Financial Transaction Taxes, Market Composition, and Liquidity

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Abstract

We use the introduction of a financial transactions tax in France in 2012 to study how such a policy affects market quality by modifying the composition of trading activity. We show that institutional investors are disproportionately affected, in particular those with a high portfolio turnover. Consistent with the view that end-investors are important liquidity providers, we find a significant erosion of market quality in stocks that do not rely on liquidity provision by tax-exempt market makers. Our results provide support for some of the economic mechanisms highlighted in the theory literature on FTTs.

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1 Introduction

The global financial crisis has renewed interest in financial transaction taxes (FTT), a development that has been largely fuelled by the combination of strapped public finances and public discontent with the financial industry.[1] While FTTs have been widely debated in the academic literature since they were suggested by Keynes (1936), no clear consensus regarding their desirability and impact has emerged.

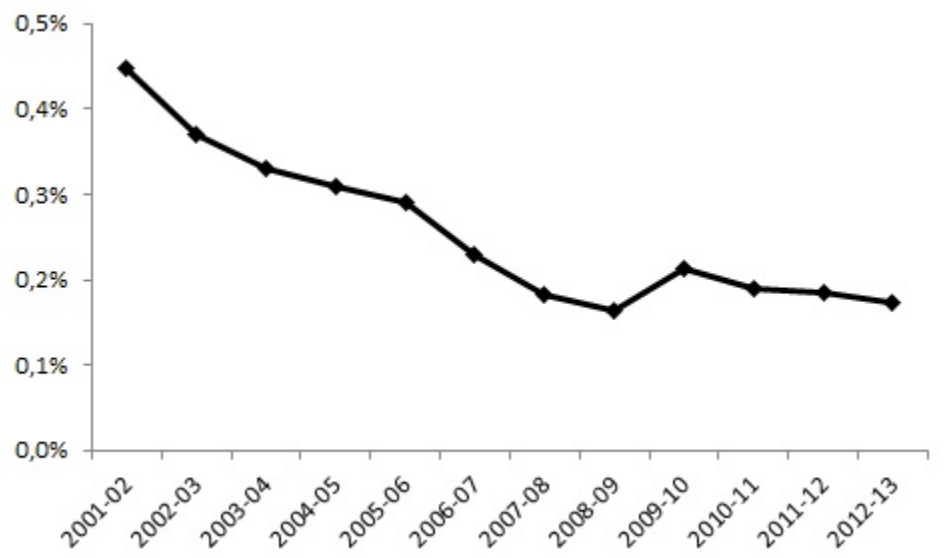
The theoretical literature predicts that the impact of an FTT will differ depending on which types of traders are most affected by the tax. For instance, an FTT should lower (raise) market volatility if noise traders reduce (increase) their trading activity relative to rational traders. More generally, we will refer to differential impacts across groups of market participants as *composition effects*. Existing empirical studies on FTTs are largely confined to estimating aggregate effects, because the lack of granular data has prevented an analysis of their impact on specific trader types to date. Unfortunately, this limits the ability to learn about the underlying economic mechanisms. In particular, it is not clear whether disagreement among existing studies is driven by differences in market compositions in a way that is consistent with the theoretical literature, or whether theories of FTTs are missing some important effects.

This paper aims to bridge this gap between the existing theoretical and empirical work by examining the introduction of a 20 bps tax on the purchase of French equities on August 1st, 2012. Within a difference-in-differences framework using non-French stocks traded on the same market (Euronext) as a control group, we estimate the causal impact of the tax on the trading activity of different types of market participants. To this end, we conduct our analysis using data that i) allows us to infer agents' trading technology and ii) isolates a large set of institutional investors with different characteristics (portfolio turnover, size, investment style, etc.). We provide strong evidence for the existence of important composition effects, and subsequently link them to the FTT's impact on market quality.

Accounting for composition effects is particularly important because most real-world

[1] In October 2012, 11 EU countries committed to the introduction of a harmonized tax on financial transactions, currently planned to be launched in 2016. Transaction taxes and administrative charges on trading activity (e.g. the SEC's Section 31 fee) are internationally widespread. See Matheson (2011) for an overview.

Figure 1: UK stamp duty revenue as a fraction of on-exchange trading volume.



FTTs are essentially "stamp duties" that only apply to transfers of ownership and thus de-facto exempt intraday transactions, a type of activity whose relative importance has increased substantially in the recent past, especially via the rise of high-frequency trading (HFT).[2] Figure 1 illustrates this evolution by showing that the revenue due to the UK stamp duty as a share of trading volume in British stocks has declined steadily over the past decade.[3] As the proportion of trades subject to taxation has been shrinking considerably, the impact of such a policy today may be different from the past, and the French experiment is a unique opportunity to study the role of FTTs in a modern environment with high-frequency trading.

The rise of HFT poses a challenge for identifying the impact of "stamp duty"-like FTTs because their impact on long-run investors is obscured by a large share of exempt intraday activity. To overcome this *clouding effect*, we conduct separate analyses for stocks with and without a significant share of HFTs and additionally examine data on the trading activity of institutional investors.

We find that the French FTT disproportionately impacts institutional investors, in par-

[2]Ownership transfers occur at the settlement stage at the end of the trading day, and thus only apply to net position changes.

[3]The data are taken from HM Revenue & Customs and the London Stock Exchange. In order to account for market fragmentation after the launch of MiFID, we assume the LSE's market share to be 100% before 2008, 90% in 2008-09, 80% in 2009-10, and 70% thereafter.

ticular those with a higher turnover, and funds relying on passive investment strategies. Importantly, this composition effect leads to a significant decline in market quality for stocks in which these market participants appear to be a more important source of liquidity provision. While the French tax design includes safeguards for market-making activities by specialized agents, it neglects the importance of decentralized liquidity provision in order driven markets.

More in detail, our analysis begins with a look at the French FTT's aggregate impact and finds a 10% decrease in trading volume across all affected stocks, accompanied by a moderate decline in market quality. In order to document the importance of clouding effects through HFT activity, we exploit Euronext's "Supplemental Liquidity Provider" (SLP) programme. This scheme grants rebates for regular liquidity provision in the most liquid stocks and naturally attracts a significantly higher share of passive trade executions by HFTs. While shares traded under this programme are virtually not affected by the FTT, the remaining stocks display a more pronounced reduction in trading volume (-20%) and a significant reduction in market quality (higher bid-ask spreads, larger price impacts, and increased volatility).

We then analyze how composition effects can explain the detrimental impact of the tax. We first employ a novel dataset that allows us to identify whether an order is submitted by an HFT, a non-HFT, or a "Mixed Trader". We find that liquidity provision in non-SLP stocks shifts from Mixed traders to non-HFTs, which are less efficient at managing their limit orders. This evidence highlights the relevance of the composition effects studied experimentally by Bloomfield, O'Hara, and Saar (2009), but in contrast to their study we find an increase in adverse selection.

In order to obtain a more granular view of such composition effects, we finally examine the trading activity of institutional investors. We find that the average fund in our sample reduces its trading volume by around -17%, which is considerably more than the average drop in volume and confirms that the tax has a higher impact on institutional investors than on the market-wide trading volume. Moreover, the effect is particularly large (-24%) for stocks outside the SLP programme (that is without HFT market-making). In addition, the FTT's impact varies considerably in the cross-section of funds. In particular, we show that investors with a high portfolio turnover decrease both their holdings and their trading

activity in French stocks relative to those with a low turnover. This is a new empirical finding on the effects of FTTs, and is consistent with standard models of transaction costs such as Amihud and Mendelson (1986).

While our evidence on different composition effects is important for understanding the impact of transaction costs in securities markets in general, it also has rich implications for the debates on transactions taxes. FTTs are frequently motivated by a mix of fiscal (raising revenue) and Pigovian (correcting externalities) motives. The evidence presented here shows that the attempt to reach both objectives and thus reap a "double dividend" is not possible, especially in the current market structure with a significant share of intraday trading activity. The French authorities levied a disappointing 198 million EUR in revenue for the period of August-December 2012.[4] Despite the claim that FTTs are targeted at reducing "short-term speculation", one may argue that they achieve precisely the opposite in today's markets, as a tax on ownership transfers applies to everything *but* speculative activity.

On the positive side, the tax has the effect of reallocating the ownership of French stocks towards the more long-term institutional investors, which can improve the corporate governance of the affected companies (see Derrien, Kecskes, and Thesmar (2013) for recent evidence). However, this effect is associated with a negative impact on market quality as institutional trades are an important source of liquidity, especially for less liquid stocks. The French tax design fails to take this into account and only protects liquidity provision by specialized market-makers.

The remainder of this paper is organized as follows. The next section relates our paper to the existing literature. Section 3 details the legal background and provides an outline of our identification strategy. Section 4 presents our results on market quality, while Section 5 details the impact on different trader types. Section 6 considers the impact on long-term portfolio changes by institutional investors, followed by the Conclusion.

[4]The figures on revenues were published by the lower house of the French Parliament, http://www.assemblee-nationale.fr/14/rap-info/i1328.asp.

2 Related literature

Building on the insights of Keynes (1936), Stiglitz (1989) provides a general overview of the composition effects through which an FTT can be a desirable policy tool. In his view, a tax should have little impact on passive investors and on investors with long-term fundamental information. However, it should have a larger impact on several types of trading that he deems harmful: i) "noise traders", who increase volatility and decrease market efficiency; ii) "speculators", who play a zero-sum game and may destabilize the market; iii) short-term investors, who incentivize managers to forego long-run profitability for immediate gains. Accordingly, the composition effects arising from the imposition of an FTT can decrease volatility, reduce over-investment in short-term information, and improve the corporate governance of companies.

However, later theoretical studies cast doubt on the assumptions underlying this rather optimistic view of FTTs. For example, Dow and Rahi (2000) study an environment in which speculation is a harmful activity (it destroys risk-sharing opportunities), as assumed by Stiglitz (1989). They show that, in this setting, an FTT will only have a positive effect on welfare if passive investors are sufficiently risk averse.[5] Otherwise, the tax will prevent investors from engaging in mutually beneficial trades. Bloomfield, O'Hara, and Saar (2009) cast doubt on the idea that FTTs have a particularly strong effect on noise trading, as their experimental results suggest a roughly similar reduction in informed trading and therefore an overall neutral effect. In addition, Song and Zhang (2005) show that an FTT can increase volatility even in cases in which it triggers a reduction in the ratio of noise traders to rational traders. In their model, this effect arises because a reduction in liquidity negatively affects rational traders' ability to correct mispricings (a "liquidity effect"). Finally, while theory unambiguously predicts that investors with a low portfolio turnover are less impacted by an FTT (Amihud and Mendelson (1986)), there is doubt about the magnitude of this effect.

Our data allows us to find direct evidence for various composition effects and thus shed light on some of the debates of the theoretical literature. As we are able to assign orders to

[5] A related argument is made by Subrahmanyam (1998), who shows that a transaction tax reduces incentives to acquire short-term information before other market participants, leading to lower adverse selection and increased liquidity.

different trader categories (HFTs, Mixed Traders, non-HFTs), we can compute measures of trade informativeness for each group and examine whether they are differentially impacted by the tax. While this is a central mechanism in assessing the FTT's impact, it is important to note that our data stems from a limit order market. Accordingly, the composition effects studied in the theory literature need to consider both the aggressive and the passive side of each trade. Moreover, our data on institutional investors provides information on investment fund characteristics and therefore allows us to quantify to what extent funds with a low portfolio turnover are less impacted than those with a high turnover. We also find that index funds are significantly more impacted than the average fund, in contradiction with Stiglitz (1989), who assumes that passive investors should be less sensitive to an FTT.

There is a rich empirical literature on the effect of FTTs on several aspects of market quality. While delivering useful insights concerning the aggregate impact of such policies, they are largely silent on the economic mechanisms such as the composition effects dominating the theoretical literature. This is due to the fact that virtually all the experiments considered in the literature, whether FTTs or more generally changes in transaction costs, took place either before the 2000s and/or in emerging markets. Accordingly, the data necessary to link empirical results to economic theory were not available.[6] This implies that it is difficult to understand whether the sometimes contradicting results are still in line with the predictions coming from the theoretical literature. The recent paper by Deng, Liu, and Wei (2014) comes closer to this objective. The authors study changes in the Chinese FTT and show that an increase in the tax rate raises volatility when the proportion of institutional investors is high, and leads to a decrease when it is low. This finding is in line with the idea that FTTs can dampen volatility when they mostly affect noise traders (proxied by retail investors), but the authors are not able to directly observe the reaction of specific investor types to FTT changes.

Some recent empirical papers study changes in the proportion of retail investors triggered by changes in other transactions costs. Foucault, Sraer, and Thesmar (2011) study a shock to the transaction costs borne by retail traders, while Malinova and Park (2014) focus on

[6]See e.g. Roll (1989), Umlauf (1993), Jones and Seguin (1997), Hau (2006), Liu and Zhu (2009), or Pomeranets and Weaver (2012), and Baltagi, Li, and Li (2006) for an emerging market.

the breakdown of exchange fees among makers and takers. However, neither paper allows to draw conclusions on whether a general increase in transaction costs, like an FTT, affects retail investors more or less than other market participants.

Finally, a number of contemporaneous research papers examine the introduction of the French FTT and its effects on market quality, e.g. Meyer, Wagener, and Weinhardt (2014) and Becchetti, Ferrari, and Trenta (2014).[7] While these studies largely corroborate our findings concerning the policy's aggregate impact (despite using a variety of different control groups), our aim is different as we are less interested in evaluating the effects of the French FTT per se than in using this experiment to investigate the composition effects at play when an FTT is introduced.

3 Methodology and data

3.1 The policy experiment

Two measures were introduced on August 1st 2012: A stamp duty on equity transactions (henceforth referred to as "the FTT") for a subset of French stocks, and a tax on the message traffic of HFTs.[8]

- The FTT is a "stamp duty" of 0.2% (20 bps) of the transaction price, payable by the buyer on daily net position changes (i.e. ownership transfers). This tax applies to shares of all listed companies incorporated in France with a market capitalization above one billion euros on December 1st of the previous year,[9] and to trades on any trading platform as well as in the over-the-counter market. American Depository Receipts (ADRs) were not subject to the tax at the time of the study.[10]

There are a number of important exemptions: The tax does not apply to newly emitted shares, to transactions by clearing houses, to employee stock ownership plans and, most

[7]Further papers include Capelle-Blancard and Havrylchyk (2013), Coelho (2014), and Haferkorn and Zimmermann (2013).

[8]These two instruments were introduced in articles 235 ter ZD and 235 ter ZD bis of the French tax law code.

[9]With the exception of the first year of implementation, for which the relevant date was January 1st 2012.

[10]Throughout our sample period, there are six French stocks whose ADRs are traded on US exchanges. In the Internet Appendix, we present some evidence that refutes the idea that these instruments were used actively in an effort to evade the French FTT.

importantly, to market makers.[11] Due to all these exemptions, the main agents directly affected by the tax are buy-side investors, irrespectively of their residence.[12]

- The HFT tax introduces a tax of 0.01% (1 bp) on the notional amount of modified or cancelled messages by HFTs with an order-to-trade ratio of more than 5:1.[13] Unlike the FTT, the HFT tax is applied to trading in all French stocks, irrespectively of their market capitalization. However, it applies only to HFTs residing in France and transacting on their own account, which excludes most of the major HFT firms, which are located in the UK and the Netherlands. In addition, message traffic due to market-making, smart-order routing and automated execution of large orders is exempt from this tax. Accordingly, the scope of this policy is extremely limited, and the evidence provided in Section 4 shows that it had no impact in practice.

3.2 Identification Strategy

We adopt a simple difference-in-differences approach for identifying the FTT's causal impact on market quality and the trading volume of different market participants. To this end, we compare treated French stocks to a group of non-treated control stocks that are otherwise as similar as possible. In order to account for the simultaneous introduction of the HFT tax, we conduct two separate analyses. In a first step, we show that the HFT tax does not have any impact by estimating a diff-in-diff procedure exclusively among a set of French and non-French stocks with a market capitalization of less than 1 billion EUR. In this setting, the French stocks are affected by the HFT tax, but not by the FTT. After confirming that the levy on HFT message traffic does not have any significant effect, we proceed to a second diff-in-diff procedure among a set of French and non-French stocks with a market capitalization that exceeds the 1 billion EUR threshold. Here, the French stocks are subject to both the FTT and the HFT tax, but the results from the previous step allow us to attribute any

[11] Market-making is defined as either quoting competitive bid and ask prices and/or providing liquidity on a regular and continuous basis, or executing orders on the behalf of clients, or hedging positions due to these activities.

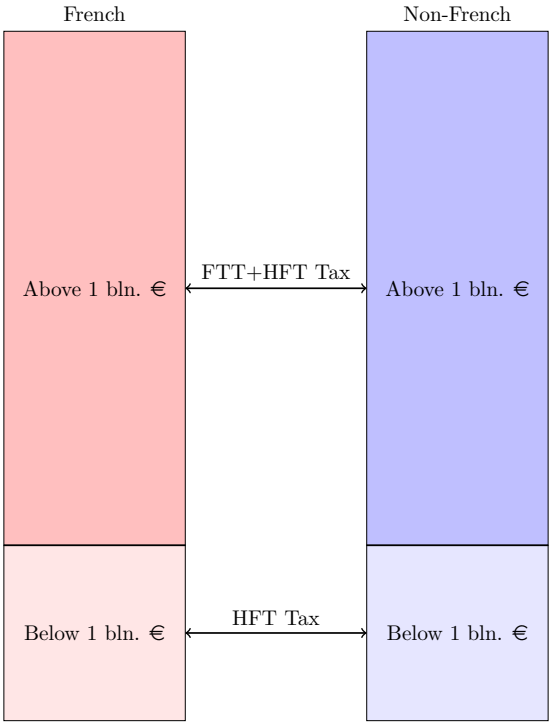
[12] The French FTT relies on the so-called "issuance principle", under which taxation is based on a security's country of registration and not on the residence of the counterparties involved in the transaction.

[13] In this context, HFT is defined as the regular submission of orders with a resting time of less than 0.5 seconds.

causal effect exclusively to the FTT. Figure 2 depicts the different groups of stocks and our identification strategy.

Figure 2: Identification strategy for estimating the impact of the FTT and the HFT tax.

This Figure illustrates the identification strategy used for the empirical analysis. Comparing French to non-French stocks below the 1 billion EUR threshold identifies the impact of the HFT tax. Comparing French to non-French stocks above the 1 billion EUR threshold identifies the impact of the FTT plus the impact of the HFT tax, if any. The impact of the FTT can be isolated by contrasting both estimates.



While many applications of the difference-in-differences estimator rely on just two observations per individual (one before and one after the treatment), the abundance of financial data allows for repeated observations in both the pre- and post-event periods. This can be particularly useful if one wants to allow the treatment effect to vary across sub-periods, for example in order to disentangle temporary effects from permanent ones. Practitioners, government officials and regulators advised us in private conversations that the trading activity in August is unlikely to correctly reflect the impact of the policy change because of i) temporary (legal) uncertainty among investors on whether they are subject to the tax or not and ii) a seasonal decline in trading activity for French stocks due to country-wide summer

holidays. In order to take such a possibility into account, we use a 5-month sample period from June to October 2012 and opt for a flexible framework that allows the treatment effect in the first month after the policy change (i.e. August) to be potentially different from the impact in September and October.[14] Formally, the assumption underlying our approach is that for each stock i and date t the variable of interest, $y_{i,t}$, satisfies the following equation:

$$\begin{aligned} \mathbb{E}(y_{i,t} \mid i,t) &= \alpha + \gamma Treated_i + \delta^{Aug} Post_t^{Aug} + \delta^{Sep/Oct} Post_t^{Sep/Oct} \\ &+ \beta^{Aug} Treated_i * Post_t^{Aug} + \beta^{Sep/Oct} Treated_i * Post_t^{Sep/Oct}, \end{aligned} \tag{1}$$

where $Treated_i$ is a dummy variable equal to one for treated stocks and zero otherwise, and $Post_t^{Aug}$ and $Post_t^{Sep/Oct}$ similarly mark days in August and September/October, respectively. This specification relies on the standard common trends assumption that the variables of interest for both groups of stocks should comove closely absent any treatment, but allows for the impacts in August and in September/October to differ. The coefficient $\beta^{Sep/Oct}$ captures the long-term impact of the treatment.

A common issue concerning the difference-in-difference methodology is that the common trends assumption cannot be tested formally. However, the Online Appendix provides some "placebo" tests that have become customary in the literature on policy evaluation. Together with visual inspection of the data series and the high correlations between the treated and the control group (reported in the Online Appendix), these tests confirm the validity of our control group.

3.3 Sample Selection and Data

As much of our work relies on high-frequency data, it is important to ensure that the data for both treated and control stocks stem from the same microstructural environment, including the trading protocol, the tick size regime, and the fee structure. The last point is of particular importance because part of our analysis makes use of a rebate scheme for limit orders offered by Euronext. Fortunately, the primary market for French stocks, Euronext, also constitutes

[14] In the Online Appendix, we provide empirical support for our choice of specification by confirming the suspicion that trading activity in French stocks is generally subject to a slowdown in August, while both September and October are free from seasonal influences.

the main trading venue for Belgian, Dutch and Portuguese stocks. Moreover, the Luxembourg Stock Exchange also uses Euronext's Universal Trading Platform (UTP) as part of a cross-membership cooperation. Accordingly, non-French stocks listed on Euronext (as of the cutoff date January 1st 2012) form a natural pool of control stocks for our diff-in-diff analysis.

We define our final sample of stocks as follows. We start by collecting all constituents of the Euronext 100 and Euronext Next 150 Indices, which represent the universe of Euronext stocks with a sufficient degree of market liquidity. Because Belgium increased its pre-existing FTT on August 1st 2012 (only levied on Belgian residents) and Portugal was heavily affected by the sovereign debt crisis, we restrict the control group to stocks registered in Luxembourg and the Netherlands. Moreover, we delete bank stocks in order not to pick up idiosyncratic effects due to the sovereign debt crisis and apply some additional filters to ensure a minimum level of liquidity.[15] The final sample contains 166 stocks (87 treated French stocks, 32 control stocks above 1 billion EUR, 29 non-treated French stocks, and 18 control stocks below 1 billion EUR).[16] As already indicated, the sample period is June 1st - October 31st, 2012 (109 trading days).

Our data stems from several sources. We obtain millisecond-stamped intraday data for the market activity (trades and quotes) on Euronext from Thomson Reuters Tick History (TRTH), which we use to compute a wide range of microstructure variables at the stock-day level (see Section 4). Further, we were granted access to the BEDOFIH database, which covers stocks for which Euronext Paris constitutes the primary market center.[17] This database assigns each side (i.e. limit and market order) of every transaction to one out of three trader categories: HFT, non-HFT, and Mixed Traders (MTs).[18] The assignment has been conducted by the Autorité des Marchés Financiers (AMF), the French securities markets regulator. Finally, we obtain data on institutional investment portfolios from Factset. Given that this last dataset is only available at the quarterly frequency, we use the four quarterly snapshots of the calendar year 2012 in our analysis of institutional trading.

[15] We discard stocks that do not trade at least 20 times a day and with days of zero volume in their call auctions. Moreover, we drop CFAO and Euro Disney due to significant corporate actions.

[16] All stocks are listed in the Online Appendix.

[17] This includes all French stocks in our sample as well as EADS, SES, STMicroelectronics, and Gemalto.

[18] MTs refer to market participants that engage in both HFT and non-HFT activity. A typical example is a large investment bank.

4 The effect on market quality

4.1 Aggregate impact

The theoretical literature predicts that composition effects should have an impact on different aspects of market quality such as volume, volatility, liquidity and price efficiency. Before examining the impact of the FTT on specific groups of market participants, we examine the causal impact of the policy change on these measures, which we compute for each stock-day in our sample using trades and quotes from the continuous trading session on Euronext.[19] The variable definitions are standard and provided in Appendix A.1. Table 1 presents the mean and standard deviation of each variable for French and non-French stocks during the pre-event period, both above and below the 1 bln EUR threshold. Overall, the differences across French and non-French stocks in terms of the overall level of market quality are rather small.[20]

As mentioned in the previous section, we conduct our diff-in-diff analysis both for the set of stocks with a market capitalization of more than 1 billion EUR (identifying the joint effect of the FTT and the HFT tax) as well as for the sample of stocks below this threshold (identifying the causal effect of the HFT tax only). Table 2 below contains the difference-in-differences estimates for the permanent impact of the policy change, $\beta^{Sep/Oct}$, together with t-statistics based on standard errors clustered at the stock level.

The second column of Table 2 compares French and control stocks below the 1 billion EUR threshold and thus measures the potential impact of the HFT tax. A glance at the results directly reveals that the HFT tax does not have any significant impact on market quality. Out of a total of 10 coefficients, only one is statistically significant at the 10% level. Moreover, the observed increase in the intraday price range is economically small and not corroborated by a similar effect for realized volatility. Our estimates thus verify that the

[19] We discard trades that are executed off-book, during call auctions and the "trading-at-last" period. Trades are signed using the Lee and Ready (1991) method, and we aggregate individual orders that are executed simultaneously into one single transaction.

[20] The only notable exception concerns market depth. Both groups have approximately the same support (5.9-210.3 vs. 10.0-243.3 thousand EUR) but the cross-sectional average of depth for non-French stocks exceeds that of French stocks by around 20 th. EUR. This difference does not seem to affect the common trends assumption. In Section 4.2 we provide results based on sub-samples chosen on stocks' participation in Euronext's SLP programme, which do not have this slight disparity in terms of depth.

surcharge on order cancellations is essentially a "cosmetic" measure without real impact due to its geographical restriction to French firms.[21]

Due to the absence of an impact of the HFT tax, we can interpret the diff-in-diff estimates pertaining to the set of stocks above the 1 billion EUR threshold as the causal effects of the FTT. They are tabulated in the first column of Table 2. In addition, we graphically illustrate these impacts in Figure 3 by plotting the cross-sectional averages of the variables for both groups of stocks minus their respective pre-event average over time. The dashed lines indicate the sub-period averages for June/July, August and September/October. The difference between the two dashed lines in September/October is equal to the diff-in-diff estimate of the causal impact of the tax.

[Insert Tables 1 and 2, and Fig. 3 here.]

The results show that the French FTT leads to a significant reduction in trading activity. Compared to the control group, trading volume in French stocks declines by approximately 10% in September and October 2012. Beyond the perspective of market quality, this estimate is of interest to the tax authorities because it proxies for the elasticity of the tax base to the tax. However, as we will show below, this measure can be misleading as it does not necessarily capture the impact on taxable trading volume (i.e. ownership transfers).

Much of the empirical literature on FTTs focuses on their impact on price volatility and predominantly concludes that FTTs moderately increase volatility. Our results however suggest that the French policy experiment does not have any material effect on both the intraday price range and realized volatility at the 5-minute frequency.

We next turn to the FTT's impact on the three dimensions of market liquidity as defined by Kyle (1985): Tightness (spreads), depth, and resiliency. Although the French authorities were careful to safeguard liquidity via an exemption for market-making, indirect effects such as increased turnaround times for inventory positions may still hurt liquidity providers. However, we find that both quoted and effective spreads remain unchanged compared to the pre-event period. In contrast, we document a strongly significant decrease in market depth of approximately 11,000 EUR (corresponding to a decline of roughly 20%) and a small reduction in resiliency of about -0.02.

[21] Notably, the HFT tax also yielded a revenue of zero in 2012.

Finally, the adoption of the FTT leads to a small decline in the informational efficiency of prices. Compared to the control group, French stocks displayed a permanent increase of 0.007 in the absolute value of 5-minute midquote return autocorrelations. While statistically significant at the 5% level, the economic magnitude of this effect is relatively modest.

Overall, our estimates suggest that the French FTT had a negative impact on market quality, which is consistent with the bulk of the existing literature. Still, the effect is economically rather small, which suggests that the market-making exemption and the restriction to ownership transfers are at least partly successful at protecting liquidity. We next turn to investigate this issue in more detail.

4.2 The importance of market-making

The absence of any significant impact on quotes and effective spreads points to an economically important role for the tax exemptions enjoyed by liquidity providers. To shed more light on this matter, we exploit the fact that some of the stocks in our sample are eligible for Euronext's "Supplemental Liquidity Provider" (SLP) programme, under which market participants enjoy rebates for executed limit orders provided they commit to matching the "European Best Bid and Offer" (EBBO) with sufficient frequency.[22]

A total of 78 stocks in our sample are eligible for the SLP programme. All but two of these stocks have a market capitalization of more than 1 billion EUR (49 French stocks and 27 control stocks). The perspective of obtaining rebates is particularly attractive for high-frequency traders, who have been shown to rely heavily on such incentive schemes (see e.g. Brogaard, Hendershott, and Riordan (2014)). Indeed, we will show in Section 5 that HFTs are more present and more important for liquidity provision in SLP than in non-SLP stocks. Non-French SLP stocks are a natural control group for the French SLP stocks subject to the FTT. For non-SLP stocks, there are unfortunately only 5 non-French stocks with a market capitalization above 1 billion EUR. Accordingly, we additionally use the 29 French and 16 non-French non-SLP stocks below the 1 bln EUR threshold to form a control group of sufficient size (50 stocks) for the 38 treated French non-SLP stocks. Table 3 contains the

[22] See https://www.euronext.com/sites/www.euronext.com/files/launch_of_a_supplemental_liquidity_provider_programme_on_european_blue_chips.pdf and https://www.euronext.com/sites/www.euronext.com/files/ifca120326.pdf for details.

diff-in-diff estimates.

[Insert Table 3 here.]

Our results show that the impact of the FTT varies substantially with SLP membership. While trading volume is broadly unchanged for SLP stocks, non-SLP stocks display a decrease in market activity of about 20% due to the FTT.[23] Moreover, stocks without regular HFT market making exhibit an increase in intraday volatility, quoted and effective spreads, price impacts, as well as a decrease in market resiliency (all significant at the 5% level or better). All these negative effects on market quality are absent in the SLP stocks, which only display a reduction in market depth and a slight decrease in price efficiency.

Taken together, these results suggest that the explicit and implicit safeguards for liquidity provision play an important role for the FTT's overall impact. Stocks with a significant regular liquidity provision through HFTs appear to be largely insulated against adverse effects on liquidity (except depth), while the rest of the market experiences a more pronounced decline in the overall level of liquidity as well as a more significant decrease in trading activity. We next turn to the potential role of composition effects in explaining these differences by examining the impact on different groups of market participants.

5 Composition effects, adverse selection and liquidity

One of the composition effects suggested in the literature is a potentially differential impact on informed and uninformed traders (see e.g. Bloomfield, O'Hara, and Saar (2009)). In this section, we investigate the existence of such effects by examining the FTT's impact on different trader categories and relate it to the increase in adverse selection for non-SLP stocks documented in the previous section. To this end, we rely on the BEDOFIH database that classifies market participants according to their trading speed. This distinction across agents is natural, given that both theoretical and empirical literatures identify HFTs as informed traders that are a source of adverse selection for others (Biais, Foucault, and Moinas (2014), and Brogaard, Hendershott, and Riordan (2014)).

[23] The interpretation of a coefficient β in a semi-log specification as a percentage change is only valid if its magnitude is sufficiently small. In the text we always report the correct percentage change, given by $\exp(\beta) - 1$ (up to a Jensen error), see Halvorsen and Palmquist (1980).

The BEDOFIH database assigns both sides of each transaction (market and limit order) to one of three categories: high-frequency traders (HFTs), mixed traders (MTs), and non-high-frequency traders (non-HFTs). The first category covers exchange members that can unambiguously be identified as pure-play HFT outlets trading on their own account. The MT category is composed of exchange members whose order flow is a blend of HFT and non-HFT. According to the providers of the database, this group mainly comprises of large banks and brokers that either have some proprietary HFT activities or offer direct market access to third parties with HFT strategies.[24] Finally, the remaining remaining category (non-HFTs) includes smaller banks and retail brokerage firms. Recall that the BEDOFIH database almost exclusively covers French stocks, as detailed in Section 3.

Table 4 contains the shares of trading volume due to HFTs, MTs, and non-HFTs separately for French SLP stocks and non-SLP stocks with a market capitalization above 1 billion EUR. As expected, a significant share of trading in SLP stocks is due to HFTs (27.5%). In contrast, HFT activity accounts for a much smaller fraction of total trading for the non-SLP stocks (16.9%). Moreover, we observe that the type of HFT activity appears to differ across SLP and non-SLP stocks. For each trader category, we separately compute the shares attributable to limit orders and market orders. While HFTs roughly split their trades equally among both order types in SLP stocks, they almost exclusively trade via market orders in non-SLP stocks. This casts doubt on their role as liquidity providers for the latter group of stocks.

The deterioration of liquidity in non-SLP stocks is accompanied by an increase in price impact measures. In line with the composition effects suggested in the literature, we proceed to examine whether the FTT had a larger effect on uninformed traders. To this end, we compute the price impact for market orders from different trader categories in order to gauge their informational content.[25] We also measure agents' profitability at providing liquidity via the realized spread for limit orders executing against market orders from each trader category. Table 5 contains the cross-sectional averages for each measure, separately for both

[24] In the Nasdaq dataset used e.g. by Brogaard, Hendershott, and Riordan (2014), this group of traders is included in the non-HFT category.

[25] We obtain very similar results when using Hasbrouck's price impacts based on a structural VAR (Hasbrouck (1991)).

groups of stocks and for different time horizons.

[Insert Tables 4 and 5 here.]

In line with the empirical literature on HFT (Brogaard, Hendershott, and Riordan (2014), Carrion (2013)), we find that the market orders of HFTs have the highest price impact across the board. Moreover, most of the information is reflected almost instantaneously in prices. In contrast, non-HFTs have the lowest price impacts, with MTs falling in between. The advantage of being fast is similarly valuable in terms of realized spreads. For instance, HFTs earn significantly more on their limit orders than MTs in SLP stocks, especially at short horizons (0.29 bps vs. -0.10 for a 10 seconds holding period). For non-SLP stocks, most limit orders are submitted by MTs and non-HFTs, and the former earn significantly more, particularly at longer horizons (0.85 bps vs. -0.08 at a 30 minutes horizon).

5.1 Trading in non-SLP stocks

We now turn to analysing the FTT's impact on the trading activity of these different trader groups. Given that the BEDOFIH data is only available for stocks whose primary market is Euronext Paris, we begin by examining non-SLP stocks. For this subsample, we can broadly follow our previous identification strategy and use our 29 French stocks below the 1 billion EUR threshold as control group. We exclude three further stocks due to irregular HFT activity.[26]

[Insert Table 6 here.]

Panel A of Table 6 details the diff-in-diff results for trading volume as well as the share of market and limit orders attributable to each trader category.[27] Overall, the FTT leads to a significant decline in trading activity of both HFTs (-29%) and MTs (-23%), while not affecting non-HFT volume, thus affecting the composition of trading volume. The result on HFTs highlights the indirect consequences of the tax; they are significantly affected although intraday trading activity is implicitly exempt due to the restriction to ownership transfers.

[26] We require stocks to have at least 2% HFT activity in both the pre- and post-event period. Accordingly, we drop Akka Technologies SA, AB Science SA, and Archos.

[27] For illustration, the Online Appendix additionally provides plots of the results for trading volume.

Clearly, the decline of trading volume by other market participants reduces the demand for immediacy and also generates fewer trading opportunities to be exploited by arbitrageurs.

The composition effect just identified also has a significant impact on the composition of limit and market orders. In particular, the share of MTs among all executed limit orders falls significantly by 5.4%, whereas the corresponding figure increases by 6.0% for non-HFTs. This implies that the most important suppliers of liquidity are partially replaced by the traders with the worst performance on their limit orders (as measured by their realized spreads). As HFTs are trading non-SLP stocks almost exclusively through market orders, a decline in their trading activity naturally leads to a reduction in the share of aggressive orders due to HFTs for these stocks (-5.3%). Accordingly, the share of market orders due to other market participants increases, in particular for non-HFTs (+3.7%).

The above changes in the composition of the order flow can be helpful in explaining the increase in price impacts for non-SLP stocks. On the one hand, we observe a relative decrease in market orders by the most informed trader category (HFTs), which should lead to a decline in adverse selection, everything else equal. On the other hand, the provision of limit orders shifts from MTs to non-HFTs, which should lead to an increase in price impacts because non-HFTs are more prone to the risk of being hit by HFTs' informed market orders. The combined impact of both effects is an increase in price impacts and, accordingly, in effective spreads.

The FTT's impact on market orders is closely related to the composition effects highlighted in the theoretical literature. Notice that unlike in a traditional dealer market, informed and uninformed traders can submit both limit and market orders in order-driven markets. Accordingly, the composition effect has both a liquidity demand and a liquidity supply component. These two components can be illustrated by considering an increase in the proportion of fast traders in the model of Hoffmann (2014). First, slow limit orders are more likely to be picked off, increasing adverse selection. Second, more limit orders are submitted by agents that are able to cancel them after news arrivals, thus yielding the opposite effect.

5.2 Trading in SLP stocks

We next turn to the SLP stocks, for which we do not observe a significant increase in price impacts following the FTT's introduction. While the BEDOFIH database mainly covers trading in French stocks, we are fortunate to have four non-French SLP stocks whose primary market is Euronext Paris (see footnote 17). We thus repeat the same analysis as above with this group of stocks. Panel B of Table 6 contains the resulting coefficient estimates. However, these results need to be interpreted as suggestive given the small size of the control group.[28] In particular, the average impact on trading volume is close to -20%, which significantly exceeds the estimate for all SLP stocks from Section 4.2. However, we are more interested in differences across trader types, for which this analysis is still informative.

The estimates suggest a somewhat different picture than for the non-SLP stocks. In particular, we find that HFTs are not significantly impacted, while we observe a reduction in trading activity by MTs and non-HFTs. Notice that HFTs are more directed towards market making in SLP stocks, an activity that is explicitly exempted from the FTT. A glance at the impact on the order flow composition reveals no changes for executed limit orders, while we observe a decrease (increase) in the share of market orders due to non-HFTs (HFTs). While this shift could be expected to yield an increase in adverse selection, the effect seems to be quantitatively too small to significantly affect market quality (see Table 3).

Overall, the disparity between SLP and non-SLP stocks highlights the importance of composition effects for understanding the impact of an FTT on liquidity. HFT market makers are explicitly exempted from the FTT and are thus not affected by the tax. Since a large share of executed limit orders in SLP stocks are due to these specialized agents, liquidity is not significantly impacted. In contrast, in non-SLP stocks the FTT heavily impacts end investors, who use limit orders as part of their execution strategies but do not engage in market making per se. As this type of liquidity provision is not exempted, the FTT leads to a detrimental impact on market quality and trading volume for non-SLP stocks. The market making exemption appears as an attractive feature of the French FTT, but by definition it cannot protect liquidity when it is provided by non-specialized agents.

[28] In the Internet Appendix, we show that the common trends assumption appears to hold surprisingly well graphically.

6 Composition effects across institutional investors

The results from the previous section suggest that the French FTT has a heterogeneous effect across different groups of investors, which is at least in part due to the implementation as a stamp duty that implicitly exempts agents with very short investment horizons. As the BEDOFIH database points towards an important effect of the FTT on end investors, we proceed by taking a closer look at this group of market participants. Absent any high-frequency data that allows for the tracking of individual investors, we resort to low-frequency data on the portfolio holdings of institutional investors provided by Factset. This is a natural choice in our setting as this dataset enables us to capture a large share of the trading activity of buy-side investors which are fully exposed to the French FTT due to their relatively long investment horizons. Accordingly, the results obtained from this analysis are free from potential *clouding effects* that arise when examining aggregate market activity which comprises of both taxable and tax-exempt trading.[29] Moreover, the availability of data on fund characteristics allows us to examine cross-sectional variation in the FTT's impact.

We start out by screening the database for funds holding any of our sample securities throughout the calendar year 2012.[30] Most funds report at the monthly or quarterly frequency, but not always at the quarter end. In order to bring all data to the same frequency, we only consider the last report in a given calendar quarter and assume it is filed at the quarter end. We then restrict our sample to funds reporting at least once per quarter and with non-zero holdings of at least one French and one control stock throughout the entire period 2012:Q1-2012:Q4.[31] This leaves us with 3,340 funds.

Given that we are interested in the FTT's effect on individual market participants and the resulting variation in the cross-section, we need to measure its impact at the fund level. For portfolio holdings, we define the fund-specific treatment effect did_f^H simply as the change in fund f's total holdings of treated stocks between the end of the third quarter (the first

[29] In a previous version of this paper, we used data on OTC transactions in order to isolate institutional trading activity. This more indirect approach using data at a higher frequency led to qualitatively similar conclusions.

[30] Factset also reports institutional holdings based on 13-F filings. However, the reporting requirement only refers to US securities, such that this part of the database is not relevant for our analysis.

[31] We also limit the sample to Closed-end Funds, Hedge Funds, Non-Public Funds, Open-end Funds, Pension Funds, and Offshore Funds.

report after the tax launch) and one quarter earlier, relative to the same change for control stocks:

$$did_f^H = [log(p_{Q2}^T.x_{f,Q3}^T) - log(p_{Q2}^T.x_{f,Q2}^T)] - [log(p_{Q2}^C.x_{f,Q3}^C) - log(p_{Q2}^C.x_{f,Q2}^C)], \quad (2)$$

where $x_{f,t}^T$ and $x_{f,t}^C$ denote the (column) vectors of holdings in treated and control stocks by fund f at time $t \in \{Q2, Q3\}$ and p_t^T and p_t^C denote the associated (row) price vectors. Note that we are using stock prices from the end of Q2 in all instances in order to avoid picking up effects due to price changes. We take a similar approach for trading volume at the fund level, which we define as the absolute value of the change in holdings relative to the previous quarter. However, given that the computation of trading volume requires data from two adjacent reporting dates, we compare activity in Q4 (the first quarter entirely under the new tax regime) to activity in Q2 (the last quarter entirely under the new tax regime). Thus, the fund-specific treatment effect for volume is computed as

$$did_f^V = [log(p_{Q3}^T.|\Delta x_{f,Q4}^T|) - log(p_{Q1}^T.|\Delta x_{f,Q2}^T|)] - [log(p_{Q3}^C.|\Delta x_{f,Q4}^C|) - log(p_{Q1}^C.|\Delta x_{f,Q2}^C|)], \quad (3)$$

where $\Delta x_{f,t}^T = x_{f,t}^T - x_{f,t-1}^T$, with $\Delta x_{f,t}^C$ being defined accordingly.[32] Notice that did_f^V is only defined for the 2,514 funds that trade both in treated and control stocks during Q2 and Q4, and we henceforth restrict our analysis to these funds.[33]

We begin by verifying that our sample of funds represents a significant part of the overall tax base. To this end, we sum up all purchases of French securities taking place in Q4:2012 across all funds in our sample and apply a 20 bps surcharge. This yields a tax revenue estimate of 21.35 million EUR, which can be linearly extrapolated to 35.58 million EUR for the 5 months of 2012 under the FTT regime. This represents roughly 18% of the total 2012 revenue of 198 million EUR. Notice that our revenue estimates are best interpreted as a lower bound because the quarterly reporting frequency obscures intra-quarter trading. Overall, we

[32] We use the notation $|X|$ for the element-wise absolute value of vector X.

[33] All our results for did_f^H are qualitatively unchanged when including funds that do not trade in either Q4 and Q2 in at least one groups of stocks, i.e. funds for which did_f^V is not defined. Moreover, all our results do not change if we do not hold stock prices constant across two adjacent quarters when measuring changes in holdings and trading volume.

conclude that a large share of the tax burden is borne by low-frequency investment funds.

Aside from reporting the portfolio holdings, Factset also provides a number of investment fund characteristics. Accordingly, our analysis is not restricted to evaluating the FTT's impact on the average fund as we are also able to judge how the treatment effect varies in the cross-section. We use the following explanatory variables at the fund level:

$Logsize_f$: Natural logarithm of assets under management, demeaned by the cross-sectional average.

$Turnover_f$: A discrete variable indicating the fund's portfolio turnover, ranging from -2 ("Very Low") to +2 ("Very High"). The categorization is provided by Factset.

$Price\_to\_book_f$: A fund's average price-to-book ratio based on its portfolio constituents, demeaned by the cross-sectional average. The ratio is computed by Factset and constitutes a proxy for the investment style (growth vs. value).

$Index_f$: A dummy variable taking the value of one if a fund is classified by Factset to be an index fund, and zero otherwise.

Table 7 contains some summary statistics concerning our explanatory variables. The average fund has a price-to-book ratio of slightly above 3 and about 1.2 billion USD assets under management. Moreover, the average portfolio is categorized to have a low turnover, although there is considerable variation across funds (average of -0.87 with a standard deviation of 1.14).[34]

[Insert Table 7 here.]

Panel A of Table 8 reports the coefficients from cross-sectional regressions of the treatment effects at the fund level on our explanatory variables, separately for changes in portfolio holdings (did_f^H) and changes in trading volume (did_f^V). In all regressions, t-statistics are based on White standard errors robust to heteroskedasticty.

[Insert Table 8 here.]

[34] 1,609 (resp. 324) funds are in the categories "Low" or "Very Low" (resp. "High" or "Very High").

We first discuss the impact on portfolio holdings. In order to gauge the average effect across funds, we start out with a simple regression on only a constant. The coefficient estimate (column (1)) is very small and statistically insignificant, indicating that, on average, the FTT does not induce the institutional investors in our sample to increase or decrease their holdings of French stocks relative to the control group. We then include the above explanatory variables in order to examine whether there is any variation in funds' reaction to the FTT that can be explained by differences in fund characteristics. The results in column (2) reveal that the treatment effect correlates negatively with fund turnover, suggesting that funds that reshuffle their portfolios more frequently sell some of their French stocks, while funds with a lower turnover do the opposite. The effect is quantitatively large, as the coefficient estimate of -0.035 implies a difference in relative position changes of more than 13% between funds with very low and very high turnover. This finding is directly in line with the "clientele effect" of Amihud and Mendelson (1986), which predicts that an increase in transaction costs will lead to an increase (decrease) in holdings by agents with a longer (shorter) investment horizon. Further, there is evidence that passive investors have decreased their holdings in French stocks significantly, as the coefficient on the index dummy is negative and highly statistically significant. This shows that the FTT has a particularly negative impact on passive investors, which is consistent with these investors being especially sensitive to transaction costs.

We now turn to the results on funds' trading volume. We proceed as before and start by a simple regression on a constant (column (3)), which yields an estimate of -0.186 (significant at the 1% level) and thus implies that the average fund reduces its trading volume in French stocks by approximately 17% relative to the control group due to the implementation of the French FTT. This effect is above one and a half times the impact on market-wide trading volume and therefore further corroborates our view that institutional investors are disproportionately affected by the new tax.[35]

A number of interesting findings emerge when turning to the role of individual fund characteristics, as shown in column (4). The coefficient on portfolio turnover is negative and

[35]We alternatively conduct a diff-in-diff analysis at the stock level instead of the fund level, which results in a similar coefficient estimate of -0.186 (significant at the 5% level). Notice that in general this number could be different from the estimate obtained at the fund level.

strongly significant, which suggests that the FTT leads to a stronger (weaker) reduction in trading volume for the most (least) active investors. This behaviour is consistent with agents using trading activity itself as an alternative margin of adjustment when facing an increase in trading costs. Models of asset market equilibrium with transaction costs predict that a small tax can lead to a large adjustment of traded volumes (see e.g. Constantinides (1986), Vayanos (1998)). Empirically, it seems that the adjustment is stronger for investors with shorter trading horizons, a feature in general not present in this literature, as investors are assumed to be homogeneous.[36] Notice that the effect is economically large, as the coefficient estimate of -0.146 suggests that the funds with the highest portfolio turnover reduce their trading in French stocks by around 42%, while those with the least reshuffling activity marginally increase their trading.[37]

We also find a strikingly large reduction of trading by index funds, which is consistent with the findings on portfolio holdings. Notice that this is in contrast to Stiglitz' (1989) hypothesis that an FTT should have a more moderate effect on passive investors. In addition, we find that larger funds and those with a growth objective (high price-to-book ratio) are more sensitive to the tax.

One potential issue in measuring the FTT's impact on trading volume is that a reduction in the holdings of French stocks will lead to a reduction in trading volume even if agents keep their portfolio turnover constant. Intuitively, a fund that reduces its holdings by 10% and keeps the same turnover will mechanically trade 10% less, everything else equal. Thus we include did_f^H as an additional control variable in our cross-sectional regression in order to disentangle a mechanical reduction in trading activity from a change in actual behaviour. The results are tabulated in column (5). As expected, the coefficient on did_f^H is positive and significant at the 1% level, confirming the mechanical relationship just discussed. However, it is clearly smaller than 1, suggesting that funds use both margins of adjustment. Accordingly, none of our previous results changes materially once controlling for the FTT-induced change in portfolio holdings.

We proceed by repeating the above analysis separately for SLP and non-SLP stocks. We

[36] In Amihud and Mendelson (1986) investors are heterogeneous but their turnover is exogenously given.

[37] Given an intercept of -0.255, the treatment effects for investors with very high (very low) turnover are $-0.255 \pm 2 \times (-0.146)$. We then apply the transformation explained in footnote 23.

follow our approach from Section 4.2 and use both French and non-French stocks below the 1 billion EUR threshold as control group for French non-SLP stocks subject to the tax. For each subsample, we only include funds that have positive holdings of at least one treated and one control stocks throughout the entire year 2012. Moreover, we discard funds for which did_f^V is not defined due to zero trading volume. The results are depicted in Table 8, where Panel B refers to SLP stocks and Panel C to non-SLP stocks.

We find that the FTT's average impact on institutional portfolio holdings does not vary across both subsamples, despite some slight differences that emerge when adding our explanatory variables. Turning to trading volume, we find that the average impact on non-SLP stocks (-0.279) is significantly more negative than the effect obtained for SLP stocks (-0.203). This finding is closely in line with the discrepancy across both groups uncovered in Section 4.2 and points to a significant role for institutional trading in the FTT's differential impact on market quality. Notice that, for SLP stocks, the negative effect on institutional trading stands in stark contrast to the virtually zero impact on aggregate trading volume uncovered in Section 4.2 (see column (1) of Table 3). This observation is in line with a large part of market activity in the most liquid stocks being due to (tax-exempt) short-term actors, so that market-wide estimates are likely to provide a blurred picture of the FTT's impact.

In terms of fund characteristics, the results for the SLP stocks closely resemble those obtained for the entire sample, as we observe a stronger (more negative) impact for funds that are larger, have a high portfolio turnover, and especially index funds. Turning to the non-SLP stocks, we observe similar effects for large funds and index funds, while the coefficients on the remaining characteristics are not statistically significant. Finally, the additional inclusion of did_f^H does not affect the results qualitatively for either subsample.

In sum, our results strongly confirm the idea that a large share of the FTT's burden is borne by institutional investors, who significantly decrease their trading activity. As predicted by theory, investors with a high turnover sell the affected stocks (as in Amihud and Mendelson (1986)), and trading volumes decrease dramatically so as to minimize the cost of the tax and its impact on market prices (see Constantinides (1986)). However, a comparison with the results from Section 5 suggests that these market participants are playing an important role for market liquidity. As observed by Keim and Madhavan (1997), institutional investors may

have different preferences regarding immediacy (depending on their investment style) and some of them can be important liquidity providers, especially in today's markets where they have access to sophisticated execution algorithms that allow them to trade with both limit and market orders. The impact on this group of market participants has particularly adverse consequences for market quality in non-SLP stocks, where little to no liquidity is provided by HFTs. In contrast, the negative effects for SLP stocks are more muted, consistent with a more prominent role of exempted market makers.[38]

However, we still find a decline in market depth for SLP stocks, which is consistent with large institutions acting as additional liquidity providers. In addition, a lower demand for liquidity may induce market makers to quote smaller quantities because their quotes have a lower probability of being hit, e.g. as in Seppi (1997). This can be seen as the "limit order market" version of the more general paradigm that a decrease in market activity will result in reduced liquidity, which is an integral part of more traditional frameworks such as Stoll (1978) and Grossman and Miller (1988).

7 Conclusion

This paper documents that the French FTT launched in 2012 has significant effects on the composition of the order flow and on the clientele of French stocks. Due to its implementation as a stamp duty, the tax mostly affects long-term investors such as e.g. mutual and pension funds, in particular those with a high portfolio turnover. Since these market participants constitute an important source of liquidity, market quality declines significantly, in particular for stocks with fewer specialized market-makers. As end-investors with sophisticated execution programs scale back their trading activity, liquidity is provided by less sophisticated agents that are more exposed to adverse selection. These effects are largely hidden when looking at aggregate market statistics only.

Composition effects are at the heart of the idea that an FTT could serve Pigovian objectives, as argued by Stiglitz (1989). In the case of the French FTT, one could argue that these effects actually go in an undesirable direction. While governments claim to tax "short-run

[38]Buy-side investors can also be important liquidity providers at lower frequencies by behaving as contrarians and absorbing market imbalances, as studied by e.g. Anand *et al.* (2013).

speculation" (in itself a debatable idea), it is probably fair to say that in today's markets a stamp duty affects everybody but short-term speculators. The decrease of liquidity and the large impact on passive investors such as index funds rather suggests that the FTT hurts market quality and savers. Nevertheless, it is not unlikely that the French implementation will serve as a blue-print for the European FTT, the first cross-national levy on financial transactions.[39] Extrapolating the 2012 revenue figures to the entire EU, we estimate that this design would yield approximately 2.7 billion EUR.[40] In contrast, the European Commission projects to raise 4.8-6.5 billion EUR from a tax on *all* equity transactions and without any safeguards for liquidity provision. Given the uncertainty surrounding this last estimate, the French design may appear as a better trade-off between revenues and market quality, or at least as a lesser evil. In any case, based on our findings, it would seem optimistic to expect a "double dividend", both tax revenues and a more efficient market, from FTTs implemented in today's markets.

The theoretical literature suggests that market participants will adjust their strategies so as to minimize the impact of the tax (e.g. Constantinides (1986)). It is thus not surprising that the FTT's aggregate impact on market quality is modest. The significant effects of such a policy are to be found in changes to the types of agents that trade, and at what frequency. In particular, we document an important change in the shareholder composition of the affected companies through the clientele effect of Amihud and Mendelson (1986). Proponents of FTTs would expect such an increase in shareholders' investment horizon to foster a reduction of managerial myopia or short-termism, as argued by Stein (1989).[41] While this could be an economically important effect of the French FTT, it is more likely to materialize in the long-run and constitutes an interesting topic for future research.

[39] See "France and Germany in push for 'Robin Hood' tax deal", Financial Times (Online Edition), February 19th, 2014.

[40] Details on the computations can be found in the Online Appendix.

[41] Bushee (2001), and Derrien, Kecskes, and Thesmar (2013) provide empirical evidence consistent with this argument.

A Appendix

A.1 Definitions

In the following, we list the definitions of the measures of market quality used in Section 4.

$logvolume_{i,t}$: Natural logarithm of order-book traded value in EUR.

$RV_{i,t}$: Realized volatility based on the final mid-quote of 5-min intervals (in %, annualized).

$range_{i,t}$: Intra-day price range normalized by median trade price (in %).

$QS_{i,t}$: Time-weighted relative quoted half-spread (in bps).

$ES_{i,t}$: Transaction-weighted relative effective half-spread (in bps).

$PI_{i,t}$: 5-minute price impact, computed as signed relative change in the mid-quote in the 5 minutes following the trade (transaction-weighted).

$RS_{i,t}$: Realized spread, equal to effective spread minus 5-minute price impact.

$depth_{i,t}$: Time-weighted depth at the inside quotes (in 1,000 EUR).

$res_{i,t}$: Speed of mean reversion for market depth, based on 1-min intervals with 5 lags (see Kempf, Mayston, and Yadav (2009)).

$|AR|_{i,t}$: Absolute value of first-order return autocorrelations, based on the final mid-quote of 5-min intervals.

A.2 Tables

Table 1: Summary statistics for treated and control stocks.

This table contains the empirical averages and standard deviations of market quality variables for French and non-French stocks, both below and above the 1 bln EUR threshold, over the period June-July 2012. All figures are computed at the stock-day level.

	Above 1bln EUR		Below 1 bln EUR	
	French	Non-French	French	Non-French
logvolume	16.16	16.71	13.41	13.94
	(1.46)	(1.14)	(0.98)	(1.09)
RV	27.32	24.83	36.05	34.19
	(10.89)	(10.43)	(17.60)	(16.16)
range	2.75	2.49	3.69	3.40
	(1.46)	(1.40)	(2.11)	(1.98)
QS	5.77	4.19	19.05	16.03
	(4.22)	(2.14)	(7.32)	(7.58)
ES	4.41	3.32	16.49	13.06
	(3.08)	(1.56)	(7.70)	(6.80)
RS	0.38	0.15	5.09	3.46
	(2.07)	(1.03)	(6.22)	(5.10)
PI	4.03	3.18	11.39	9.60
	(2.51)	(1.71)	(6.44)	(5.02)
depth	57.39	80.61	10.63	17.75
	(51.31)	(47.17)	(7.02)	(11.35)
res	0.49	0.53	0.27	0.32
	(0.15)	(0.13)	(0.12)	(0.14)
$\|AR\|$	0.11	0.11	0.12	0.12
	(0.09)	(0.09)	(0.09)	(0.09)
# Obs.	3,741	1,376	1,247	774

Table 2: Causal impact of the FTT and HFT tax.

This table contains the estimates for the coefficient $\beta^{Sep/Oct}$ from the regression equation

$$\begin{aligned} y_{i,t} &= \alpha + \gamma Treated_i + \delta^{Aug} Post_t^{Aug} + \delta^{Sep/Oct} Post_t^{Sep/Oct} \\ &+ \beta^{Aug} Treated_i * Post_t^{Aug} + \beta^{Sep/Oct} Treated_i * Post_t^{Sep/Oct}, \end{aligned}$$

where $y_{i,t}$ denotes one of the ten market quality variables defined in Section 4. Column (1) refers to the sample of stocks with a market capitalization of more than 1 billion EUR and identifies the joint impact of the FTT and the HFT tax. Column (2) refers to the sample of stocks below this threshold and identifies the impact of the HFT tax only. T-statistics based on standard errors clustered at the stock level are given in parentheses. $***$, $**$, and $*$ denote statistical significance at the 1%, 5%, and 10% level, respectively.

Variable	$>$ 1 bln EUR	$<$ 1 bln EUR
logvolume	-0.106**	0.003
	(-2.51)	(0.03)
RV	0.324	2.709
	(0.37)	(1.33)
range	-0.053	0.362*
	(-0.50)	(1.70)
QS	-0.038	0.852
	(-0.16)	(0.69)
ES	0.015	0.759
	(0.08)	(0.75)
PI	0.193	0.185
	(1.23)	(0.32)
RS	-0.178	0.573
	(-1.39)	(0.95)
depth	-10.773***	-6.421
	(-2.85)	(-1.28)
res	-0.018*	0.017
	(-1.91)	(1.64)
$\|AR\|$	0.007**	-0.006
	(2.06)	(-0.79)
# Treated	87	29
# Control	32	18
# Obs.	12,971	5,123

Table 3: Causal impact of the FTT for SLP and non-SLP stocks.

This table contains the estimates for the coefficient $\beta^{Sep/Oct}$ from the regression equation

$$\begin{aligned} y_{i,t} &= \alpha + \gamma Treated_i + \delta^{Aug} Post_t^{Aug} + \delta^{Sep/Oct} Post_t^{Sep/Oct} \\ &+ \beta^{Aug} Treated_i * Post_t^{Aug} + \beta^{Sep/Oct} Treated_i * Post_t^{Sep/Oct}, \end{aligned}$$

where $y_{i,t}$ denotes one of the ten market quality variables defined in Section 4. Column (1) refers to the stocks pertaining to Euronext's SLP programme and uses non-French SLP stocks as control group. Column (2) refers to the remaining stocks, and uses both non-French non-SLP stocks and French non-SLP stocks below the 1 billion EUR threshold as control group. T-statistics based on standard errors clustered at the stock level are given in parentheses. $***$, $**$, and $*$ denote statistical significance at the 1%, 5%, and 10% level, respectively.

Variable	SLP	Non-SLP
logvolume	-0.032	-0.225***
	(-0.69)	(-3.46)
RV	0.479	2.612**
	(0.51)	(2.29)
range	-0.069	0.272**
	(-0.62)	(2.11)
QS	0.176	1.331**
	(1.45)	(1.97)
ES	0.175	1.144**
	(1.58)	(2.23)
PI	0.181	1.805***
	(1.37)	(5.65)
RS	0.010	-0.660***
	(0.09)	(-1.95)
depth	-12.750***	-2.265
	(-2.72)	(-1.19)
res	-0.008	-0.027***
	(-0.82)	(-3.03)
$\|AR\|$	0.009**	0.008
	(2.24)	(1.52)
# Treated	49	38
# Control	27	50
# Obs.	8,284	9,592

Table 4: Breakdown of trading activity by trader type for SLP and non-SLP stocks.

This table contains the cross-sectional averages for the proportion of trading volume (Share Volume) as well as the proportion of limit orders (Share Limit) and market orders (Share Market) attributable to each of the three trade type categories in the BEDOFIH database (HFT, MT, non-HFT). The estimates are tabulated separately for SLP and non-SLP stocks above the 1 billion EUR threshold. Standard errors computed across stock-days are given in parentheses. All figures are based on the months of June and July only.

Variable/Group	SLP			Non-SLP > 1 bln		
	Share Volume	Share Limit	Share Market	Share Volume	Share Limit	Share Market
HFT	27.5	27.3	27.8	16.9	3.7	30.1
	(0.2)	(0.2)	(0.2)	(0.2)	(0.1)	(0.3)
Mixed	56.4	55.4	57.5	55.7	65.2	46.3
	(0.2)	(0.2)	(0.2)	(0.3)	(0.3)	(0.3)
Non HFT	16.0	17.3	14.7	27.3	31.0	23.7
	(0.1)	(0.1)	(0.1)	(0.3)	(0.3)	(0.3)

Table 5: Breakdown of trading activity by trader type for SLP and non-SLP stocks.

This table contains the cross-sectional averages for price impacts and realized spreads at different time horizons. Both measures are tabulated separately for SLP and non-SLP stocks above the 1 billion EUR threshold, and each trader type available in the BEDOFIH database (HFT, MT, non-HFT). In the computation, stock-day observations with a missing value for at least one trader category were discarded. Standard errors computed across stock-days are given in parentheses. All figures are based on the months of June and July only.

Variable/Group		SLP			Non-SLP > 1 bln		
	Horizon	HFT	MT	Non-HFT	HFT	MT	Non-HFT
Price impact	10s	3.25	2.44	1.38	5.46	3.62	3.14
		(0.02)	(0.02)	(0.02)	(0.07)	(0.05)	(0.06)
	5min	3.25	2.98	1.74	6.12	5.16	4.26
		(0.03)	(0.04)	(0.05)	(0.09)	(0.08)	(0.10)
	30min	3.27	2.90	1.54	6.53	5.95	4.59
		(0.05)	(0.08)	(0.12)	(0.07)	(0.05)	(0.06)
Realized spread	10s	0.29	-0.10	-0.20	4.25	2.15	2.06
		(0.01)	(0.01)	(0.02)	(0.17)	(0.06)	(0.08)
	5min	-0.05	-0.37	-0.46	3.19	1.17	0.64
		(0.02)	(0.02)	(0.05)	(0.18)	(0.07)	(0.10)
	30min	-0.10	-0.17	-0.37	2.51	0.85	-0.08
		(0.05)	(0.06)	(0.13)	(0.17)	(0.06)	(0.08)

Table 6: Causal impact of the FTT on trading volume and the order flow composition for different trader types.

This table contains the estimates for the coefficient $\beta^{Sep/Oct}$ from the regression equation

$$\begin{aligned} y_{i,t} &= \alpha + \gamma Treated_i + \delta^{Aug} Post_t^{Aug} + \delta^{Sep/Oct} Post_t^{Sep/Oct} \\ &+ \beta^{Aug} Treated_i * Post_t^{Aug} + \beta^{Sep/Oct} Treated_i * Post_t^{Sep/Oct}, \end{aligned}$$

where $y_{i,t}$ denotes, for a specific trader type (HFT, MT, non-HFT) either the log of 1+ trading volume, the share of limit order volume, or the share of market order volume. Panel A refers to non-SLP stocks, where the control group is composed of French non-SLP stocks below the 1 bln EUR threshold. Panel B refers to SLP stocks, where the control group is composed of non-French SLP stocks above the 1 billion EUR threshold. T-statistics based on standard errors clustered at the stock level are given in parentheses. $***$, $**$, and $*$ denote statistical significance at the 1%, 5%, and 10% level, respectively.

Panel A: Non-SLP stocks.

Group/Variable	Log volume	Share Limit	Share Market
HFT	-0.338**	-0.005	-0.053***
	(-2.23)	(-1.56)	(-3.31)
MT	-0.266***	-0.054***	0.016
	(-3.29)	(-3.80)	(1.42)
Non-HFT	-0.017	0.060***	0.037***
	(-0.19)	(3.94)	(2.94)
# Treated	38	38	38
# Control	25	25	25
# Obs.	6,798	6,798	6,798

Panel B: SLP stocks.

Group/Variable	Log volume	Share Limit	Share Market
HFT	-0.125	0.000	0.059*
	(-1.07)	(0.02)	(1.94)
MT	-0.238***	0.015	-0.018
	(-3.74)	(0.64)	(-0.74)
Non-HFT	-0.407***	-0.015	-0.041***
	(-3.63)	(-1.51)	(-4.55)
# Treated	49	49	49
# Control	4	4	4
# Obs.	5,724	5,724	5,724

Table 7: Summary statistics of fund characteristics.

This table contains summary statistics on fund characteristics for the 2,514 investment funds used in our analysis. *size* denotes total assets under management in million USD. *Turnover* is a discrete variable ranging from −2 ("Very Low" portfolio turnover) to +2 ("Very High" portfolio turnover). *Price_to_book* denotes the fund's average price-to-book ratio based on its portfolio holdings, and *Index* is a binary variable equal to one for Index Funds, and zero otherwise. All variables are provided by Factset.

Variable	Mean	Std. Dev.
size	1,196	6,180
Turnover	-0.87	1.14
Price_to_book	3.20	1.17
Index	0.13	0.34

Table 8: Causal impact of the FTT on investment funds' portfolio holdings and trading volume, for all stocks, SLP and non-SLP stocks.

This table contains coefficient estimates from a linear regression of fund-specific treatment effects in terms of portfolio holdings (columns (1) and (2)) and trading volume (columns (3) - (5)) on investment fund characteristics. Panel A refers to all stocks, and the control group consists of all non-French stocks. Panel B refers to SLP stocks, and the control group consists of all non-French SLP stocks. Panel C refers to non-SLP stocks, and the control group consists of non-French non-SLP stocks as well French non-SLP stocks below the 1 bln EUR threshold. The dependent variables are defined as

$$\begin{aligned} did_f^H &= [log(p_{Q2}^T.x_{f,Q3}^T) - log(p_{Q2}^T.x_{f,Q2}^T)] - [log(p_{Q2}^C.x_{f,Q3}^C) - log(p_{Q2}^C.x_{f,Q2}^C)] \\ \text{and } did_f^V &= [log(p_{Q3}^T.|\Delta x_{f,Q4}^T|) - log(p_{Q1}^T.|\Delta x_{f,Q2}^T|)] - [log(p_{Q3}^C.|\Delta x_{f,Q4}^C|) - log(p_{Q1}^C.|\Delta x_{f,Q2}^C|)], \end{aligned}$$

where $x_{f,t}^T$ and $x_{f,t}^C$ denote the (column) vectors of holdings in treated and control stocks by fund f at time $t \in \{Q2, Q3\}$ and p_t^T and p_t^C denote the associated (row) price vectors. $\Delta x_{f,t}^T$ is equal to $x_{f,t}^T - x_{f,t-1}^T$, with $\Delta x_{f,t}^C$ defined accordingly, and the notation $|.|$ is used for the element-wise absolute value of a vector. *size* denotes total assets under management in million USD. *Turnover* is a discrete variable ranging from -2 ("Very Low" portfolio turnover) to $+2$ ("Very High" portfolio turnover). *Price_to_book* denotes the fund's average price-to-book ratio based on its portfolio holdings, and *Index* is a binary variable equal to one for Index Funds, and zero otherwise. All variables are provided by Factset. T-statistics based on standard errors clustered at the stock level are given in parentheses. $***$, $**$, and $*$ denote statistical significance at the 1%, 5%, and 10% level, respectively.

Panel A: all stocks.

	Holdings		Trading volume		
Expl. variable	(1)	(2)	(3)	(4)	(5)
Cons.	0.001	-0.006	-0.186***	-0.255***	-0.252***
	(0.11)	(-0.38)	(-5.12)	(-5.02)	(-5.02)
Logsize		-0.001		-0.050**	-0.050**
		(-0.17)		(-2.53)	(-2.53)
Turnover		-0.035***		-0.146***	-0.130***
		(-3.17)		(-4.25)	(-3.84)
Price_to_book		-0.027***		-0.109***	-0.097***
		(-2.82)		(-3.13)	(-2.76)
Index		-0.183***		-0.452***	-0.371***
		(-5.23)		(-5.07)	(-4.15)
did_f^H					0.442***
					(2.85)
R^2	0.000	0.022	0.000	0.021	0.036
# Obs.	2,514	2,514	2,514	2,514	2,514

Panel B: SLP stocks.

	Holdings		Trading volume		
Expl. variable	(1)	(2)	(3)	(4)	(5)
Cons.	-0.002	-0.011	-0.203***	-0.290***	-0.286***
	(-0.19)	(-0.71)	(-5.06)	(-5.07)	(-5.02)
Logsize		-0.010**		-0.065***	-0.061***
		(-1.98)		(-3.03)	(-2.88)
Turnover		-0.030***		-0.168***	-0.157***
		(-3.11)		(-4.51)	(-4.26)
Price_to_book		0.007		-0.094**	-0.096**
		(0.69)		(-2.30)	(-2.37)
Index		-0.142***		-0.428***	-0.378***
		(-4.32)		(-4.46)	(-4.00)
did_f^H					0.354**
					(2.33)
R^2	0.000	0.014	0.000	0.021	0.030
# Obs.	2,256	2,256	2,256	2,256	2,256

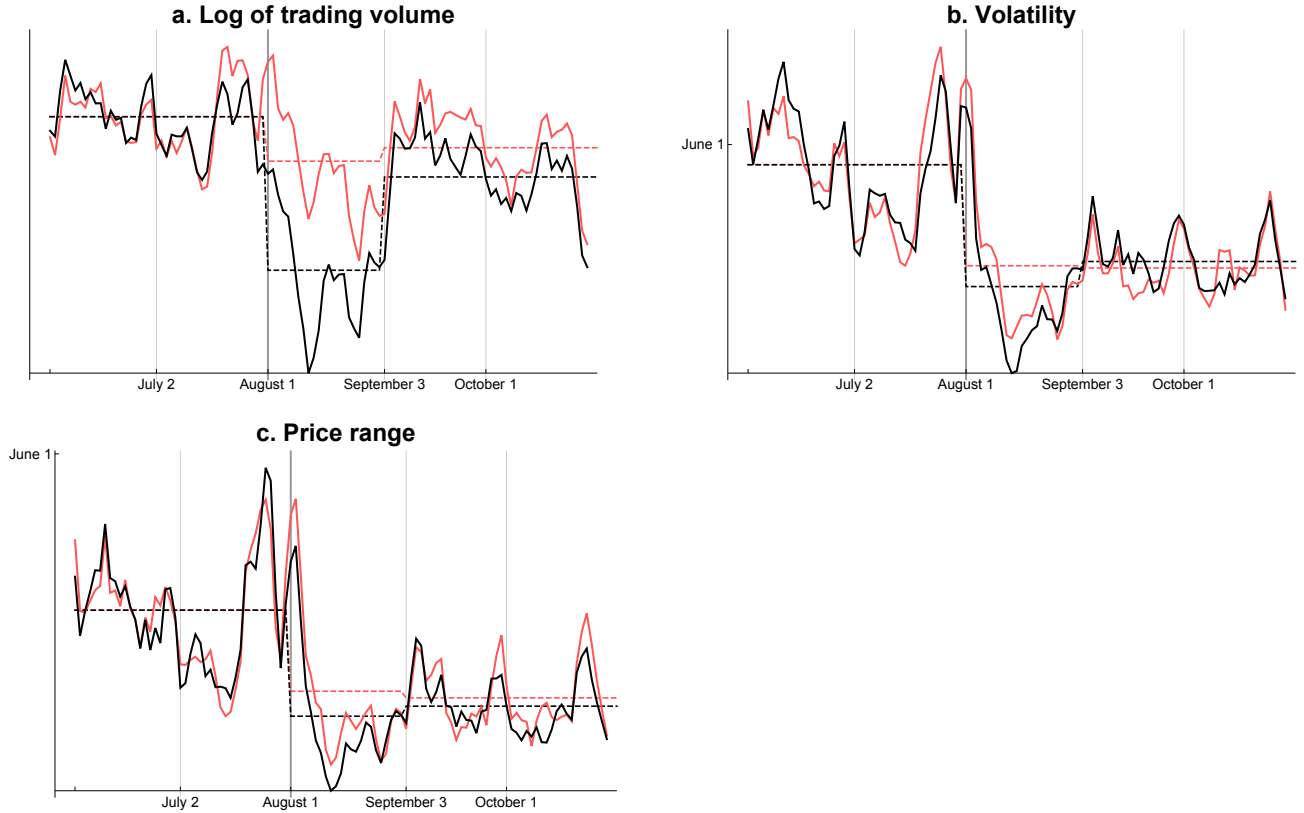
Panel C: Non-SLP stocks.

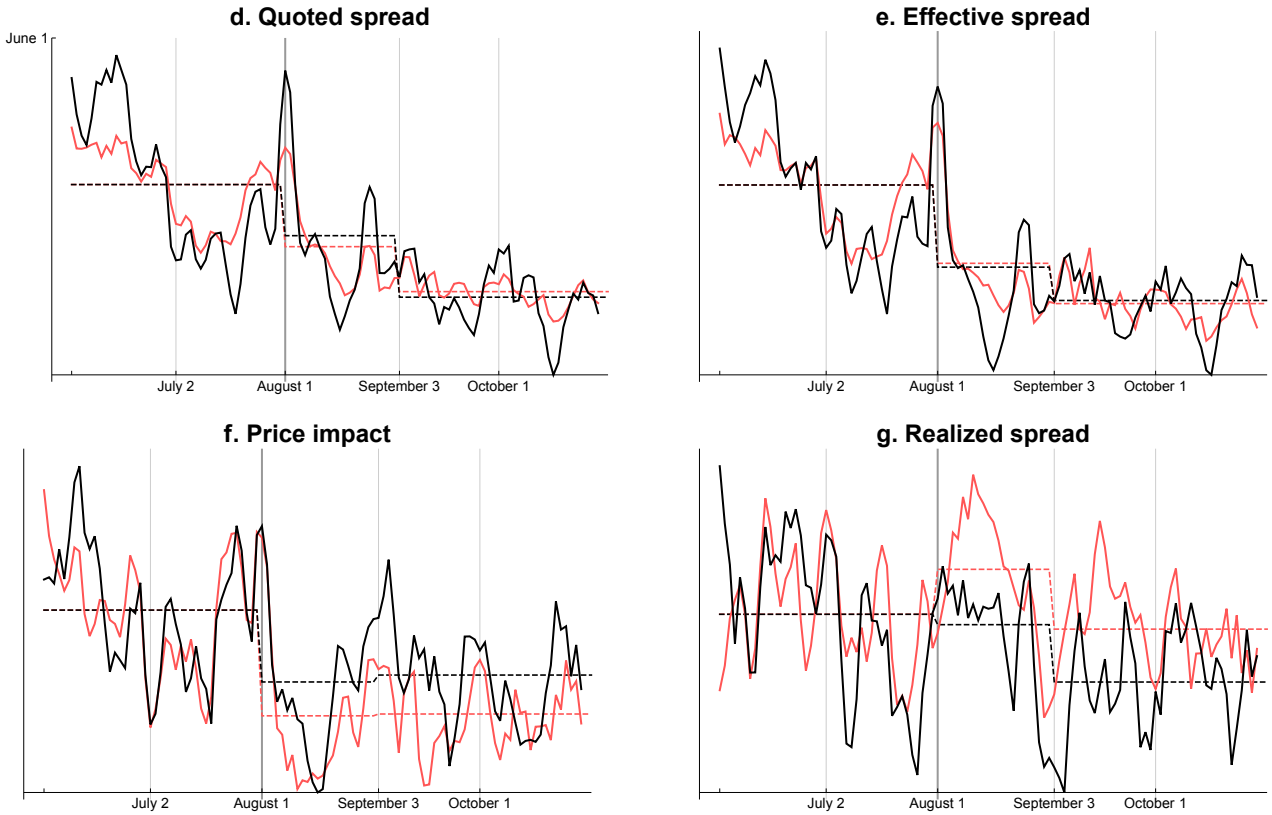
	Holdings		Trading volume		
Expl. variable	(1)	(2)	(3)	(4)	(5)
Cons.	-0.007	-0.008	-0.279***	-0.147*	-0.143*
	(-0.42)	(-0.29)	(-4.69)	(-1.73)	(-1.71)
Logsize		-0.006		-0.113***	-0.109***
		(-0.71)		(-3.26)	(-3.20)
Turnover		0.007		-0.023	-0.026
		(0.30)		(-0.39)	(-0.46)
Price_to_book		-0.032**		-0.043	-0.025
		(-2.36)		(-0.74)	(-0.43)
Index		0.029		-0.564***	-0.580***
		(0.49)		(-3.98)	(-4.24)
did_f^H					0.550***
					(2.65)
R^2	0.000	0.006	0.000	0.034	0.059
# Obs.	857	857	857	857	857

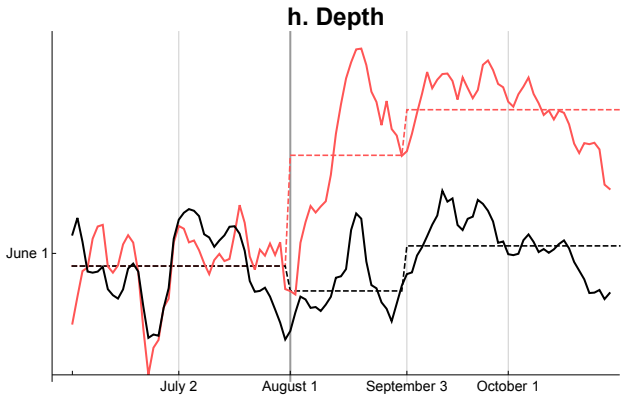
A.3 Figures

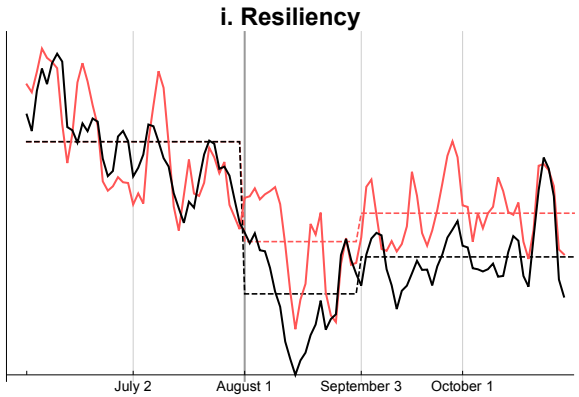
Figure 3: Graphical illustration of the causal impact of the FTT.

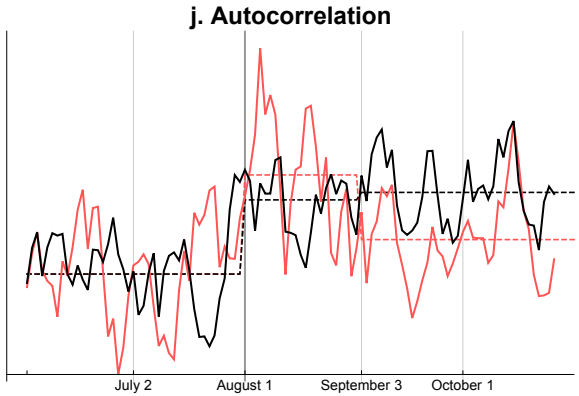
This figure illustrates our difference-in-difference estimates for the causal impact of the FTT on the market quality variables defined in 4. For each variable, we plot the cross-sectional average for treated (in black) and control (light red) stocks with a market capitalization of more than 1 billion EUR, minus the respective pre-event average. For improved readability, we use 3-day moving averages. The dashed lines indicate the sub-period averages for June/July, August, and September/October. The difference between the two dashed lines in September/October is equal to the diff-in-diff estimate of the causal impact of the tax.




d. Quoted spread
June 1
July 2
August 1
September 3
October 1
e. Effective spread
July 2
August 1
September 3
October 1
f. Price impact
July 2
August 1
September 3
October 1
g. Realized spread
July 2
August 1
September 3
October 1


h. Depth
June 1
July 2
August 1
September 3
October 1


i. Resiliency
July 2
August 1
September 3
October 1


j. Autocorrelation
July 2
August 1
September 3
October 1

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