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Curbing the Growth of Stock Trading? Order-to-Trade Ratios and Financial Transaction Taxes[◊]

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Abstract: The growth of financial markets provokes regular debate, particularly in Europe, and in the aftermath of the global crisis a number of reforms have been proposed. In particular, two regulatory measures have been put forward: order-to-trade ratios and transaction taxes. This paper aims to quantify the impact of such initiatives. To do so, I consider market liquidity and volatility in the Italian Stock Exchange (*Borsa Italiana*) over the 2011-2013 period, which provides a unique opportunity for empirical assessment: first, a penalty for high order-to-trade ratios (OTR) was implemented in April 2012; second, a transaction tax on securities (STT) was introduced in March 2013 on Italian large and mid-caps; third, this tax was extended to derivatives in September 2013 (FTT). No other country has gone so far in terms of financial market regulation. I identify causality via a difference-in-difference approach (with German firms and Italian small caps, when appropriate, as control groups) and a regression discontinuity design. I find that neither the OTR nor the STT/FTT had a meaningful impact on market liquidity or volatility. There was however a substantial drop in OTC trading.

Keywords: Financial transaction tax, Securities transaction tax, Tobin tax, Order-to-trade ratio, High-frequency trading, Liquidity, Volatility, Italian Stock Exchange, *Borsa Italiana*.

JEL Classification: G21, H25.

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1. Introduction

The increase in securities trading over the past few decades has been spectacular. In the US in 2010 the value of stocks traded was €43,000 billion, which is four times annual GDP. It was "only" €1,500 billion – or 30% of GDP – twenty years earlier. In Europe, the level of stock trading is lower, but the growth has also been exponential. Between 1990 and 2010, the value of stocks traded in terms of percentage of GDP increased from 9% to 169% in France, from 29% to 145% in Germany, from 4% to 91% in Italy, from 8% to 180% in Spain, and from 27% to 245% in the UK (see Table 1).

Such growth has attracted a great deal of attention, especially in the aftermath of the global financial crisis, and there continues to be lively debate over its impact on the economy. On the one hand, this growth can be viewed as an increase in liquidity, and might reflect the better execution of orders for clients. On the other hand, some consider that this growth is excessive, for the sole benefit of the financial sector itself and socially useless, if not damaging. The debate is still open, but has given rise to a number of initiatives aimed at curbing the growth of stock trading. These initiatives should be interpreted as precautionary measures against increased systemic risk, which might be triggered by the overloading of the systems of trading venues, overreaction, erroneous algorithmic trading, etc.

Table 1. The growth of stock trading over three decades

The data come from the World Bank (Standard & Poor's, Global Stock Markets Factbook and supplemental S&P data) for 1990 and 2000, and from Thomson Reuters (Monthly Market Share Reports) for 2010.

	France	**Germany**	**Italy**	**Spain**	**UK**	**US**
Stock traded, total value (€ billion)						
1990	98	421	36	34	234	1,469
2000	1,081	1,067	777	984	1,831	31,789
2010	3,016	3,330	1,307	1,737	3,900	43,482
Stock traded, % of GDP						
1990	9.4	29.3	3.7	7.9	27.3	29.3
2000	81.7	56.7	70.5	169.9	122.9	309.7
2010	168.7	144.6	91.2	180.0	244.8	417.1

How effective have these initiatives been? Did they have a negative effect on market quality? Did they deter speculative trading? And what has been the effect on market volatility? To answer these questions, I focus on the case of Italy. This focus results from the numerous regulatory changes that have been applied to the *Borsa Italiana* since 2012 (described in detail in the following section). First, an order-to-trade ratio (OTR) was applied to all exchange members in April 2012: for each member, financial penalties are due if the OTR exceeds 100:1. Second, a securities transaction tax (STT) was introduced in March 2013: this tax is due on the net daily balance of transactions on the same security if the market capitalization is over €500 million, as well as on high-frequency trading in these securities. Third, this STT evolved into a financial transaction tax (FTT) which was extended to equity derivatives in September 2013. One should note also that the tax rate of the Italian STT is higher for over-the-counter transactions, than for trades executed on a regulated market or multilateral trading facility MTF (0.22% against 0.12%, respectively, in 2014). This series of events and the differences in taxation provide a unique opportunity to undertake a global-impact assessment based on quasi-experiments.

In this paper, I examine and compare the impact of these regulatory initiatives on market quality – namely market liquidity and volatility. To investigate rigorously the causal impact of these measures, I rely on the difference-in-difference method (DiD) and a regression discontinuity design (RD). I consider a number of control groups, composed of German stocks and, when appropriate, Italian small caps. I also appeal to a wide range of proxies for liquidity (which is poorly measured by traded stock value) and volatility.

This paper is partly related to the literature on the impact of high-frequency trading (HFT). Biais and Foucault (2014) survey a dozen of pieces of work and conclude that there is no evidence of a significant effect of computerized trading on market quality. There is very little work on the impact of OTR. Friederich and Payne (2015) is particularly relevant in the context of this study, as it refers to the Italian stock market, although they do not consider the impact of OTR on volatility. There are also a number of recent papers on the impact of the STT in France (Becchetti, Ferrari and Trenta, 2013; Capelle-Blancard and Havrylchyk, 2013; Colliard and Hoffman, 2013; Haferkorn and Zimmermann, 2013; and Meyer, Wagener and Weinhardt, 2013) and Italy (Coelho, 2014). All of these (unpublished) papers use a similar method, albeit only few consider the impact on volatility. Above all, none of these papers examine the impact of a tax which applied to derivatives (while this issue is the stumbling block in the European debate) and their research design does not allow them to distinguish the effects of OTR, STT and FTT.

Hence, this paper contributes to the literature in a number of ways. First, it provides new empirical evidence about the impact of FTT to the burgeoning literature based on DiD and RD. Second, it compares the effectiveness of two regulation devices: a quota-system based on the amount of financial orders with penalties above a threshold (OTR) *versus* a tax on financial transactions (STT/FTT). Third, it delivers unique results concerning the taxation of transactions on equity derivatives.

This paper shows that neither the OTR nor the STT/FTT meaningfully reduced market liquidity or volatility. More precisely, there was a transitory decrease in trading volumes on the Italian Stock Exchange following the introduction of the STT, partly compensated by a subsequent rise when the tax was extended to derivatives trading. However, there was no net impact on the bid-ask spread or the liquidity ratio, and a negative effect (if any) on volatility. The main consequence of the Italian STT was a substantial drop in OTC trades, consistent with a higher tax rate. These results are robust to different control groups and Regression Discontinuity analysis. These results help us to understand the regulatory reforms undertaken following the financial crisis.

The remainder of the paper is structured as follows. Section 2 describes the data, the empirical strategy and the construction of the liquidity and volatility measures. Section 3 then reports the empirical results, and Section 4 presents a number of robustness tests. Last, Section 5 concludes.

2. Data and methodology

2.1. The Italian Stock Exchange

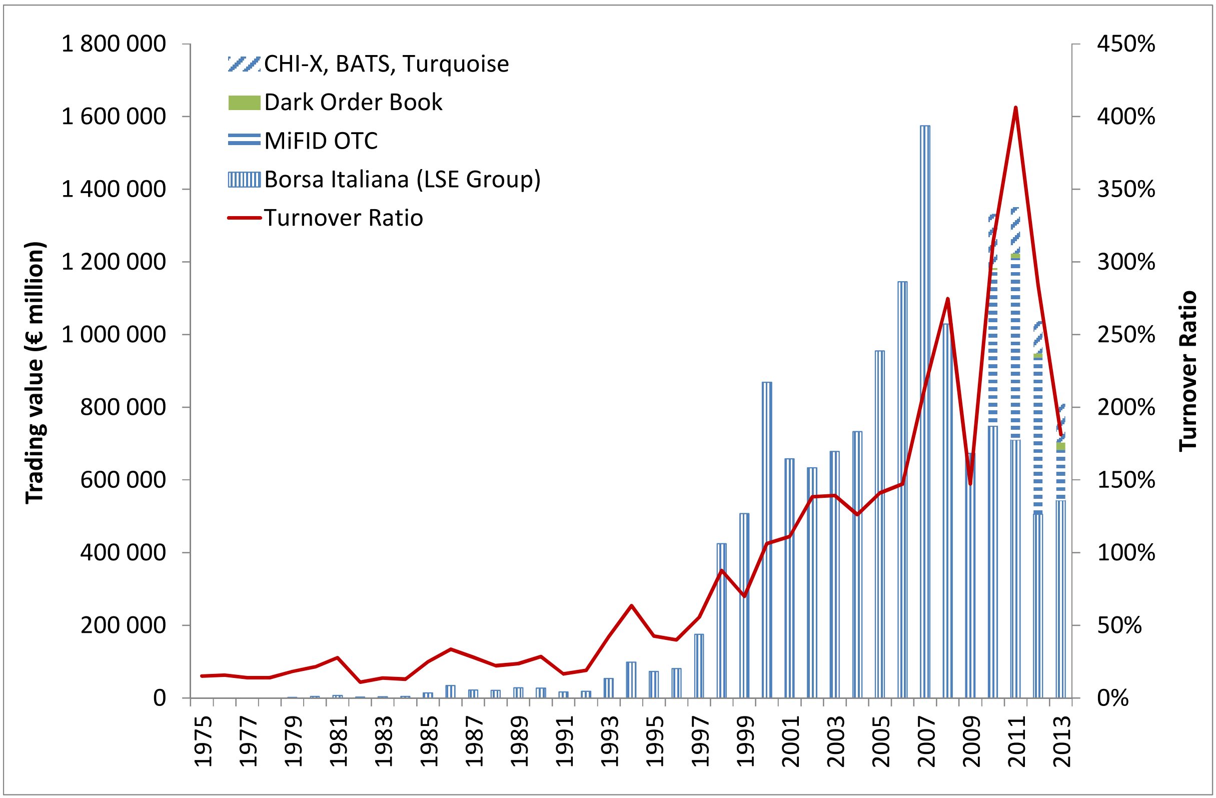
The Italian stock exchange (*Borsa Italiana*) is located in Milan, dating back to 1808, and operates as an electronic order book. It has been part of the London Stock Exchange Group since 2007. In terms of the market capitalization of listed companies ($450 billion at the end of 2013), the Italian stock market is the eighth-largest in Europe.

The growth of the Italian stock exchange over the past forty years has been spectacular (see Figure A in the Appendix). Until the end of the 1970s, market capitalization was under €10 billion, representing less than 5% of GDP (2.5% in 1977). In the 1980s, this rose to €100 billion, around 20% of GDP. Market capitalization grew again in the 1990s to reach more than €800 billion in 2000 (nearly 70% of GDP), before returning to its mid-1990s level with the burst of the Internet bubble and the financial crisis.[1]

Over these four decades, the growth in trading value has been even larger. Figure 1 shows the trading value of Italian equities from 1975 to 2013 (left-hand scale). The data comes from *Borsa Italiana* over the whole period, plus data from the other trading venues provided by Thomson Reuters (Monthly Market Share Reports) since 2010 (unfortunately, these data are only publicly available since that date).[2]

Figure 1. Historical trading in Italian equities

This figure depicts the growth in the trading value of Italian equities from 1975 to 2013. The data are from *Borsa Italiana* and Thomson-Reuters Monthly Market Share Reports (only available since 2010). The Turnover ratio is calculated as the ratio of total trading value to market capitalization.



[1] The figures here come from the *Borsa Italiana*. In some years, these differ substantially from World Bank data.
[2] The monthly market-share reports provide a comprehensive measure of the value of stocks traded. The data are aggregated from the individual trades reported by all European Exchanges, MTFs, and OTC trade-reporting venues. These data are summarized on a per market basis (data exists also on an index basis for large-caps only). Attribution by country is based on the domicile of the stocks (with reference to the two-character country code of each ISIN).

From 1977 to its peak in 2007 at €1,600 billion, the trading value of the *Borsa Italiana* grew by a factor of 4,000 – i.e. an average annual increase of almost 32%. Since 2007, the value of stock trading on the *Borsa Italiana* has fallen by over a half, but this largely reflects the fall in stock market prices (see Appendix Figure B). At the same time, together with the computerization of order flows, the Markets in Financial Instruments Directive (MiFID #2004/39/EC) has fostered stock trading in Europe. Hence, the decline in the value of stock trading on the *Borsa Italiana* has been countered by the boom in multilateral trading facilities (MTFs) and over-the-counter (OTC) trade-reporting venues.

Figure 1 also shows the turnover ratio (on the right-hand axis), calculated as the ratio of total trading value to market capitalization. Total trading value is defined, until 2009, as the trading value on the *Borsa Italiana*, and from 2010 to 2013 as the trading value at all trading venues, including the *Borsa Italiana* but also the MTFs (Chi-X, BATS, Turquoise) – known as the "Lit" platforms –, Dark and Off Order Books, and OTC trades.[3]

From the mid-1970s to the early-1990s, trading value followed the growth of market capitalization, with a turnover ratio of around 20%. Since then, the increase in stock trading has been more than proportional to market capitalization. The turnover ratio for Italian equities reached 400% in 2011, one of the highest figures in Europe (this ratio was about 300% for French equities and 200% for Spanish and British equities in 2011).

Figure 2 distinguishes the main trading venues for Italian equities over the 2010-2013 period. The market share in Italian equities of the *Borsa Italiana* has been rather stable at around 50%. The "Lit" platforms, mainly BATS/Chi-X Europe and Turquoise, and the Dark pools accounted for 10% each, which was unchanged over the period. Last, OTC trades represented approximately 30% of all trades. The market share of OTC platforms declined sharply in March 2013, at the same time as the introduction of the STT (a point to which I shall return below).

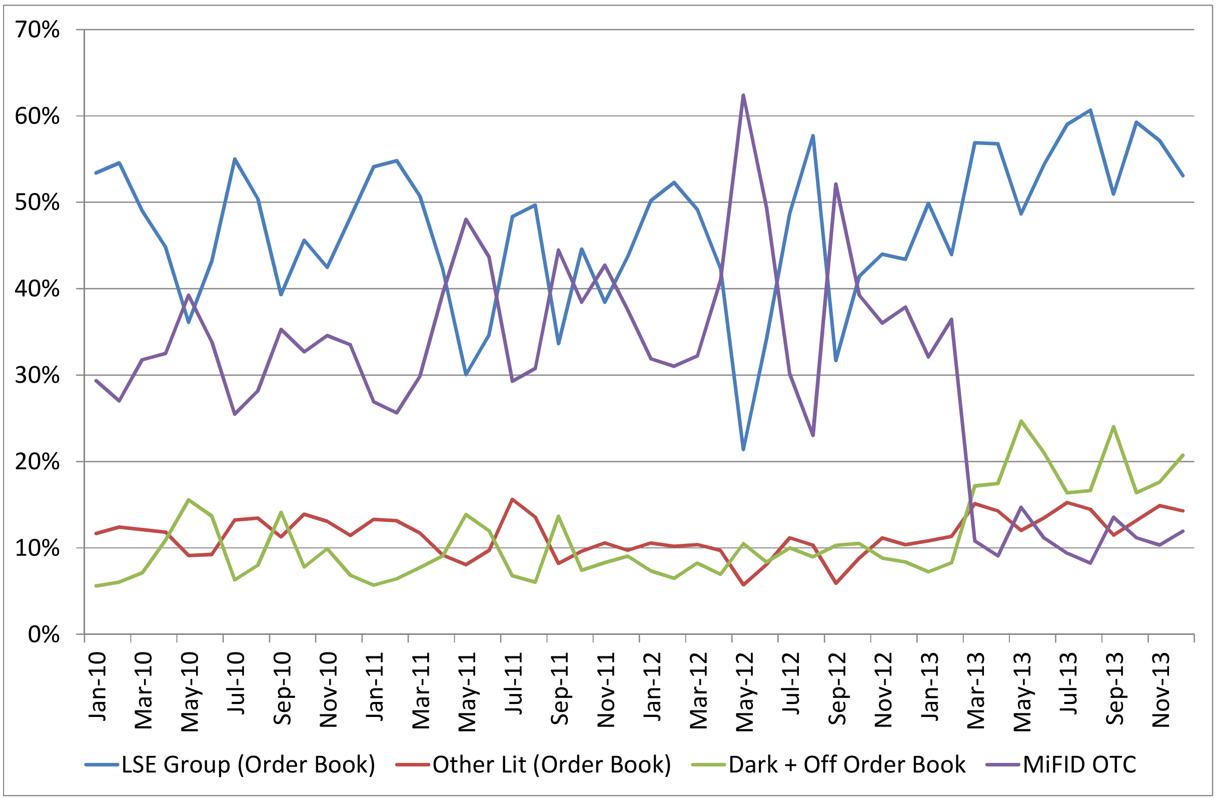
Note also that, according to the European Securities Markets Authority (Bouveret and Guillaumie, 2014), HFT accounts for one quarter of the value traded and one half of orders at the *Borsa Italiana* in May 2013. This is at approximately the same level as in Euronext Paris or the London Stock Exchange.[4]

[3] The rise of MTF and OTC trades dates back to 2008, but data are not available. Consequently, the turnover ratio in 2008 and 2009 is likely underestimated.

[4] This analysis is based on a sample of 100 European stocks listed on eleven regulated markets: Belgium (#6), Germany (#16), Spain (#12), France (#16), Ireland (#5), Italy (#11), Netherlands (#13), Portugal (#5) and the

Figure 2. The main trading venues for Italian equities

This figure shows the market share of the main trading venues for Italian equities. The data are from Thomson-Reuters Monthly Market Share Reports.



2.2. Financial market regulation reforms in Italy

In 2012 and 2013, a range of regulatory measures were imposed on Italian equity and derivatives markets. These included order-to-trade ratios and taxes on equity, derivative and high-frequency trading.

Order-to-trade ratio (OTR). Since April 2012, at the request of the Italian regulator, *Consob*, the *Borsa Italiana* imposed daily limits and fees on orders entered in excess of an order-to-trade ratio (OTR) of 100:1 for instruments listed on the equity market's main segment, called the MTA (*Mercato Telematico Azionario*).[5] For each order sent in excess of the ratio (irrespective of type or placement, the proprietary or agency nature of the order, or the phase

UK (#16). The data also covers the three main multilateral trading facilities in the EU: BATS, Chi-X and Turquoise. The stocks were chosen using a stratified sampling approach.

[5] On the platforms for small enterprises (AIM Italiana, *Mercato Alternativo del Capitale*) and investment vehicles (MIV) the OTR is only 40:1. These segments represent less than 1% of the total market capitalization of Italian equities and are not considered here.

of trading), the stock exchange charges the trading firm at an increasing rate: the fee is €0.01 for 1 to 5 OTR, €0.02 for 5 to 10 OTR and €0.025 above 10 OTR. There is also a daily cap at €1,000 per trading firm, which considerably reduces the financial constraint. According to Friederich and Payne (2015), apart from the financial penalty, the OTR may act as a threat, given that regulators may ask for the penalties to be stepped up or via the stigmatizing effect of being consistently above the threshold.

Note that while the Italian OTR were apparently initiated by the *Consob*,[6] similar tariff systems had been in place for a number of years on Euronext and the London Stock Exchange (the parent company of the Italian Stock Exchange), and since 2012 on the Deutsche Börse, on their own initiative. By doing so, these platforms intend to prevent massive order flows that might slow down their systems, and so affect market latency.

Securities transaction tax (STT). In March 2013, a tax was introduced on financial transactions applying to shares (Article 1, Law No 228, December 24, 2012, §491).[7] The STT applied to the transfer of ownership of shares, participating financial instruments and other securities (e.g. ADRs, GDRs, EDRs) issued by companies resident in Italy (residence being based on the registered office). The tax is due on the net daily balance of transactions on the same security. The tax is due only for firms with an average market capitalization over €500 million (in November of the year preceding the transaction).

The standard tax rate is 0.1 percent (0.12 percent in 2013) for transactions executed on regulated markets or a multilateral trading facility, and 0.2 percent (0.22 percent in 2013) for over-the-counter transactions (§493).

An additional tax of 0.02 percent on high-frequency trading was introduced on the counter-value of orders automatically generated by computerized mathematical algorithms (§495 and 496). This tax is calculated on a daily basis and is payable when the ratio between the sum of cancelled orders and modified orders, and the sum of entered orders and modified orders exceeds 60 percent, with reference to the single financial instrument.

The tax does not apply to units in collective-investment undertakings (called OICR in Italy). The main exemptions also include (§494)[8]: i) transfers of ownership taking place via inheritance or gift; ii) transactions in bonds and debt securities; iii) repurchases of securities

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[6] "Italy to limit high-frequency orders", J. Grant & R. Sanderson, *Financial Times*, Feb. 20th 2012.

[7] The first proposal dated back to November 22nd 2012. Note that, initially, the failure to pay the FTT rendered the transaction null and void.

[8] See www.tesoro.it/primo-piano/documenti/draftdecreto__1_2_2013_EN_FINAL_REV.pdf for details.

by the issuer; iv) issuances of equity securities on the primary market; v) collateralized transactions, vi) intra-group and restructuring transactions; vii) temporary transfers of securities (repos); viii) transactions by a financial intermediary acting as a counterparty to both sides; ix) transactions by clearing houses or central depositories; x) activities related to market making and effected in the course of liquidity assistance activities; xi) transactions by pension funds and compulsory social security institutions, xii) transactions involving EU institutions, the ECB, central banks of EU Member States, central banks and organizations managing the official reserves of other States or institutions established by international agreements executed by Italy; and xiii) transactions in qualifying "ethical" financial products.

To prevent tax avoidance, the tax applies regardless of the place of residence of the counterparties, where the transaction was concluded, and the place of residence of the issuer in the case of certificates. This "issuance principle" is a crucial component of recent STT initiatives, including the French STT and the European Commission proposal, since it meaningfully reduces the risk of tax avoidance through the geographical relocation of transactions (as experienced by Sweden in the 1980s).

Financial transaction tax (FTT). The tax also applied to transactions and high-frequency trading on derivatives (whether cash or physically settled, securitized or not), based on in-scope Italian shares or where the derivative refers to the value of in-scope Italian shares (§492). This includes futures, forwards, options, warrants, covered warrants, certificates, etc. (but not credit default swaps). The inclusion of derivatives represents the main difference from the French STT and actually turns the Italian tax into a FTT. Derivatives contracts traded OTC are subject to a fixed amount between € 0.01875 and € 200 depending on the type of contract and its notional value. If derivative contracts are executed on a regulated market or MTF, the tax is reduced to 20% of the original notional amount. The same exemption rules applied. In particular, the tax does not apply to financial derivatives whose underlying assets are issued by entities with a market capitalization of under €500 million.

It was planned, from the outset, to tax derivatives and not only shares. However, there was a delay in application of several months. Initially, the tax should have started in July 2013, but the Legislative Decree No 69 of June 21st 2013 modified the starting date to September 2013. This delay provides us with a unique opportunity to disentangle the impact of the two components of the tax.

2.3. The sample

The initial sample consists of all stocks (#190) listed on the *Mercato Telematico Azionario* (MTA), the main constituent part of the Italian Stock Exchange, and fully available on Bloomberg. The formal requirements for MTA listing include a capitalization of at least €40 million and a free float of at least 25%. I also consider, as a control group, all of the stocks included in the DAX (#30), MDAX (#44) and SDAX (#46) indices. The period extends over 3 years: 2011-2013 (761 business days),[9] and data are daily. For each stock, I extract from Bloomberg the opening and closing (adjusted) prices, the volume, the number of shares, the average bid-ask spread,[10] and the highest and lowest prices for the day.

Many firms listed on the *Borsa Italiana* are very small. I exclude from the initial sample stocks with a total traded volume over the period 2010-2013 of under €100 million, as well as stocks with a market capitalization below €100 million. These filters are binding only for Italian stocks. This leaves 100 Italian stocks (of which 36 are included in the FTSE MIB index) and 120 German stocks.[11]

Table 2 presents the descriptive statistics of annual turnover and market capitalization for the firms included in the sample. The data are averaged over the whole period (2011-2013). The firms are categorized into six subsamples according to their listing market (*Borsa Italiana* or *Deutsche Börse*) and size (large, mid and small caps). All firms in the sample listed on the *Borsa Italiana* are subject to the OTR, but only the largest ones (market cap. > €500 ml.) with their headquarters in Italy, are subject to the tax (STT and FTT). It leads to three Italian subsamples.

- The first is composed of 34 firms with their headquarters in Italy which are included in the FTSE MIB index (MIB hereafter).[12]
- The second consists of 30 Italian firms large enough to be taxed, but not included in the MIB.
- The third includes 34 Italian firms whose transactions are exempt from taxation.

German firms, which act as the control group (and are thus neither exposed to the OTR nor the tax), are classified into three subsamples according to whether they are included in the

[9] The results (available on request) are the same over a two-year period (2012-2013).
[10] The average bid-ask spread is available only since 2012. The data also include, for the whole period, bid and ask quotes at the close of the market. However, the bid-ask spread calculated using these quotes is occasionally negative, probably due to synchronization problems. To be on the safe side, I do not use these quotes.
[11] By way of comparison, Friederich and Payne (2015) consider only the 45 most-liquid Italian stocks.
[12] The sample was initially composed of 36 firms from the MIB, but two of these (Tenaris and STMicroelectronics) do not have their headquarters in Italy and are thus not subject to the tax.

DAX, MDAX or SDAX indices. By construction, average market capitalization is lower in these groups, although the different groups overlap.

Table 2. Average market capitalization and trading value

This table shows the market capitalization and annual trading value (averaged over 2011-2013) for several subsamples of Italian and German firms. The subsamples are defined as follow: MIB = 34 Italian large caps (subject to the tax); ITA = 64 Italian mid- and small caps (30 midcaps are subject to the tax and 34 small caps are not); DAX = 30 German large caps; MDAX = 44 German midcaps; SDAX = 46 German small caps. The data come from Bloomberg.

(€ million)	**Average market cap.**	**Annual trading value**	**Average market cap.**	**Annual trading value**	**Average market cap.**	**Annual trading value**
Italian firms	**MIB {#34}** [OTR, STT/FTT]		**ITA mid {#30}** [OTR, STT/FTT]		**ITA small {#34}** [OTR, no STT/FTT]	
Mean	8,749	14,480	1,165	677	329	124
Min	770	1,007	499	170	150	28
Max	64,498	105,130	3,493	3,410	606	597
SD	12,332	23,547	571	736	135	127
German firms	**DAX {#30)** [no OTR, no STT/FTT]		**MDAX {#44}** [no OTR, no STT/FTT]		**SDAX {#46}** [no OTR, no STT/FTT]	
Mean	27,058	28,151	3,457	2,835	627	250
Min	4,458	6,937	770	369	175	31
Max	72,953	66,304	25,067	18,251	3,444	1,427
SD	20,036	19,415	4,026	3,078	562	267

It is worth noting that the co-movement in trading activity between the *Borsa Italiana* and the *Deutsche Börse* is quite high. The statistical correlation between the value of stock trading is higher between Italian and German stocks (78% based on monthly data from January 2010 to March 2012), than between Italian and Spanish stocks (32%), Italian and UK stocks (58%), and Italian and US stocks (57%).[13] German stocks thus seem to be a good candidate for the control group.

Figure 3 overlays the empirical distributions in terms of market capitalization and trading value (in logs) for Italian and German firms. The data are averages over the Jan. 2011-March

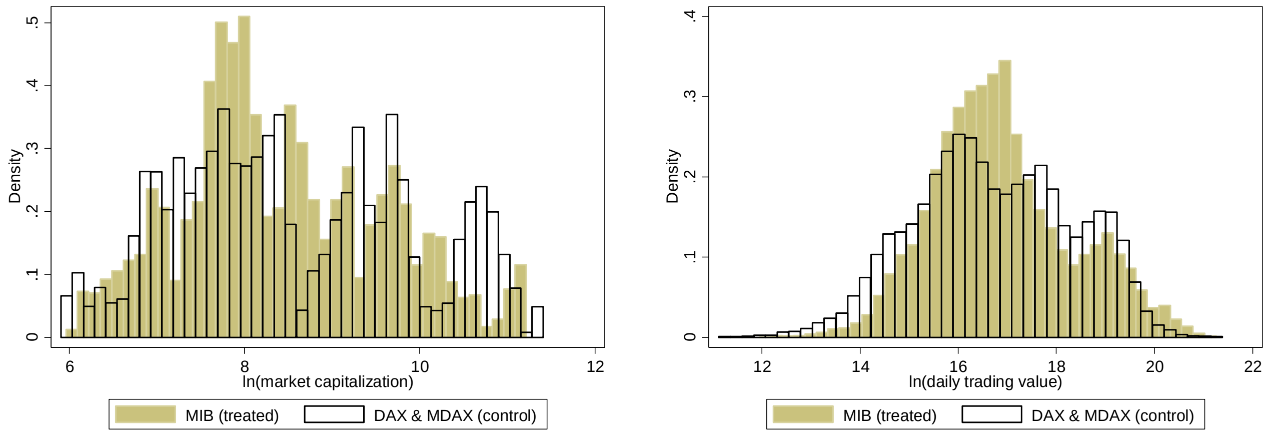
[13] The only higher correlation is with French stocks (84%). However, French stocks cannot be used as a control group because of the introduction of the French STT in August 2012, which might bias the results. The data come from Thomson Reuters (Monthly Market Share Reports).

2012 period (before the introduction of the OTR and the STT/FTT). The groups are defined as previously. Again, the preliminary evidence suggests that the Italian and German firms are quite similar in this respect.

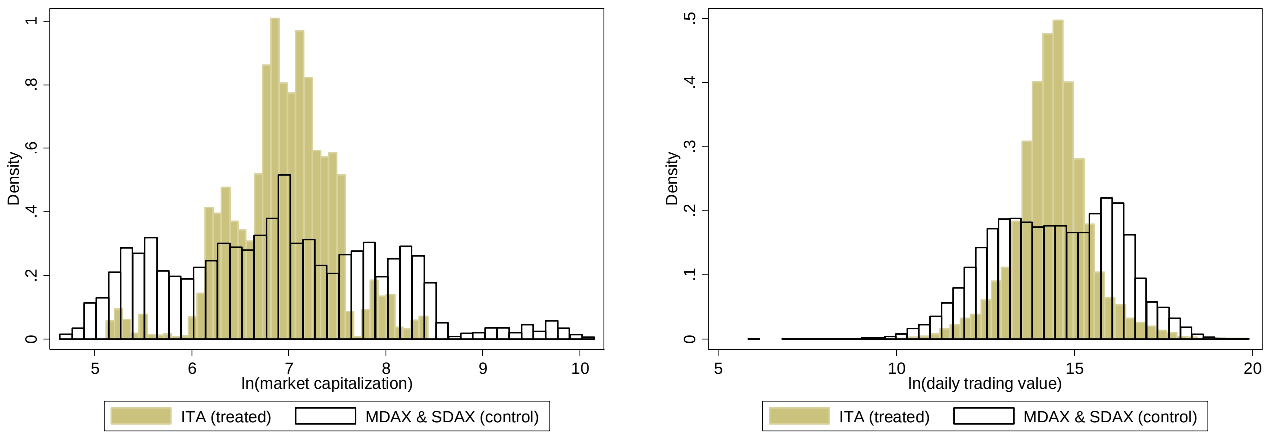
Figure 3. The empirical distribution of market capitalization and trading value

This figure depicts the empirical distribution (in logs) of market capitalization and trading value for the treated and control groups. The data are averages over the Jan. 2011-March 2012 period (before the introduction of the OTR and the STT/FTT). Daily trading value is calculated as the number of shares times the closing price. The groups are defined as follows: MIB = 34 Italian large caps; ITA = 64 Italian mid- and small caps; DAX = 30 German large caps; MDAX = 44 German midcaps; SDAX = 46 German small caps.

Panel A. Large caps



Panel B. Small & midcaps



2.4. The difference-in-difference approach

To compare the impact of the OTR, the STT and the FTT, I mainly rely on a generalized version of the difference-in-difference (DiD) method. The following econometric model is estimated:

$$V_{it} = \alpha_0 + \alpha_1 D_i + \alpha_2 D_t + \alpha_3 OTR_{it} + \alpha_4 STT_{it} + \alpha_5 FTT_{it} + \epsilon_{it}, \tag{1}$$

where V_{it} is a measure of market liquidity or volatility for firm *i* at day *t*, D_i is a firm dummy variable, D_t is a time dummy variable, OTR_{it} is a dummy variable for Italian firms after the introduction of the OTR on April 2012, STT_{it} is a dummy variable for large Italian firms (market values of over €500 million) after the introduction of the STT on March 2013, FTT_{it} is a dummy variable for large Italian firms (market values over €500 million) after the tax was extended to derivatives on September 2013, and ε_{it} is an error term. The coefficients of interest are α_3, α_4, and α_5: these measure the impact of the order-to-trade ratio, the security transaction tax and the financial transaction tax on liquidity and volatility. Time dummy variables capture all other changes in the regulatory and economic environment during the period that affect the treated and control groups similarly, and firm dummy variables control for differences between firms that are constant over time. Robust standard errors are clustered at the firm-level. Equation (1) is estimated for the whole sample, then separately for large caps (MIB *versus* DAX+MDAX) on the one hand, and for mid- and small caps (ITA *versus* MDAX+SDAX) on the other.

The robustness checks provide additional evidence, based on different samples and a regression discontinuity design.

2.5. Measuring market liquidity and volatility

Following Capelle-Blancard and Havrylchyk (2013), I calculate a wide range of measures to account for different dimensions of market behavior. This section describes variable construction, and Table 3 shows some descriptive statistics.[14]

Market liquidity. The concept of liquidity is clearly multi-dimensional. As stated, among others, by Sarr and Lybek (2002), "*a number of measures must be considered because there is no single theoretically correct and universally accepted measure to determine a market's*

[14] Table C in the Appendix shows the pairwise correlation coefficients for the measures of liquidity and volatility. Unsurprisingly, all coefficients are significantly different from zero. However, these correlations are sufficiently low to justify empirically the use of a wide range of measures.

degree of liquidity. The usual liquidity measures can be classified – from the least- to the most-sophisticated – into three main categories: activity-based measures (trading volume and value), transaction-cost measures (the bid-ask spread), and price-impact measures (liquidity ratio); see Gabrielsen, Marzo and Zagaglia (2011) and Vayanos and Wang (2013). As such, I consider the following variables:

- *Trading value*, $V_{i,t}$= The number of shares traded of stock i on day t *$P_{i,t}$, where $P_{i,t}$ is the closing price for stock i on day t.
- *Turnover ratio*, $T_{i,t}$ = 100*the number of shares traded of stock i on day t / total number of shares of stock i on day t available to ordinary investors; turnover is expressed as a percentage.
- *Bid-ask spread*, $S_{i,t} = 2*100*(PA_{i,t}–PB_{i,t}) / (PA_{i,t}+PB_{i,t})$, where $PA_{i,t}$ and $PB_{i,t}$ are the asking and bid prices offered for stock i at close of market on day t, respectively; the bid-ask spread is expressed as a percentage.
- *Liquidity ratio*, $LR_{i,t} = V_{i,t} / |R_{i,t}|$ where $R_{i,t}$ is the continuously-compounded return, $\log(P_{i,t} / P_{i,t-1})$, of stock i on day t; the liquidity ratio is expressed in Euros of trade for a price change of one percent.

These measures reflect complementary aspects of market liquidity. Trading value and the turnover ratio capture market breadth and depth. Another widely-used measure of liquidity is the bid-ask spread, which assesses tightness. Note that this measure provides no information on the prices at which larger transactions take place. By the same token, it provides no information on how the market might respond to a long sequence of transactions in the same direction. The market's response to substantial buying or selling pressure is an important aspect of illiquidity.

Liquidity denotes the ability to trade large quantities quickly, at low cost, and without moving the price. A number of indicators of market resiliency reflect this definition. I have chosen to use the liquidity ratio, which assesses how much trade is necessary to induce a price change of one percent:[15] larger ratios are associated with greater liquidity.

[15] This ratio can also be expressed as the inverse of the illiquidity measure of Amihud (2002). For the sake of robustness, I have also considered the price reversal: *Price reversal*, $PR_{i,t}$ is minus the coefficient of a regression of $R_{i,t}$ on $V_{i,t-1}$*sign($R_{i,t-1}$), controlling for $R_{i,t-1}$. Price reversal is also a measure of price impact, albeit less intuitive. It is based on the idea that, if markets are illiquid, trades should generate transitory deviations between price and fundamental value: greater price reversal is associated with less liquidity (Pastor and Stambaugh, 2003). This does not change the results (available on request).

Market volatility. There are equally a number of alternative measures of market volatility. According to Engle and Gallo (2006), for instance, "*the concept of volatility itself is somewhat elusive, as many ways exist to measure it and hence to model it*". In this paper, I consider three different metrics:

- *Squared return*, $SR_{i,t} = (R_{i,t})^2$, where $R_{i,t} = \log(P_{i,t} / P_{i,t-1})$.
- *Conditional variance*, $CV_{i,t}$ is proxied by a GARCH(1,1) model – the model for the conditional mean is an AR(1) with a constant.
- *High-low range*, $HLR_{i,t} = (\log PH_{i,t} - \log PL_{i,t})^2 / 4 \log(2)$, where $PH_{i,t}$ and $PL_{i,t}$ are the highest and lowest price achieved for stock i on day t, respectively.

The squared close-to-close return is a common estimator of the daily variance.[16] Volatility clustering has been extensively documented, so I estimate daily conditional variance, which is proxied by a conventional GARCH(1,1) model over a 12-month period (February 2012 – January 2013).[17] Finally, I use a measure of the price range, defined as the scaled difference between the highest and lowest prices achieved on a day. The range provides volatility information from the entire intraday price path, without the need for high-frequency data. Parkinson (1980) shows that the daily high-low range is an unbiased estimator of daily volatility and is more efficient than the squared daily return. More recently, Brandt and Diebold (2006) found that the efficiency of this range is comparable to that of the realized variance calculated as the sum of the squared 3-hour returns, while being more robust to the effects of market microstructure noise, particularly the bid-ask bounce.

One of the distinctive features of the Italian stock market is the low level of stock prices. The average stock price of a firm in the MIB is €10, five times smaller than that of a German firm of similar size. Conversely, the number of outstanding shares is much higher. The nominal value of a share is not usually an issue, but when the price is low, volatility measurement can be noisy. For the robustness checks, firms with a stock price lower than €1 on at least one day over the period (2 German and 76 Italian firms) will be dropped in some specifications.

Market capitalization is overall similar between the treated and control groups. However, the turnover ratio is higher for Italian large caps than for German large caps. In terms of the bid-

[16] Jones and Seguin (1997) and Pomeranets and Weaver (2012) consider an unbiased estimator of the standard deviation calculated as $\sqrt{(\pi/2)}|R_{i,t}|$. As the first term is a constant, this does not affect the econometric results (available on request).

[17] I consider two specifications of the mean equation: one with only a constant term and one with an AR(1). These yield very similar results, and I report only those corresponding to the AR(1).

ask spread, the difference between the treated and control groups is not significant. Last, volatility is higher in Italian than in German firms, which is likely related to the turbulent economic times that Italy has faced during the Eurozone debt crisis.

Table 3. Descriptive statistics

This table presents daily averages and standard deviations (in parentheses). The sample period is from 2011 to 2013 (761 days). OTR is a dummy variable from April 2012 for the firm being subject to the OTR. STT (FTT) is a dummy variable from March (September) 2013 for the firm being subject to the STT (FTT). $P_{i,t}$ is the closing price of stock *i* on day *t*. $MV_{i,t}$ is the market value of stock *i* at close of market on day *t*. $NBST_{i,t}$ is the number of shares traded in stock *i* on day *t*. $NOSH_{i,t}$ is the total number of ordinary shares of stock *i* on day *t*. $NOSHFF_{i,t}$ is the percentage of shares available to ordinary investors of stock *i* on day *t*. *Trading value*$_{i,t}$ = $NBST_{i,t}$ * $P_{i,t}$. *Turnover ratio*$_{i,t}$ = 100*$NBST_{i,t}$ / ($NOSH_{i,t}$ * $NOSHFF_{i,t}$). *Bid-ask spread*$_{i,t}$ is the average difference between the asking and bid price offered for stock *i* on day *t*, in percent. *High-low range*, $HLR_{i,t}$ = (log $PH_{i,t}$ – log $PL_{i,t}$)² / 4 log(2), where $PH_{i,t}$ and $PL_{i,t}$ are the highest and lowest price achieved for stock *i* on day *t*, respectively. *Return*$_{i,t}$ is the continuously calculated return $R_{i,t}$ = 100*log($P_{i,t}$ / $P_{i,t-1}$). *Squared return*$_{i,t}$, $SR_{i,t}$ = ($R_{i,t}$)² with $R_{i,t}$= log($P_{i,t}$ / $P_{i,t-1}$).-*Conditional variance*$_{i,t}$ is estimated from a GARCH(1,1). *Liquidity ratio*$_{i,t}$ = $V_{i,t}$ / |$R_{i,t}$|; liquidity ratio is expressed in Euros of trades for a price change of 1%.

	MIB {#34}	**ITA mid {#30}**	**ITA small {#34}**	**DAX + MDAX {#30 + #44}**	**MDAX + SDAX {#44 + #46}**
OTR (D)	0.58	0.58	0.58	0	0
STT (D)	0.28	0.28	0	0	0
FTT (D)	0.11	0.11	0	0	0
$P_{i,t}$ (€)	10.55 (16.68)	7.14 (7.03)	5.66 (8.21)	46.66 (36.03)	36.23 (39.85)
$MV_{i,t}$ (€ million)	8,749 (12,364)	1,165 (651)	329 (165)	13,024 (17,754)	2,010 (3,307)
$NOSH_{i,t}$ (million)	2,505 (3,877)	468 (573)	238 (299)	348 (601)	80 (125)
$NOSHFF_{i,t}$ (%)	61.55 (20.91)	44.32 (20.85)	40.07 (16.55)	72.83 (23.81)	61.26 (24.68)
$NBST_{i,t}$	21,976,359 (52,327,337)	1,054,286 (3,357,136)	428,289 (2,215,808)	1,674,656 (3,399,988)	266,733 (668,112)
Trading value$_{i,t}$ (€)	57,084,364 (109,907,014)	2,669,220 (7,420,743)	491,134 (1,038,489)	51,636,286 (83,963,809)	5,967,189 (14,404,827)
Turnover ratio$_{i,t}$ (%)	0.71 (0.73)	0.24 (0.40)	0.14 (0.29)	0.45 (0.43)	0.29 (0.36)
Bid-ask spread$_{i,t}$ (%)	0.15 (0.07)	0.39 (0.18)	0.78 (0.44)	0.13 (0.10)	0.39 (0.31)
High-low range$_{i,t}$ (10^{-5})	52 (94)	55 (282)	50 (98)	44 (152)	55 (203)
(*Return*$_{i,t}$)² (%)	6.43 (22.11)	6.45 (77.20)	4.73 (19.43)	4.28 (13.47)	4.95 (16.34)
Conditional variance$_{i,t}$	6.37 (5.28)	5.40 (5.13)	4.86 (5.27)	4.29 (3.97)	5.02 (4.87)
Liquidity ratio$_{i,t}$ (€)	85,139 (308,866)	4,432 (19,806)	728 (2,336)	136,698 (777,649)	14,763 (110,287)

3. Empirical results

3.1. The parallel-trends assumption

The descriptive statistics above suggested that German firms are a good control group. Figures 4-5 confirm this intuition. For each proxy of liquidity and volatility, I provide two graphs (one for large caps, the other for mid- and small caps) representing the evolution of each variable (averaged across firms) between 2011 and 2013 for the treated and control groups. Recall that, for large caps, the treated group is composed of firms from the MIB (#34), while the control group is composed of firms from the DAX and the MDAX (#74). For mid- and small caps, I distinguish between Italian midcaps subject to the OTR and the STT/FTT (#30), Italian midcaps, subject to the OTR but not the STT/FTT (#34), and German mid- and small caps included in the MDAX or the SDAX (#90). The thin vertical lines indicate the date of introduction of the OTR, the STT and the FTT. For the sake of clarity, the data are weekly.

Overall, whatever the variable of interest, before the introduction of the OTR and the STT/FTT, Italian and German firms clearly exhibit parallel trends. This observation allows us to make a counterfactual assumption that the variables of interest would have continued these trends had the OTR and the STT/FTT not been applied.

Figure 4. The evolution of stock-market activity

These figures show weekly unweighted averages for five groups defined as follows: MIB = 34 Italian large caps; ITA = 64 Italian mid- and small caps; DAX = 30 German large caps; MDAX = 44 German midcaps; and SDAX = 46 German small caps. The thin vertical lines indicate the introduction of the OTR, the STT and the FTT in order.

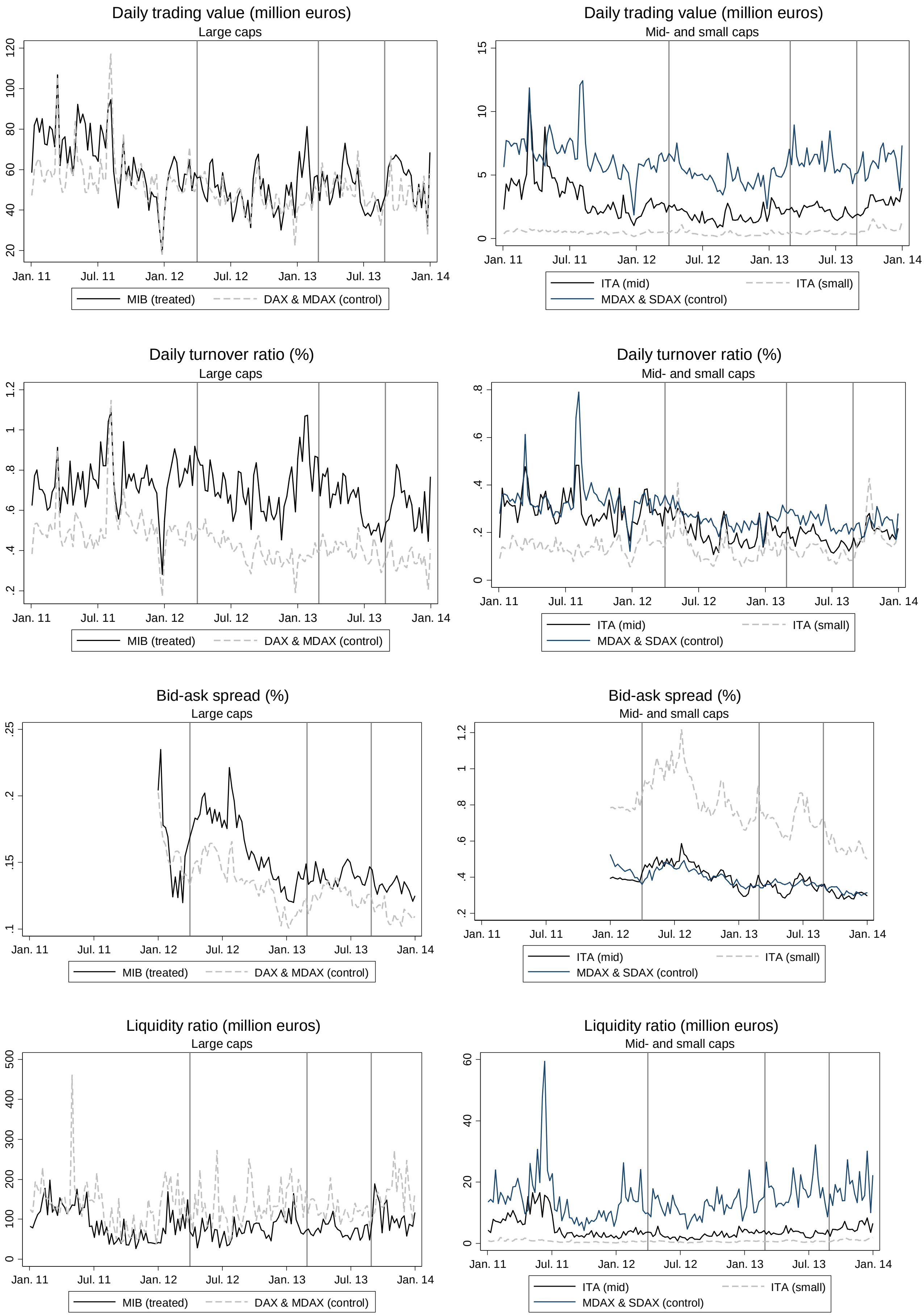
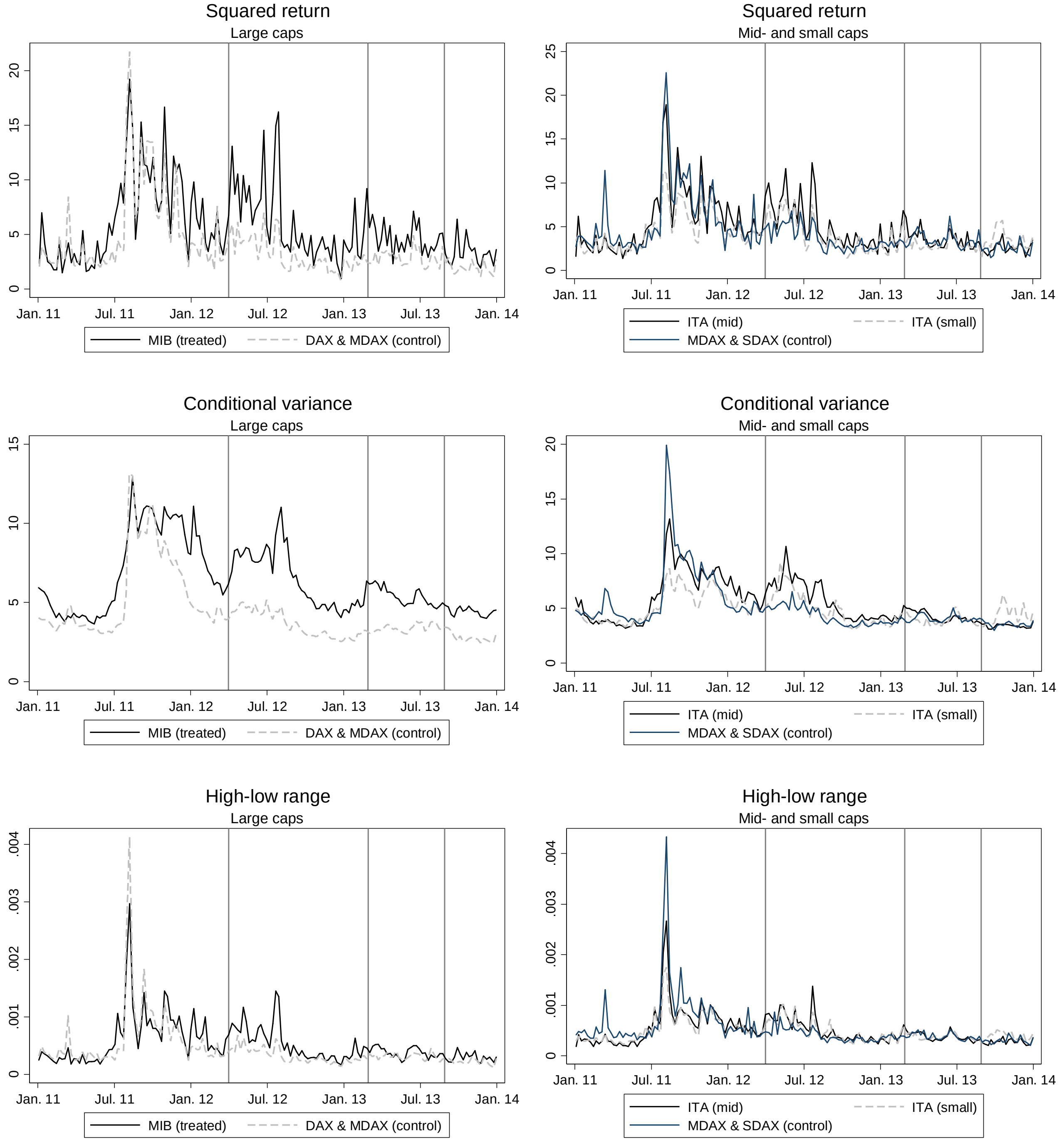


Figure 5. The evolution of stock-market volatility

These figures show weekly unweighted averages for five groups defined as follows: MIB = 34 Italian large caps; ITA = 64 Italian mid- and small caps; DAX = 30 German large caps; MDAX = 44 German midcaps; and SDAX = 46 German small caps. The thin vertical lines indicate the introduction of the OTR, the STT and the FTT in order.



3.2. Difference-in-difference results

The impact of the introduction of the OTR and the STT/FTT is estimated using a difference-in-difference approach (Eq. 1) over a three-year period (2011-2013). This estimation is carried out for all firms together, and then separately for large caps and mid- and small caps.[18]

Table 4 presents the results for liquidity, measured by the trading value, turnover ratio (trading volume), daily average bid-ask spread and liquidity ratio – see Section 2.5 for the definitions. The coefficients of interest, associated with the introduction of the OTR, the STT and the FTT are rarely statistically significant.

First, if one considers large Italian stocks, included in the MIB, there is no impact of the OTR on liquidity for any of the proxies considered here: trading value, bid-ask spread or liquidity ratio. This result contrasts with the findings of Friederich and Payne (2015). While they do not find any impact on bid-ask spread, which is consistent with the findings here, they do find a negative and significant impact on trading value. However, as they focus on a sample period of two months before and after the introduction of the OTR, this could be a temporary effect. To investigate, I run additional regressions on a similar four-month period (the results are available on request) that reveal a negative impact on trading value, although this effect vanishes over longer time horizons.

Second, there is a small negative effect following the introduction of the STT, but this is offset by a positive effect when the STT changed into a FTT.[19] One possible interpretation of this seesaw effect might be as follows. After the introduction of the STT, some traders might have had an incentive to trade on the derivatives market, causing a decrease in liquidity in the spot market, but when the tax was expanded this initial incentive vanished and they stepped backwards, producing the opposite effect. This interpretation is in line with the theoretical multimarket model of Easley, O'Hara and Srinivas (1998). In addition, the fall (rise) in trading following the STT (FTT) caused a narrowing (widening) of the spread. The relationship between trading volume and spread is typically considered to be negative: higher trading volume should translate into a narrower spread and vice versa. However, the literature

[18] For the robustness checks, more stringent filters are applied in order to preclude any outliers that might bias the results: companies for which stock price was lower than €1 at least one day over the period are excluded. This robustness sample contains 94% of the initial sample. The results are qualitatively the same (see Tables A-B in the Appendix).

[19] Coehlo (2014) focuses on the introduction of the Italian STT in March 2013 and does not examine how the market reacted in September 2013 when the SST was extended to derivatives. The method is similar, but her sample is smaller; she also uses several control groups composed of small Italian mid-caps, ADRs or Spanish stocks. Overall, she finds no effect of the introduction of the STT on trading value, bid-ask spread or the Amihud liquidity measure for the Italian Stock Exchange. Note that the R^2's in her regressions are surprisingly low.

on financial-market microstructure has shown a number of times that this depends on the type of trader. Again, according to Easley, O'Hara and Srinivas (1998), if the traders who migrate from the spot to the derivatives market after the introduction of the STT are sophisticated/informed traders, then the impact on the spread should be negative, as is the case here.

Third, concerning Italian midcaps, the only significant effect is that of lower trading value following the introduction of the OTR, but there is no such impact on volume, as measured by the turnover ratio, nor on the bid-ask spread and the liquidity ratio.

Table 5 shows the difference-in-difference econometric results for the impact of OTR, STT and FTT on market volatility. Volatility is measured by squared returns, conditional variance and high-low range – see Section 2.5 for variable definitions. Regardless of the volatility measure, I find a rise after the introduction of the OTR, and a fall after the introduction of the STT/FTT.[20] Overall, the two effects are of a similar magnitude.

While Friederich and Payne (2015) do not provide any evidence regarding the impact of OTR on volatility, these results are consistent with Coehlo (2014), who finds little or no net effect of the Italian STT on basic proxies for volatility (measured either by the standard deviation of closing daily prices or the standard deviation of high, low, opening and closing prices).

4. Additional results on the impact of the STT

The Italian STT/FTT is due only on large- and mid-caps with an *ad hoc* cutoff of €500 million in terms of market capitalization. It is thus very tempting to see what happens around this threshold. There are two possible approaches. The first consists in re-applying the previous difference-in-difference (DiD) tests with small Italian firms as the control group. The second is to consider a Regression Discontinuity (RD) design. The use of Italian stocks (instead of foreign stocks) as a control group is also motivated by the contested elections in Italy, which coincided with the introduction of the STT, and which may have contributed to a slowdown of trade specifically for Italian securities.

[20] It should be noted, however, that the coefficients of determination are quite low, except for the measure of conditional variance.

Table 4. The impact of the Italian OTR, STT and FTT on stock-market liquidity

This table presents the difference-in-difference results. The sample period extends from 2011 to 2013 (761 days). All of the data are daily. OTR is a dummy variable from April 2012 for the firm being subject to the OTR. STT is a dummy variable from March 2013 for the firm being subject to the STT. FTT is a dummy variable from September 2013 for the firm being subject to the FTT. $P_{i,t}$ is the closing price of stock *i* on day *t*. $NBST_{i,t}$ is the number of shares traded of stock *i* on day *t*. $NOSH_{i,t}$ is the total number of ordinary shares of stock *i* on day *t*. $NOSHFF_{i,t}$ is the percentage of shares available to ordinary investors of stock *i* on day *t*. *Trading value*$_{i,t}$ = $NBST_{i,t} * P_{i,t}$. *Turnover ratio*$_{i,t}$ = $100*NBST_{i,t} / (NOSH_{i,t} * NOSHFF_{i,t})$. *Bid-ask spread*$_{i,t}$ is the average difference between the asking and bid prices offered for stock *i* on day *t*, in percent. *Liquidity ratio*$_{i,t}$ = $V_{i,t} / |R_{i,t}|$; liquidity ratio is expressed in million Euros of trades for a price change of 1%. Time and firm dummies are included but the estimated coefficients are not shown. Standard errors are clustered at the firm level and appear in parentheses.

Sample (No. firms: treated vs. control group)	**All firms (100 MIB+ITA vs. 120 DAX+MDAX+SDAX)**	**Large caps (36 MIB vs. 74 DAX+MDAX)**	**Mid- and small caps (64 ITA vs. 90 MDAX+SDAX)**
ln(Trading value$_{i,t}$)			
OTR	0.0008	0.0407	–0.2682***
(s.e.)	(0.0791)	(0.0754)	(0.0858)
STT	–0.1096	–0.0428	–0.0662
(s.e.)	(0.0806)	(0.0555)	(0.1009)
FTT	0.0020	0.1911***	0.1435*
(s.e.)	(0.0548)	(0.0527)	(0.0827)
No. of obs.	167,420	82,188	91,320
Adj. R^2	0.906	0.876	0.798
Turnover ratio$_{i,t}$ (%)			
OTR	0.0647***	0.0981	–0.0107
(s.e.)	(0.0246)	(0.0683)	(0.0317)
STT	–0.0774***	–0.0897**	–0.0253
(s.e.)	(0.0222)	(0.0386)	(0.0176)
FTT	0.0090	0.0385	0.0406*
(s.e.)	(0.0203)	(0.0315)	(0.0214)
No. of obs.	167,420	82,188	91,320
Adj. R^2	0.470	0.443	0.375
Bid-ask spread$_{i,t}$ (%)			
OTR	–0.0152	0.0078	0.0314
(s.e.)	(0.0206)	(0.0098)	(0.0198)
STT	0.0117	–0.0149**	–0.0322
(s.e.)	(0.0149)	(0.0072)	(0.0205)
FTT	0.0282***	0.0070*	–0.0090
(s.e.)	(0.0096)	(0.0040)	(0.0118)
No. of obs.	105,167	52,510	58,805
Adj. R^2	0.779	0.739	0.759
Liquidity ratio$_{i,t}$ (€ millions)			
OTR	–6.5602	–16.0929	–0.4092
(s.e.)	(5.0680)	(11.5943)	(3.1626)
STT	1.3800	7.9797	–4.6945
(s.e.)	(4.6664)	(10.8060)	(2.8422)
FTT	–2.7660	–10.5989	1.4458
(s.e.)	(10.5028)	(19.8535)	(2.6322)
No. of obs.	164,453	81,315	89,984
Adj. R^2	0.082	0.070	0.058

*, **, *** indicate a coefficient statistically different from zero at the 10%, 5%, 1% levels, respectively.

Table 5. The impact of the Italian OTR, STT and FTT on stock-market volatility

This table presents the difference-in-difference results. The sample period extends from 2011 to 2013 (761 days). All of the data are daily. OTR is a dummy variable from April 2012 for the firm being subject to the OTR. STT is a dummy variable from March 2013 for the firm being subject to the STT. FTT is a dummy variable from September 2013 for the firm being subject to the FTT. $P_{i,t}$ is the closing price of stock i on day t. *Squared return*$_{i,t}$, $SR_{i,t} = (R_{i,t})^2$ with $R_{i,t} = 100 \ast \log(P_{i,t} / P_{i,t-1})$. *Conditional variance*$_{i,t}$ is estimated from a GARCH(1,1). *High-low range*, $HLR_{i,t} = (\log PH_{i,t} - \log PL_{i,t})^2 / 4 \log(2)$, where $PH_{i,t}$ and $PL_{i,t}$ are the highest and lowest prices achieved for stock i on day t, respectively. Time and firm dummies are included but the estimated coefficients are not shown. Standard errors are clustered at the firm level and appear in parentheses.

Sample (No. firms: treated vs. control group)	**All firms (100 MIB+ITA vs. 120 DAX+MDAX+SDAX)**	**Large caps (36 MIB vs. 74 DAX+MDAX)**	**Mid- and small caps (64 ITA vs. 90 MDAX+SDAX)**
***Squared return*$_{i,t}$ (%)**			
OTR	3.0327***	2.3206***	5.7382*
(s.e.)	(0.9099)	(0.6621)	(3.2707)
STT	–2.6262*	–1.7423***	–5.4422
(s.e.)	(1.3714)	(0.5569)	(3.9035)
FTT	–0.9114***	–0.6891*	–0.1091
(s.e.)	(0.3119)	(0.3888)	(0.2850)
No. of obs.	167,200	82,080	91,200
Adj. R^2	0.032	0.112	0.027
***Conditional variance*$_{i,t}$**			
OTR	1.3586***	1.2601***	1.5374***
(s.e.)	(0.2550)	(0.4206)	(0.4168)
STT	–0.9813***	–0.8860***	–1.2802***
(s.e.)	(0.2652)	(0.2649)	(0.3865)
FTT	–0.6205***	–0.4425**	–0.3037
(s.e.)	(0.1583)	(0.1925)	(0.1986)
No. of obs.	167,293	82,163	91,254
Adj. R^2	0.458	0.567	0.470
***High-low range*$_{i,t}$**			
OTR	0.0003***	0.0002***	0.0004***
(s.e.)	(0.0000)	(0.0000)	(0.0001)
STT	–0.0002**	–0.0001***	–0.0003*
(s.e.)	(0.0001)	(0.0000)	(0.0002)
FTT	–0.0000**	0.0000	–0.0000
(s.e.)	(0.0000)	(0.0000)	(0.0000)
No. of obs.	167,420	82,188	91,320
Adj. R^2	0.079	0.133	0.065

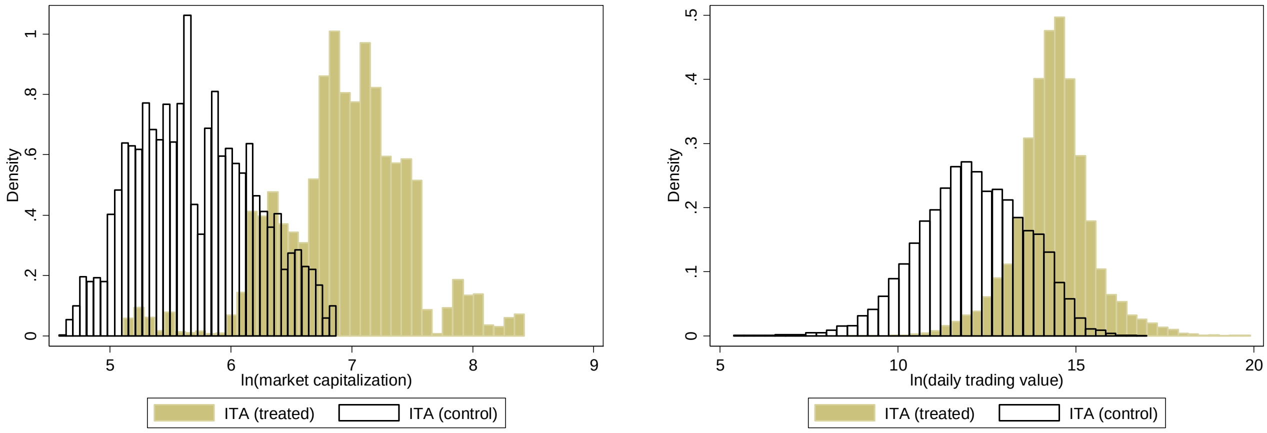
*, **, *** indicate a coefficient statistically different from zero at the 10%, 5%, 1% levels, respectively.

4.1. Difference-in-difference (DiD) estimates with Italian small firms as the control group

Figure 6 overlays the empirical distributions, in terms of market capitalization and trading value (in logs), of the Italian mid- and small caps subject to the STT/FTT (the treated group) and those which are not (the control group). This figure is similar to Figure 3, panel B, but with Italian small caps as the control group instead of German stocks. The distribution of the treated group is to the right, by construction, but the two groups do overlap. This is due to continuous changes in market capitalization, whereas the list of firms falling within the scope of the STT/FTT is revised only once a year (and announced several months in advance).

Figure 6. Italian stocks around the STT/FTT threshold

This figure shows the empirical distribution (in logs) of market capitalization and trading value for Italian mid- and small caps. Data are averaged over the period Jan. 2011-March 2012 (before the introduction of the OTR and the STT/FTT). Daily trading value is calculated as the number of shares times the closing price. The treated group is composed of 30 Italian mid-caps while the control group is composed of 34 Italian small caps.



The difference-in-difference results with Italian small firms as the control group appear in Table 6. Overall, these results are consistent with those using German firms as the control group: there is no significant or robust liquidity effect, and some evidence of a negative volatility effect.

Table 6. The impact of the Italian STT and FTT on stock-market liquidity and volatility (Italian small caps as the control group)

This table shows difference-in-difference results. The sample period extends from 2011 to 2013 (761 days). All of the data are daily. STT is a dummy variable from March 2013 for the firm being subject to the STT. FTT is a dummy variable 1 from September 2013 for the firm being subject to the FTT. $P_{i,t}$ is the closing price of stock *i* on day *t*. $NBST_{i,t}$ is the number of shares traded of stock *i* on day *t*. $NOSH_{i,t}$ is the total number of ordinary shares of stock *i* on day *t*. $NOSHFF_{i,t}$ is the percentage of shares available to ordinary investors of stock *i* on day *t*. *Trading value*$_{i,t}$ = $NBST_{i,t}$ * $P_{i,t}$. *Turnover ratio*$_{i,t}$ = 100*$NBST_{i,t}$ / ($NOSH_{i,t}$ * $NOSHFF_{i,t}$). *Bid-ask spread*$_{i,t}$ is the average difference between the asking and bid prices offered for stock *i* on day *t*, in percent. *Liquidity ratio*$_{i,t}$ = $V_{i,t} / |R_{i,t}|$; liquidity ratio is expressed in million Euros of trades for a price change of 1%. *Squared return*$_{i,t}$, $SR_{i,t}$ = $(R_{i,t})^2$ with $R_{i,t}$= 100*log($P_{i,t} / P_{i,t-1}$). *Conditional variance*$_{i,t}$ is estimated from a GARCH(1,1). *High-low range*, $HLR_{i,t}$ = (log $PH_{i,t}$ – log $PL_{i,t})^2$ / 4 log(2), where $PH_{i,t}$ and $PL_{i,t}$ are the highest and lowest prices achieved for stock *i* on day *t*, respectively. Time and firm dummies are included but the estimated coefficients are not shown. Standard errors are clustered at the firm level and appear in parentheses.

Sample (No. firms: treated vs. control group)	Mid- vs. small caps (30 vs. 34)		Mid- vs. small caps (30 vs. 34)
ln(Trading value$_{i,t}$)		***Squared return$_{i,t}$ (%)***	
STT	–0.2167		–2.2143
(s.e.)	(0.1822)		(2.0794)
FTT	–0.4927		–2.3181***
(s.e.)	(0.3137)		(0.8591)
No. of obs.	48,704		48,640
Adj. R^2	0.689		0.016
Turnover ratio$_{i,t}$ (%)		***Conditional variance$_{i,t}$***	
STT	–0.0683		–0.6348
(s.e.)	(0.0773)		(0.5219)
FTT	–0.0533*		–1.3123***
(s.e.)	(0.0311)		(0.3788)
No. of obs.	48,704		48,617
Adj. R^2	0.277		0.355
Bid-ask spread$_{i,t}$ (%)		***High-low range$_{i,t}$***	
STT	0.0750*		–0.0001
(s.e.)	(0.0420)		(0.0001)
FTT	0.0941***		–0.0002***
(s.e.)	(0.0275)		(0.0001)
No. of obs.	28,535		48,704
Adj. R^2	0.644		0.048
Liquidity ratio$_{i,t}$ (€ millions)			
STT	–1.1992*		
(s.e.)	(0.6863)		
FTT	1.3687*		
(s.e.)	(0.7623)		
No. of obs.	47,150		
Adj. R^2	0.111		

*, **, *** indicate a coefficient statistically different from zero at the 10%, 5%, 1% levels, respectively.

4.2. Regression Discontinuity (RD) design

RD analysis has attracted increasing attention in economics (see Lee and Lemieux, 2010). In the present context, the idea is that firms just below the threshold (which are not taxed) serve as a good comparison group for those just above the cutoff (which are taxed).

Lee and Lemieux (2010) suggest that RD provides a "highly credible and transparent way of estimating program effects", provided that the subjects in the analysis cannot manipulate the assignment variable (they should have at most imprecise control over assignment). In the present case, this crucial assumption very likely holds as it is very expensive to manipulate stock-market capitalization. It is also clear that no-one has precise control over stock prices.

The initial dataset was a long panel, with a small numbers of stocks but many observations on each stock over time. This panel suited the DiD approach. However, in the RD analysis, the source of identification is the similarity between units on both sides of the threshold, and adding dynamic structure introduces additional restrictions without any estimation advantage. Accordingly, the RD analysis is carried out using a single cross-section of data. For all variables, observations are pooled over a six-month period consecutive to the introduction of the Italian STT (March to August 2013). Moreover, the analysis is restricted to firms whose headquarters are located in Italy. Among these, the distribution in term of market capitalization in February 2013 is spread out, from €101 million for Landi Renzo to €64 billion for ENI. The sample is limited to 69 firms with a market capitalization of under €2 billion. As the list of the Italian firms falling within the scope of the STT was published several months in advance, one firm in the sample is subject to the STT, although its average market capitalization is under the threshold over the sample period. Conversely, six firms are not subject to the STT, although their average market capitalization is over the threshold during the sample period. These firms are excluded, leaving 28 stocks which are below the €500 million threshold, and 34 above.

Figure D in the Appendix provides a graphical representation of the RD design for some liquidity and volatility measures. The graphs follow the procedure proposed by Nichols (2007) using different bandwidths (see below). The value of the variable of interest is plotted on the vertical axis, and the corresponding value of market capitalization (in € billion), minus the cutoff, is plotted on the horizontal axis. It appears that, first, the goodness-of-fit is quite low, and second there is no clear visual evidence of any "jump" at the cutoff point. Although the graph may suggest some volatility discontinuities, the effects are not easy to detect.

Table 7. The impact of the Italian STT on stock-market liquidity and volatility (regression discontinuity design)

This table shows non-parametric estimates using different bandwidths (local Wald estimates). The procedure was proposed by Nichols (2007) and the bandwidths are optimally defined based on Imbens and Kalyanaraman (2009). The data are averaged over a six-month period after the introduction of the Italian STT (March to August 2013). The sample is composed of 62 firms with a market capitalization under €2 billion: 28 are below the €500 million threshold, while 34 are above it. *ln*(*Trading value*$_{i,t}$) = ln(Number of shares traded of stock i on day t * $P_{i,t}$), where $P_{i,t}$ is the closing price of stock i on day t; number of shares is expressed in thousands. *Turnover ratio*$_{i,t}$ = 100*No. of shares traded of stock i on day t divided by total number of shares of stock i on day t available to ordinary investors. *Bid-ask spread*$_{i,t}$ = 2*100*($PA_{i,t}$–$PB_{i,t}$)/($PA_{i,t}$+$PB_{i,t}$) where $PA_{i,t}$ and $PB_{i,t}$ are the asking and bid prices offered for stock i at close of market on day t, respectively. *Liquidity Ratio*$_{i,t}$ = $V_{i,t} / |R_{i,t}|$ with $R_{i,t}$ = 100*log($P_{i,t} / P_{i,t-1}$), for stock i on day t, respectively; liquidity ratio is expressed in thousands of Euros of trades for a price change of 1%. *Squared Return*$_{i,t}$, $SR_{i,t}$ = $(R_{i,t})^2$ with $R_{i,t}$= 100*log($P_{i,t} / P_{i,t-1}$). *Absolute Return*$_{i,t}$ = $|R_{i,t}| \sqrt{\pi/2}$. *Conditional variance*$_{i,t}$ is estimated from a GARCH(1,1). *High-low range, HLR*$_{i,t}$ = (log $PH_{i,t}$ – log $PL_{i,t}$)² / 4 log(2), where $PH_{i,t}$ and $PL_{i,t}$ are the highest and lowest prices achieved for stock i on day t, respectively.

	100%	**50%**	**200%**
ln(Trading value)			
Estimated jump	–0.1310	–0.2249	0.0735
(s.e.)	0.5055	0.6435	0.3920
Bandwidth	1.3185	0.6592	2.6371
Turnover ratio (%)			
Estimated jump	–0.0153	–0.0364	–0.0633
(s.e.)	0.0463	0.0533	0.0620
Bandwidth	0.9106	0.4553	1.8212
Bid-ask spread (%)			
Estimated jump	0.0590	0.1353	0.0620
(s.e.)	0.1821	0.1908	0.1343
Bandwidth	0.9532	0.4766	1.9065
Liquidity ratio			
Estimated jump	0.0690	0.2347	–0.8020
(s.e.)	0.4319	0.4250	0.8672
Bandwidth	0.8918	0.4459	1.7836
Squared return (%)			
Estimated jump	–1.4144**	–1.11463	–1.3996**
(s.e.)	0.6272	0.86829	0.6459
Bandwidth	0.9152	0.45761	1.8304
Conditional variance			
Estimated jump	–1.4764*	–1.78449	–1.1974
(s.e.)	0.7881	1.28091	0.8117
Bandwidth	0.8291	0.41456	1.6582
High-low range			
Estimated jump	0.0001	0.0001	–0.0001
(s.e.)	0.0001	0.0001	0.0001
Bandwidth	0.3000	0.1500	0.6000

*, **, *** indicate a coefficient statistically different from zero at the 10%, 5%, 1% levels, respectively.

Table 7 shows the estimates from non-parametric local linear regression (Wald statistics). This method imposes few restrictions on the functional form of the data, with bandwidth size being the key issue. There is a delicate trade-off between precision and robustness: the larger the bandwidth, the smoother the estimates. For each variable, the optimal bandwidth is defined based on Imbens and Kalyanaraman (2009), but I also consider smaller (50%) and larger (200%) bandwidths. The details of the implementation are provided in Nichols (2007). There is no significant difference between stocks below and above the threshold, except for two volatility measures (squared returns and conditional variance), where a fall can be seen. While the RD design might not be the most appropriate analysis method, it does confirm the previous results.

4.3. The impact on trading venues and OTC trades

I have so far exclusively considered trades that occurred on the *Borsa Italiana*. However, these only represent half of the total trading value in Italian equities over the 2010-2013 period. This section aims to provide some insights into possible changes in the market shares of all trading venues, using monthly aggregated data from Thomson-Reuters (Monthly Market Share Reports).

Two effects should be considered *a priori*. First, trading might have moved away from the *Borsa Italiana* to other trading platforms: this is what happened with Swedish stocks in the 1980s (Umlauf, 1992). However, the Swedish STT was levied on residents buying local shares, and was thus easy to avoid. In contrast, the Italian STT (like the French STT) is due regardless of the market, the place of establishment or residence of the parties to the transaction, and the place where the contract was established. Second, the tax rate is higher when the transaction applies to OTC trades (0.22% instead of 0.12% in the sample period). One might hence expect no overall significant impact on the market share of the *Borsa Italiana*, but a fall in the market share of OTC trading venues. The results based on aggregate data largely confirm this intuition.

As already shown in Figure 2, the aggregate market share of the *Borsa Italiana* has been roughly stable since 2010, whereas there was a fall in OTC trades for Italian equities following the introduction of the Italian STT. To ensure that this was due to the STT, I check that this was particular to Italian equities. Figure 7 compares trading activity in Italian and German equities. Panel A shows the aggregate value of share trading for the *Borsa Italiana* and the *Deutsche Börse*. In line with the econometric results based on individual daily data, the introduction of the STT had no apparent impact. Panel B, however, indicates a fall in OTC trades for Italian equities, whereas there is no such movement for German equities.[21]

Table 8 shows the aggregated trading value for Italian and German equities one year before the introduction of the Italian STT (March 2012 to February 2013) and one year after (March 2013 to February 2014). The grand total value of equity trading, across all trading venues, is stable for German stocks over the two periods. However, the grand total value for Italian equities fell from around €1,000 billion the year before the introduction of the STT to 800 billion the year after, a 23% decrease. This fall is exclusively due to lower OTC trades. While OTC trades for German equities fell by less than 10%, those for Italian equities dropped by a factor of five; the difference is clearly significant. This fall was partly compensated by greater trading on the *Borsa Italiana* and the other "Lit" plateforms.[22]

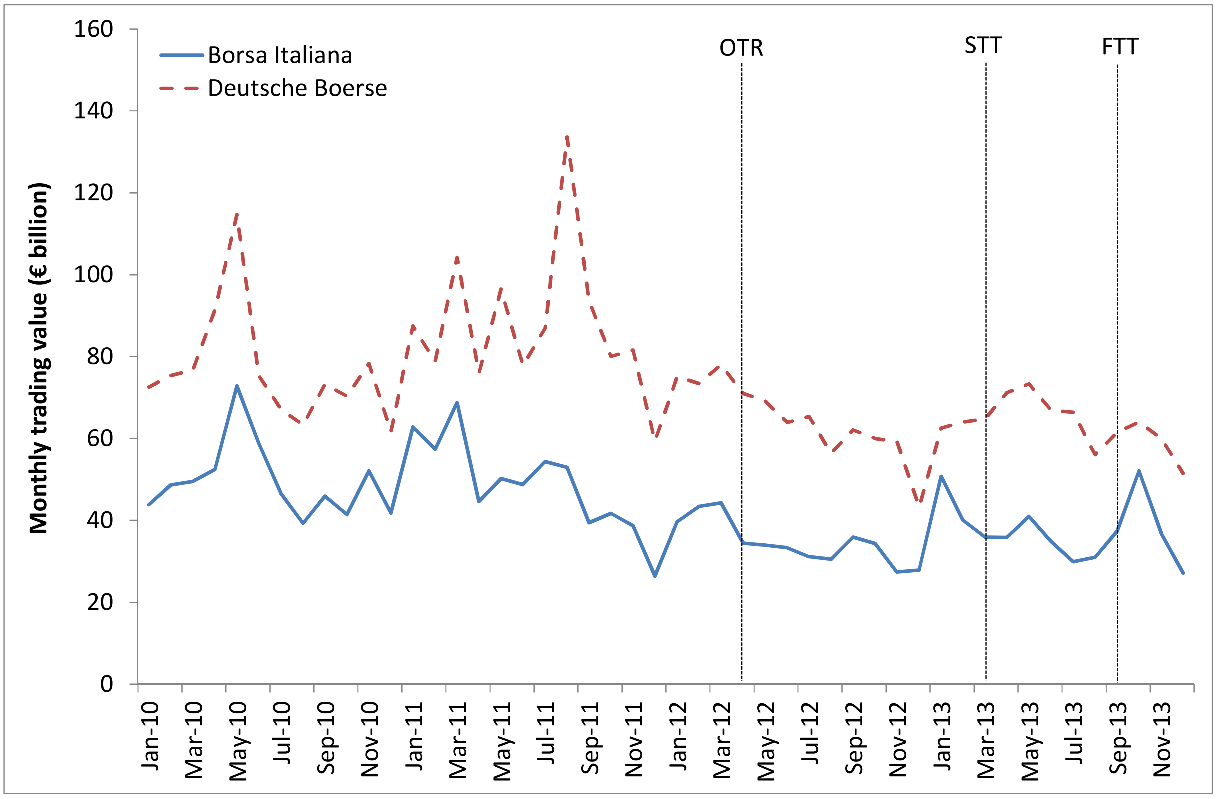
[21] Nor for British, Dutch, French or Spanish equities.

[22] Note that most press articles published shortly after the introduction of the Italian STT reported a decline in trading activity, but without specifying what kinds of trade were affected (e.g. Financial Times, March 2013: "*Tax blow to Italian stock trading*"; World Finance, Sept. 2013: "*FTT Fears*", etc.). Only a few articles have noted the migration of trades from the OTC (e.g. Richard Henderson, April 2013, thetradenews.com: "*Italian FTT boosts exchange-reported trades. […] Since the tax was implemented we've seen trades reported to BOAT decrease and trades reported to the exchange increase, with BATS Chi-X Europe also capturing an increase in reported trades*").

Figure 7. Italian *versus* German equity trading values

This figure compares the traded value of Italian and German equities. The data are from Thomson-Reuters Monthly Market Share Reports.

Panel A. Monthly trading value of historical trading venues



Panel B. Market share of OTC trades

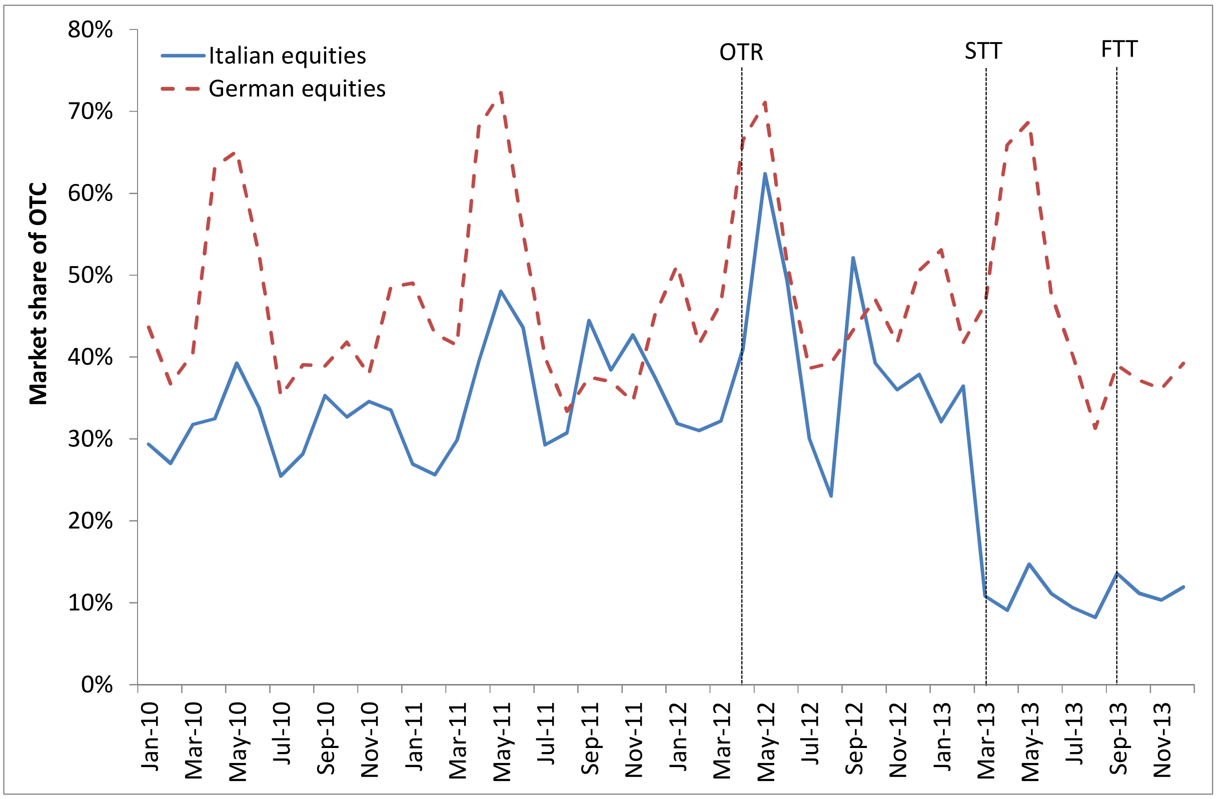


Table 8. The impact of the Italian STT on trading venues

This table presents the aggregated trade values for Italian and German equities one year before the introduction of the Italian STT and one year after. Trading values for Hidden, Auction, Dark and Off Order Books are included in the Grand Total, but are not reported individually.

(€ million)	**March 2012 to Feb. 2013**	**March 2013 to Feb. 2014**	**Difference**
Historical trading platforms (Order Book)			
Borsa Italiana	424,060	457,726	7.9%
Deusche Börse	755,116	790,421	4.7%
Diff-in-Diff			3.3%
Other "Lit" markets (Order Book)			
Italian equities	95,728	112,631	17.7%
German equities	432,916	477,606	10.3%
Diff-in-Diff			7.3%
Dark + Off Order Book			
Italian equities	95,155	153,541	61.4%
German equities	372,620	408,747	9.7%
Diff-in-Diff			51.7%
OTC			
Italian equities	445,113	88,344	–80.2%
German equities	1,713,900	1,573,175	–8.2%
Diff-in-Diff			–71.9%
Grand Total			
Italian equities	1,060,057	813,775	–23.2%
German equities	3,274,551	3,249,949	–0.8%
Diff-in-Diff			–22.5%

5. Conclusion

In the aftermath of the financial crisis, Italy took steps to curb the growth of stock trading. After a peak in 2011 at 400% (the highest in Europe), the turnover ratio has fallen below 200% in 2013. In the meantime, a penalty for high order-to-trade ratios and a financial transaction tax – first applied to stocks only, then extended to derivatives – were introduced. Italy thus provides us with a unique opportunity to examine the effect of these initiatives.

The conclusion of this paper is that these measures have barely affected market functioning. The econometric results based on difference-in-difference or discontinuity regressions, with a number of control groups, show no net impact on the bid-ask spread or the liquidity ratio, and a negative effect (if any) on volatility. There was however a substantial drop in OTC trading, consistent with a higher tax rate (0.22% vs. 0.12% for transactions executed on regulated markets).

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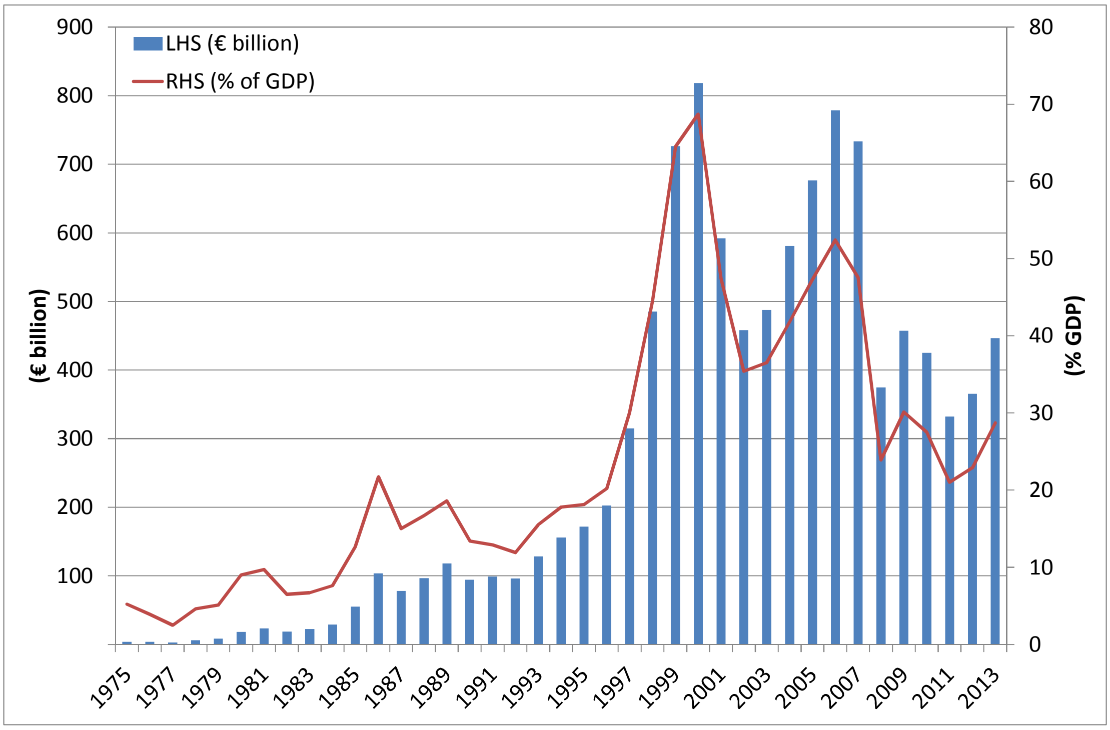
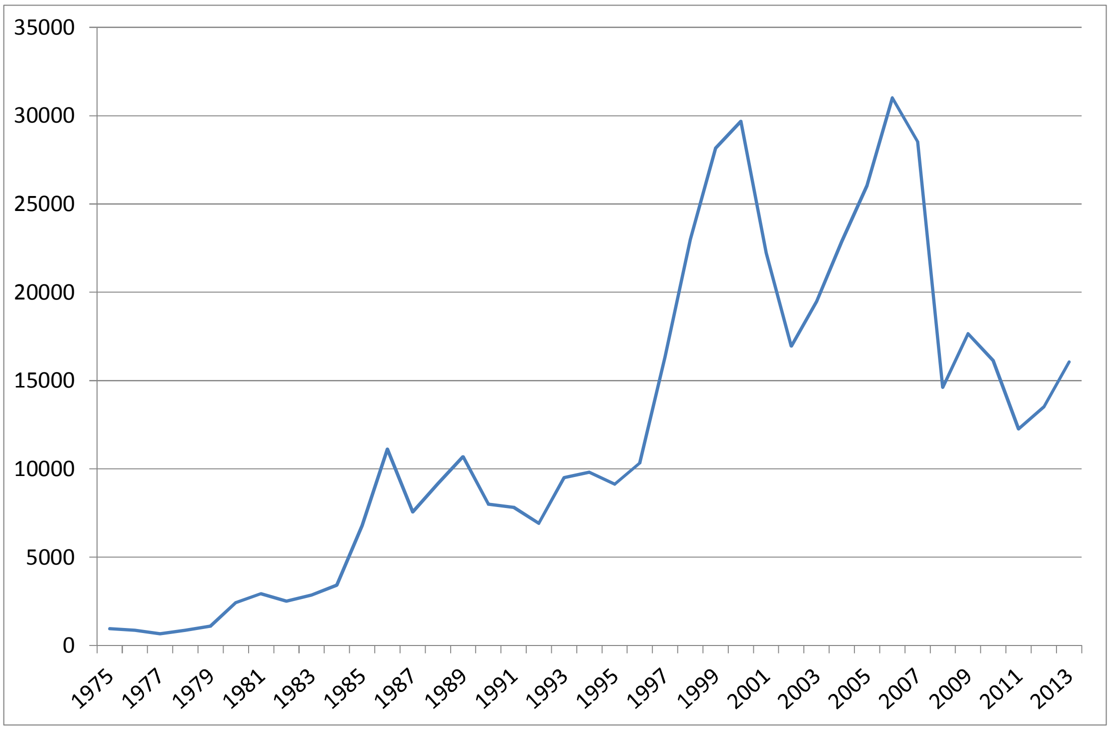
Appendix

Figure A. The market capitalization of the Italian Stock Exchange (*Borsa Italiana*)



Source: Borsa Italiana, Main Indicators.

Figure B. FTSE Italia MIB Index



Source: Borsa Italiana, Main Indicators.

Figure C. Distribution of stock prices and shares outstanding

This figure shows the empirical distribution of daily stock prices and number of shares outstanding for Italian and German firms over the 2011-2013 period. Italian firms are listed on the *Borsa Italiana* (34 large caps, 30 midcaps and 34 small caps) and German firm on the *Deutsche Börse* (30 large caps, 44 midcaps, and 46 small caps). For the sake of clarity, stock prices over 100€ are dropped here.

Large caps *Mid- and small caps*

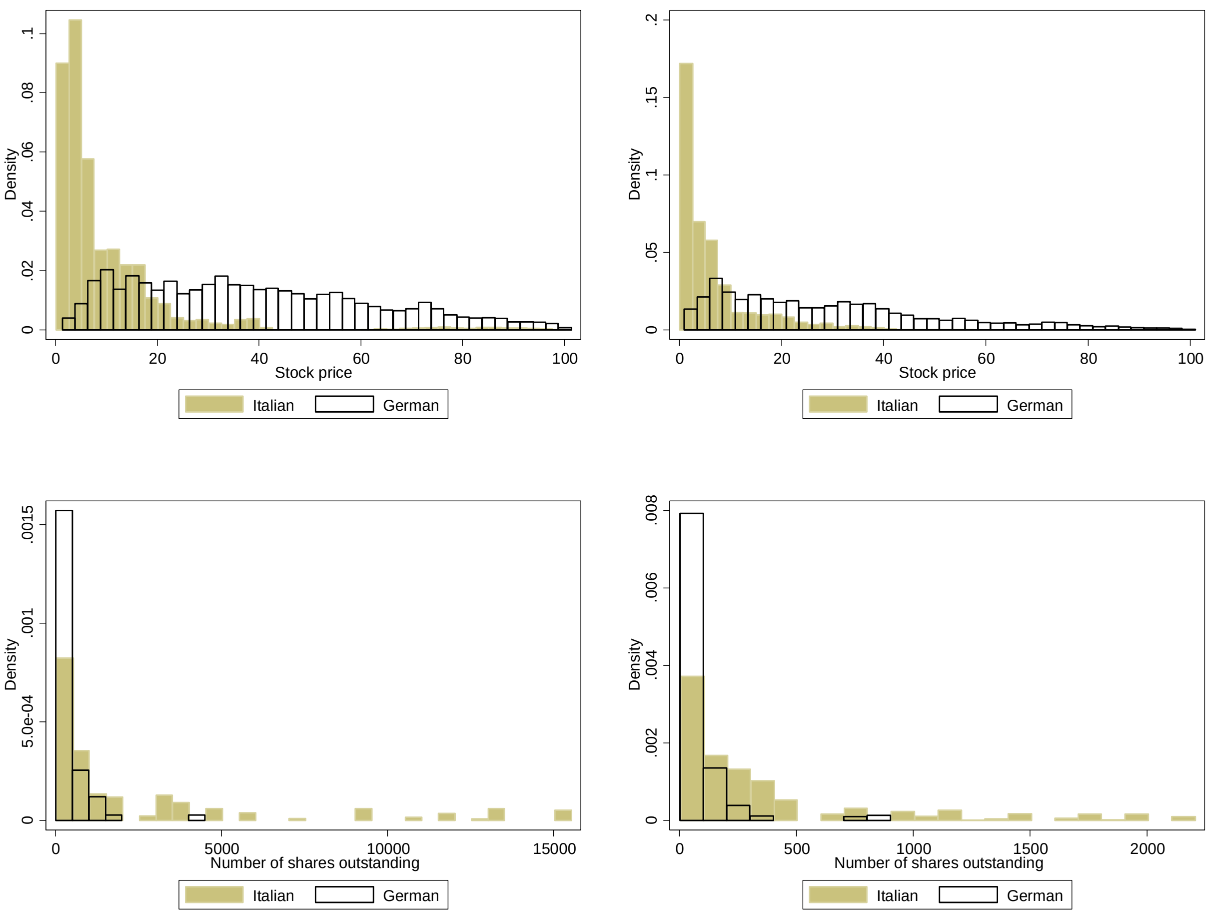
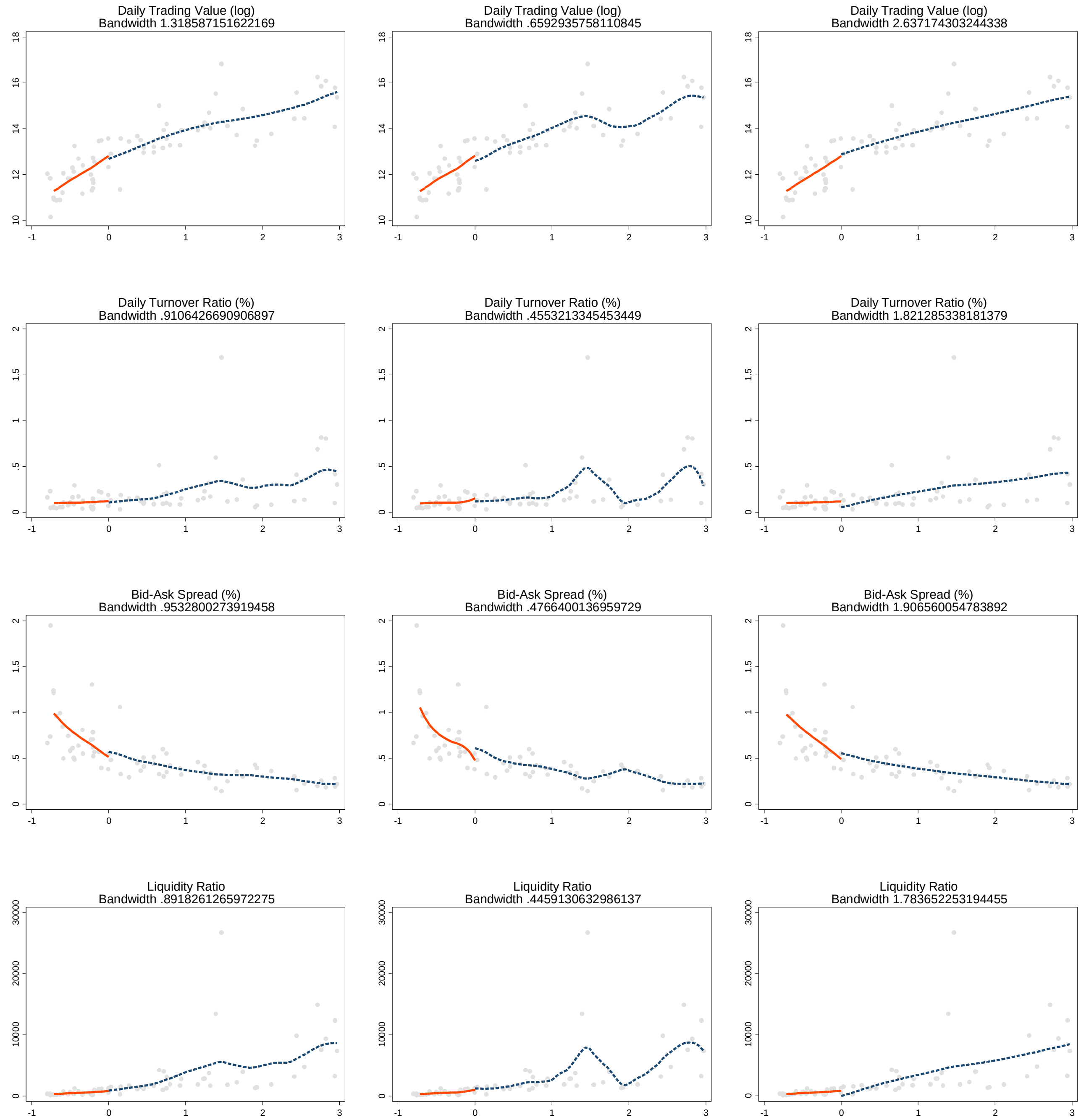


Figure D. Regression discontinuity design

This figure is a graphical representation of the RD design. The data are averaged over a six-month period following the introduction of the Italian STT (March 2013 to August 2013). The sample is composed of 62 firms with a market capitalization of under €2 billion: 28 are below the €500 million threshold, while 34 are above. The value of the variable of interest for each data point is plotted on the vertical axis, and the corresponding value of the market capitalization (in € billion), less the cutoff, is plotted on the horizontal axis. The graphs are implemented using the procedure proposed by Nichols (2007) and the bandwidths are optimally-defined based on Imbens and Kalyanaraman (2009). A triangular kernel is used.



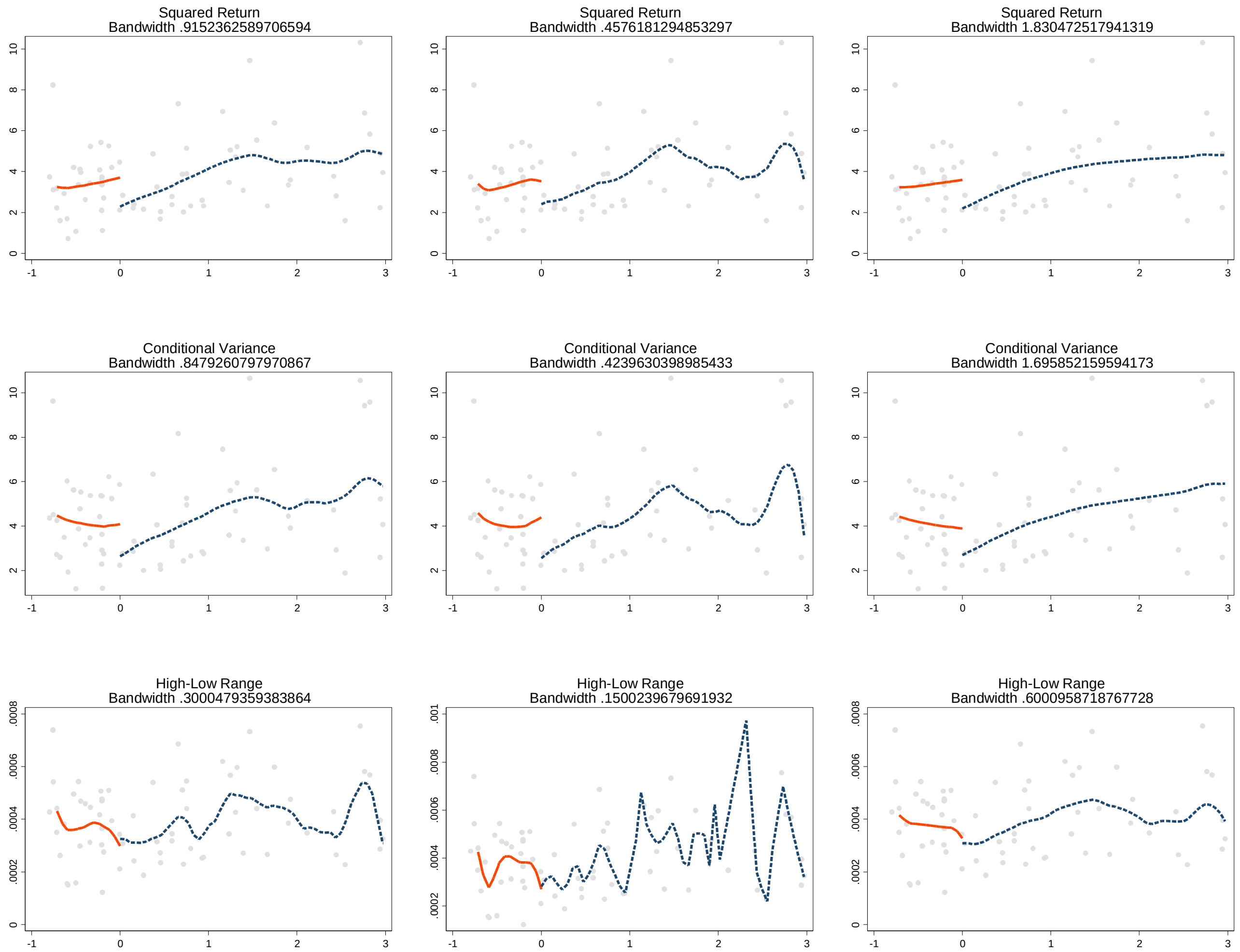

Squared Return
Bandwidth .9152362589706594
Squared Return
Bandwidth .4576181294853297
Squared Return
Bandwidth 1.830472517941319
Conditional Variance
Bandwidth .8479260797970867
Conditional Variance
Bandwidth .4239630398985433
Conditional Variance
Bandwidth 1.695852159594173
High-Low Range
Bandwidth .3000479359383864
High-Low Range
Bandwidth .1500239679691932
High-Low Range
Bandwidth .6000958718767728

Table A. The impact of the Italian OTR, STT and FTT on stock-market liquidity Robustness sample (Mk cap. > €100 ml.; Trading value > €100 bl.; P > €1)

This table presents the difference-in-difference results. The sample period extends from 2011 to 2013 (761 days). All of the data are daily. OTR is a dummy variable from April 2012 for the firm being subject to the OTR. STT is a dummy variable from March 2013 for the firm being subject to the STT. FTT is a dummy variable from September 2013 for the firm being subject to the FTT. $P_{i,t}$ is the closing price of stock i on day t. $NBST_{i,t}$ is the number of shares traded of stock i on day t. $NOSH_{i,t}$ is the total number of ordinary shares of stock i on day t. $NOSHFF_{i,t}$ is the percentage of shares available to ordinary investors of stock i on day t. $Trading\ value_{i,t} = NBST_{i,t} * P_{i,t}$. $Turnover\ ratio_{i,t} = 100*NBST_{i,t} / (NOSH_{i,t} * NOSHFF_{i,t})$. $Bid\text{-}ask\ spread_{i,t}$ is the average difference between the asking and bid prices offered for stock i on day t, in percent. $Liquidity\ ratio_{i,t} = V_{i,t} / |R_{i,t}|$; liquidity ratio is expressed in million Euros of trades for a price change of 1%. Time and firm dummies are included but the estimated coefficients are not shown. Standard errors are clustered at the firm level and appear in parentheses.

Sample (No. firms: treated vs. control group)	**Large caps (36 MIB vs. 74 DAX+MDAX)**	**Mid- and small caps (64 ITA vs. 90 MDAX+SDAX)**
ln(Trading value$_{i,t}$)		
OTR	0.0193	–0.2762***
(s.e.)	(0.0784)	(0.0984)
STT	–0.0156	–0.0375
(s.e.)	(0.0599)	(0.1200)
FTT	0.1735***	0.1436
(s.e.)	(0.0561)	(0.0916)
No. of obs.	78,084	84,867
Adj. R^2	0.877	0.808
Turnover ratio$_{i,t}$ (%)		
OTR	0.0668	–0.0126
(s.e.)	(0.0641)	(0.0302)
STT	–0.0783**	–0.0161
(s.e.)	(0.0368)	(0.0182)
FTT	0.0114	0.0362*
(s.e.)	(0.0277)	(0.0205)
No. of obs.	78,084	84,867
Adj. R^2	0.478	0.404
Bid-ask spread$_{i,t}$ (%)		
OTR	0.0037	0.0105
(s.e.)	(0.0117)	(0.0157)
STT	–0.0150*	–0.0307
(s.e.)	(0.0076)	(0.0211)
FTT	0.0079*	–0.0011
(s.e.)	(0.0044)	(0.0117)
No. of obs.	50,216	55,116
Adj. R^2	0.743	0.768
Liquidity ratio$_{i,t}$ (€ millions)		
OTR	–18.7863	–0.9732
(s.e.)	(12.9214)	(3.5138)
STT	7.8937	–4.6501
(s.e.)	(11.3257)	(2.9228)
FTT	–15.7257	1.0445
(s.e.)	(21.2721)	(2.6173)
No. of obs.	77,361	83,770
Adj. R^2	0.069	0.057

*, **, *** statistically different from zero at the 10%, 5%, 1% levels, respectively.

Table B. The impact of the Italian OTR, STT and FTT on stock-market volatility Robustness sample (Mk cap. > €100 ml.; Trading value > €100 bl.; P > €1)

This table presents the difference-in-difference results. The sample period extends from 2011 to 2013 (761 days). All of the data are daily. OTR is a dummy variable from April 2012 for the firm being subject to the OTR. STT is a dummy variable from March 2013 for the firm being subject to the STT. FTT is a dummy variable from September 2013 for the firm being subject to the FTT. $P_{i,t}$ is the closing price of stock i on day t. *Squared return*$_{i,t}$, $SR_{i,t} = (R_{i,t})^2$ with $R_{i,t} = 100*\log(P_{i,t} / P_{i,t-1})$. *Conditional variance*$_{i,t}$ is estimated from a GARCH(1,1). *High-low range*, $HLR_{i,t} = (\log PH_{i,t} - \log PL_{i,t})^2 / 4 \log(2)$, where $PH_{i,t}$ and $PL_{i,t}$ are the highest and lowest prices achieved for stock i on day t, respectively. Time and firm dummies are included but their estimated coefficients are not shown. Standard errors are clustered at the firm level and appear in parentheses.

Sample (No. firms: treated vs. control group)	**Large caps (36 MIB vs. 74 DAX+MDAX)**	**Mid- and small caps (64 ITA vs. 90 MDAX+SDAX)**
***Squared return*$_{i,t}$ (%)**		
OTR	1.6947***	1.5001***
(s.e.)	(0.3555)	(0.4115)
STT	–0.8065***	–1.2331***
(s.e.)	(0.2662)	(0.3327)
FTT	–0.4477	0.0350
(s.e.)	(0.3158)	(0.2613)
No. of obs.	78,084	84,867
Adj. R^2	0.259	0.180
***Conditional variance*$_{i,t}$**		
OTR	1.1424***	1.4140***
(s.e.)	(0.3670)	(0.3476)
STT	–0.6258**	–0.7612***
(s.e.)	(0.2429)	(0.2563)
FTT	–0.3951**	–0.2171
(s.e.)	(0.1952)	(0.2134)
No. of obs.	78,062	84,851
Adj. R^2	0.555	0.476
***High-low range*$_{i,t}$**		
OTR	0.0002***	0.0002***
(s.e.)	(0.0000)	(0.0000)
STT	–0.0001***	–0.0001***
(s.e.)	(0.0000)	(0.0000)
FTT	0.0000	–0.0000
(s.e.)	(0.0000)	(0.0000)
No. of obs.	78,084	84,867
Adj. R^2	0.125	0.074

*, **, *** statistically different from zero at the 10%, 5%, 1% levels, respectively.

Table C. Correlation matrix

This table shows the pairwise correlation coefficients between the liquidity and volatility measures. The sample period extends from 2011 to 2013 (761 days). All of the data are daily. $P_{i,t}$ is the closing price of stock *i* on day *t*. *ln(Trading value$_{i,t}$)* = ln(Number of shares traded of stock *i* on day *t* * $P_{i,t}$), where $P_{i,t}$ is the closing price. *Turnover ratio$_{i,t}$* = 100*$NBST_{i,t}$ / ($NOSH_{i,t}$ * $NOSHFF_{i,t}$). *Bid-ask spread$_{i,t}$* is the average difference between the asking and bid prices offered for stock *i* on day *t*, in percent. *High-Low Range*, $HLR_{i,t}$ = (log $PH_{i,t}$ – log $PL_{i,t}$)² / 4 log(2), where $PH_{i,t}$ and $PL_{i,t}$ are the highest and lowest prices achieved for stock *i* on day *t*, respectively. *Squared return$_{i,t}$*, $SR_{i,t} = (R_{i,t})^2$ with $R_{i,t}= \log(P_{i,t} / P_{i,t-1})$.-*Conditional variance$_{i,t}$* is estimated from a GARCH(1,1). *Liquidity ratio$_{i,t}$* = $V_{i,t} / |R_{i,t}|$; the liquidity ratio is expressed in Euros of trades for a price change of 1%.

	Liquidity measures			
	ln(Trading value$_{i,t}$)	*Turnover ratio$_{i,t}$*	*Bid-ask spread$_{i,t}$*	*Liquidity ratio$_{i,t}$*
ln(Trading value$_{i,t}$)	1.0000			
Turnover ratio$_{i,t}$	0.5124	1.0000		
Bid-ask spread$_{i,t}$	–0.7721	–0.2976	1.0000	
Liquidity ratio$_{i,t}$	0.2034	0.0603	–0.1169	1.0000

	Volatility measures		
	Squared return$_{i,t}$	*Conditional variance$_{i,t}$*	*High-low range$_{i,t}$*
Squared return$_{i,t}$	1.0000		
Conditional variance$_{i,t}$	0.2420	1.0000	
High-low range$_{i,t}$	0.3941	0.2583	1.0000