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1 Introduction

For more than a decade, a group of European Union countries, in the framework of reinforced cooperation, has been promoting the harmonised implementation of a financial transaction tax (hereinafter, FTT).[1] However, despite the progress made in the configuration of the tax, it has not been possible to reach an agreement at European level that results in a Directive. This lack of agreement has led several countries, such as Italy and France, to introduce their own version of the FTT into their national legislation. The last country to introduce the FTT was Spain, in January 2021.

The motivation for the implementation of a Financial Transaction Tax has its origin in the financial crisis of 2008, which had serious repercussions for the economies of European countries and their public finances. After analysing the causes of the crisis, the European Commission considered it appropriate to discourage transactions that did not reinforce the efficiency of financial markets and therefore advocated the creation of an FTT.[2] The FTT would tax transactions on financial instruments in which financial institutions participate in secondary markets. In addition, the tax would have a second objective, namely for financial institutions to contribute to a greater extent to public budgets in accordance with the recommendations of the International Monetary Fund (IMF).[3]

The objective of discouraging transactions that negatively affect the efficiency of the markets is in line with a stream of the economic literature. Thus, in 1972, James Tobin proposed the introduction of a tax on foreign exchange markets to reduce the threat that their volatility may pose to financial stability. Along similar lines, John Maynard Keynes had advocated a tax for transactions in the stock markets that would make it difficult to trade this type of asset in the short term (Stiglitz, 1989; Summers and Summers, 1989).[4] However, given the characteristics of the tax established both in France and in Italy and Spain, this does not seem to be an objective of the FTT, since the tax base applied to investors is calculated on their net trading position at the end of each session and not on each of the transactions they carry out.

1 The group of countries is made up of: Austria, Belgium, France, Germany, Greece, Italy, Portugal, Slovenia and Spain.

2 European Commission (2011)

3 IMF (2010).

4 In this regard, Stiglitz (1989) presents the hypothesis that in financial markets there are too many investors who contribute noise, whose transactions are based on information that could generate excessive volatility. In addition, the existence of more short-term investors than is desirable could imply a negative externality for long-term investors, by separating the market price from the fundamental value of the asset.

There is also another line of thought that opposes the introduction of an FTT in stock markets. This opposition is based on the lack of evidence that introducing such a tax reduces speculation (Matheson, 2011). In addition, according to this line of thought, these types of measures, if they are not applied globally, mainly affect investors who have a more inelastic demand and who cannot migrate their operations to other markets that do not have an FTT. Lastly, the introduction of an FTT could increase the cost of capital for companies due to reduced liquidity of their shares in secondary markets, which would have a negative effect on the real economy (Matheson, 2011 and Antony et al., 2012).

In any case, the introduction of a new tax generates costs and benefits. The assessment of this cost-benefit analysis falls within the sphere of economic policy. This article focuses exclusively on analysing the impact of the tax introduced in Spain on the Spanish stock markets and aims to contribute to the debate and analysis of the tax using the methodology followed in the analyses carried out in other jurisdictions.

The effects of the FTT are not completely unknown, as various countries have or have had taxes applying to particular types of transactions. For this paper, the experience derived from the implementation of the FTT in both France and Italy is especially relevant, since the design of the tax in both countries is very similar to that applied in Spain. Specifically, the tax applied in France has been extensively studied in Becchetti et al. (2014) and in Colliard and Hoffmann (2017). These articles focus on determining the effect of the introduction of this tax on the liquidity, volatility and trading volumes of the markets in which it has been implemented. The main conclusions of these works are that the introduction of this type of tax reduced trading volumes in the markets in which it was introduced. At the same time, this reduction in trading translated into a loss of liquidity in secondary equity markets.

This article follows the same approaches as the articles of Becchetti et al. (2014) and Colliard and Hoffman (2017) and seeks to assess the effect that the introduction of the FTT has had on the secondary markets on which Spanish shares are traded. In order to do this, two types of complementary analysis are carried out. In the first, a differences-in-differences model is used (Abadie and Cattaneo, 2018). This involves measuring various parameters linked to the liquidity, volatility and trading volumes of the Spanish equity markets both in the situation in which the FTT was introduced and in another alternative and unobservable situation, artificially created, in which there is no FTT. The difference in the values in each of the two situations helps us to evaluate the impact of the introduction of the FTT on the equity markets. In the second analysis, a regression discontinuity model is applied (Imbens and Lemieux, 2008; Lee and Lemieux, 2010). This methodology makes it possible to study the effect of a measure when its application is conditional on a threshold. Specifically, it is possible to establish what happened to the experimental units close to the threshold which were affected by the measure and compare them with those also close to the threshold but which were not affected. The difference found in the variables of the units subject to the measure with respect to those which were not can be used to measure the impact of the FTT.

The rest of the document is structured as follows: Section 2 describes the FTT that was established in Spain in the secondary stock markets. Section 3 shows the data used and describes the variables of interest for carrying out the different empirical analyses. Section 4 discusses the empirical analysis carried out by means of the difference-in-differences model using data from the markets in which Spanish shares are traded and from equity markets in other countries to which no FTT is applied. Section 5 focuses on the analysis carried out with Spanish data where the regression discontinuity model is applied. Finally, the conclusions are presented in Section 6.

2 Description of the Spanish Financial Transaction Tax in secondary equity markets

On 16 October 2020, the law regulating the FTT on shares of Spanish listed companies was published in the *Boletín Oficial del Estado* (Official State Gazette). The tax entered into force on 16 January 2021, with the aim of contributing to the consolidation of public finances and reinforcing the principle of equity of the tax system. The first business day in the secondary equity markets on which the FTT was in force was 18 January.

The design of the tax is similar to that of other neighbouring countries, such as France and Italy, which had previously adopted this type of tax. The tax is governed by the "issuance principle", since the acquisition of shares of Spanish companies is taxed, regardless of the residence of the buyer or the place where the trade takes place, with the aim of minimising the risk of relocation.

The tax is applied to the acquisition of shares admitted to trading on a regulated or equivalent market, regardless of whether the transaction takes place on a MiFID trading market or over the counter (OTC).[5] Therefore, the selling party is not subject to the tax. In addition, the FTT applies only to shares whose issuers have a market value that exceeds €1 billion on 1 December of the previous year. This threshold is intended to reduce the effects of the tax on the market liquidity of the shares of smaller companies.

Another important characteristic of the tax design is that it excludes intraday trading, since the tax base is calculated as the net acquisition of shares, that is, subtracting from the number of securities acquired those transferred on the same day, multiplied by the average price of purchases made that day. The tax rate is 0.2%. The law provides for the exemption of certain types of transactions from the tax. For example, primary market operations such as acquisitions derived from the issuance of shares or from a public offering are exempt. Notably, intra-group transactions or those necessary for the proper functioning of the market, such as those carried out by financial intermediaries in their market-making or liquidity provision activities, are not taxed either. Lastly, business restructuring operations and those derived from the application of resolution measures, as well as transfers and financing operations of securities, are excluded from the tax.

5 There are three types of MiFID secondary markets: regulated markets, multilateral trading facilities and organised trading facilities.

3 Database

The database includes several variables that summarise the trading characteristics of the securities listed on the main equity markets in Austria, Germany, the Netherlands, Portugal and Spain. The variables relating to trading prices have been extracted from the main market in which each security is listed, as it is the most liquid. As regards the variables relating to the amounts traded, both transactions carried out in secondary markets in accordance with MiFID II and OTC transactions have been taken into account for each security.[6] The period studied is from 10 February 2019 to 23 December 2021. If each security/session is considered as an observation, the base is made up of 322,458 observations from 669 different issuers. Of these observations, 52,538 correspond to the Spanish market (109 issuers), 17,834 to the Portuguese market (37 issuers), 18,316 to the Austrian market (38 issuers), 47,236 to the Dutch market (98 issuers) and 186,534 to the German market (387 issuers). The source of the database is Bloomberg.

Since the main objective of this article is to establish the impact of the introduction of the FTT on the markets in which Spanish shares are traded in terms of liquidity, volatility and trading volumes, the following variables have been taken into consideration for each of the securities:

- The bid-ask differential as a percentage of the price on the main regulated market on which the security is listed.

- Amihud's liquidity measure:[7] The measure has been calculated for each security taking into account the previous five sessions through the average return in absolute values divided by trading in euros for each of the sessions. Subsequently, the values have been converted into index numbers, where 100 corresponds to the Amihud measure for each security on 18 January 2021.

- Trading ratio: it has been calculated as the quotient between the number of securities traded in a session over the total number of shares issued at the time the session was held. Subsequently, the values have been converted into index numbers, where 100 corresponds to the trading ratio of each security on 18 January 2021.

6 The OTC trading considered is that of transactions reported through Bloomberg by: CBOE BXTR Trade Reporting Services, CBOE Bats Europe, TradEcho EU APA and London SE OTC.

7 Amihud's measure is defined as a measure of illiquidity that represents the variation in price produced by a traded monetary unit. In this case, the ratio is calculated as the daily return on a share in absolute terms divided by its registered trading in thousands of euros.

- Trading volume in euros: this variable includes trading in euros in all markets corresponding to each session and for each issuer.

- Intraday volatility: this has been calculated for each security and session as a percentage using the formula described in Floros (2009), which considers the opening, closing, high and low prices. Subsequently, the values have been converted into index numbers, where 100 corresponds to the intraday volatility calculated for each security on 18 January 2021.

- Historical volatility: this volatility has been calculated as the standard deviation of the daily returns of the last 20 sessions. Subsequently, the values have been converted into index numbers, where 100 corresponds to the historical volatility calculated for each security on 18 January 2021.

- Difference between maximum and minimum price: it has been calculated for each session as the difference between the maximum and minimum intraday prices. Subsequently, the values have been converted into index numbers, where 100 corresponds to the difference between the maximum and minimum prices of each security on 18 January 2021.

- OTC trading percentage: it has been calculated, for each session, as the trading in euros carried out in markets considered OTC as a percentage of the total traded.

- Market value: the market value of each of the securities at the close of each session expressed in millions of euros.

Additionally, in the econometric analysis section we have used the variables that capture the global and idiosyncratic risk perceived in the markets for the five countries considered:

- Country risk: as an approximation, we have used the CDS premium on 5-year sovereign debt in basis points (bp) of Spain, Portugal, Austria, the Netherlands and Germany.

- Global risk: as an approximation, we have used the VIX (implied volatility of the S&P500) as a percentage.

Table 1 shows the descriptive statistics for each of the variables in the first database.

Descriptive statistics of the database[1]

TABLE 1

	Average	Standard deviation
Bid-ask spread (%)	1.8	4.1
Amihud's measure (index number)	281.9	583.2
Trading ratio (index number)	197.4	333.6
Trading volume (millions of euros)	28.7	78.9
Intraday volatility (index number)	121.7	101.3
Historical volatility (index number)	117.0	68.4
Difference between maximum and minimum prices (index number)	170.8	491.8
OTC trading percentage (%)	18.7	18.4
Market value (billions of euros)	5.7	16.9
Spain 5-year CDS (bp)	51.6	26.9
Portugal 5-year CDS (bp)	47.4	26.6
Austria 5-year CDS (bp)	11.5	3.5
Netherlands 5-year CDS (bp)	11.3	2.8
Germany 5-year CDS (bp)	12.2	4.3
VIX (%)	25.2	10.2
Number of observations	**322,458**	

Source: Bloomberg and own compilation by the authors.

1 For the calculation of the various statistics corresponding to the trading of each of the securities, the data have been winsorised (that is, observations located in the tails of the distribution have been eliminated in order to reduce the undesired effects due to their unreliability or unrepresentativeness) at 1% for each of the variables.

4 Results of the difference-in-differences model

Volume and share price data from five countries have been used in this section: Germany, Austria, Spain, the Netherlands and Portugal. The period for which the data is collected begins on 10 February 2019 and ends on 23 December 2021. The original base has been subjected to a filtering process to adapt it to the analysis of the effect of the FTT on the Spanish stock market. Thus, securities with a capitalisation of less than €1 billion have been excluded. In addition, observations for which no data exist are also discarded. Finally, observations from the 99% winsorisation to a single tail of each of the relevant variables are eliminated from the database to measure the impact of the introduction of the tax on the Spanish stock market.

This database has been used to estimate a differences-in-differences model with fixed effects at issuer level and per trading session. The following model with fixed effects has been estimated:

$$DepVar_{i,m,t} = \alpha + \beta_1\, intro\_tax_t + \\ + \beta_2\, values\_tax_i\, x\, intro\_tax_t + \delta\, controls_{i,m,t} + \\ + e_i + \gamma_t + \varepsilon_{m,i,t}$$

The dependent variables considered that define liquidity, volatility and trading in secondary stock markets are: the bid-ask spread, Amihud's measure of illiquidity, the trading ratio, the trading volume in euros, the daily intraday volatility, the historical daily volatility, the daily difference between maximum and minimum prices and the daily percentage traded OTC.[8] As controls, the following have been used: the VIX index, the country risk measured through sovereign debt CDS, the logarithm of the issuer's capitalisation, the logarithm of trading in euros and the historical volatility of the share calculated from the last 20 sessions. It is important to note that not all controls are used in all regressions. For example, historical volatility is not used when analysing the impact of the tax on volatility, nor is the logarithm of trading used when seeking to establish the impact of the tax on traded volumes. These equations also have a series of dummy variables relating to the in-troduction of the FTT.[9] Among them the variable $values\_tax_i\, x\, intro\_tax_t$ is key.

This variable, renamed the "dummy effect" in the results tables, is key in that it shows the effect of the introduction of the FTT on the dependent variable.

8 The definition of each of these variables can be found in the section describing the database used.

9 A dummy variable is one that takes the value 0 or 1 depending on certain conditions.

The estimation of the model was carried out in two stages. In the first, the database described above was used and subjected to a process known as "coarsened exact matching" (Iacus et al., 2012). This technique consists of selecting part of a data set from the original database that has similar characteristics and makes comparison easier. This is because it selects groups of treated observations (in this case, subjected to the tax) and a more balanced control group, which helps increase the robustness of the analysis. This sample selection process was carried out using the following variables to identify shares with similar characteristics: market value, the sector to which the issuer belongs, and its liquidity. For this last variable, the liquidity assessment carried out by the European Securities and Markets Authority (ESMA) for its transparency calculations was used.[10] The second stage consisted of estimating the regression model proposed with the data selected in the first stage.

Below are the results of the analysis for different variables and session windows around the introduction of the tax in Tables 2-9. Each of the tables shows the results that reflect the effect of the implementation of the tax on the dependent variable for different time series: windows of 40 sessions (short term), 100 and 200 sessions (medium term) and 480 sessions (long term).

Results for bid-ask spreads TABLE 2

%

	Window 40 sessions	Window 100 sessions	Window 200 sessions	Window 480 sessions
Dummy effect	**-0.0012**	**-0.0011**	**-0.0024**	**-0.0278*****
Market value log	-0.0267	-0.0500**	-0.0318***	-0.0408***
Trading volume log	0.0006	-0.0015	-0.0081***	-0.0218***
Historical market volatility	0.0031*	0.0019	0.0049***	0.0059***
OTC trading percentage	0.00002	-0.00002	0.00005	0.0002***
Country risk	0.0004	0.0009	0.0011**	0.0009***
Dummy tax	-0.0017	-0.0020	-0.0191*	-0.0404***
VIX	-0.0049	0.0021	-0.0005	0.0186***
Number of observations	7,884	19,066	36,756	90,937
R^2	0.24	0.27	0.32	0.35

Source: Bloomberg and own compilation by the authors.

* Coefficient statistically different from zero at the 10% significance level.

** Coefficient statistically different from zero at the 5% significance level.

*** Coefficient statistically different from zero at the 1% significance level.

10 These data are available at: https://registers.esma.europa.eu/publication/searchRegister?core=esma_registers_fitrs_files#.

Results for Amihud's measure of illiquidity[1]

TABLE 3

Index[2] (base 100)

	Window 40 sessions	Window 100 sessions	Window 200 sessions	Window 480 sessions
Dummy effect	**10.2509****	**11.5832*****	**8.1029****	**-1.0336**
Market value log	-34.2785**	-71.4050***	-63.7622***	-64.7105***
Trading volume log	-7.6374***	-12.2677***	-20.0569***	-30.4864***
Historical market volatility	6.1274***	6.0647***	7.8948***	11.8196***
OTC trading percentage	0.0891	0.1393***	0.2335***	0.4102***
Country risk	1.2679	0.6786*	0.5608	0.0368
Dummy tax	2.2653	-29.7248**	-29.4257***	44.4188***
VIX	3.9722*	0.1387	-0.0960	-10.6304***
Number of observations	7,583	19,163	37,154	90,434
R^2	0.0001	0.0009	0.0017	0.0192

Source: Bloomberg and own compilation by the authors.

1 Amihud's measure of illiquidity is defined as the return necessary to offset the price variation induced by daily trading. In this case, the dependent variable comes from the mean of Amihud's measure of illiquidity in the last five sessions.

2 Amihud's measure of illiquidity has been translated into index numbers relative to its value on 18 January 2021.

* Coefficient statistically different from zero at the 10% significance level.

** Coefficient statistically different from zero at the 5% significance level.

*** Coefficient statistically different from zero at the 1% significance level.

Results for trading ratio[1]

TABLE 4

Index[2] (base 100)

	Window 40 sessions	Window 100 sessions	Window 200 sessions	Window 480 sessions
Dummy effect	**-2.9103**	**-21.203***	**-34.136*****	**-17.193****
Market value log	79.8414***	50.6486**	-8.5356	4.0842
Historical market volatility	12.4326***	29.0623***	23.5333***	26.7667***
OTC trading percentage	1.1658***	2.1033***	1.4371***	1.7150***
Country risk	1.2720	0.0191	-1.1594***	-0.5486***
Dummy tax	-5.9672	-53.9845	20.0437	-93.6101***
VIX	29.2677***	2.4174	-3.1977	17.9331
Number of observations	7,653	20,368	38,101	93,618
R^2	0.03	0.04	0.03	0.13

Source: Bloomberg and own compilation by the authors.

1 The trading ratio is defined as the volume of shares traded as a percentage of the total issued.

2 The trading ratio has been translated into index numbers by relative to its value on 18 January 2021.

* Coefficient statistically different from zero at the 10% significance level.

** Coefficient statistically different from zero at the 5% significance level.

*** Coefficient statistically different from zero at the 1% significance level.

Results for the trading volume log

TABLE 5

	Window 40 sessions	Window 100 sessions	Window 200 sessions	Window 480 sessions
Dummy effect	**-0.0997****	**-0.1258*****	**-0.183*****	**-0.073****
Market value log	1.4786***	1.0680***	0.9505***	1.0176***
Historical market volatility	0.1017***	0.1210***	0.1415***	0.1643***
OTC trading percentage	0.0081***	0.0080***	0.0089***	0.0102***
Country risk	0.0069	-0.0040	-0.0076***	-0.0033***
Dummy tax	-0.1109	-0.2052	0.1510	-0.5188***
VIX	0.1305***	0.0126	-0.0182	0.1323***
Number of observations	7,136	18,368	36,905	89,597
R^2	0.62	0.64	0.63	0.63

Source: Bloomberg and own compilation by the authors.

* Coefficient statistically different from zero at the 10% significance level.

** Coefficient statistically different from zero at the 5% significance level.

*** Coefficient statistically different from zero at the 1% significance level.

Results for intraday volatility[1]

TABLE 6

Index[2] (base 100)

	Window 40 sessions	Window 100 sessions	Window 200 sessions	Window 480 sessions
Dummy effect	**5.9563****	**3.4659**	**0.4316**	**-8.8119*****
Market value log	-53.0208***	-45.2084***	-43.4599***	-49.2901***
Trading volume log	39.8197***	40.7344***	36.8239***	35.5902***
OTC trading percentage	-0.7161***	-0.7388***	-0.7161***	-0.7368***
Country risk	0.4278	0.3650	0.3772*	0.0181
Dummy tax	-1.5123	17.1735	-31.7721**	-6.1735
VIX	-5.9563	6.2351**	-1.9069	5.9556
Number of observations	7,685	19,189	38,123	93,345
R^2	0.03	0.04	0.05	0.13

Source: Bloomberg and own compilation by the authors.

1 Volatilities have been calculated following the methodology described in Floros (2009).

2 The volatilities have been translated into index numbers relative to the intraday volatility of 18 January 2021.

* Coefficient statistically different from zero at the 10% significance level.

** Coefficient statistically different from zero at the 5% significance level.

*** Coefficient statistically different from zero at the 1% significance level.

Rests for historical volatility[1]

TABLE 7

Index[2] (base 100)

	Window 40 sessions	Window 100 sessions	Window 200 sessions	Window 480 sessions
Dummy effect	**0.2526**	**0.6811**	**-6.645****	**-5.7432****
Market value log	43.8850***	3.5908	4.5588	-14.0643***
Trading volume log	3.1155***	5.9701***	6.8565***	8.7104***
OTC trading percentage	-0.0538**	-0.0727***	-0.7614***	-0.1619***
Country risk	0.0721	-0.0347	-0.2535	-0.2025***
Dummy tax	-5.4134*	-13.2891**	-18.9233***	30.8777***
VIX	-3.0984***	0.9292	1.7962***	-0.6679
Number of observations	6,836	15,398	34,785	82,664
R^2	0.00	0.02	0.07	0.18

Source: Bloomberg and own compilation by the authors.

1 The volatilities have been calculated from the daily returns of the last 20 sessions.

2 The volatilities have been translated into index numbers relative to the historical volatility of 18 January 2021.

* Coefficient statistically different from zero at the 10% significance level.

** Coefficient statistically different from zero at the 5% significance level.

*** Coefficient statistically different from zero at the 1% significance level.

Results for difference between maximum and minimum prices[1]

TABLE 8

Index[2] (base 100)

	Window 40 sessions	Window 100 sessions	Window 200 sessions	Window 480 sessions
Dummy effect	**9.679*****	**7.2473****	**2.3686**	**-7.641*****
Market value log	-41.3287***	-46.1555***	-47.3237***	-53.5317***
Trading volume log	41.4953	45.3979***	43.6977***	40.3022***
OTC trading percentage	-0.7815***	-0.8604***	-0.8618***	-0.8308***
Country risk	0.5821	0.5907**	0.4045**	0.0752
Dummy tax	-8.3684	-19.1316	-32.9141**	3.0093
VIX	-8.4777**	0.8145	-1.3678	4.1270
Number of observations	7,679	19,320	39,026	97,519
R^2	0.04	0.05	0.07	0.17

Source: Bloomberg and own compilation by the authors.

1 The dependent variable consists of the difference between the maximum and minimum intraday prices.

2 The differences between maximum and minimum prices have been translated into index numbers relative to the difference between the maximum and minimum prices registered on 18 January 2021.

* Coefficient statistically different from zero at the 10% significance level.

** Coefficient statistically different from zero at the 5% significance level.

*** Coefficient statistically different from zero at the 1% significance level.

Results for percentage of OTC trading[1] TABLE 9

%

	Window 40 sessions	Window 100 sessions	Window 200 sessions	Window 480 sessions
Dummy effect	**-1.1265***	**-1.6326*****	**-0.5356**	**-2.7428****
Market value log	-6.8199**	-4.8855***	-1.7553	-0.7690
Trading volume log	2.2768***	2.4481***	3.1313***	3.8487***
Historical market volatility	-0.7441**	-0.6508***	-0.6946***	-1.1187***
Country risk	0.1210	0.0002	0.0716	-0.0101
Dummy tax	2.9467**	22.0811***	10.6383***	-1.4514
VIX	0.3662	2.6328***	0.8603	1.6056
Number of observations	6,989	17,605	35,889	88,535
R^2	0.01	0.03	0.14	0.21

Source: Bloomberg and own compilation by the authors.

1 The dependent variable is the percentage of trading in euros that takes place in OTC markets.

* Coefficient statistically different from zero at the 10% significance level.

** Coefficient statistically different from zero at the 5% significance level.

*** Coefficient statistically different from zero at the 1% significance level.

The results of the empirical analysis show that in the short and medium term the tax does not appear to affect bid-ask spreads (Table 2). Only a longer-term effect is seen as significant, although its amount is marginal. On the other hand, there is evidence that the introduction of the tax contributed to a significant reduction in the trading volume of the shares that were affected (Tables 4 and 5). This reduction in trading volume translated into an increase in Amihud's measure of illiquidity that was apparently only small in absolute terms. Thus, after the application of the FTT, there would have been a slight deterioration in liquidity in the dimensions captured by this measure (Table 3). An effect is also observed in the volatility of share prices. In this regard, the results indicate that volatility could have increased at the beginning of the introduction. However, in the long term, volatility seems to have tended to decrease (Tables 6 and 7).[11] Lastly, the introduction of the FTT could have shifted a significant part of OTC trading to markets subject to MiFID regulation. This result may have been expected: with the reduction in the total volume of trading in shares subject to the tax, some investors would try to concentrate their operations in markets where there is a higher trading volume (Beber et al., 2009). This means that when evaluating how the tax affects price formation in regulated markets there are two opposing effects: on the one hand, trading volume decreases, but at the same time, on the other hand, part of the trading previously carried out in OTC markets is transferred to them. This result could be the subject of further analysis or study.

When the results are compared with those previously obtained in the literature, they are aligned for the most part.

11 Similar results can be found when, instead of considering volatility as a dependent variable in the regressions, the price differential between the maximum and the minimum recorded in each session is used (see Table 8).

As derived from the theoretical literature, investors try to behave strategically and adjust their behaviour to minimise the impact that the FTT may have on their operations (Constantinides, 1986). Both Becchetti et al. (2014) and Colliard and Hoffmann (2017) also find that volumes fell in the French market after the introduction of the FTT. This translated into an increase in Amihud's measure of illiquidity and, therefore, into more illiquid markets in this dimension. The only area in which there is any divergence is the effect of the FTT on bid-ask spreads. These authors found an increase in these spreads, while this study shows that there is no evidence that they have been significantly affected. This difference could be explained by the fact that in France the FTT was introduced in 2012, at a time when trading was less fragmented than it later became. The Spanish FTT was introduced in 2021, in an environment of greater fragmentation, and had the effect of concentrating trading in regulated markets, which may have contributed to maintaining bid-ask spreads stable.

Therefore, trading volumes reduced appreciably for shares subject to the tax. Due to the design of the FTT, it could be deduced that some investors who do not trade intraday decreased their participation in the stock market, since only investors obtaining a positive balance in stock trading at the end of the trading session are taxed. The tax would therefore have had a limited impact on the activity of many of the high-frequency traders and other liquidity providers, whose objective, among other things, is to try to close each session with a zero trading balance. In this regard, the fact that bid-ask differentials are not significantly affected, despite the general decline in trading, could indicate that this type of investor has a greater relative importance in regulated markets. Along the same lines, the reduction in trading by investors who do not trade intraday could also reduce the variability of market prices, which means that, in the long term, volatility tends to decrease due to the introduction of the FTT.

5 Results of the regression discontinuity model

A complementary approach to analyse the impact of the FTT would focus on comparing the evolution of the variables linked to the trading of the shares of Spanish companies subject to the tax with those that are not subject.

However, in this case, the application of the differences-in-differences methodology would not be appropriate, since the classification of the shares in the control and treatment groups is not random. Instead, it is conditioned by the market value of their issuers. This is because the law establishes that only shares with a market value of more than €1 billion are taxed.

Therefore, the classification based on market value means that both groups have different characteristics and that the necessary conditions to apply the difference-in-differences methodology are not met. Differences in the capitalisation variable could introduce biases in the analysis. To circumvent this problem, we resort to the construction of a two-dimensional regression discontinuity. The regression discontinuity analysis aims at a local extrapolation to compare the control and treatment groups around an area very close to the threshold. Thus, if for two companies the explanatory variable (in this case, market value) has a similar value close to the threshold (one below and the other above the threshold), large differences in the response variable should be explained by their belonging to the treatment or control group. In this exercise it is assumed that the rest of the characteristics do not change abruptly around the threshold.

A challenge in applying regression discontinuity analysis is the nature of the database of the present study: while the standard application is performed on cross-sectional samples, in this case the observations contain time series. To address this problem, we follow the approach of Becchetti et al. (2014) and the sample will be restricted to observations that are closest to the market value threshold (companies with capitalisation closest to €1 billion) and closest to the date on which the tax was introduced (limited time series). This will allow us to establish the effects of the event on the observations that are closest to both thresholds. Specifically, a model with four regimes is specified that takes into account the dependent variable, the market value and the date of the observation:

$$Y_{it} = i_1 + f_1\left|cap_{it} - threshold\right| + g_1\left|day_{it} - event\right| + \varepsilon, \text{if } cap_{it} < threshold \;\&\; day_{it} < event$$
$$Y_{it} = i_2 + f_2\left|cap_{it} - threshold\right| + g_2\left|day_{it} - event\right| + \varepsilon, \text{if } cap_{it} < threshold \;\&\; day_{it} > event$$
$$Y_{it} = i_3 + f_3\left|cap_{it} - threshold\right| + g_3\left|day_{it} - event\right| + \varepsilon, \text{if } cap_{it} > threshold \;\&\; day_{it} < event$$
$$Y_{it} = i_4 + f_4\left|cap_{it} - threshold\right| + g_4\left|day_{it} - event\right| + \varepsilon, \text{if } cap_{it} > threshold \;\&\; day_{it} > event$$

Where Y corresponds to the dependent variable (which will be a measure of liquidity, trading or volatility) of company *i* on date *t*. The variable *cap* is the market capitalisation of company *i* on date *t*; the variable *day* corresponds to the date of each observation; the variable *threshold* refers to the tax threshold of €1 billion of capitalisation. Finally, the variable *event* refers to the date on which the tax was introduced, 18 January 2021.

This approach makes it possible to evaluate the impact of the introduction of the tax through a function, in this case linear, that considers the distances of each observation from the two thresholds. The first is the distance measured as the difference in euros between the market capitalisation of company *i* at time *t* and the tax threshold. The second considers the distance in the temporal dimension, measured as the difference in days between the moment of the observation and the date of introduction of the tax.

Assuming linearity in the functions, the following model is obtained:

$$Y_{it} = \alpha_0 + \alpha_1 D + \alpha_2(cap_{it} - threshold) + \alpha_3 D(cap_{it} - threshold) + \alpha_4 DT + \alpha_5 DT(cap_{it} - threshold) + \alpha_6 T + \alpha_7 T(cap_{it} - threshold) + \alpha_8(day_{it} - event) + \alpha_9 D(day_{it} - event) + \alpha_{10} DT(day_{it} - event) + \alpha_{11} T(day_{it} - event) + \theta\ controls_{it} + e_i + \varepsilon_{it}$$

Where D is a dummy variable which takes value 1 if the market capitalisation of company *i* at the time *t* is greater than the threshold of €1 billion and 0 otherwise. The variable T is another dummy which takes value 1 if the observation date is after the date on which the tax was introduced, 18 January 2021, and 0 otherwise.

The relevant variables have been renamed as shown below:

$$Treated = \alpha_4 DT$$
$$Treated\ dif\ cap = \alpha_5 DT(cap_{it} - threshold)$$
$$Treated\ dif\ days = \alpha_{10} DT(day_{it} - event)$$

It can be observed that the coefficients α_4 , α_5 and α_{10} correspond respectively to i_4, f_4 and g_4.

This regression discontinuity analysis is carried out on 109 Spanish companies admitted to trading on the regulated market. The regressions are applied to time series of different lengths: 40 sessions (short term), 100 and 200 sessions (medium term) and 480 sessions (long term). Establishing time windows of different lengths makes it possible to explore the sensitivity of the results to the distance between the date of the observations and the day the tax was introduced. The dependent variable is winsorised to 10% in both tails.

Since there is no consensus on how to estimate the optimal band of observations around the threshold in the regression discontinuity, two ranges have been established. In the first instance, all the shares of companies whose market value is within the range of the 20th to 80th percentiles of the total winsorised sample are included in the analysis. In the second, the sample is reduced to those companies within the range of percentiles 30 to 70. Establishing two cut-off points on each side of the threshold allows us to check the robustness of the results obtained in

the regressions. By excluding the shares of companies whose capitalisation is very far from the threshold, this analysis makes it possible to observe the effects of the tax on a more homogeneous sample, in which the size of the companies is similar and the most significant difference is whether or not they are subject to the FTT.

The regression discontinuity includes fixed effects and additional control variables, which are: the logarithm of trading volume, historical volatility, the percentage of OTC trading, country risk and the VIX (when any of these is the dependent variable of the regression, it is excluded as a control). As in Colliard and Hoffmann (2017), we exclude a period in which the trading data may be populated with outliers. In this case, these are the Christmas dates immediately prior to the introduction of the tax (from 21 December 2020 to 10 January 2021).

Results for bid-ask differentials TABLE 10

%

	Window 40 sessions	Window 100 sessions	Window 200 sessions	Window 480 sessions
Treated (band 20-80%)[1]	**0.0411**	**-0.0348**	**-0.0040**	**0.0036**
Treated dif cap (band 20-80%)[1, 3]	**0.0001**	**-0.0001**	**-0.0001**	**-0.0001**
Treated dif days (band 20-80%)[1]	**0.0001**	**0.0003**	**0.0009***	**0.0000**
Number of observations	1,975	4,913	9,745	23,243
R^2	0.23	0.10	0.30	0.45
Treated (band 30-70%)[2]	**0.1549****	**0.1076**	**0.1157**	**0.0704**
Treated dif cap (band 30-70%)[2, 3]	**0.0006***	**0.0003**	**0.0003**	**0.0002**
Treated dif days (band 30-70%)[2]	**-0.0025**	**0.0002**	**0.0010***	**0.0000**
Number of observations	1,317	3,276	6,498	15,503
R^2	0.24	0.23	0.17	0.30

Source: Bloomberg and own compilation by the authors.

1 The variable is winsorised in each tail at 10% and all companies whose capitalisation is below the 20th percentile or above the 80th percentile are excluded.

2 The variable is winsorised in each tail at 10% and all companies whose capitalisation is below the 30th percentile or above the 70th percentile are excluded.

3 Effect expressed per million euros in capitalisation.

* Coefficient statistically different from zero at the 10% significance level.

** Coefficient statistically different from zero at the 5% significance level.

*** Coefficient statistically different from zero at the 1% significance level.

Results for Amihud's measure of illiquidity[1]

TABLE 11

Index[2] (base 100)

	Window 40 sessions	Window 100 sessions	Window 200 sessions	Window 480 sessions
Treated (band 20-80%)[3]	**22.2510**	**-5.3171**	**-0.9473**	**20.2220**
Treated dif cap (band 20-80%)[3, 5]	**0.0314**	**-0.0325**	**-0.0253**	**0.0315**
Treated dif days (band 20-80%)[3]	**-1.1264****	**-0.1372**	**-0.0052**	**0.0065**
Number of observations	2,005	4,991	9,946	23,729
R^2	0.00	0.00	0.01	0.01
Treated (band 30-70%)[4]	**49.5913*****	**21.0150**	**12.2579**	**24.7713**
Treated dif cap (band 30-70%)[4, 5]	**0.1170*****	**0.0429**	**0.0458**	**-0.117*****
Treated dif days (band 30-70%)[4]	**-0.7139**	**-0.1179**	**0.0752**	**-0.0137**
Number of observations	1,340	3,333	6,640	15,845
R^2	0.00	0.00	0.03	0.04

Source: Bloomberg and own compilation by the authors.

1 Amihud's measure of illiquidity is defined as the return necessary to offset the price variation induced by daily trading. In this case, the dependent variable comes from the mean of Amihud's measure of illiquidity in the last five sessions.

2 Amihud's measure of illiquidity has been translated into index numbers by reference to its value on 18 January 2021.

3 The variable is winsorised in each tail at 10% and all companies whose capitalisation is below the 20th percentile or above the 80th percentile are excluded.

4 The variable is winsorised in each tail at 10% and all companies whose capitalisation is below the 30th percentile or above the 70th percentile are excluded.

5 Effect expressed per million euros in capitalisation.

* Coefficient statistically different from zero at the 10% significance level.

** Coefficient statistically different from zero at the 5% significance level.

*** Coefficient statistically different from zero at the 1% significance level.

Results for trading ratio[1]

TABLE 12

Index[2] (base 100)

	Window 40 sessions	Window 100 sessions	Window 200 sessions	Window 480 sessions
Treated (band 20-80%)[3]	**15.5991**	**-16.3347**	**-15.1464**	**-15.6438**
Treated dif cap (band 20-80%)[3, 5]	**0.0831****	**0.0137**	**0.0071**	**-0.0153**
Treated dif days (band 20-80%)[3]	**-0.0635**	**0.2934**	**-0.0755**	**-0.1092**
Number of observations	2,004	4,997	9,954	23,769
R^2	0.05	0.02	0.03	0.06
Treated (band 30-70%)[4]	**9.5766**	**-21.5470**	**-45.3102****	**-28.1943**
Treated dif cap (band 30-70%)[4, 5]	**0.1040**	**-0.0723**	**-0.1150*****	**-0.1180****
Treated dif days (band 30-70%)[4]	**1.0275**	**0.2435**	**-0.1875**	**-0.0978**
Number of observations	1,336	3,331	6,637	15,852
R^2	0.03	0.02	0.01	0.04

Source: Bloomberg and own compilation by the authors.

1 The trading ratio is defined as the volume of shares traded as a percentage of the total issued.

2 The trading ratio has been translated into index numbers by relative to its value on 18 January 2021.

3 The variable is winsorised in each tail at 10% and all companies whose capitalisation is below the 20th percentile or above the 80th percentile are excluded.

4 The variable is winsorised in each tail at 10% and all companies whose capitalisation is below the 30th percentile or above the 70th percentile are excluded.

5 Effect expressed per million euros in capitalisation.

* Coefficient statistically different from zero at the 10% significance level.

** Coefficient statistically different from zero at the 5% significance level.

*** Coefficient statistically different from zero at the 1% significance level.

Results for the logarithm of trading volume

TABLE 13

	Window 40 sessions	Window 100 sessions	Window 200 sessions	Window 480 sessions
Treated (band 20-80%)[1]	**0.0335**	**0.1017**	**0.0003**	**-0.0918**
Treated dif cap (band 20-80%)[1, 3]	**0.0005**	**0.0003**	**0.0000**	**-0.0003**
Treated dif days (band 20-80%)[1]	**-0.0050**	**0.0000**	**-0.0010**	**0.0001**
Number of observations	2,007	5,009	9,988	23,846
R^2	0.42	0.52	0.51	0.48
Treated (band 30-70%)[2]	**-0.0386**	**-0.1115**	**-0.0848**	**-0.3159**
Treated dif cap (band 30-70%)[2, 3]	**0.0007**	**-0.0002**	**-0.0009****	**-0.0011****
Treated dif days (band 30-70%)[2]	**-0.0024**	**-0.0027**	**-0.0018**	**-0.0002**
Number of observations	1,338	3,339	6,659	15,899
R^2	0.27	0.41	0.37	0.34

Source: Bloomberg and own compilation by the authors.

1 The variable is winsorised in each tail at 10% and all companies whose capitalisation is below the 20th percentile or above the 80th percentile are excluded.

2 The variable is winsorised in each tail at 10% and all companies whose capitalisation is below the 30th percentile or above the 70th percentile are excluded.

3 Effect expressed per million euros in capitalisation.

* Coefficient statistically different from zero at the 10% significance level.

** Coefficient statistically different from zero at the 5% significance level.

*** Coefficient statistically different from zero at the 1% significance level.

Results for intraday volatility[1]

TABLE 14

Index[2] (base 100)

	Window 40 sessions	Window 100 sessions	Window 200 sessions	Window 480 sessions
Treated (band 20-80%)[3]	**21.3349**	**18.8687***	**13.3719**	**13.9229****
Treated dif cap (band 20-80%)[3, 5]	**-0.0047**	**-0.0007**	**0.0040**	**0.0211****
Treated dif days (band 20-80%)[3]	**-0.4300**	**0.3030*****	**-0.0216**	**-0.0174**
Number of observations	1,955	4,875	9,687	23,097
R^2	0.00	0.01	0.01	0.05
Treated (band 30-70%)[4]	**22.2960**	**26.5930***	**22.5294***	**21.7289****
Treated dif cap (band 30-70%)[4, 5]	**0.0149**	**0.0375**	**0.0515**	**0.0711*****
Treated dif days (band 30-70%)[4]	**-0.1539**	**0.3665*****	**0.0028**	**-0.0121**
Number of observations	1,303	3,250	6,460	15,396
R^2	0.00	0.01	0.01	0.07

Source: Bloomberg and own compilation by the authors.

1 Volatilities have been calculated following the methodology described in Floros (2009).

2 Intraday volatility has been translated into index numbers relative to intraday volatility on 18 January 2021.

3 The variable is winsorised in each tail at 10% and all companies whose capitalisation is below the 20th percentile or above the 80th percentile are excluded.

4 The variable is winsorised in each tail at 10% and all companies whose capitalisation is below the 30th percentile or above the 70th percentile are excluded.

5 Effect expressed per million euros in capitalisation.

* Coefficient statistically different from zero at the 10% significance level.

** Coefficient statistically different from zero at the 5% significance level.

*** Coefficient statistically different from zero at the 1% significance level.

Results for historical volatility[1]

TABLE 15

Index[2] (base 100)

	Window 40 sessions	Window 100 sessions	Window 200 sessions	Window 480 sessions
Treated (band 20-80%)[3]	**-7.8139**	**4.8406**	**12.9803**	**7.5203**
Treated dif cap (band 20-80%)[3, 5]	**-0.0014**	**0.0013**	**0.0138**	**0.0241****
Treated dif days (band 20-80%)[3]	**0.0279**	**0.0443**	**-0.0591**	**-0.0404***
Number of observations	2,006	5,001	9,974	23,833
R^2	0.00	0.07	0.07	0.19
Treated (band 30-70%)[4]	**-5.4192**	**-3.5728**	**-5.6835**	**-5.7961**
Treated dif cap (band 30-70%)[4, 5]	**-0.0162**	**0.0018**	**0.0006**	**0.0362*****
Treated dif days (band 30-70%)[4]	**0.2304**	**0.0345**	**-0.0248**	**-0.0607****
Number of observations	1,342	3,347	6,670	15,930
R^2	0.01	0.11	0.08	0.20

Source: Bloomberg and own compilation by the authors.

1 The volatilities have been calculated from the daily returns of the last 20 sessions.

2 Historical volatility has been translated into index numbers relative to historical volatility on 18 January 2021.

3 The variable is winsorised in each tail at 10% and all companies whose capitalisation is below the 20th percentile or above the 80th percentile are excluded.

4 The variable is winsorised in each tail at 10% and all companies whose capitalisation is below the 30th percentile or above the 70th percentile are excluded.

5 Effect expressed per million euros in capitalisation.

* Coefficient statistically different from zero at the 10% significance level.

** Coefficient statistically different from zero at the 5% significance level.

*** Coefficient statistically different from zero at the 1% significance level.

Results for difference between maximum and minimum prices[1] TABLE 16

Index[2] (base 100)

	Window 40 sessions	Window 100 sessions	Window 200 sessions	Window 480 sessions
Treated (band 20-80%)[3]	**6.4631**	**9.9199**	**8.2412**	**12.3118***
Treated dif cap (band 20-80%)[3, 5]	**-0.0066**	**-0.0072**	**0.0036**	**0.0206****
Treated dif days (band 20-80%)[3]	**-0.2741**	**0.2861*****	**-0.0156**	**-0.0220**
Number of observations	1,955	4,874	9,690	23,096
R^2	0.00	0.01	0.02	0.05
Treated (band 30-70%)[4]	**9.1551**	**14.4877**	**13.3531**	**17.4043***
Treated dif cap (band 30-70%)[4, 5]	**0.0302**	**0.0238**	**0.0510**	**0.0700*****
Treated dif days (band 30-70%)[4]	**0.0854**	**0.2828****	**-0.0137**	**-0.01638**
Number of observations	1,303	3,250	6,463	15,397
R^2	0.01	0.01	0.01	0.06

Source: Bloomberg and own compilation by the authors.

1 The dependent variable consists of the difference between the intraday maximum and minimum prices (intraday range).

2 The intraday range has been translated into index numbers relative to the intraday range on 18 January 2021.

3 The variable is winsorised in each tail at 10% and all companies whose capitalisation is below the 20th percentile or above the 80th percentile are excluded.

4 The variable is winsorised in each tail at 10% and all companies whose capitalisation is below the 30th percentile or above the 70th percentile are excluded.

5 Effect expressed per million euros in capitalisation.

* Coefficient statistically different from zero at the 10% significance level.

** Coefficient statistically different from zero at the 5% significance level.

*** Coefficient statistically different from zero at the 1% significance level.

As can be seen in Tables 10 and 11, for the larger sample, the one in the 20th to 80th percentile range, no relevant effects are observed, either in the bid-ask differentials or in Amihud's measure of illiquidity. However, in the reduced sample, the one in the 30th to 70th percentile range, the tax seems to have contributed to increasing both market liquidity variables in the short term, that is, the increase in the range has a limited effect over time, since it is only observed in the time series of 40 sessions.

Significant effects on the trading variables (trading ratio and logarithm of trading) were not identified in the larger sample either. In the reduced sample, the results are similar, although an apparently negative effect on the trading ratio is observed in the 200-session window (see Tables 12 and 13).

Intraday volatility seems to have increased for both samples in the medium and long term (see Table 14). In addition, this effect seems to have been greater with long-term market value, that is, companies that, within the bands established around the threshold, are larger would have experienced greater increases in intraday volatility, as shown by the explanatory variable *treated diff cap*. On the contrary, no relevant effect on historical volatility is identified in any of the samples (see Table 15).

Table 16 suggests that the tax contributes to increasing the difference between minimum and maximum daily prices in the long term.

In other words, in the case of the shares of companies with a market value closer to the threshold and, therefore, excluding the shares of the largest Spanish companies, there is evidence that the tax could have contributed to increasing bid-ask spreads and Amihud's measure of illiquidity (thus leading to deterioration of these liquidity measures) only in the short term (window of 40 sessions), with no effects observed in the medium and long term. For the group of shares closer to the threshold, the trading ratio seems to have decreased only in the medium term, and intraday volatilities and differences between minimum and maximum prices seem to have increased in the long term.

Conclusions

The introduction of a new tax always generates costs and benefits. This article adopts an approach along the same lines as Becchetti et al. (2014) and Colliard and Hoffman (2017), and tries to evaluate the effect of the introduction of the Financial Transaction Tax on Spanish shares in secondary markets, focusing, therefore, on its costs. In order to do this, several dimensions of liquidity are analysed (measured through the bid-ask differential and Amihud's measure of illiquidity), volatility (both intraday and historical) and the trading volume of the secondary markets on which Spanish shares are traded.

The results of the difference-in-differences analysis reveal that the tax had hardly any effect on bid-ask spreads. However, the tax reduced the level of share trading, which in turn caused a slight deterioration in the liquidity dimensions, measured through Amihud's measure of illiquidity, which shows a small increase in absolute terms after its introduction. For its part, volatility, although it increased in the short term, tended to decrease in the long term. This was the case for both intraday volatility measures and historical volatility measures. In addition, the results indicate that the introduction of the tax could have displaced part of the OTC trading to MiFID secondary markets.

The results of the regression discontinuity analysis suggest that liquidity, measured through bid-ask spreads, Amihud's measure of illiquidity and the trading volume, were not generally affected for the companies subject to the tax closest to the market value threshold of €1 billion. However, in some cases, deterioration was observed (increase in bid-ask spreads and Amihud's measure of illiquidity in the short term and decrease in trading volume in the medium term). In addition, the intraday volatility of the shares of these companies increased after the introduction of the tax.

Therefore, according to the results of this study, in general, the trading of taxed Spanish shares decreased after the introduction of the tax. The design of the tax could have reduced the incentives of some long-term investors to participate in the market, since the tax base is calculated from the net acquisitions of shares made on the day. At the same time, there is no evidence that bid-ask spreads of the companies with the largest capitalisations were affected, although Amihud's measure of illiquidity increased slightly in absolute terms. In the case of the shares of companies that are close to the €1 billion market value threshold, the results reveal that after the introduction of the FTT, the bid-ask spreads and Amihud's measure of illiquidity increased only in the short term (window of 40 sessions), without observed effects in the medium and long term.

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