Short-Selling Restrictions and Returns: a Natural Experiment

PRELIMINARY

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ABSTRACT

In this paper, we measure the causal impact of short-selling restrictions on returns by taking advantage of an unique dataset and an unique source of exogenous variation in equity loan fees, due to a tax arbitrage strategy. Our data contains all equity loan transactions in Brazil and the identity of the parts, thus allowing us identify transactions for tax arbitrage. The tax arbitrage strategy resulted from the differential tax treatment for a preferred type of dividend payment between individual investors and mutual funds, which were tax exempt. Tax saving was achieved whenever individual investors lent equities to mutual funds before the dividend record date. The strategy generated an exogenous spike in rental fees and short interest in the days surrounding the record date, reducing the availability of stock loans for short-selling reasons and increasing their lending fees. We find that the induced variation of the equity loan fee for stocks borrowed for short-selling reasons had a large impact on abnormal returns around dividends record date. Thus, it corroborates Miller's hypothesis that an increase in short-selling restrictions on a stock impacts positively its price.

JEL classification: G12, G14.

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I. Introduction

Since the seminal article of Miller (1977), the impact of short-selling constraints on financial markets have been subject of numerous theoretical [1] and empirical studies.[2] One of the most widely predicted effect, is that the interaction between heterogeneous valuations and short-sale constraint would lead to prices superior to the average valuation. Thus, both an increase in heterogeneity or in short-sale constraints would pressure prices upwards [3]. While several empirical papers have convincingly illustrated the effect of the (cross-sectional and temporal) variation in heterogeneity and loan demand on stock prices,[4] documenting the effect of variation of stock loans supply pose a greater challenge.

Identification of the causal impact of short-selling restrictions on returns has been elusive for two reasons: data availability and the endogeneity of the decision to sell short. Many studies have empirically tested the proposed models, but they all had to deal with the problem of limited data availability (see, e.g., Cohen et al. (2007), Saffi and Sigurdsson (2011)). In most financial markets, lending services are provided over the counter by big custodian banks, and there is no institution that centralizes the registration of the loan contracts. This makes data aggregation virtually impossible, and many times jeopardizes the reliability of the results. Perhaps more importantly, the decision to short sell is not random. Thus, variations in both rental fees and short interest contain changes in investors' (unobserved) expectations about returns, reducing its usefulness for causal inference.

In this paper we make use of an unique dataset and an unique source of exogenous variation in equity loan fees and short interest in order to measure the causal impact on short-selling restrictions on returns. In Brazil, during the 2010-2013 period there were large spikes in stock loan activities on days surrounding (certain type of) dividends record date, due to a tax arbitrage operation involving equity loans to domestic mutual funds, who are exempt from income taxation on this type of dividends. The increased loan activity caused by tax arbitrage opportunities restricted the supply of loans on those days. Thus, they provide a quasi-natural experiment of exogenous variation in availability of equity loans for short-

[1] e.g. Harrison and Kreps (1978), Diamond and Verrecchia (1987), Duffie, Garleanu, and Pedersen (2002), Scheinkman and Xiong (2003), Hong and Stein (2003), Hong, Scheinkman, and Xiong (2006)

[2] e.g. Chen, Hong, and Stein (2002), Asquith, Pathak, and Ritter (2005), Cohen, Diether, and Malloy (2007), Saffi and Sigurdsson (2011), Beber and Pagano (2013), Boehmer, Jones, and Zhang (2013), De-Losso, Genaro, and Giovannetti (2013), Kaplan, Moskowitz, and Sensoy (2013), Prado, Saffi, and Sturgess (2014)

[3] Boehme, Danielsen, and Sorescu (2006), Desai, Ramesh, Thiagarajan, and Balachandran (2002), Nagel (2005)

[4] e.g. Chen et al. (2002), Asquith et al. (2005), Cohen et al. (2007), De-Losso et al. (2013), Prado et al. (2014)

selling in the spot market. Our result show that the increased short-selling restrictions around (certain type of) dividends register day cause an increase in the stock price, corroborating the effect predicted by Miller (1977).

The Brazilian security lending market provides an unique opportunity to circumvent the difficulties with data and identification. In Brazil the rental market take place in a centralized platform in the only stock exchange presently operating in Brazil - the BM&FBovespa. Thus, we observe all rental transactions, which mitigates possible biases due to selective data availability. We also observe the type of investor transacting, which allows us to distinguish between stock loan transactions motivated by tax arbitrage and by the desire to be short in stock.

We take advantage of a natural experiment that is provided by the opportunity to avoid income taxation. In Brazil firms may issue two types of dividends. They prefer to issue IoNE (literally meaning interest on net equity) type dividends, whose recipients are subject to a 15-percent tax rate on income.[5] However, domestic mutual funds are exempt from taxation on the IoNE dividends they receive. If an individual investor (retail or foreign) lends a stock to a domestic mutual fund during the IoNE dividend register day, the mutual fund will receive the full dividend but will return to the lender the stock plus the dividend payment net of the taxes the investor would pay. Thus, the fund keeps the tax amount for itself. Typically, lending fees spike sharply during events of IoNE dividend distribution, implying that lender appropriates part of the tax savings. The mean lending fee in stock loan transactions jumps fivefold, from an average of 2% of the notional value in normal periods to 10% in periods of IoNE distribution. The short interest jumps from 1.6% to 3.6%.

The supply shock can be tantamount to a short-selling restriction because it could make short-selling for speculative reasons all but unprofitable. This is the first part of our empirical strategy. We use daily variation to associate the event of IoNE dividend distribution to abnormal returns, a reduced-form object. We find that in a typical ten-day event window around the distribution of IoNE, the stock experience an average of 69 bps abnormal return (see Figure 8).

The mean increase in fees is very large, but there is considerable variation in the supply shock across events. Because we observe the identity of the parties in the transaction, we can compute the increase in fees across transaction which are not driven by tax arbitrage. We call this increase in fees the non-arbitrage increase in fees. Thus, we have a direct quantitative measure of the size of the supply shock for each event. We associate this direct measure

[5]The other type of dividends is tax exempt. Therefore it does not generate any tax arbitrage.

of the magnitude of the supply shock to abnormal returns. We do not associate abnormal returns to all the variation in the increase in lending fees in non-arbitrage transactions because variations in those fees could also reflect changes in demand for loans for speculative reasons. We use only variation in the increase in fees in non-arbitrage transactions that is explained by the increase in fees and by the short-interest in arbitrage transactions. In summary, we estimate the causal impact of lending fees on returns.

Why is this a legitimate source of exogenous variation? On average across events, both the short-interest and the lending fees in arbitrage transactions increase sharply because of the tax arbitrage opportunity. But we go farther and explore the fact that in some cases the spike is stronger than in others cases. As expected, the amount of IoNE dividends determines the increase in lending fees and the amount of short-interest in arbitrage transactions. If the amount of IoNE dividends contains information about the value of the firm, then the instruments would not be valid. Companies distribute IoNE up to the legal limit because it entails a 15-percent tax rate instead of rate that is almost always higher than 15% [6]. They are also required to distribute a minimum of 25% of profits. They distribute the common form of dividends only if the upper bound of IoNE dividends is not large enough. Thus, in practice the amount of IoNE dividends is determined deterministically by the amount of earnings, which is announced earlier, outside our window of analysis. In summary, the high frequency of the data helps identification.

The empirical literature has dealt with the problem of the endogeneity of short-selling restrictions with varying degrees of success. Saffi and Sigurdsson (2011) explore a panel of stocks and associate lending supply and fees to several measures of price efficiency, such as bid-ask spreads. Their panel strategy with fixed-effects and a long time-series accounts for a large fraction of variation. However, it is not possible to guarantee that unobserved (to the econometrician) shocks are not driving simultaneously both returns (or bid-ask spreads) and fees or lending supply. In fact, results in earlier papers showed that short-interest predicted negative future abnormal returns, suggestive that it has informational content (Cohen et al. (2007); Figlewski (1981). This presents a challenge to any identification strategy that the relationship between equilibrium short-interest and returns as a measure of short-selling restrictions.

Boehmer et al. (2013) explores the short-sale ban of 2008 of more than 1,000 stocks, and find no price bump for these stocks. Their identification strategy is matching banned stocks with similar stocks that never suffered the ban. Matching is an adequate procedure to

[6] For the companies in our sample, the corporate tax rate is 15% plus 10% multiplied by the difference between annual earnings and R$240,000 (or U$95,000), which amounts to a corporate tax rate of almost 25%.

account for observed heterogeneity, but the decision to ban short-selling of some particular stocks is not random. Arguably, regulators were particularly concerned about supporting the prices of those stocks. In this case, it may be that regulators had information - unavailable to the econometrician - and thus not captured in the matching procedure. Cohen et al. (2007) choose a different strategy. They postulate that increases in fees associated with increases in lending indicate a (net) increase in the demand for shorting. Increases in fees coupled with reductions in lending represent a supply shock. If supply shocks are due to institutional changes, their impact on returns would be a test of the Miller hypothesis. But this assumes implicitly that supply shocks do not themselves contain any information about the returns, which in many settings can be a strong assumption.

Kaplan et al. (2013) perform a field experiment, randomly increasing the supply of stocks available for lending by a particular money manager. They find almost no impact on outcome variables such as returns and bid-ask spreads. Experimental data provides convincing exogenous variation. But the size of the supply shock, large as the variation in relative supply of the money manager for these stocks, may be too small to produce a quantitatively relevant impact. Finally, De-Losso et al. (2013) explore the same Brazilian data that we do, associate supply shocks with overpricing. They define a supply shock the same way Cohen et al. (2007) do, with the advantage of observing the size of supply shock for each stock, not a qualitative indicator of an increase in fees coupled with a reduction in lending (the supply shock in Cohen et al. (2007)). Similarly to Cohen et al. (2007), this identification strategy works only if the decision to change the supply is driven solely by factors other than opinions on the stock value - a strong assumption.

In some sense Thornock (2013) is the closest work to ours. He also finds that dividend payments adversely affects the equity loan market, leading to an increase in loan fees and a reduction in short-interest. He attributes the effect to two mechanism. For certain types of investors is costly to lend since their dividends would loose the qualified status and would be subject to higher tax rates. As in our case, the effect on the equity loan market occurs on the register day. The other reason for not lending around dividend events is the incomplete price-drop at the ex-date. This should affect the equity loan market at the ex-date instead of the register date. He also documents that there exists overpricing around dividend payments at the ex-date. However, this can be confounded with the incomplete price drot at the same date. Furthermore, there is no clean identification strategy to sort out whether the overpricing causes the restriction in the stock loan market - since it will be less profitable to sell short - or if it is caused by the stock loan market restriction.

We move one step forward relative to the empirical literature. We find a clear source of

exogenous source of variation in lending fees (and in the supply of stocks for lending), which has two major advantages. First, we do not rely on assuming that non-observables are not systematically related to variation in lending fees, an implicit assumption in both Saffi and Sigurdsson (2011) and Boehmer et al. (2013). We also do not need to assume that supply shocks are not driven by expectations on the stock returns, an implicit assumption in Cohen et al. (2007) and De-Losso et al. (2013). We have much larger shocks than Kaplan et al. (2013), which may explain the difference between our results and theirs. Differently from Kaplan et al. (2013), Cohen et al. (2007) and De-Losso et al. (2013), we find an impact of short-selling restrictions on the most liquid stocks in the IBOVESPA index. This is a strong result because the literature suggests that short-selling restrictions have a weaker impact on liquid stocks Cohen et al. (2007).

The plan for the rest of the paper is as follows. In the next section gives an overview of the market for stock loans in Brazil. In section III we explain the tax arbitrage opportunity that impacts the loan market in the period surrounding the IoNE payment dates. In section IV we describe the data used for the paper. The following section we present our identification strategy. The results are analyzed in section VI. The last section concludes.

II. Stock Loan Market in Brazil

Similarly to other countries, the loan market in Brazil is mostly over-the-counter (OTC), i.e., parties match through a non-centralized market. Lenders may also use a system in which submitted offers are publicly displayed to all market participants, and traded in a transparent and centralized format. Centralized trading represented only a small fraction of all loan trades from January 2007 to June 2013 [7]. In both cases, and differently from other countries, all loan contracts must be registered in the Brazilian stock exchange, BM&FBovespa. BM&FBovespa acts both as a clearing. It guarantees all loan contracts, and keeps track of the collateral of the contract.

A typical lending operation involves the exchange and four different participants: the lender, the borrower, the lender's broker and the borrower's broker. The diagram bellow illustrates a typical loan contract:

[7] Some brokers estimate that the order of magnitude is about 1%.

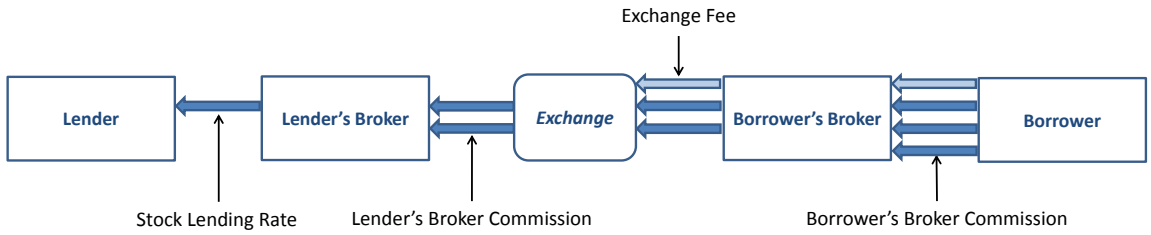


Figure 1. Loan market diagram: typical contract

The cost to borrow an stock is then the loan fee (which includes both brokers commission fees), plus an exchange fee of 0.25% annually.

Table I has some summary statistics about the Brazilian equity loan market between 2007 and 2013. In this period, the annual volume growth of the flow of equity loans was 23.5%, while the average loan fee dropped by 43 basis points (bps) per year. On the lending side, retail investors, domestic mutual funds and foreign investors represent together approximately 90% of the market. Borrowers are mostly domestic mutual funds (56.7%) and foreign investors (27,8%)

Table I. Summary Statistics: Brazilian Equity Loan Market

Year	Num. Stocks	Volume (BRL$ bi)	Volume (US$ bi)	Median Fee (%)	Average Short-Interest(%)
2007	323	272.473	142.106	5	0.611
2008	313	303.505	174.568	3.655	0.540
2009	323	258.912	137.483	2.850	0.365
2010	346	465.605	265.892	2.990	0.427
2011	353	732.750	436.302	2.842	0.675
2012	330	785.927	405.854	2.252	0.849
2013 (until June)	294	500.269	246.665	2.148	1.236

Number of stocks is the number of different shares traded in stock loan market in a certain year. Volume is the financial volume, price times number of shares, of all stocks lent. Average fee is the mean of stocks daily loan fee, while daily loan fee is a value weighted average loan fee each day for each stock that accounts for the lenders fee and commissions fees. Short-interest is number of shares held in loan contracts normalized by the total number of shares outstanding, this measure is calculated daily for each stock and the average presented is the simple mean.

Figure 2 depicts the distribution of the annual average loan fees for each stock between January 2007 and June 2013. Fees are quite high in Brazil relative to more mature markets. Roughly 20% of the fees charged are higher than 6%. Nevertheless, the lending market is rapidly resembling a more normally functioning market. Figure 2 and the median fee reported in Table I show that not only the median fee is dropping, but the whole distribution is shifting to the left.

Figure 2. Distribution of Loan Fees By Firms by Year

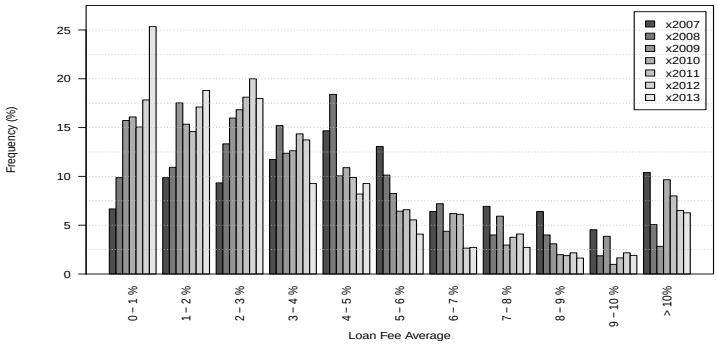


Figure shows the distribution of the average daily value-weighted loan fees in percentage points per year between January 2007 and June 2013. The vertical axis shows the frequency of firms with loan fees in the interval reported on the horizontal axis.

III. The Tax Arbitrage

Over the last 6 years, a tax arbitrage opportunity involving equity loans had important effect in the equity loan market, causing spikes in both short interest and loan fees around the IoNE payout date. The opportunity appears during IoNE dividend payout, which is subject to an income tax of 15%. However, domestic mutual funds are exempt.

Brazilian firms distribute profits to its shareholders through common dividends and IoNE dividends. The IoNE dividend was established in 1995 with the stated goal of incentivizing capitalization. The main difference between common dividend payments and IoNE dividends is the tax treatment. Corporate taxable income is reduced by the distribution of IoNE dividends, but shareholders pay a 15% tax rate. Common dividends are not deducted from the corporate taxable income but recipient shareholders are exempt. In Brazil the law requires the distribution of a minimum of 25% of profits. The firms prefer to pay IoNE type of dividends. But there is a limit, that is the minimum between the net worth times the Long-Term Interest Rate (a prime rate determined by the federal government), 50% of the current period earnings before corporate taxes, and 50% of the accumulated earnings and reserves in previous periods.

Almost all companies in our sample operate under the so-called Real Income regime. The Real Income regime is progressive. Companies pay a 15% tax rate on annual incomes up to BRL 240,000.00, approximately US$89,000.00; above this threshold companies pay an additional 15% surcharge. Almost all companies in our sample have annual income well above the threshold. The tax rate is then about 24% for those companies. In contrast, the tax rate

on IoNE dividends is 15%. Thus, when corporations choose to distribute, they almost always distribute through IoNE up to the legal. Very often they choose to distribute the minimum of 25% of profits.

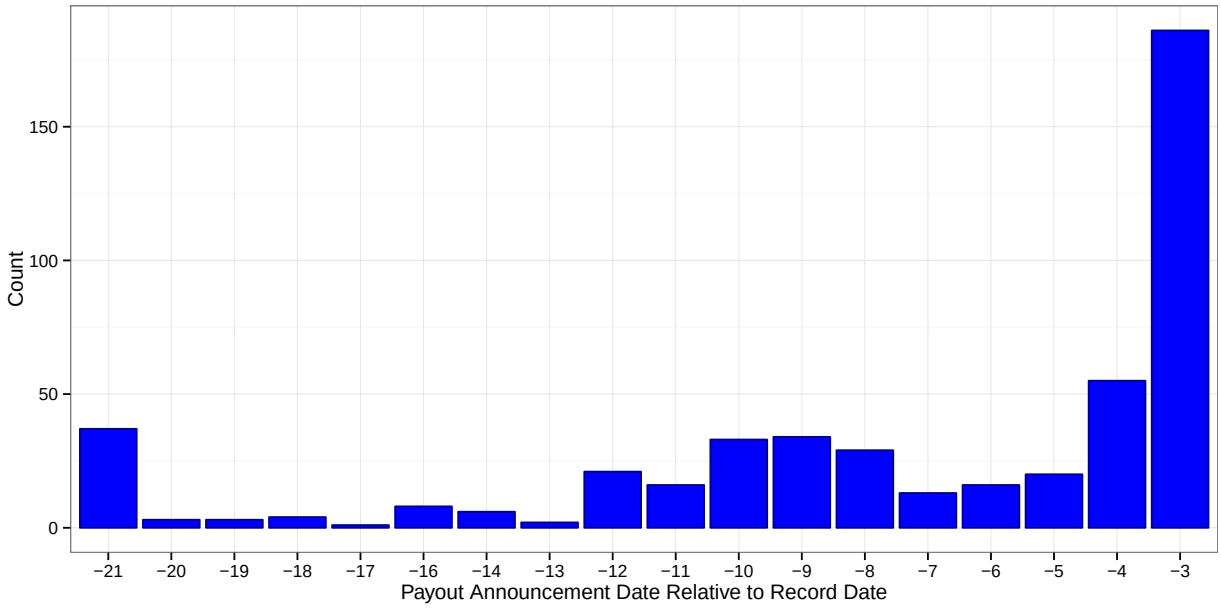
Mutual fund are exempt from the 15% tax on IoNE dividends. The difference in tax treatment generates a tax arbitrage, which consists on retail and foreign investors lending stocks to mutual funds at the time a tax payment would be due. During the loan contract, ownership belongs to the borrower; if IoNE dividend is distributed during a loan contract, the applicable tax status is the borrower's. A mutual fund will receive the IoNE dividend in its entirety, without tax withholding. When the loan contract is liquidated the fund must reimburse the lender the payout payment he would receive if he had the stock custody, that is, the after-tax IoNE dividend. The incentives for the lending activity around IoNE payouts are clear: retail and foreign investors, and domestic mutual funds can split 15% of the IoNE payment. Retail and foreign investors appropriate their share through the spikes in lending fees.

Figure 3 depicts the flowchart of important dates for the tax arbitrage. The first date is the earning announcements, an official public statement of a company's profitability for a specific time period, typically a quarter or a year. Based on the earning announcements and the company's distribution policy, the investors can anticipate the amount of payouts in the form of dividends and IoNE. The earnings announcements usually cluster around the results' season. The second date is the payout announcement, on which the next IoNE payment is announced, as well as the IoNE's value per share, ex-date date and payment dates. There is not a fixed period after the earning announcement date, but the payout announcement usually takes place a month after the earnings' announcement. The next is the ex-date. Stocks traded on or after the ex-date do not receive the announced IoNE. typically, the ex-date is at least one business day after the payout announcement. The record date is the date established by an issuer of a security for the purpose of determining the holders who are entitled to receive a dividend or distribution. Normally, there is a three-business-day period between the cum-date and the record date.[8] Finally, the payment date, which varies considerably.

The record date is then the crucial date to the tax arbitrage opportunity. It is the day on which the tax exempt investor must hold the stock and the dividend is *recorded* under her name. Thus, we consider to be an arbitrage contract any loan contract that has three characteristics: 1) the lender is not a domestic mutual fund and borrower is a domestic

[8]Liquidation takes place in three business days.

Figure 4. Payout Announcement



mutual fund; 2) it takes place the day or right before the record date; 3) it is liquidated after the record date.

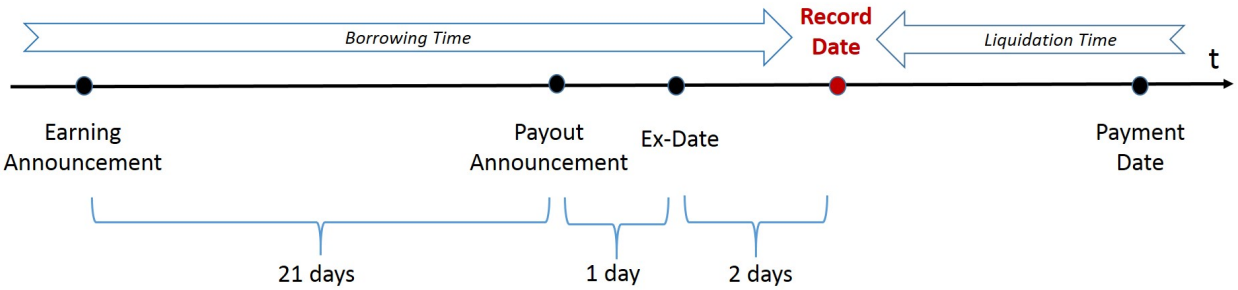


Figure 3. Typical dates flowchart for the IoNE dividend event.

As expected, loan fee increase sharply during the IoNE dividend event. Figure 5 depicts the dynamics over the 42 trading days around the IoNE dividend event. Between 21 and 9 before the event, fee oscillate around 2.2%. Then it starts going up, reaching an impressive 10% at the record date. Quite interestingly, most the the increase in fees occurs during the three-day period between the announcement date and the record date, exactly when one would expect.

Figure 5. Loan Fee around Record Date of an IoNE dividend event

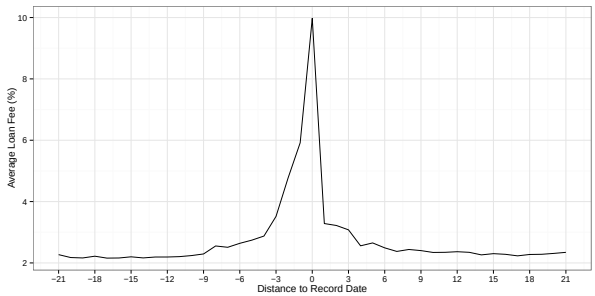
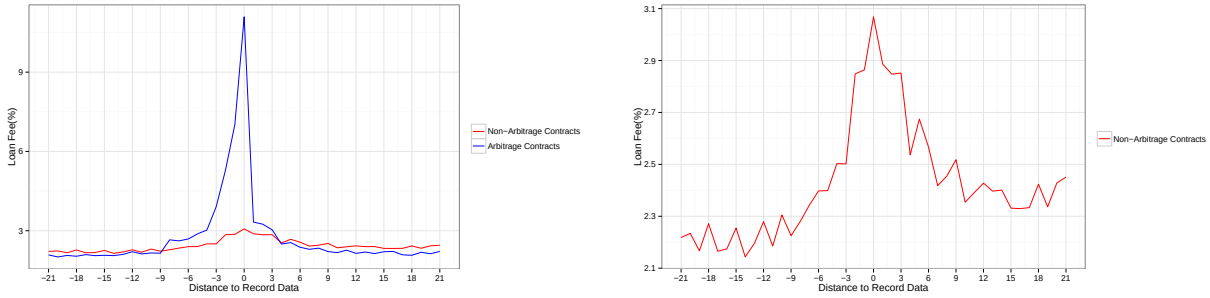


Figure shows the average loan fee around the record date of the IoNE dividend event. The daily loan fee for each share is the value weighed fee among all contracts in a certain day. The average loan fee is the common mean among shares. We consider 487 IoNE dividend events from January 2010 until June 2013.

Non-arbitrage contracts fees also go up. Figure 6 depicts the dynamics of loan fees separately for arbitrage and non-arbitrage contracts. As expected, the loan fee for arbitrage contracts increase much more, from 2.0% 21 days before the IoNE's record date to 11.1% at the record date. But non-arbitrage loan fee also increase significantly, from 2.2% from to 3.06%, a 40% increase.

Figure 6. Loan Fee around Record Date of an IoNE dividend event by Groups



(a) Loan Fee for Groups of Contracts (b) Loan Fee for Non-Arbitrage Contracts

Arbitrage loan contracts are the ones that have tax benefits - i.e, borrowers are mutual funds and lenders are retail investors or foreign investors that took place before the record date and were liquidated after it. Non-Arbitrage contracts are the other contracts. We define the daily loan fee as the value weighed average loan fee for each stock and each day around the IoNE date. The figure shows the average loan fee among all stocks for each day around the IoNE record date.

Figure 7 depicts the dynamics of the short-interest around the event. Twenty-one days business days before IoNE record the average short-interest is 1.6%, increasing to 3.6% on

the record date. In contrast, short-interest on non-arbitrage contracts drop, from an average of 1.83% to 1.31%. This 28.4% decrease in short-interest, along with a 40% spike in loan fees, suggests that the lending market for non-arbitrage reasons becomes very tight around IoNE dividend events.

Figure 7. Short-Interest around Record Date of an IoNE Event

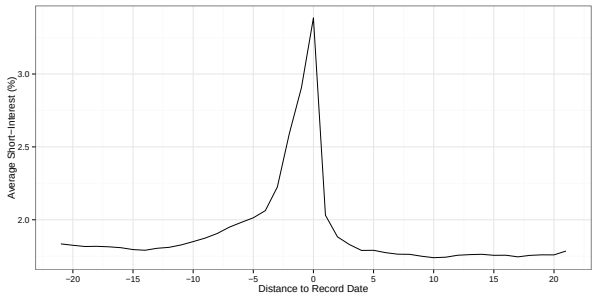
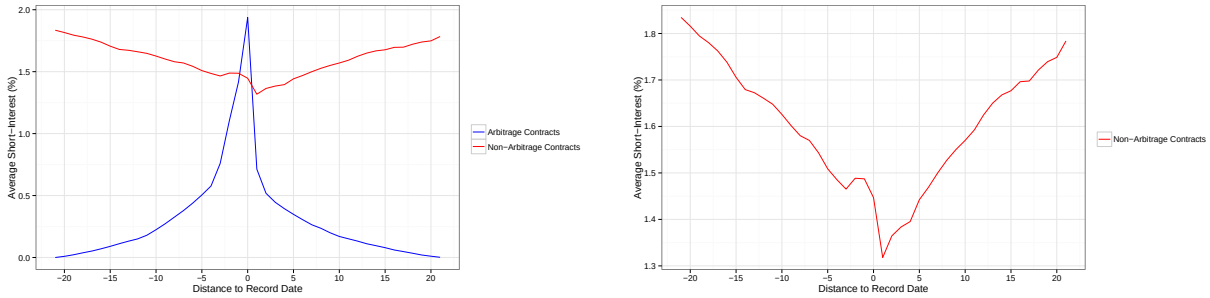


Figure shows the average short-interest around the record date of the IoNE dividend event. The average short-interest is the common mean among shares. We consider 487 IoNE dividend events from January 2010 until June 2013.

Figure 8. Short Interest around Record Date of an IoNE dividend event by Groups



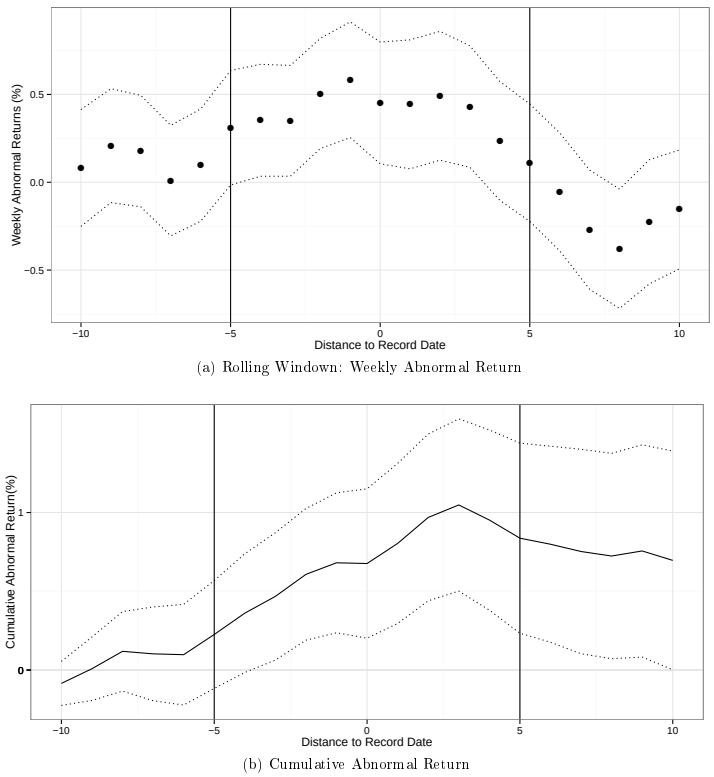
(a) Short Interest for Groups of Contracts (b) Loan Fee for Non-Arbitrage Contracts

Arbitrage loan contracts are the ones that have tax benefits - i.e, borrowers are mutual funds and lenders are retail investors or foreign investors that took place before the record date and were liquidated after it. Non-Arbitrage contracts are the other contracts. We define the daily loan fee as the value weighed average loan fee for each stock and each day around the IoNE date. The figure shows average short interest among stocks for each day around the IoNE dividend record date.

Events in the lending market may spillover into the spot market. We perform an event study to calculate the abnormal returns around the IoNE dividend record date. Figure 10(a) depicts the abnormal return accumulated for the 5 trading-days prior to the record. Stocks

with IoNE have a 50bps abnormal return (significant at 5% level). Inspection of Figure 10(b) shows that the positive abnormal return persists a little after IoNE record date.

Figure 9. Abnormal Returns around the IoNE Date



(a) Rolling Windown: Weekly Abnormal Return

(b) Cumulative Abnormal Return

Abnormal return is calculated as the stock return minus the stock loading on the market portfolio IBX50, that accounts for the first 50 biggest stocks in market capitalization. For each IoNE data and stock we calculate the loading on he IBRX50 using returns the daily interval [-126,-21) U (22,126]. Our event window is 21 days before and after an IoNE dividend record date. (a) shows the average (past week - $r_{t-4,t}$) abnormal return for each day around the record day of the IoNE, while (b) accumulates the abnormal from the 21 days before the IoNE dividend record date until 21 days after. The dotted line is the 95% percent confidence interval.

IV. Data

BM&FBovespa keeps detailed records of all transaction. We observe the whole process: offers, contracts, and liquidation. We also observe information about investors, brokers, and maturity.

Our data run from January 2010 to June 2013. We use the following variables: contract date, liquidation date, loan fee, quantity of shares and final investor type. We combine it with the Radar dataset, which contain information about payout events. Merging the two datasets allows us to identify loan contracts that are eligible for tax arbitrage, which we call *arbitrage contracts* as described above.

Information on stocks returns and volume are from Economática, the Brazilian equivalent of the Compustat. The abnormal return is the stock return adjusted by its exposure to the market portfolio, measured by the IBX50 [9]. For each IoNE event, we calculate the abnormal return in the 21-day windows before and after an IoNE event. For estimating the exposure to the market portfolio we use a one calendar year window around the event[10] We are ultimately interested in associating abnormal returns to the IoNE dividend. Thus, prudence requires that we take a conservative stance, and use stock prices net of the IoNE dividends:

$$r_{t,t+1} = log\left(\frac{P_{t+1} + 0.85 * IoNE_{t+1}}{P_t}\right)$$

The loan fee for a given stock an a given day is the value-weighted average fee of loan contracts that took place that day. The ΔFee is the difference between the loan fee inside and outside of the event. Inside the event means within 5 trading days of the record date. Outside means belonging to the interval $[-21, -17] \cup [17, 21]$, where 0 is the IoNE record date. We only count as arbitrage contracts those that took place within the 5 trading days of the record day.

There are also criteria for an IoNE dividend event to be included in the sample. There must be arbitrage contracts that started in the five days before the record date of the event. The stock must have valid abnormal returns in the event window, as well as turnover data for the last 21 days before the record date. We do not consider stocks that have more than three months without transaction in the the loan market in out sample. We are left with 391 IoNE events for 59 different stocks. For robustness purposes, we also implement tougher filter on stock liquidity. Stocks in the main sample represent roughly 70% of BM&FBovespa market capitalization. Table II contains the summary statistics for those events.

Summary statistics hint at our main results. Stocks show an average 0.691 percentage point abnormal return over a 11-trading-day period around the IoNE dividend event, but with a very large variation. Total short-interest increase drastically. Fees on arbitrage contracts

[9] The index is value weighted and accounts for the first 50 biggest stocks in market capitalization

[10] We exclude stocks that: 1) had no valid prices for less than half a calendar year within the estimation window; 2) do not have valid prices in the event window.

increase sixfold, reflecting the fact that lender appropriate part of tax arbitrage. Fees on non-arbitrage contract also increase significantly, more than 68%. The amount of IoNe dividend distributed is roughly 0.9% of the companies' market cap.

Table II. Summary Statistics for Arbitrage Contracts

	mean	min	median	max	std.dev	obs.
Abnormal Return ($r_{\tau-2,\tau+5}$)	0.321	-13.044	0.514	18.942	4.619	391
Arbitrage Short-Interest (%)	1.244	0.0003	0.732	13.307	1.561	391
Arbitrage ΔFee	6.382	-0.675	1.368	74.075	11.353	391
Non-Arbitrage ΔFee	0.684	-0.851	0.096	17.188	1.872	391
IoNE	0.934	0.013	0.663	15.724	1.303	391
Turnover	0.344	0.009	0.269	1.698	0.262	391
Median Fee	1.925	0.279	1.684	15.552	1.814	391
Liquidity	1.215	0.013	0.564	10.965	1.700	391

Abnormal returns are the cumulative abnormal return from 2 days before the record date of the event until 5 days after it. Abnormal return is calculated as the stock return adjusted by the stock loading on the IBX50 stock index. For each IoNE dividend event we calculate the abnormal return in the event window of 21 days before and after an IoNE dividend event. The estimation window for the stock exposition is given by the 126 days before and after the event. Arbitrage loan contracts are the ones that generated tax benefits - i.e, borrowers are mutual funds and lenders are retail investors or foreign investors - and took place in the 5 days window before the IoNE dividend event . Arbitrage Short-Interest is the total shares involved in arbitrage loan contracts divided by the total shares outstanding in the record day. Arbitrage ΔFee is the relative loan fee increase during the IoNE dividend window for arbitrage contracts. Non-Arbitrage ΔFee is the relative loan fee increase during the IoNE dividend window for non-arbitrage contracts. IoNE is the IoNE dividend value as as a percentage of the ex-date price. Turnover is the average daily turnover in the 30 days before the IoNE dividend event. The daily turnover is the traded volume in a day normalized by the market capitalization. Median loan is the average median of daily loan, median loan fee for each stock in the whole sample median. Liquidity is defined in equation 1.

Table III. Summary Statistics for Arbitrage Contracts

	mean	min	median	max	std.dev	obs.
Abnormal Return ($r_{\tau-5,\tau+5}$)	0.691	-15.844	0.519	17.998	5.113	391
Arbitrage Short-Interest (%)	1.244	0.0003	0.732	13.307	1.561	391
Arbitrage ΔFee	6.382	-0.675	1.368	74.075	11.353	391
Non-Arbitrage ΔFee	0.684	-0.851	0.096	17.188	1.872	391
IoNE	0.934	0.013	0.663	15.724	1.303	391
Turnover	0.344	0.009	0.269	1.698	0.262	391
Median Fee	1.925	0.279	1.684	15.552	1.814	391
Liquidity	1.215	0.013	0.564	10.965	1.700	391

Abnormal returns are the cumulative abnormal return from 5 days before the record date of the event until 5 days after it. Abnormal return is calculated as the stock return adjusted by the stock loading on the IBX50 stock index. For each IoNE dividend event we calculate the abnormal return in the event window of 21 days before and after an IoNE dividend event. The estimation window for the stock exposition is given by the 126 days before and after the event. Arbitrage loan contracts are the ones that generated tax benefits - i.e, borrowers are mutual funds and lenders are retail investors or foreign investors - and took place in the 5 days window before the IoNE dividend event . Arbitrage Short-Interest is the total shares involved in arbitrage loan contracts divided by the total shares outstanding in the record day. Arbitrage ΔFee is the relative loan fee increase during the IoNE window for arbitrage contracts. Non-Arbitrage ΔFee is the relative loan fee increase during the IoNE dividend window for non-arbitrage contracts. IoNE is the IoNE dividend value as as a percentage of the ex-date price. Turnover is the average daily turnover in the 30 days before the IoNE dividend event. The daily turnover is the traded volume in a day normalized by the market capitalization. Median loan is the average median of daily loan, median loan fee for each stock in the whole sample median. Liquidity is defined in equation 1.

V. Identification Strategy

The events of IoNE dividend distribution are the source of exogenous variation to estimate the causal impact of short-selling restrictions on returns. Entitlement over the distribution

of the IoNE dividend is determined by the ownership of the stock at the date of the actual distribution. In other words, the IoNE dividend accrues to whomever holds the stock when the IoNE is distributed.

As explained above, the tax arbitrage operation consists of individuals lending the stock to mutual funds. Figure 6 shows a sharp increase in fees in lending transaction from individuals to mutual fund respond around the events of IoNE distribution. Figure 7 depicts a sharp increase in short-interest. Fees in lending transactions from individuals to mutual funds start to increase around fifteen trading days before the event. They spike sharply a few days before the event, reaching a peak the day prior to the event, and then dropping sharply after the event but still maintaining historically high levels for the next 10 days after the event, returning to normal levels only after about 18 trading days passed the event. On average, lending fees increased fivefold and short-interest more than doubled during the events of IoNE dividend distribution.

Fees in lending transactions that do not generate the tax arbitrage opportunity - we call them non-arbitrage transaction - follow the same dynamics around the event, but less intensively. Fees on non-arbitrage transactions increase from an average of 2.20% to 3.06%,an increase of almost 40% at the height of event. The non-arbitrage lending market suffers a negative supply shock of stocks available due to the use of stocks in arbitrage transactions, i.e., from individuals to mutual funds. Under certain identification assumptions, the changes in lending fees and short-interest on arbitrage transactions provide exogenous variation on short-selling restrictions because issuing a negative opinion on the stock by short-selling becomes momentarily more expensive.

We show that the magnitude in the increase in fees in non-arbitrage transactions is strongly associated with the increases in fees and short-interest in the arbitrage transactions (the first-stage). The identification assumption is that the magnitudes of the increases in fees and short-interest in arbitrage transactions are exogenous to the short-selling market. In this case, variations in non-arbitrage transactions fees are tantamount to experimental variation in short-selling restrictions. In some events the increase in short-selling restrictions are steeper than others for random reasons. In other words, changes in fees and short-interest in arbitrage transaction are instruments to changes in fees in non-arbitrage transactions. One may argue that prices (lending fees) and quantities (the amount of stocks lent in arbitrage transactions) capture the same phenomenon, and thus are only one instrument. We take an agnostic stand and verify in the first stage whether one instrument contributes to explaining the endogenous variable (lending fees in arbitrage transactions) above and beyond other. Evidently, the additional payoff in terms of stronger first stage is important. But more

importantly, having two instruments allows us to test whether the model is overidentified.

We argue that it is reasonable to assume that changes in fees and short-interest in arbitrage transactions are exogenous. We regress the magnitudes of the increases in arbitrage short-interest and fee on several covariates. Table IV has the results. In a nutshell, the increase in arbitrage fees and, to a lesser extent, in arbitrage short-interest is determined by the amount of IoNE dividend distribution. This is expected because the amount of IoNE dividend determines the size of the pie to appropriated in the tax arbitrage procedure. The share of the pie appropriated by the lender is materialized by the increase in lending fees in arbitrage transactions. The formal announcement of the amount of IoNE dividend distribution is made within 3 days of the event. Thus, if the size of the IoNE dividend signals something about the value of the firm, then our identification strategy is not valid.

Table IV. Instrument Regressions

	Dependent variable:			
	Arbitrage Short-Interest		Arbitrage Δfee	
	(1)	(2)	(3)	(4)
IoNE	0.312	0.210*	7.363**	6.874**
	(0.193)	(0.123)	(3.289)	(2.830)
Turnover		1.684		7.566
		(1.088)		(11.553)
Median Loan Fee		0.065		−0.316
		(0.170)		(1.227)
Median Short-Interest		−0.190**		−3.503***
		(0.089)		(1.059)
Constant	1.304***	0.672*	6.530**	7.681*
	(0.231)	(0.379)	(2.556)	(4.258)
Observations	391	391	391	391
R^2	0.046	0.229	0.230	0.340
Adjusted R^2	0.044	0.221	0.228	0.333

Robust standard errors clustered at the ticker level in parentheses. Observations weighted by the stock liquidity. Arbitrage Short-Interest is the total shares involved in arbitrage loan contracts divided by the total shares outstanding in the record day. Arbitrage ΔFee is the relative loan fee increase during the IoNE dividend window for arbitrage contracts. Non-Arbitrage ΔFee is the relative loan fee increase during the IoNE window for non-arbitrage contracts. IoNE is the IoNE dividend value as a percentage of the ex-date price. Turnover is the average daily turnover in the 21 days before the IoNE dividend event. Median loan is the average median of daily loan, median loan fee for each stock in the whole sample median. Liquidity is defined in equation 1.
$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Several facts suggest that the size of the distribution of IoNE dividends contains no information about the value of the firm. Quite simply, although the formal announcement is within the event window, in practice the amount of IoNE dividends is known when earnings are announced, which is outside the window of the events. Shareholders dividends are tax free. IoNE pays 15% (the taxation on interest). For companies in the sample, the corporate tax rate on earnings is at least 24%. Companies almost always distribute the legal allowed maximum in IoNE dividends. [11]

[11] There are two legal limits. One is the minimum payout, which can be common dividends or IoNE dividends. Given an amount distributed, companies try to maximize the proportion of IoNE dividends. One

Stocks' liquidity in the spot market vary a lot in our sample. Information from abnormal returns coming from less liquid stocks is much less informative than observations from more liquid stocks. There are different ways to deal with this issue, all of them containing some degree of arbitrariness. As described above, we start out by imposing a soft filter to eliminate event or stocks which we know contain no useful information at all. But we do not want to impose very tough filter because we loose too many observations. One solution it to add a Weighted Least Squares procedure that gives from weight to the information coming from more liquid stocks. More precisely, we weight observations by the stock liquidity because the variance of abnormal returns is inversely related to liquidity. Liquidity is measured as:

$$Liquidity = 100 * p/N * sqrt(n/N * v/V) \tag{1}$$

where p is the period in business days - we chose one month period, 21 business days-, n is the number of trades of the stock in the period p, N is the number of total trades in the exchange in period p, v is the monetary value of all trades of the stock in period p and V is the total volume of trades in the exchange in period p.

Ou weighting procedure not only makes sense theoretically, but has support in the data. To show this, we estimate the reduced-form regression of accumulated returns (from -5 to +5 trading days around the event) on exogenous variables:

$$\begin{aligned} Return_e = \beta_0 + \beta_1 Liquidity_e + \beta_2 ArbShortInt_e + \beta_3 \Delta ArbFee_e + \\ \beta_4 IoNE_e + \beta_5 Turnover_e + \beta_6 MedianLoanFee_s + \epsilon_e \end{aligned} \tag{2}$$

The subscript e is an event. *Liquidity* is defined in equation 1, *ArbShortInt* is the total shares involved on arbitrage contracts normalized the total shares outstanding, $\Delta ArbFee$ is the change in the lending fee on arbitrage transactions, $IoNE$ is the IoNE dividend per share normalized by the ex-date price, $Turnover$ is the average daily turnover of the stock in the last month before the record date of the IoNE, and $MedianFee$ is the median fee on lending transactions. We take the residuals in 2, and square then to have a proxy of the variance of the abnormal return conditional on exogenous variables. Finally, we regress the squared residuals on the same exogenous variables in (2).

limit to IoNE dividend distribution is given by net worth times the Long-Term Interest Rate, a prime rate determined by the federal government; this value is limited to the maximum of 50% of the current period earnings before corporate taxes, and 50% of the accumulated earnings and reserves in previous periods.

Table V. Volatility Model

	Dependent variable:	
	Squared Residuals of Equation (2)	
	(1)	(2)
Liquidity	-4.209^{***}	-4.867^{***}
	(0.989)	(1.553)
Arbitrage Short Interest		0.537
		(1.958)
Δ Arbitrage Fee		-0.458
		(0.636)
IoNE		2.639
		(3.641)
Turnover		27.875
		(17.009)
Median Loan Fee		0.069
		(1.699)
Constant	31.186^{***}	19.918^{***}
	(3.444)	(4.899)
Observations	391	391
R^2	0.023	0.049
Adjusted R^2	0.020	0.035

Robust standard errors corrected for clustering at the ticker level. Regression of the squared residuals of the reduced-form on the exogenous variables. Reduced-form: $Return_e = \beta_0 + \beta_1 Liquidity_e + \beta_2 ArbShortInt_e + \beta_3 \Delta ArbFee_e + \beta_4 IoNE_e + \beta_5 Turnover_e + \beta_6 MedianLoanFee_s + u_e$. Arbitrage Short-Interest is the total shares involved in arbitrage loan contracts divided by the total shares outstanding in the record day. Arbitrage ΔFee is the relative loan fee increase during the IoNE dividend window for arbitrage contracts. Non-Arbitrage ΔFee is the relative loan fee increase during the IoNE dividend window for non-arbitrage contracts. IoNE is the IoNE dividend value as as a percentage of the ex-date price. Turnover is the average daily turnover in the 30 days before the IoNE dividend event. Median loan is the average median of daily loan, median loan fee for each stock in the whole sample median. Liquidity is defined in equation 1.
$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Estimates in column (1) show that liquidity has a strong statistical impact on the estimated variance. In column (2) we include the other exogenous variables. The impact of liquidity is even stronger. Thus the results justify our procedure of weighting each observation by the stock liquidity index. Finally, our results do not dependent crucially on weighting

the observations by liquidity. In the robustness section, we show that the main results stand when we do not weight observations according to liquidity, although we lose precision.

The main object of interest is the impact of non-arbitrage fees on returns, which provides a measure of the impact of short-selling restrictions on returns.

$$Return_e = \alpha + \beta \Delta NonArbFee_e + Controls + u_e \tag{3}$$

where NonArbFee is the change in the fee on non-arbitrage contracts during the event. Controls include liquidity, turnover, median fee, median short interest and the IoNE dividend as a percentage of the ex-price. The excluded exogenous variables are the instruments: increases in fees and short-interest on arbitrage transactions. Excluding the instruments from (2) is equivalent to identification hypothesis. During the event, period changes in the fees and short-interest on arbitrage transactions contain no relevant information for returns.

The first stage is:

$$\begin{aligned} \Delta NonArbFee_e = \beta_0 + \beta_1 ArbShortInt_e + \beta_2 \Delta ArbFee_e + \\ Controls + \epsilon_e \end{aligned} \tag{4}$$

VI. Results

We present three sets of results. We start by presenting the results of a reduced form estimation, which documents abnormal returns during events of IoNE dividend distribution. We then show that that the increases in fees for non-arbitrage transactions are related to the increase in fees and shot-interest in arbitrage transactions, the first stage. Finally, we present structural estimates: the impact of lending fees on abnormal returns, also known as the second stage estimation.

A. Reduced Form

Table VII contains the results of the reduced-form, when we regress the cumulative returns within the event window on the instruments. In column (1) we include only the short-interest in arbitrage operations: abnormal returns are statistically related to the size of the short-interest in arbitrage transactions. The typical increase in short-interest during the event is roughly 1.24%. Using the coefficient in column (1), we find predicted abnormal returns of $1.24 \times 0.52 = 0.65$ percentage point. In column (2) we regress the abnormal returns on

the size of the increase in fees in arbitrage transactions. Again, the larger the increase in arbitrage fees, the higher are abnormal returns. The same exercise yields a 0.33 percentage point abnormal returns during the event.[12] When both instruments are included (column 3), both instruments explain abnormal retunrs. The impact during the event is roughly 0.76 percentage. Column 4 presents OLS results: regressing abnormal returns on the increase in fees in non-arbitrage transactions. We find no impact on abnormal returns of increases in fees in non-arbitrage transactions. This is not surprising because most of the variation in fees in non-arbitrage transactions is endogenous. Finally, in column 5 we include the instruments and the endogenous variable, and reach the same conclusions as in columns 3 and 4.

In summary, the reduced-form shows that the stock experience significant abnormal returns during events of IoNE distribution. No structural interpretation is warranted. In section VI.C below we report the second stage, which associates this abnormal returns with the exogenous part of the increase in non-arbitrage transactions' fees. Differently from the reduced-form, this object has a structural interpretation: an exogenous rise in the price to issue a negative opinion about the stock causes an increase in its spot price.

[12] Table II shows that the typical increase in fees in arbitrage transaction is approximately 6.38%. We multiply this by 0.052, the coefficient in column 2.

Table VI. Reduced Form Results

	Dependent variable: Cumulative Returns from -5 to 5				
	Reduced Form			OLS	
	(1)	(2)	(3)	(4)	(5)
Arbitrage Short Interest	0.521**		0.413*		0.466*
	(0.246)		(0.245)		(0.276)
Δ Arbitrage Fee		0.052***	0.040**		0.045**
		(0.018)	(0.017)		(0.018)
Δ Non-Arbitrage Fee				0.061	−0.092
				(0.110)	(0.114)
IoNE	−0.182	−0.434	−0.438	−0.123	−0.416
	(0.337)	(0.311)	(0.299)	(0.393)	(0.307)
Turnover	−2.104	−1.372	−2.130	−1.093	−2.219
	(1.608)	(1.436)	(1.440)	(1.724)	(1.421)
Median Loan Fee	0.021	0.111	0.145	−0.047	0.135
	(0.199)	(0.182)	(0.192)	(0.223)	(0.201)
Constant	1.052**	1.009**	0.818**	1.343***	0.835**
	(0.501)	(0.435)	(0.407)	(0.517)	(0.407)
Observations	391	391	391	391	391
R^2	0.035	0.033	0.049	0.010	0.052
Adjusted R^2	0.025	0.023	0.037	−0.001	0.037

Robust standard errors corrected for clustering at the ticker level. Observations are weighted by the stock liquidity. Arbitrage Short-Interest is the total shares involved in arbitrage loan contracts divided by the total shares outstanding in the record day. Arbitrage ΔFee is the relative loan fee increase during the IoNE dividend window for arbitrage contracts. Non-Arbitrage ΔFee is the relative loan fee increase during the IoNE dividend window for non-arbitrage contracts. IoNE is the IoNE dividend value as as a percentage of the ex-date price. Turnover is the average daily turnover in the 21 days before the IoNE dividend event. Median loan is the average median of daily loan, median loan fee for each stock in the whole sample median. Liquidity is defined in equation 1.
$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

B. *First Stage*

Table VIII presents the first stage results. Instruments are strongly related to the endogenous variable - the change in fees in non-arbitrage transactions. We include the two instruments - the change in fee in arbitrage transactions and the amount of short-interest - separately (columns 1 and 2). In both cases the instrument is significant at the 5% level. When included jointly, the instruments are, if anything, more significant. Thus, we have strong instruments.

Table VII. First Stage

	Dependent variable:		
	Δ Non-Arbitrage Fee		
	(1)	(2)	(3)
Arbitrage Short Interest	0.727**		0.604***
	(0.309)		(0.232)
Δ Arbitrage Fee		0.260**	0.206**
		(0.110)	(0.081)
IoNE	0.612**	−0.582	−0.428
	(0.281)	(0.508)	(0.391)
Turnover	−0.931	0.216	−0.931
	(0.986)	(0.712)	(0.817)
Median Loan Fee	−0.287***	−0.216	−0.149
	(0.089)	(0.134)	(0.105)
Constant	0.528*	0.823*	0.454
	(0.312)	(0.431)	(0.277)
Observations	391	391	391
R^2	0.230	0.215	0.285
Adjusted R^2	0.222	0.206	0.275

Robust standard errors clustered at the ticker level in parentheses. Observations weighted by the stock liquidity. Arbitrage Short-Interest is the total shares involved in arbitrage loan contracts divided by the total shares outstanding in the record day. Arbitrage ΔFee is the relative loan fee increase during the IoNE dividend window for arbitrage contracts. Non-Arbitrage ΔFee is the relative loan fee increase during the IoNE dividend window for non-arbitrage contracts. IoNE is the IoNE dividend value as as a percentage of the ex-date price. Turnover is the average daily turnover in the 30 days before the IoNE dividend event. Median loan is the average median of daily loan, median loan fee for each stock in the whole sample median. Liquidity is defined in equation 1.

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

C. Second Stage

Table X presents results for the second stage. We present three specifications, using instruments separately and jointly. The estimated coefficient for the non-arbitrage fee variation is similar across the board, ranging from 0.695 to 0.716. Our preferred estimate is 0.705 (column 3), when we use both instruments. The standard deviation of the change in the lending fee in non-arbitrage transaction across events is 1.872. Thus, a one-standard deviation increase in fees a 1.31-percent point in abnormal returns over 11 trading days. This a large yet plausible effect.

Table VIII. Instrumental Variables

	Dependent variable:		
	$r_{\tau-5,\tau+5}$		
	One Instrument: SI	One Instrument:ΔFee	Two Instruments
	(1)	(2)	(3)
Non-Arbitrage Δ fee	0.716**	0.695**	0.705***
	(0.343)	(0.324)	(0.274)
IoNE	−0.621*	−0.605**	−0.613**
	(0.327)	(0.300)	(0.278)
Turnover	−1.437	−1.426	−1.432
	(1.382)	(1.337)	(1.356)
Median Loan Fee	0.227	0.218	0.223
	(0.213)	(0.189)	(0.186)
Constant	0.673	0.696	0.684
	(0.482)	(0.524)	(0.465)
Observations	391	391	391

This table shows the estimates of equation 3. The dependent variable is the cumulative returns. ΔFee on Non-Arbitrage Transactions is instrumented by the amount of short interest in arbitrage transactions and/or by delta fee in arbitrage transactions. Robust standard errors are clustered at the ticker level . Observations are weighted by the stock liquidity. Arbitrage Short-Interest is the total shares involved in arbitrage loan contracts divided by the total shares outstanding in the record day. Arbitrage ΔFee is the relative loan fee increase during the IoNE dividend window for arbitrage contracts. Non-Arbitrage ΔFee is the relative loan fee increase during the IoNE dividend window for non-arbitrage contracts. IoNE is the IoNE dividend value as as a percentage of the ex-date price. Turnover is the average daily turnover in the 30 days before the IoNE dividend event. Median loan is the average median of daily loan, median loan fee for each stock in the whole sample median. Liquidity is defined in equation 1.
$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

We estimate the parameters in equation 3 for different periods of abnormal return accumulation, which serves as a placebo test. Figure 6 shows that loan fees on non-arbitrage transactions starting increasing nine days before the record date, possibly anticipating the IoNE event. However, the increase between -9 and -3 is small. Thus, results should be smaller if one accumulates before -3. Symmetrically, as we roll the windows away from the record date, results should also be smaller.

Table IX. Instrumental Variables: Different Periods of Accumulation

	Dependent variable:				
	$r_{\tau-15,\tau-5}$	$r_{\tau-10,\tau}$	$r_{\tau-5,\tau+5}$	$r_{\tau,\tau+10}$	$r_{\tau+5,\tau+15}$
	(1)	(2)	(3)	(4)	(5)
Non-Arbitrage Δ fee	-0.024	0.003	0.705^{***}	0.510^{*}	-0.290
	(0.174)	(0.254)	(0.274)	(0.275)	(0.264)
IoNE	-0.008	0.200	-0.613^{**}	-0.154	1.137^{***}
	(0.353)	(0.550)	(0.278)	(0.294)	(0.301)
Turnover	0.511	-0.271	-1.432	-2.060^{***}	-0.847
	(1.075)	(1.121)	(1.356)	(0.670)	(0.845)
Median Loan Fee	-0.364^{*}	-0.116	0.223	0.311^{*}	0.081
	(0.205)	(0.275)	(0.186)	(0.160)	(0.210)
Constant	0.838^{*}	0.943	0.684	-0.290	-1.069
	(0.502)	(0.598)	(0.465)	(0.394)	(0.691)
Observations	389	391	391	391	388

This table shows the estimates of equation 3. The depended variable is the cumulative returns. ΔFee on Non-Arbitrage Transactions instrumented by the amount of short interest in arbitrage transactions. Robust standard errors are clustered at the ticker level . Observations are weighted by the stock liquidity. Arbitrage Short-Interest is the total shares involved in arbitrage loan contracts divided by the total shares outstanding in the record day. Arbitrage ΔFee is the relative loan fee increase during the IoNE dividend window for arbitrage contracts. Non-Arbitrage ΔFee is the relative loan fee increase during the IoNE dividend window for non-arbitrage contracts. IoNE is the IoNE dividend value as as a percentage of the ex-date price. Turnover is the average daily turnover in the 30 days before the IoNE dividend event. Median loan is the average median of daily loan, median loan fee for each stock in the whole sample median. Liquidity is defined in equation 1.

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Table XI shows the results for different periods of accumulation. We find no impact of increases in fees on cumulated abnormal returns from 15 to 5 before the event (column 1). Nor do we find an impact when returns are cumulated from -10 to 0 (column 2). We find the strongest impact when we cumulate from five days before to five days after the event

(column 3). We also find a impact from 0 to 10 after the even, but smaller than in column 3. We find no impact when we cumulate away from the event, from 5 days to 15 after the event. All results in Table XI are in line with with the pattern in Figure 6.

VII. Robustness

In this section we present several robustness exercises. First, Table XII shows the results when we apply a stricter spot-market liquidity filter but not weight the observations by liquidity. Results remain similar, although we loose a lot of precision if we instrument only by the arbitrage short-interest. Table XIV is the equivalent of Table XI. Again, the impact of the increases in lending fees on abnormal returns occur only within the ten-day event window. In summary, our main results are not driven by the the weighting procedure, although weighting does help with precision. Finally, Tables XVIII and XX reproduce the IV results using all events (applying no filter) but weighting observations. Again the same pattern arises. Thus, our results are not driven by filter choices.

Table X. Robustness 1: Unweighted

	Dependent variable:		
	$r_{\tau-5,\tau+5}$		
	One Instrument: SI	One Instrument:ΔFee	Two Instruments
	(1)	(2)	(3)
Non-Arbitrage Δ fee	1.147	0.495*	0.539**
	(0.927)	(0.256)	(0.263)
IoNE	−0.691**	−0.513*	−0.525*
	(0.339)	(0.282)	(0.279)
Turnover	−2.823*	−2.583*	−2.599*
	(1.448)	(1.387)	(1.386)
Median Loan Fee	0.506*	0.338**	0.349**
	(0.267)	(0.155)	(0.155)
Constant	0.547	1.068**	1.033*
	(0.780)	(0.543)	(0.538)
Observations	391	391	391

This table shows the estimates of equation 3. The dependent variable is the cumulative returns. Delta Fee on Non-Arbitrage Transactions is instrumented by the amount of short interest in arbitrage transactions and/or by delta fee in arbitrage transactions. Robust standard errors are clustered at the ticker level . Observations are weighted by the stock liquidity. Arbitrage ΔFee is the relative loan fee increase during the IoNE dividend window for arbitrage contracts. Non-Arbitrage ΔFee is the relative loan fee increase during the IoNE dividend window for non-arbitrage contracts. IoNE is the IoNE dividend value as as a percentage of the ex-date price. Turnover is the average daily turnover in the 30 days before the IoNE dividend event. Median loan is the average median of daily loan, median loan fee for each stock in the whole sample median.
$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Table XI. Robustness 2: Unweighted Instrumental Variables + Persistence

	Dependent variable:				
	$r_{\tau-15,\tau-5}$	$r_{\tau-10,\tau}$	$r_{\tau-5,\tau+5}$	$r_{\tau,\tau+10}$	$r_{\tau+5,\tau+15}$
	(1)	(2)	(3)	(4)	(5)
Non-Arbitrage Δ fee	-0.129	0.051	0.539^{**}	0.215	-0.832^{***}
	(0.250)	(0.289)	(0.263)	(0.206)	(0.262)
IoNE	-0.311^{*}	-0.298	-0.525^{*}	0.146	1.386^{***}
	(0.175)	(0.330)	(0.279)	(0.196)	(0.202)
Turnover	-1.331	-1.353	-2.599^{*}	-3.300^{***}	-0.983
	(1.371)	(1.261)	(1.386)	(0.893)	(0.944)
Median Loan Fee	-0.298^{*}	0.046	0.349^{**}	0.285^{*}	-0.187
	(0.167)	(0.238)	(0.155)	(0.151)	(0.147)
Constant	1.917^{***}	1.296^{**}	1.033^{*}	0.255	-0.186
	(0.474)	(0.586)	(0.538)	(0.544)	(0.545)
Observations	389	391	391	391	388

This table shows the estimates of equation 3. The depended variable is the cumulative returns. ΔFee on Non-Arbitrage Transactions instrumented by the amount of short interest in arbitrage transactions. Observations are not weighted by liquidity. Robust standard errors are clustered at the ticker level. Arbitrage Short-Interest is the total shares involved in arbitrage loan contracts divided by the total shares outstanding in the record day. Arbitrage ΔFee is the relative loan fee increase during the IoNE dividend window for arbitrage contracts. Non-Arbitrage ΔFee is the relative loan fee increase during the IoNE dividend window for non-arbitrage contracts. IoNE is the IoNE dividend value as as a percentage of the ex-date price. Turnover is the average daily turnover in the 30 days before the IoNE dividend event. Median loan is the average median of daily loan, median loan fee for each stock in the whole sample median.
$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Table XII. Robustness 3: All Events

	Dependent variable:		
	$r_{\tau-5,\tau+5}$		
	One Instrument: SI	One Instrument:ΔFee	Two Instruments
	(1)	(2)	(3)
Non-Arbitrage Δ fee	0.784**	0.693**	0.731***
	(0.352)	(0.316)	(0.273)
IoNE	−62.422*	−55.457*	−58.415**
	(32.071)	(30.506)	(27.965)
Turnover	−1.333	−1.290	−1.308
	(1.308)	(1.301)	(1.305)
Median Loan Fee	0.253	0.216	0.232
	(0.195)	(0.174)	(0.170)
Constant	0.458	0.553	0.513
	(0.481)	(0.509)	(0.458)
Observations	487	487	487
R^2	-0.209	-0.158	-0.179
Adjusted R^2	-0.219	-0.168	-0.189

This table shows the estimates of equation 3. The dependent variable is the cumulative returns. Delta Fee on Non-Arbitrage Transactions is instrumented by the amount of short interest in arbitrage transactions and/or by delta fee in arbitrage transactions. Robust standard errors are clustered at the ticker level . Observations are weighted by the stock liquidity. Arbitrage ΔFee is the relative loan fee increase during the IoNE dividend window for arbitrage contracts. Non-Arbitrage ΔFee is the relative loan fee increase during the IoNE dividend window for non-arbitrage contracts. IoNE is the IoNE dividend value as as a percentage of the ex-date price. Turnover is the average daily turnover in the 30 days before the IoNE dividend event. Median loan is the average median of daily loan, median loan fee for each stock in the whole sample median.
$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Table XIII. Robustness 3: All Events + Persistence

	Dependent variable:				
	$r_{\tau-15,\tau-5}$	$r_{\tau-10,\tau}$	$r_{\tau-5,\tau+5}$	$r_{\tau,\tau+10}$	$r_{\tau+5,\tau+15}$
	(1)	(2)	(3)	(4)	(5)
Non-Arbitrage Δ fee	−0.050	0.019	0.736**	0.521*	−0.311
	(0.174)	(0.223)	(0.288)	(0.275)	(0.285)
IoNE	0.464	23.549	−58.753**	−15.922	113.400***
	(35.477)	(55.274)	(27.993)	(29.169)	(30.305)
Turnover	0.631	−0.230	−1.310	−1.959***	−0.997
	(1.028)	(1.058)	(1.300)	(0.662)	(0.843)
Median Loan Fee	−0.290	−0.090	0.233	0.330**	0.126
	(0.200)	(0.242)	(0.170)	(0.154)	(0.212)
Constant	0.784	0.816	0.508	−0.377	−0.945
	(0.491)	(0.562)	(0.466)	(0.387)	(0.701)
Observations	483	487	487	487	482
R^2	0.002	0.013	-0.209	-0.067	0.037
Adjusted R^2	-0.007	0.004	-0.219	-0.076	0.029

This table shows the estimates of equation 3. The depended variable is the cumulative returns. Delta Fee on Non-Arbitrage Transactions instrumented by the amount of short interest in arbitrage transactions and by delta fee in arbitrage transactions. Robust standard errors are clustered at the ticker level . Observations are weighted by the stock liquidity. Arbitrage ΔFee is the relative loan fee increase during the IoNE dividend window for arbitrage contracts. Non-Arbitrage ΔFee is the relative loan fee increase during the IoNE dividend window for non-arbitrage contracts. IoNE is the IoNE dividend value as as a percentage of the ex-date price. Turnover is the average daily turnover in the 30 days before the IoNE dividend event. Median loan is the average median of daily loan, median loan fee for each stock in the whole sample median.

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

VIII. Conclusions

Despite an intense debate about the impact of short-selling restriction price, the evidence regarding the effects of short sales on asset prices is mixed. The lack of consensus is in large part due to two difficulties. First, identifying a clear source of exogenous variation in supply and demand for stock loan. Second, lack of data availability on lending due to the OTC nature of these markets in most countries. Our study estimates the causal impact of

short-selling restrictions on returns by taking advantage of an unique dataset and an unique source of exogenous variation in rental fees. A two standard-deviation increase in loan fees - tantamount to banning short-sales - causes a 274 bps of abnormal returns over 11 trading days. This is strong evidence in favor of Miller's Hypothesis.

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