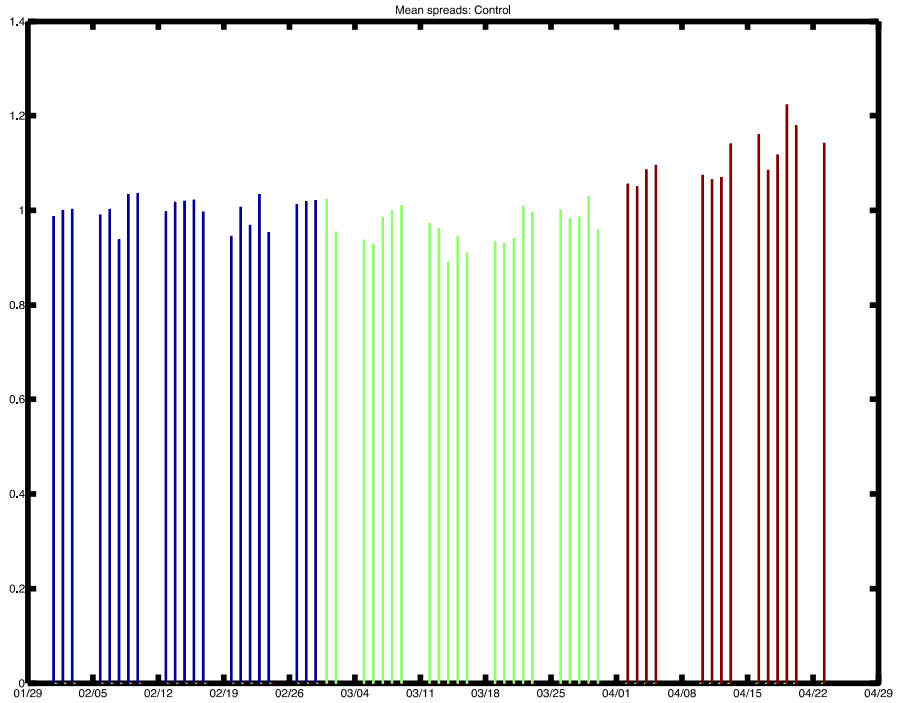


Figure 7

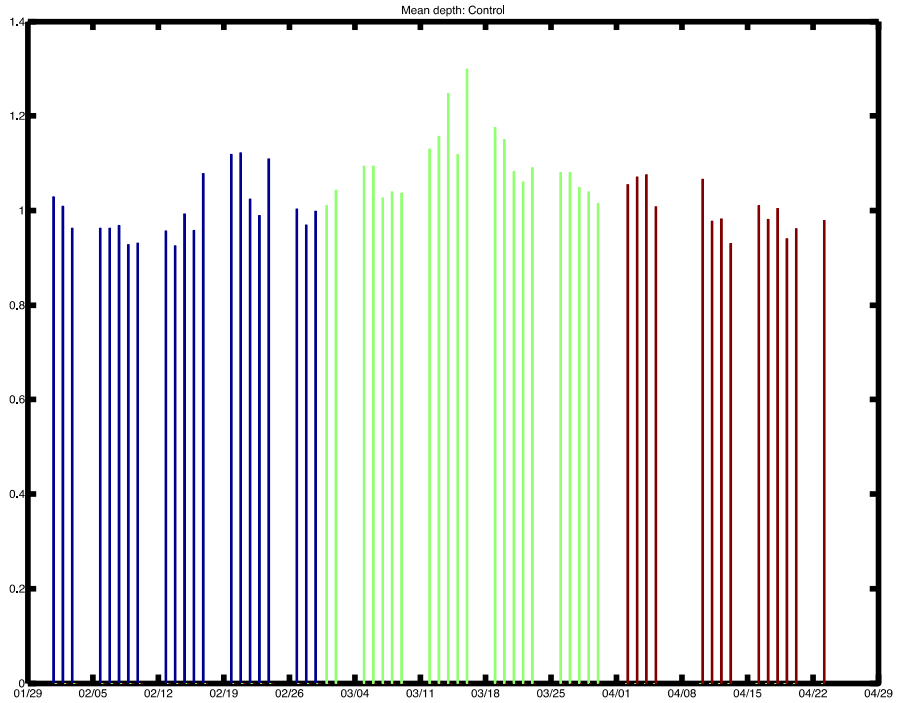


Figure 8

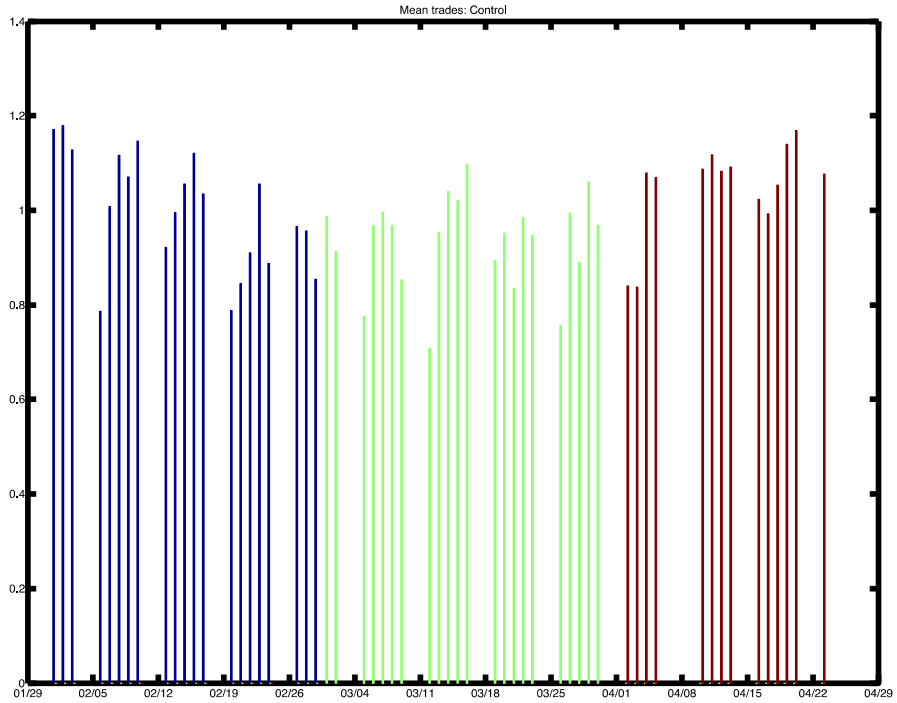
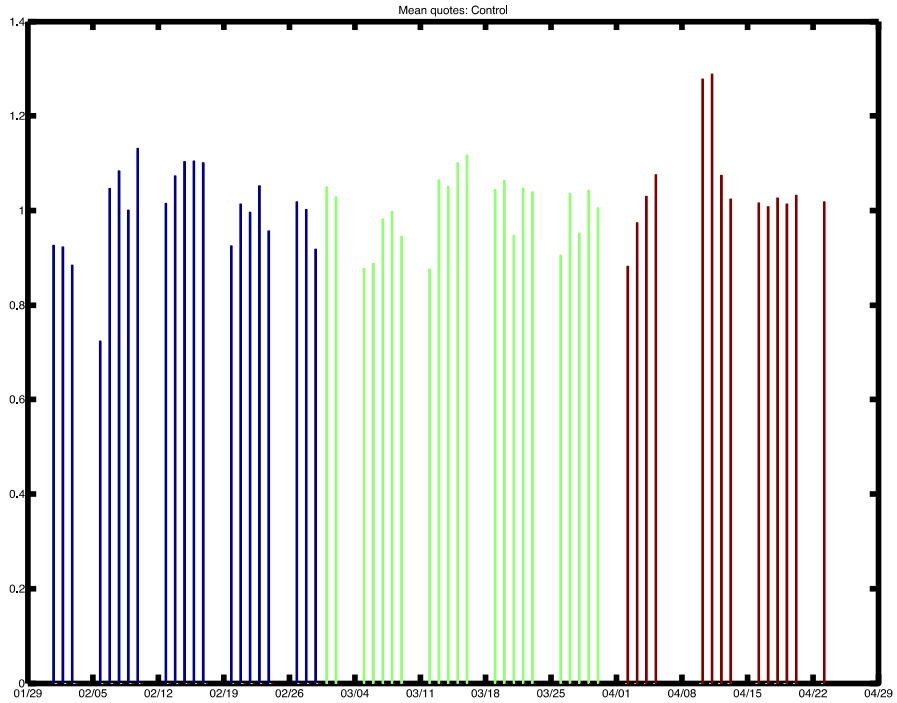


Figure 9



Figures 6 to 9 present evidence that the patterns that we saw above for spreads, depth, trades and quotes are replicated in this set of non-Italian stocks. Thus, on the face of things there appears to be very little evidence that market quality in Italy changed relative to that in other markets. Our results suggest that if liquidity supply did change in Italy it might well have been a result of changes in market conditions in Europe more broadly, rather than the introduction of the OTR.

7. Regression analysis

A simple panel regression analysis will help us to formalize the preceding graphical evidence. Here we have run difference-in-difference panel regressions including our main and control sample stocks. We regress our chosen market quality metric on a constant, a dummy variable picking out the treatment group of Italian stocks (Main), a dummy picking out the period after the OTR penalty introduction (Post) and the interaction of those two dummies (Main × Post). We also include controls for market-wide return volatility and stock-level trading activity (as measured by the number of trades per day).

In Appendix Table A2, we show empirical correlation matrices for our regressors. All correlations are on the low to very low side, with the exception of that between quotes and trades.

If there is any difference in the behaviour of the variable for main and control sample stocks in the OTR penalty period, it will show up as a significant coefficient on the (Main × Post) interaction variable. Thus, this coefficient is where the focus of our attention should be. Results of our estimations are contained in Table 1.[17]

Table 1. Regression analysis of the OTR introduction

	Spread		Depth		Quotes	
	Coeff	*t-stat*	*Coeff*	*t-stat*	*Coeff*	*t-stat*
Constant	1.0532	65.474	0.9854	44.064	0.6237	15.832
Main	-0.0094	-0.9862	-0.0113	-0.7030	0.0028	0.2040
Post	0.1332	6.4531	-	-2.4718	0.0209	0.7488

[17] Note that, as in our plots, data for each sample stock is standardized by scaling it by its mean value during February. Thus, all data is roughly centered on unity and so we do not include any fixed effects in our panel regression.

	Spread		Depth		Quotes	
			0.0550			
Main × Post	0.0674	2.5845	-0.0523	-1.9299	0.1477	3.3813
Volatility	-0.0005	-0.0725	0.0046	0.6873	-0.0010	-0.1133
Trades	-0.0712	-4.9616	0.0617	3.7646	0.3883	9.9707
R^2	0.16		0.03		0.35	

Notes: results from difference in difference regressions for main sample versus control sample market quality measures. Regression uses least squares and reported t-statistics are clustered by stock and day.

A first thing to note is that the depth regression has relatively low explanatory power. The fact that the right-hand side data variables are centered on unity for both treatment and control sample stocks is reflected in the constant term in each regression being close to 1 and also in the very small magnitudes and lack of significance for the 'Main' dummy.

The coefficients on the 'Post' dummy show how our market data for control sample stocks change in the OTR penalty period. While trades are hardly affected, there are statistically significant increases in spreads (of around 12%) and a more modest mean reduction in depth. Both of these effects are significantly different from zero at, at least, a 5% significance level.

The key remaining question is whether our main sample stocks showed similar changes in market liquidity in the period after Borsa Italiana introduced their OTR regime. The Table suggests that the answer to this question is in the negative. Consider the 'Main*Post' dummy coefficient in the spreads regression. It is positive and significant, indicating that treated sample spreads were significantly wider in the post-OTR period than control sample spreads. The same is true for that coefficient in the quotes regression, while depth in control sample stocks fell by more than that for main sample stocks. All of these effects are statistically significant at the 10% level at least.

Thus, the post-OTR period saw significantly lower liquidity for Italian stocks (as measured by spreads and depth) that was not matched by lower liquidity in non-Italian stocks. This suggests that the OTR regime may well have reduced the incentives for liquidity supply to Italian stock markets. Somewhat puzzlingly, though, quoting activity on the Italian book appears to have increased and also to have relative to that for non-Italian stocks in the OTR period. While it is

worth noting once more that our quotes measure is not identical to a measure of limit order flow, interpretation of this specific result is less obvious.

8. The cross-section of main sample stocks

A final question we analyse is whether changes in market variables were different in the cross-section of Italian stocks. Using the three subsets of heavy, medium and low QTR stocks described above, below we show the evolution of mean spreads and mean depths over our sample period. We might expect that the OTR regime might have had more dramatic effects on stocks with larger QTRs. (This prediction appears in the financial press.)

However, Figures 10 and 11 indicate virtually no discernible difference in the time series behaviour of the three subsamples, for either spreads or depth. Thus there is no evidence for the OTR penalties affecting more active stocks to a greater extent than less active stocks.

Figure 10

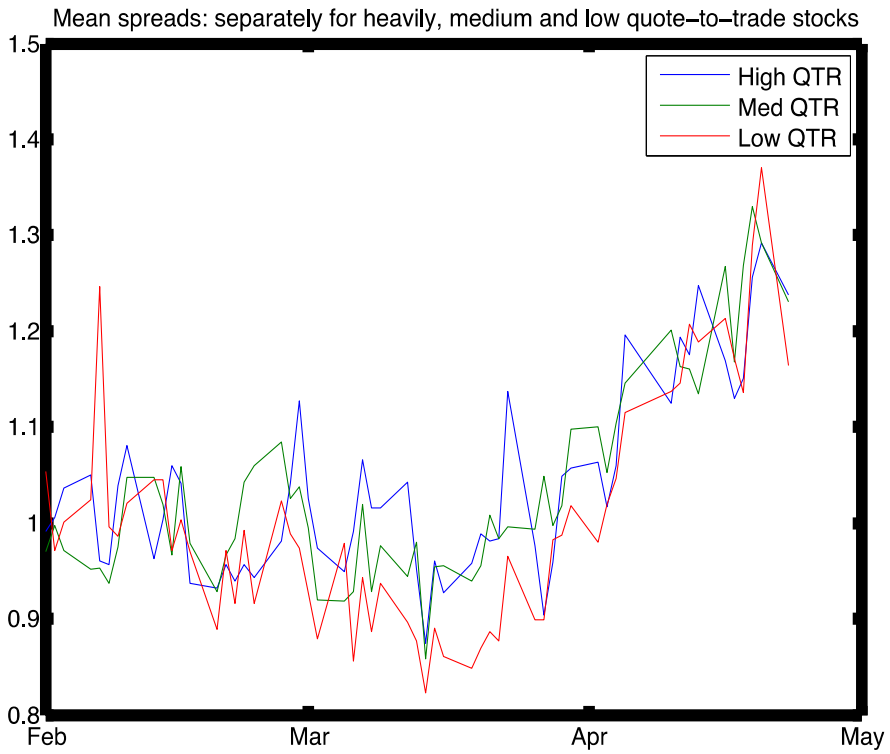
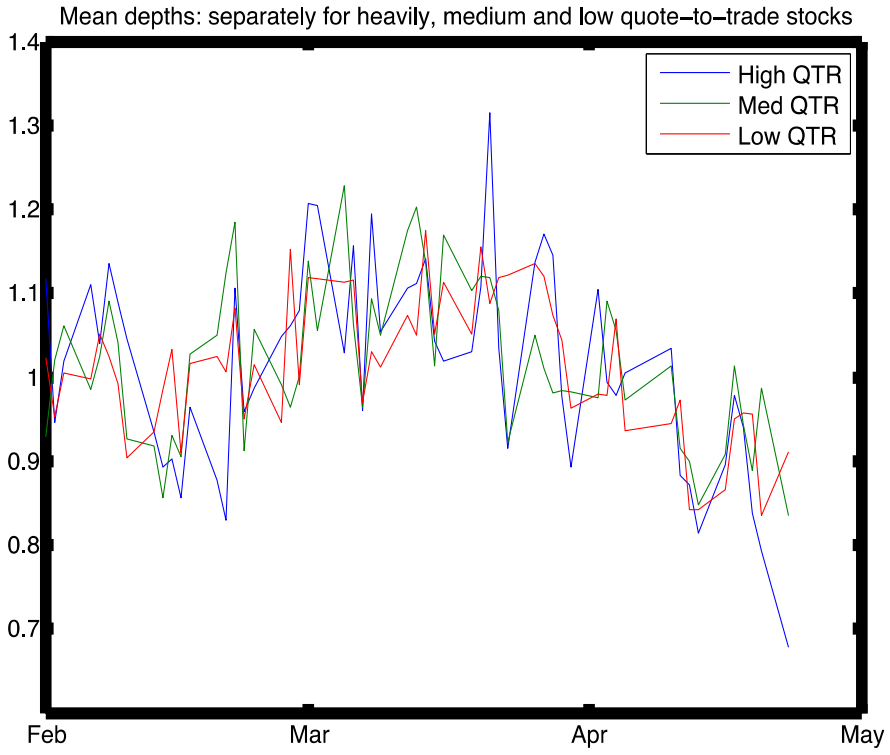


Figure 11



To verify this result, we conducted regressions involving the same variables as in the previous specification (Table 1) but this time splitting the sample in half by liquidity (using mean spreads computed before the event). The results previously reported are confirmed for the more liquid half of the sample, but the significance is lost for the less liquid ones – that is, there is no significant change in spreads and depth after the event for less liquid securities, consistent with the OTR constraint not 'biting'.

9. Conclusion

OTR schemes currently seem to be popular amongst pro and anti HFT constituencies alike. These individual parties seem to have very different ideas in mind, however. Some see OTRs as a means to reduce HFT spam by more careful coding of trading scripts, whilst others support the ratios as a way to prevent what they consider HFT-driven abuse like quote-stuffing.

We draw attention to the fact that these are quite different goals and participants should be very explicit regarding which one they intend to pursue when designing and implementing an OTR scheme.

We also highlight the fact that even when the goals of Order-to-Trade ratios are made clear, they are difficult to calibrate given the large number of parameters involved, and there may be easy ways for HFT firms to prevent them from achieving their intended effects (e.g. by generating a few more executions in very small size). Therefore we would treat the current enthusiasm for OTRs with a great deal of caution.

Our preliminary analysis of the effects of the Italian OTR penalty regime on market quality is consistent with the following:

- Spreads in Italian stocks increase in the OTR regime and, further, they increase relative to control sample stock spreads.
- Depth in Italian stocks falls in the OTR regime and also falls relative to that for control sample stocks.
- There is no clear effect on the number of trades in those stocks.
- Somewhat counter-intuitively, quoting activity in Italian stocks increases in the OTR regime and also increases relative to control sample stocks.
- There is evidence that the effects of the OTR penalty system differ in the cross-section of stocks. The liquidity of smaller shares appears less or not at all affected by the OTR constraint. Given that the ratio is set to an identical value for all securities, the constraint may not affect less liquid shares.

Of course, several caveats are in order here. Our sample period following the introduction of the OTR penalty regime is very short, covering only a couple of trading weeks. Second, our control sample stocks are not matched to our Italian stocks in any meaningful way. We simply use a set of liquid non-Italian stocks as a control sample without attempting to pair treated and control sample stocks by, say, industry or size. Yet, our comparison with the control sample indicates that any changes we detect were not likely to be the result of broad factors like macro uncertainty or other issues that affected other European markets at the same time.

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Appendix

Table A1. Descriptive statistics for the main and control sample stocks

Panel (a): Treated Italian stocks (depth, quotes and trades are expressed in thousands of units)

Stock	Spread (bp)	Depth	Quotes	Trades
A2	16.37	27.57	5.14	0.85
ACE	25.74	8.48	1.13	0.16
ADMI	39.53	5.59	2.51	0.75
AGL	13.99	32.20	5.03	0.66
AMPF	25.50	8.10	1.64	0.31
ATL	12.50	78.69	6.94	0.90
ATMI	28.44	7.79	1.11	0.19
AZMT	24.19	24.95	3.57	0.55
BAPO	18.15	37.77	7.53	1.88
BMPS	11.82	22.72	10.32	4.08
BNSI	43.25	4.49	3.05	0.29
BPSI	27.84	14.64	1.66	0.34
BZU	18.01	22.82	4.84	0.70

Stock	Spread (bp)	Depth	Quotes	Trades
CASS	55.54	5.12	1.25	0.10
CIRX	26.90	6.09	1.56	0.37
CLED	193.90	1.69	0.72	0.03
CPRI	15.62	51.38	4.75	0.56
CRDI	7.19	137.14	19.06	7.22
CRGI	21.52	12.66	2.79	0.85
EDN	10.46	23.63	1.08	0.24
EMBI	43.63	5.54	1.52	0.23
ENEI	8.09	288.49	14.36	3.35
ENI	6.33	403.51	15.19	2.40
ERG	24.67	8.50	1.50	0.32
ESPI	48.74	4.09	1.11	0.10
EXOR_p	46.07	7.65	1.33	0.08
FIA	8.71	63.98	12.84	3.64
FOSA	39.36	8.85	2.76	1.03
GASI	12.01	179.55	10.33	2.02

Stock	Spread (bp)	Depth	Quotes	Trades
GEMI	38.26	5.21	0.86	0.15
GEO	28.94	8.08	1.73	0.34
HRA	20.82	10.45	1.28	0.29
IND	26.80	7.63	2.20	0.42
IPGI	17.21	36.99	4.85	0.83
ISP	9.38	148.91	16.42	4.56
ITAI	27.71	7.80	1.47	0.27
LTO	16.67	34.43	4.46	0.64
LUX	10.28	37.28	5.75	0.83
MDBI	15.46	29.93	6.96	1.41
MED	23.82	22.72	4.10	0.61
MOED	52.64	4.63	1.48	0.16
MS	15.50	44.06	6.93	1.11
PCRE	47.79	4.88	2.00	0.54
PECI	11.98	63.86	7.63	1.50
PGIT	64.86	5.56	1.45	0.56

Stock	Spread (bp)	Depth	Quotes	Trades
PIA	27.88	9.90	1.48	0.38
PLT	19.53	16.15	2.83	0.46
PMII	17.91	24.01	8.05	2.24
RCSM	78.15	3.07	0.98	0.09
RECI	20.68	13.73	1.50	0.32
SFLG	33.74	6.83	1.25	0.22
SIFI	14.42	36.16	8.08	2.02
SIS	22.80	10.12	1.46	0.30
SNAI	94.41	3.59	1.29	0.04
SORN	25.43	8.13	1.40	0.32
SPMI	7.00	49.23	9.03	1.62
SRG	9.44	70.98	6.96	0.86
SRS	27.55	10.15	2.42	0.64
TCM	54.02	2.14	0.65	0.18
TIS	40.23	7.58	0.96	0.41
TLIT	9.92	81.91	9.91	1.76

Stock	Spread (bp)	Depth	Quotes	Trades
TOD	15.52	40.81	4.69	0.71
TRN	10.98	80.87	6.33	0.74
UBI	17.84	31.42	7.25	1.36
UNPI	47.72	7.19	2.14	0.55

Panel (b): Control sample stocks (the letters after the period in each security identification code indicate the main exchange the security is traded on)

Stock	Spread (bp)	Depth	Quotes	Trades
AAL.L	5.45	3144.74	20.79	2.88
ABBN.VX	6.79	254.51	11.29	1.69
ALVG.DE	3.78	41.98	17.75	3.68
AXAF.PA	7.17	61.79	12.71	2.68
AZN.L	3.39	4304.53	14.44	2.12
BARC.L	6.62	2438.84	21.40	3.33
BASFn.DE	3.58	61.47	18.93	3.77
BATS.L	3.36	4107.01	13.82	2.19
BAYGn.DE	4.39	51.48	15.66	2.68
BBVA.MC	5.04	52.44	21.30	4.79

Stock	Spread (bp)	Depth	Quotes	Trades
BG.L	5.98	5202.94	11.43	1.51
BLT.L	4.97	5687.74	21.80	3.08
BNPP.PA	5.32	38.86	21.80	5.12
BP.L	2.88	2677.36	19.29	3.20
CSGN.VX	7.90	132.01	14.09	2.20
DAIGn.DE	3.72	37.29	19.53	4.78
DBKGn.DE	4.11	39.85	20.46	5.10
DGE.L	5.37	6933.61	9.79	1.27
DTEGn.DE	3.04	39.09	14.46	3.12
EONGn.DE	5.27	86.55	15.57	2.78
ERICb.ST	8.49	1725.85	9.42	1.64
FTE.PA	6.20	103.66	11.33	2.05
GSK.L	4.99	11688.62	12.12	1.73
GSZ.PA	5.50	60.73	15.37	2.55
HSBA.L	3.71	3742.54	18.21	2.86
IBE.MC	5.56	45.90	12.90	2.87

Stock	Spread (bp)	Depth	Quotes	Trades
ING.AS	5.19	42.62	17.78	4.56
NESN.VX	9.09	4176.84	9.24	1.61
NOK1V.HE	7.73	93.45	14.08	3.57
NOVN.VX	8.08	2143.49	9.16	1.67
RDSa.AS	2.71	115.74	12.80	2.51
RIO.L	4.51	3382.11	22.14	3.72
ROG.VX	6.87	853.86	9.30	1.74
RWEG.DE	4.18	33.60	16.03	3.23
SAN.MC	4.23	62.71	23.18	7.18
SAPG.DE	3.61	58.63	13.32	2.95
SASY.PA	3.37	81.07	14.48	2.52
SIEGn.DE	2.68	51.68	18.63	4.11
SOGN.PA	7.62	46.01	19.58	4.40
TEF.MC	5.03	156.97	14.82	3.96
TOTF.PA	2.65	61.96	18.63	4.28
TSCO.L	3.14	2407.40	14.15	2.33

Stock	Spread (bp)	Depth	Quotes	Trades
UBSN.VX	9.28	324.54	11.52	1.94
UNc.AS	3.11	83.20	11.63	2.23
VOD.L	3.99	11176.95	15.77	2.31

Table A2. Correlation matrix of regressors, main and control sample stocks

Panel (a): Italian sample				
	Spreads	Depth	Quotes	Trades
Spreads	1.000	-0.273	0.031	-0.214
Depth	-0.273	1.000	0.050	0.153
Quotes	0.031	0.050	1.000	0.651
Trades	-0.214	0.153	0.651	1.000
Panel (b): Control sample				
	Spreads	Depth	Quotes	Trades
Spreads	1.000	-0.178	-0.069	-0.118

Panel (a): Italian sample				
Depth	-0.178	1.000	0.069	-0.056
Quotes	-0.069	0.069	1.000	0.596
Trades	-0.118	-0.056	0.596	1.000

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