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Abstract

We provide new insights about centralized and OTC stock lending in the context of Tokyo Stock Exchange listed stocks from July 2006 to December 2009. We find that the demand drivers in the two markets are significantly different, which imply also differences in pricing efficiency implications. Specifically, we find that higher OTC stock lending activity is associated with greater pricing efficiency with better liquidity. the benefits of the centralized market on average is less clear, but in a subsample where the OTC market is constrained, the centralized stock lending seem to relax short sale constraint and improve liquidity.

Keywords: Stock Lending, Pricing efficiency, Short selling
JEL classification: G12, G14, G18

[1] Central European University (CEU), Budapest 1051, Hungary; National University of Singapore (NUS), Singapore, email: zsuzsa.r.huszar@gmail.com (corresponding author)

[2] Nova School of Business and Economics. Campus de Campolide, 1099-032 Lisboa - Portugal. email: melissa.prado@novasbe.pt.

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Abstract

We provide new insights about centralized and OTC stock lending in the context of Tokyo Stock Exchange listed stocks from July 2006 to December 2009. We find that the demand drivers in the two markets are significantly different, which imply also differences in pricing efficiency implications. Specifically, we find that higher OTC stock lending activity is associated with greater pricing efficiency with better liquidity. the benefits of the centralized market on average is less clear, but in a subsample where the OTC market is constrained, the centralized stock lending seem to relax short sale constraint and improve liquidity.

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1. Introduction

The 2010 Dodd-Frank Wall Street Reform and Consumer Protection Act (hereafter Dodd-Frank Act) in the United States and the 2004 Markets in Financial Instruments Directive (MiFID) in the European Union (EU) aim to promote transparency and reduce risk in the financial system, including a shift towards centralized clearing for many financial products.[1] This entails moving derivatives, bonds, and even securities lending transactions from over-the-counter (OTC) markets to transparent markets with central counterparties (CCP) to reduce settlement and counterparty risk (Bank of England, 2013; ECB, 2017). Centralized markets are expected to aid regulators in accessing information, estimating risk, and intervening in a timely manner if needed. For security lending in particular, one major concern is the limited transparency that can hinder regulators' ability to act upon aggressive short selling that could destabilize the market.[2]

On the other hand, borrowers are more concerned with the direct and indirect costs, such as borrowing fees and search costs. Borrowing fees are relatively low, on average a couple of basis points, for large and liquid stocks (D'Avolio, 2002). However, the costs can be substantial for some stocks, either because the aggregate supply is restricted or because the available supply is not readily accessible due to concentrated institutional ownership (Porras Prado et al., 2016). In the nontransparent OTC markets, prime brokers can exploit their information advantage and set very high fees for less connected borrowers (Duffie et al., 2002; Kolasinski et al., 2013; Chague et al., 2017) and take a large cut from the fee income at the expense of the lenders.

Besides the OTC securities lending, various centralized securities lending markets existed and still exist around the world (see Appendix 1). For example, the New York Stock Exchange

[1] For more details on the Dodd-Frank Act, visit the U.S. commodity exchange commission website and for a good overview and recent changes in the MIFID, visit the UK's Financial Conduct Authority (FCA, 2017).

[2] In the aftermath of the 2007-2009 financial crisis, numerous exchanges have introduced new short-sale restrictions and/or mandatory reporting requirements to address this lack of transparency. See Gruenwald et al. (2010) for a complete summary of recently implemented regulatory and disclosure requirements relevant to short selling.

(NYSE) had a centralized lending market for hard to borrow stocks from 1926 to 1933 to alleviate short-sale constraints (Jones and Lamont, 2002). For European securities, SecFinex and SL-x group tried to operate centralized electronic stock borrowing and lending platforms in the new Millennium, but they shut down within a couple of years due to inefficiencies, under-utilization, and funding problems. These failures and recent issues concerning AQS Quadriserv (wholly-owned subsidiary of EquiLend Holdings LLC; CCP-based securities lending platform for US securities) seem to support recent legal complaints filed by a number of U.S. pension funds where major players allegedly boycotted automated centralized securities lending platform to maintain prime brokers' informational advantages (WSJ, 2017; Bloomberg, 2018).[3]

While centralized stock lending markets with increased transparency may offer significant benefits for regulators and less connected borrowers, the empirical evidence on the workings and pricing efficiency implications of centralized lending is limited. Centralized markets may not be able to substitute OTC stock lending if informed institutional traders are rather abstain from trading to reveal private information in a centralized market (Easley et al., 2014). Some form of market segmentation in stock lending is consistent with Menkveld et al. (2017), who show that more informed trades are more prevalent in more opaque markets. Boehmer et al. (2017) also suggest that in the presence of centralized stock lending, the concentration of informed traders declines amongst short sellers. While their latter study does provide insights about the implications of centralized stock lending, it does so only at the country levels. Thus, whether centralized stock lending markets promote pricing efficiency at the stock level still remains an open empirical question.

[3] The three U.S. funds seeking legal ramification for underrepresented lenders interest in stock lending are the Iowa Public Employees' Retirement System ("IPERS"), the Orange County Employees Retirement System ("OCERS"), and the Sonoma County Employees' Retirement Association ("SCERA") (collectively, "Plaintiffs") (WSJ, 2017). In more recent development, the proceedings turned into

Japan is one of the few markets where both regulated centralized and unregulated OTC stock lending markets have been active for decades. The availability of information, from the exchange and propriety sources from July 2006 to December 2009, allows us to examine the implications of these two alternative stock lending markets for Tokyo Stock Exchange (TSE) listed stocks.[4] Our first contribution is to provide insights into the functioning of the centralized stock lending market in comparison with OTC stock lending. We find that during our sample period, the majority of the stocks have borrowing and lending activity in both markets. All stocks can be borrowed through the centralized lending market but in reality its utilization is limited. On average only about 200 (400 at the peak) stocks exclusively borrowed in the centralized market and similarly only about 200 stocks are exclusively borrowed OTC.

We describe the determinants of stock borrowing in each lending market and find that OTC lending activity is positively related to market capitalization and institutional ownership (IO). This finding is consistent with U.S. studies (e.g., D'Avolio, 2002; Porras Prado et al., 2016), which show that wide-scale institutional ownership is necessary to support supply in the OTC market. In contrast, centralized market activity is higher in smaller stocks with lower IO, where the usual OTC supply is likely to be constrained (Nagel, 2005). Our results also show that a short sale facilitated with OTC borrowing exhibits a momentum style, while a short sale facilitated through the centralized market is more of a contrarian, as suggested by the increase in borrowing in the centralized market after rising stock prices. These descriptive findings suggest some degree of market segmentation, where the two markets likely operate with different clientele. The exact trader's choice cannot be defined due to unobserved differences among the two lending markets; however, we contribute to the literature by describing the types of stocks and

[4] For simplicity, we refer to the Japanese standardized stock lending market as a centralized stock lending market, where the transactions are standardized with centralized non-negotiable fees. The raw data are available from NEEDS and from the formerly TSE websites. For more details, see Appendix 2.

trades that appear on each lending market, along with the pricing implications that arise when there are many trades on a market.

To examine the pricing efficiency implications of alternative stock lending market activity at the stock level, we use both panel regression framework and matched firm approach. We find differences in liquidity and pricing efficiency across the alternative stock lending markets in Japan. Specifically, the OTC stock lending on average is associated with price discovery with lower bid-ask spreads and daily price spreads while the centralized stock lending is associated with higher spreads and higher daily return volatility. While these results suggest that the centralized market has limited benefits, we reexamine the centralized market's role in a subsample where the OTC market may not be able to facilitate informed trading because high search costs may discourage relatively informed traders from participation.

We also address regulatory claims that the centralized market helps where it is need and reexamine the pricing efficiency implications of a centralized market for stocks with high OTC demand and small market capitalization where the OTC market is more likely to be constrained. In this subsample, we find that the centralized market alleviates short-sale constraints and improves liquidity and price discovery. We also provide robustness analysis with a simultaneous regression approach adopted from algorithm trading and dark pool studies (e.g., Buti et al., 2011, 2017; Hasbrouck and Saar, 2013) to address the concern that stock lending activity and pricing efficiency are jointly determined.

Overall, this study provides new insights into stock lending markets by documenting the pricing efficiency implications of alternative market structures. Our results are useful for market participants and regulators alike in the midst of regulatory debates to shift derivatives trading and stock lending to centralized markets to reduce counterparty risks and increase transparency. We

find that the regulatory intentions are well placed with the centralized stock lending market in that it helps to alleviate short-sale constrains and illiquidity when OTC market demand is unusually high. However, the economic benefits of centralized stock lending may not be fully realized in our sample where the OTC market seems to remain the preferred venue to facilitate short selling for the relatively informed traders.

Next, in Section 2, we discuss the data and sample construction. In Section 3, we provide details about the Japanese stock lending market and hypothesis development. In Sections 4 and 5, we provide results regarding the determinants of borrowing in the two alternative lending markets and their pricing efficiency implications. In Section 6, we summarize our results and discuss the regulatory implications.

2. Data

Our panel dataset includes a cross-section of about 1,532 unique stocks representing the majority of the first section of the TSE, restricted to stocks for which we have valid stock price, returns, book value, and securities lending market data.[5] The time frame of the study is 169 weeks, from July 2006 to December 2009. We rely on weekly frequency in our analysis because centralized stock lending market data is only available weekly from the exchange through a private data provider. In the subsections below, we discuss the key data sources and present the descriptive statistics.

2.1. Securities lending market information

For information about the Japanese centralized stock lending market, we obtain data from the Nikkei Economic Electronic Database Systems (NEEDS). The dataset includes weekly margin

[5] The first section of the TSE includes stock listings of about 1,650 of the largest, most established Japanese companies. Smaller companies, new listings, and foreign firms are generally not included in the first section.

reports, which reflect the number of stocks lent out at the end of the week from local regulated markets. The Nikkei stock lending data include: (1) standardized lending/borrowing transactions via Japanese Securities Financing companies (JSFCs) and (2) negotiated lending/borrowing via Japanese securities companies. Since 1977, Japanese regulators have had oversight of the centralized standardized securities lending contracts via JSFCs; the locally negotiated securities contracts have been regulated since 1998.

The negotiated stock lending contracts are also regulated and reported to the Japanese regulators and to the public, together with the standardized contracts. Negotiated contracts as indicated by the name have more flexible contract terms but they account for only a negligible amount in the market. Because we want to clearly differentiate across the centralized and the OTC market in terms of contractual terms and regulatory oversight, we excluded the negotiated market. Section 3 and Appendix 2 include more details about the Japanese stock lending market development and activity.

We also obtain stock lending information from IHS Markit's Securities Lending database, which captures effectively the global securities lending market as suggested by Saffi and Sigurdsson (2011). The difference between the lending amount reported by Markit and the amount reported by the Nikkei is considered to be OTC borrowings.[6] In our sample of 1,532 stocks, for each stock we have valid data coverage by IHS Markit during our sample period. Markit coverage is excellent for large Japanese stocks during our sample period, as only 61

6 With this calculation we assume that Markit has full coverage, which is consistent with the extant short sale and securities lending literature that uses Markit data as the benchmark. More importantly, Saffi and Sigurdsson (2011) report 95% market coverage for Japan based on the same Markit data. In our case, all stocks in the TSE first section have data coverage from Markit at some point. Alternatively, we could treat Markit data as a proxy for OTC short sales. The two alternative *OTC_SIR* measures, based on raw Markit borrowing demand or based on Markit demand minus regulated margin shorts from NEEDs data, have 88% correlation. The empirical results with the raw Markit demand as a proxy for OTC stock borrowing are economically and statistically consistent (results are available upon request).

stocks have a large number of trading days with missing data coverage (i.e., more than 60 weeks) from Markit.

Our key variables are based on the well-established short interest ratio (SIR), the number of shares shorted relative to the total number of shares outstanding. Here, rather than using the number of shorted shares, we use the borrowed shares in the numerator. Since, the primary reason for stock borrowing is short selling, we use the expression of shares shorted and shares borrowed interchangeably, consistent with the literature (e.g., Saffi and Sigurdsson, 2011; Laird, 2015). Specifically, the *Centr_SIR* is the ratio of the shares borrowed in the centralized market relative to total shares outstanding using the standardized margin shorts as an input for the centralized market. The *OTC_SIR* is the weekly average of the Markit reported total number of shares borrowed during week *t* minus the standardized and negotiated shorts as reported by NEEDS in week *t* divided by the average total shares outstanding during the corresponding week. We also calculate the centralized market share (*MarketshareCentr*) based on the ratio of the number of shares borrowed in centralized market reported by NEEDs divided by the weekly average of the total stock borrowing reported by Markit.

In addition to the stock lending activity, we capture borrowing costs as the value-weighted average annual lending fees from Markit. To address the extreme skewness in the fee measure due to a handful of extremely high lending fee observations, we use the natural logarithm of the annualized lending fees on all outstanding contracts recorded in basis points (*Logallfee*). In auxiliary analyses, we include a lending supply (*Supply*) measure, the percentage of the total shares available for borrowing per Markit. We do not use the supply in the primary analysis because we do not have supply information for the centralized market where the market is often cleared by auction (see Appendix 2 for details).

2.2. Stock market and financial information

The primary stock information such as stock price, trading volume, daily high and low prices, bid-ask spread, and book-to-market ratios, we obtain from Datastream. For additional financial information, such as institutional and insider ownership, we rely on data from FactSet. Our empirical analyses use weekly cumulative returns as raw returns (*RawRet*) and market model adjusted excess returns (*ExcRet*) based on TOPIX, the value-weighted market index for the TSE.

As firm characteristics controls, we include firm size (*Size*) as the natural logarithm of the market capitalization of the stock in million yen, book-to-market ratio (*BtoM*), institutional ownership (*IO*) as a percentage of total shares held by institutions, insider ownership (*Insider*) as a percentage of total shares held by insiders, bid-ask spread (*BAspread*) as the difference between the ask price and the bid price relative to the average of the ask price and the bid price, and high-low price spread (*HLspread*) as the difference between the daily highest price and the lowest price relative to the high price.

2.3. Liquidity and pricing efficiency measures

To examine the impact of the stock lending market organizational structure on market quality and pricing efficiency, we follow prior studies in constructing a number of liquidity and pricing efficiency measures. We use daily liquidity measures (defined in Subsection 2.1.), average high and low price spread (*HLspread*), bid-ask spread (*BAspread*), and the natural logarithm of the high and low price spread and the bid-ask spread (e.g., *LogBAspread* and *LogHLspread*) as in Buti et al. (2011) in analyzing the dark pools' effect on liquidity.

Our pricing efficiency measures adopted from Saffi and Sigurdsson (2011) are based on general stock return characteristics, such as return standard deviation (*Stdev*), skewness (*Skew*), and kurtosis (*Kurt*). Rather than using an annual horizon to calculate the above measures, as in

Saffi and Sigurdsson (2011), we use 60-day moving trading windows because we have a relatively short time horizon. Also, we prefer more dynamic measures, which may be more suitable to capture the effect of centralized and OTC lending market activity if stock borrowing activity has significant variation from month to month, which is expected as the duration of large Japanese short position is about 38 days (Boehmer et al., 2018). Each week, the measures are calculated as the weekly averages of the standard deviation, skewness, or kurtosis of the daily stock returns based on the previous 60 days.[7] In addition, we consider stock return cross-correlation (*Cross*) with the market index and the natural logarithm of the cross-correlation (*LnCross*). Last, we adopted a price delay measure (*Delay*) from Hou and Moskowitz (2005).

$$Delay = \frac{\sum_{n-1}^{4} \delta_i(-n)}{2|\beta_1| + \sum_{n-1}^{4} |\delta_i(-n)|}$$

This *Delay* measure is constructed from regression results with the contemporaneous value-weighted aggregate market index (TOPIX) and the last four daily lags using a moving window of 60 trading days to calculate the most relevant price delay measure. Again, as with the standard deviation measure, we use the weekly averages of the daily measures in our empirical analysis. Larger values imply greater price delay in responding to market information.

3. Discussion of alternative stock lending markets and hypothesis development

In this section, we first review the relevant literature and introduce the unique features of the Japanese market. Then in the second sub-section, we discuss the hypothesis development.

3.1. Literature review and introduction to Japanese stock lending

[7] The daily return standard deviation for week *i*, which includes trading days *t*, *t*+1, … *t*+4, is the average of the standard deviation of the previous 60 days; that is the 1/5*(std[Ret_{t-60},Ret_t], std[Ret_{t-59}, Ret_{t+1}] … [Ret_{t-56}, Ret_{t+4}]).

In Japan, a well-established form of the centralized stock lending market has been operating since 1977. In this centralized market, the supply is the total number of shares available from JSFC holdings (e.g., through margin accounts or from the custodian business) at a standardized rate, which is usually low if the internal supply is sufficient to meet the demand. On any given day, if the daily borrowing demand exceeds the supply, an open auction is conducted to meet the excess demand (see Appendix 2 for more details). At that point, the fees, established in the market, are generally significantly higher than the general collateral rate, resulting in a situation when the stock is considered to be on special: the fees are so high that the rebate rate is actually negative (i.e., rebate rate received by the borrower = general collateral rate – lending fee). This means that the a stock considered to be on special when the borrower has to pay a significant amount for borrowing the stock in access of the income that can be earned on the collateral (Geczy et al., 2002).

The Japanese centralized stock lending market is considered to be more expensive and more restrictive than OTC borrowing because the collateral and fees are standardized and non-negotiable. The centralized market's primary benefit is that supply is guaranteed, effectively, ensuring execution but not the exact cost of the borrowing. Such contracts can be extremely costly and risky for institutional investors or traders who want a reliable estimate of the cost and flexibility for their trading strategy. On the other hand, the OTC market allows price negotiation but the success of the transaction hinges upon the availability and accessibility of supply (Duffie et al., 2002; Duffie et al., 2005). Thus, ex ante supply is necessary for short selling in the OTC market but not in the centralized market.

The TSE (now part of the Japanese Exchange Group), one of the largest and most developed exchanges in the world, has attracted a large amount of domestic and international institutional

traders who generally have well developed brokerage contacts and are able to arrange stock borrowing OTC. While we are unable to directly link institutional trading to OTC market activity in the absence of trade level information and trader identity, in auxiliary analysis we provide some supportive evidence. The results from Appendix 3 (A. Table 7) reveal that higher OTC market activity is associated with negative returns, implying that OTC short selling in Japan provides information just like short selling in the U.S. and European markets. On the other hand, the centralized market activity is relatively uninformative, suggesting that OTC traders are more likely to be informed institutional traders.

3.2. Hypothesis development

In the decision to borrow shares from either the centralized lending market or in an OTC arrangement, short sellers trade off the cost and benefits of each arrangement. While OTC borrowing may involve higher search cost, it allows more customization and negotiation, whereas centralized borrowing provides immediacy but at higher costs with inflexible standardized contract terms. U.S. studies (e.g., D'Avolio, 2002; Porras Prado et al., 2016) show that wide-scale institutional ownership is necessary to support supply in the OTC lending market and therefore we expect OTC borrowing to be more pervasive in stocks with higher institutional ownership. Since institutional investors tend to prefer large-cap and more liquid stocks (e.g., Del Guercia, 1996; Falkenstein, 1996; Gompers and Metrick, 2001), we conjecture that stock characteristics such as size, liquidity, and ownership should be important determinants of borrowing in the OTC market.

In the OTC market, the supply is pooled together primarily from institutional investors and custodians. On the other hand, the centralized market supply emanates from the consolidation of the retail and institutional margin holdings within the system or obtained through auction when

the internal supply is exhausted (See Appendix 2 for details). Thus, the OTC market and the centralized market supply are expected to be relatively segmented. While institutional traders likely have good access to supply in the OTC market through prior relationships and their prime broker, less connected borrowers may not be able to locate shares or only at a very high cost in the OTC market, as suggested theoretically by Duffie et al. (2005) and empirically by Chague et al. (2017) using Brazilian data. Thus, ex ante based on supply and demand conditions, we expect larger liquid stocks to have more OTC stock borrowing and for smaller, illiquid, stocks to have higher centralized lending activity, leading to our first hypothesis for the two lending markets:

H1A: OTC stock lending/borrowing activity is more prevalent for large stocks with greater institutional investor ownership.

H1B: Centralized stock lending/borrowing activity is more prevalent for smaller and less liquid stocks with lower institutional investor ownership.

Our second hypothesis concerns with the price efficiency implications of the two lending markets. Ample evidence suggests that a well-functioning OTC stock lending market provides important market benefits because it supports the short-sale trades of institutions who in turn can facilitate price discovery (Engelberg et al., 2012; Boehmer and Wu, 2013). Short-sale trades, especially large or concentrated trades, convey new material information to the market (e.g., Boehmer et al., Desai et al., 2002; Diether et al., 2009). More recent short-sale studies focus on short-sale bans and show that the restrictions on short selling adversely affect liquidity and volatility, suggesting that short sellers are essential for providing liquidity to ensure normal market function and reduce volatility (Beber and Pagano, 2013; Boehmer et al., 2013).

Based on these U.S. studies, we expect that OTC stock borrowing is associated with improved pricing efficiency because it is known to support institutional traders' price discovery

trades. On average, all short-sale trades irrespective of the corresponding stock lending market (centralized vs. OTC) are likely to improve pricing efficiency and price discovery because short sellers are likely to be relatively more informed traders because of the higher costs and higher risk associated with these trades (Diamond and Verrecchia, 1987). However, across the centralized and OTC market traders, there might be some informational difference. Specifically, the centralized market could have more adverse pricing efficiency implications, as suggested by Boehmer et al. (2017), who find that in countries with active centralized stock lending markets, the private information from short selling is diluted because of the lower concentration of relatively informed traders among short sellers. Thus, we hypothesize:

H2A: OTC stock lending market activity is associated with greater pricing efficiency by incorporating new information more timely, or by providing liquidity, or by reducing uncertainty.

H2B: Centralized stock lending market activity improves pricing efficiency by incorporating new information more timely, or by providing liquidity, or by reducing uncertainty.

We examine the centralized lending market's implications with the full sample and with a subsample where the centralized market may be more relevant. Short-sale constraints are known to arise in the OTC market when supply is restricted and/or demand is exceptionally high. In such situations, the centralized market may be able to relax short-sale constraints, as suggested by Jones and Lamont (2002) who examine the role of a NYSE-based centralized lending market, the lending pit, during the Great Depression. The authors find that high short sale costs were associated with persistent overpricing, and prices reverted to fundamentals only as short-sale constraints relaxed in the lending pit. In addition, OTC market-based short sellers are known to shy away from risky, small stocks with high idiosyncratic volatility (Au et al., 2009), which

means the price and information discovery role is more likely to be left for traders who trade via the centralized market.

4. Empirical analysis of coexisting centralized and OTC markets

In this section, we first provide the summary statistics and review the centralized and OTC market activity for stocks listed on the first section of the TSE from July 2006 to December 2009. Then, in the last two sections, Sections 4.3 and 4.4, we examine the determinants of the demand drivers each market and the coexistence of the alternative lending markets.

4.1. Summary statistics

Table 1 provides the summary statistics. On the left side of Table 1 we report summary statistics based on stock-week observations for stocks with concurrently active centralized and OTC stock borrowing. On the right side of Table 1, we report summary statistics based on stock-week observations when the stocks are borrowed exclusively in the centralized or in the OTC lending market. Comparing stocks across the panels, we find that stocks with both markets active are somewhat larger, with lower weekly returns consistent with being less overpriced and less likely to exhibit binding short-sale constraints. Focusing on stocks only with OTC stock lending/borrowing, these stocks tend to have higher institutional ownership while insiders tend to hold less of them. The finding is consistent with earlier studies (D'Avolio, 2002; Asquith et al., 2005) showing that institutional ownership is necessary to support short sales in the OTC market because institutional investors are the primary stock loan supply providers.

We find that stocks with only centralized lending activity are somewhat smaller, have significantly higher returns, and greater cross-correlation with the market, suggesting that as some informed traders abstain from trading, they withhold some private firm-specific information, resulting in less informative stock prices (Morck et al., 2013). We also reveal that

lending/borrowing is primarily concentrated in the OTC market by showing that the average market share of the centralized market for stocks in both lending markets is only about 28%. This suggests that traders strongly prefer the OTC market because of lower costs.

[Table 1 about here]

Looking at stock lending fees and supply, we see that lending fees are the highest on average for stocks that are borrowed only through the OTC market and the lowest for stocks that are borrowed in both markets. For lending supply, we observe the opposite. Supply is the lowest for stocks that are borrowed only through the centralized market and the highest for stocks that are borrowed in both markets. This suggests that the centralized lending market alleviates short-sale constraints with respect to lending fees and supply. For the efficiency measures, price delay is the highest for stocks with only OTC borrowing and lowest for stocks borrowed in both the OTC and the centralized lending market. The higher moment measures, skewness, and kurtosis are also lower in the sample of stocks borrowed in both lending markets. Our summary statistics suggest that stocks with two active lending markets exhibit the highest levels of pricing efficiency.

4.2. Review and comparison of OTC and centralized lending market activity

First we review the economic importance and relevance of the centralized and the OTC lending markets for our sample. Figure 1 shows the time series of the number of TSE stocks and the percentage market share of stocks that are borrowed in either the OTC or the centralized market and the stocks that are borrowed in both. At any point in time, slightly above 200 (at the peak 400) stocks rely on the centralized stock lending market alone while about 200 stocks rely solely on the OTC. Except for a few stocks, each stock has some stock lending/borrowing activity in both markets at least for some day during our sample period. In terms of market capitalization

(bottom plot, Panel B), on average about 2/3 of the sample has stock lending activity in both markets on any given week.

[Figures 1 and 2 about here]

In Figure 2, we compare the time-series of stock lending activity relative to shares outstanding for the centralized and OTC markets. Panel A shows that the median SIR in the centralized lending market is about 0.12%, while the median SIR in the OTC market is about 0.2%; however, the OTC market has significantly greater volatility. In Panel B, we focus on the extremes and plot the time series of the SIR in the centralized and OTC markets for the top decile of stocks, which is the average SIR based on the subsample of stocks from the top decile of the distribution. Figure 2 also reveals that in the OTC market, the borrowing activity is highly concentrated. While in the extreme, at the 90th percentile SIR is about 2.5% in the OTC market, the median SIR in the OTC and the centralized market are only around 0.5% and 0.1%, respectively. In the centralized market the extreme 90th percent is also still at a rater negligible rate, below 1%.[8] Again, this finding suggests a strong preference among traders for the OTC market.

Next, in Figure 3, we consider our market segmentation conjecture and visualize whether the stocks with high borrowing activity in the centralized market are also experiencing high demand in the OTC market and vice versa. In the top Panel in Figure 3, in the subsample of stocks with high centralized stock lending demand, stocks from the top decile, the median SIR is 1.5% in the centralized market but negligible in the OTC market. As we see similar trend in Panel B with the

[8] There is some seasonality in the OTC stock lending market activity, which has pronounced peaks at end of March and September, coinciding with the fiscal year end and the midyear reporting times. These trades according to professionals are driven by accounting changes as the *keiretsu* members are often required to offload ownership interest in related firms, which can be accomplished by lending out the shares temporarily. It is extremely hard to identify the full supply chain of keiretsu firms; thus, we cannot effectively exclude these accounting trades. However, the inclusion of these trades is not expected to bias our results in any systematic way, rather it is expected to weaken our results.

subsample of stocks with high OTC demand, we can infer that the demand drivers and consequently the investors are likely different in the two markets.

[Figure 3 about here]

In all three figures we also note a slight declining trend consistent with the decline in aggregate short selling as reported by Duong et al.'s (2015) after November 2008, in response to implementation of mandatory disclosure requirement of large short-sale positions in TSE stocks.[9] The authors suggest that with increased regulatory oversight, professional short sellers who prefer to protect their trade secrets by concealing their market positions reduced their trading in TSE stocks.

4.3. Determinants of stock lending activity in OTC and centralized lending markets

In Table 2, we examine the lending activity of the centralized and OTC markets and the relative importance of the centralized market using panel regression analyses with time fixed effects and allowing for clustering of the standard errors at the week and firm level. We regress the market share of the centralized market (models 1-3), the centralized market borrowing demand (models 4-6), and OTC market borrowing demand (models 7-9) on stock characteristics to identify which what are the key demand drivers in the different markets. Our key variables are two dummy variables to examine whether there is any evidence of cross-market spillovers. *HighOTC_SIR* and *HighCentral_SIR* dummies are assigned to stocks with stock lending activity from the top decile of the distribution of the *OTC_SIR* and the *Centr_SIR* variables. In the last specification, we also control for lagged stock lending market activity levels with our raw measures, the *Centr_SIR* and *OTC_SIR*.

9 Although numerous exchanges, including major U.S., European, and Indian exchanges, implemented short-sale bans during our sample period, the TSE restricted only naked short selling and introduced reporting requirements on large short positions in excess of 0.25% of the shares outstanding.

The base specification is as follows:

$$SecLendingActivity_{i,t} = Constant + \beta_2 HighCentralSIR_{i,t-1} + \beta_3 HighOTCSIR_{i,t-1} + \\ + \beta_4 SecLendingActivity_{i,t-1} + \beta' StockCharact_{i,t} + \alpha_t + \varepsilon_{i,t} \quad (1)$$

where $SecLendingActivity_{i,t}$ is either the market share of the centralized market (Models 1-3), or the centralized market activity (Models 4-6), or the OTC market activity (Models 7-9). The stock characteristics vector ($StockCharact_{i,t}$) include the natural logarithm of the total market capitalization (*Size*), book-to-market ratio, institutional ownership (*IO*) as a percentage of the total shares outstanding, insider ownership (*Insider*) as a percentage of the total shares outstanding, bid-ask spread (*BAspread*), high and low price spread (*HLspread*), the previous week's cumulative return (*LagRet*), and α_t captures the time fixed effect and $\varepsilon_{i,t}$ is the error term All variables are standardized to facilitate interpretation.

We find that stocks with greater institutional investor or insider ownership have lower centralized stock lending activity, while IO ownership is positively associated with OTC stock lending. Focusing on the relative importance of the centralized market, Table 2 Model 1 results show that a one standard deviation increase in *IO* is associated 1.95 standard deviation lower market share for the centralized platform. This means that when the OTC market is relatively unconstrained, supply can be facilitated by institutional traders, the stock lending primarily takes place OTC, and there is limited centralized market activity. Model 1 results also show that a one standard deviation increase in the previous week's stock return predicts a significantly higher centralized market share for the following week.

[Table 2 about here]

Besides institutional investor holdings, liquidity and price volatility also influence stock lending activity in the alternative stock lending markets. The higher bid-ask spread seems to

discourage stock lending activity in both markets, suggesting that liquidity is very important for all market participants. Results from Table 2 Models 1–6 reveal that stock lending activity in the centralized market and the relative importance of the centralized market are positively related with daily price volatility. Since past returns are known to influence short sellers (Diether et al., 2009), we examine the past return implications and find that higher past returns are associated with higher centralized market activity but lower OTC activity. The results from Models 4 and 7 suggest that a one standard deviation higher return in the previous week is associated with 1.77% higher centralized and –0.518% lower OTC short selling.

In the Table 2, in the second and third specifications of each dependent variable panel (in Models 2–3, 5–6, 8–9), we include the lagged controls in each lending market. Table 2 Models 5–6 results imply not only that there is strong persistence in the OTC stock lending market but also some spillover effect into the centralized market based on the positive coefficient on the *HighOTCSIR* dummy. On the other hand, the OTC stock lending has insignificant relation with the past centralized lending activity in Models 8 and 9. Overall, as expected based on prior U.S. studies (e.g., D'Avolio, 2002; Kolasinski et al., 2013), we find that IO is critical in the OTC stock lending market but effectively irrelevant in the centralized market, where supply is created from margin accounts within the system or through auctions. Thus, the results from Table 2 provide support for first set of hypotheses, that the demand drivers for the determinants of OTC and centralized lending market activity are different.

We also consider the implications of different clientele in the alternative stock lending markets. While U.S. studies (e.g., Diether et al., 2009) suggest that short sellers are largely contrarians as informed traders and profit from meeting buying pressure, in Japan the local retail traders are more likely to follow contrarian trading strategies based on public order imbalance

information (Chou et al., 2007) while professional traders are more likely to be momentum traders (Bae et al., 2008). Our results suggest that short selling facilitated with OTC stock lending reflects more momentum-style trading, implying more of institutional trading in the Japanese context. Finally, we also show that high OTC stock lending demand has a spillover effect into the centralized market but there is no evidence of any influence of high centralized market demand on OTC stock lending.

4.4. The coexistence of the OTC and centralized lending markets

In Table 3, we examine the determinants of (co)-existence of the alternative lending markets as well as the stock characteristics that contribute to relatively low stock lending activity, and only one of the stock market being active. We run a logit regression in which the dependent variable takes the value of one for a stock in a specific week with lending activity in both lending markets (in Models 1–3), with lending activity only in the centralized market (in Models 4–6), and with lending activity only in the OTC market (in Models 7–9) as a function of stock characteristics and lagged stock lending market activity.

The three specifications are as follows:

$$Prob(BothMarket_{i,t}) = 1 \mid HighSecLending_{i,t\text{-}1}, StockCharact_{i,t}, BothMarket_{i,t\text{-}1}, \alpha_t \quad (2)$$

$$Prob(CentrOnly_{i,t}) = 1 \mid HighSecLending_{i,t\text{-}1}, StockCharact_{i,t}, CentrOnly_{i,t\text{-}1}, \alpha_t \quad (3)$$

$$Prob(OTCOnlyt_{i,t}) = 1 \mid HighSecLending_{i,t\text{-}1}, StockCharact_{i,t}, OTCOnly_{i,t\text{-}1}, \alpha_t \quad (4)$$

where $BothMarket_{i,t}$ dummy variable takes on the value of one if the stock in a specific week has securities lending activities in both the centralized and the OTC markets. The $CentrOnly_{i,t}$ and $OTCOnly_{i,t}$ dummies take on the value of one for stocks with only centralized or OTC market activity, respectively. $HighSecLending_{i,t\text{-}1}$ indicates one of the two dummy variables: *HighCentralSIR* and *HighOTCSIR*, which capture whether the stock borrowing activity in the

respective market was high, within the top decile of the distribution during the previous week. The $StockCharact_{i,t}$ vector includes *Size*, *BtoM*, *IO*, *Insider*, *BAspread*, *HLspread*, and *LagRet* as defined for Table 2. All variables are standardized with mean zero and unit standard deviation. The coefficient estimates with the corresponding *t*-stats are from panel logistic regression with weekly time fixed effect (α_t) and clustered standard errors at the firm level.

[Table 3 about here]

The results from Models 1–3 show that smaller stocks with higher book-to-market ratios are more likely to be borrowed in both lending markets. While these results seem surprising at first, the significant positive coefficients on *Size* in Models 7-9 show that large stocks are much more likely to have only OTC stock lending market activity. Although IO is insignificant in these models, Table 2 results do reveal that IO facilitates OTC supply, which could imply that for larger stocks with significant IO all borrowers are able to locate shares OTC and the centralized market may not be needed. In Table 3 Models 1–3, the positive coefficients on the *BAspread* imply that stocks with a higher bid-ask spread are more likely to be borrowed in both lending markets while stocks with a high price spread are less likely to be borrowed. The negative coefficients on *LagRet* suggest that higher returns during the past week predict a smaller likelihood that the stock will be borrowed in both lending markets.

In Model 2, we include our high demand dummy variables to capture high stock borrowing in the OTC or in the centralized market. From the regression results, we infer that high OTC short selling during the previous week increases the likelihood that in the next week both the OTC and the centralized markets will be active. This suggests that the centralized lending market may alleviate short-sale constraints by accommodating potentially unfulfilled lending demand from the OTC market. The Model 3 specification is an extended version of Model 2 and includes an

additional dummy variable, $BothD_{-1}$, to assign a value of one for stocks with both stock lending markets active during the previous week to test whether the coexistence of the markets is persistent. We find that stocks active in both markets during the previous week are much more likely to have short selling in both markets during the following week.

In Table 3 with Models 4–9, we examine the determinants of the exclusive use of the centralized and the OTC market. The results for Models 4–6 show that stocks with lower IO are much more likely to have only centralized stock lending activity, as suggested earlier in interpreting Table 2. Regarding the exclusive existence of the OTC market, Models 7–9 results reveal that larger market size facilitates OTC activity while higher insider ownership tends to block it. This is consistent with studies which document that insiders are less likely to lend shares or perhaps the opaqueness of more tightly held firms discourages traders (Kobayashi, 1985; McGuire and Dow, 2004; Khanna and Yafeh, 2005; Anderson et al., 2011).[10]

Taken together, the results from Tables 2 and 3 provide support for the first set of hypothesis (*H1A and H1B)*, that the two stock lending markets' demand drivers are significantly different, suggesting that the two markets are likely to support different clientele and their coexistence could be beneficial.

5. Pricing efficiency implications of the OTC and centralized lending markets

In this section, we present the empirical analysis on the pricing implications of alternative stock lending markets. First, we use panel regression setting in Subsection 5.1 and matched firms approach in Subsection 5.2. Last, in Subsection 5.3., we discuss robustness analyses using a simultaneous regression approach.

[10] Appendix 4 provides robustness results for explaining the OTC market activity controlling the supply in the OTC market. The results show that supply is necessary for the OTC market but negatively related with the centralized market, suggesting that the centralized market may provide the much needed services for stocks that are underrepresented in the OTC market, such as smaller stocks and stocks with low IO.

5.1. Pricing efficiency and alternative lending markets: Panel regression analyses

In Table 4, we examine the relation between stock lending market activity and the stock level liquidity and pricing efficiency for TSE listed stocks from July 2006 to December 2009. In the absence of strong consensus in the literature on the choice of pricing efficiency measures, we use an array of proxies, such as: stock lending fees, bid-ask spread, price spread, higher moments of daily returns, return cross-correlation with the market index (i.e., cross correlation), and price delay. We discuss the intuition for these measures and their construction process in Section 3.

[Table 4 about here]

We regress alternative short-sale constraints, liquidity, and market efficiency measures on lending activity in the corresponding lending markets as measured by *Centr_SIR* and *OTC_SIR*:

$$Efficiency_{i,t} = Constant + \beta_2 Centr\_SIR_{i,t} + \beta_3 OTC\_SIR_{i,t} + \beta' StockCharact_{i,t-1} + \alpha_t + \varepsilon_{i,t} \quad (5)$$

where $Efficiency_{i,t}$ includes measures such as the natural logarithm of annualized lending fees in basis points (*Logallfee*), bid-ask spread (*BAspread*), high and low price spread (*HLspread*), moving average 60-day return standard deviation (*Stdev*), moving average 60-day return skewness (*Skew*) and kurtosis (*Kurt*), the natural logarithm of the stock return cross-correlation with the market index using the 60-day moving window (*LnCross*), and the price delay measure (*Delay*) adopted from Hou and Moskowitz (2005). The control variables are firm characteristics like *Size*, *BtoM*, *IO*, *Insider*, *BAspread*, *HLspread*, and *LagRet* as defined for Table 2. All dependent and explanatory variables are standardized with mean zero and one standard deviation. The coefficient estimates with the corresponding *t*-stats are obtained from panel regression analyses allowing for clustering of the standard errors at the week and firm level and weekly time fixed effects.

Model 1 in Table 4 documents the relation between lending fees and the stock lending activity in the two alternative markets. As mentioned above with Eq. 5, we use the natural logarithm of the lending fee in basis point in our regression analyses (*Logallfee*). We find that fees are positively related to borrowing demand in both markets captured by positive coefficients on both *Centr_SIR* and *OTC_SIR*. Interpreting Model 1 results, we find that a one standard deviation increase in *Centr_SIR* is associated with about a 0.13 standard deviation increase in fees, while a one standard deviation increase in *OTC_SIR* is associated with a 0.16 standard deviation increase.[11] As for the stock characteristics, we show that lending fees are higher for stocks with smaller market capitalization, lower book-to-market ratios, higher recent returns, and lower institutional ownership. The results are consistent with U.S. stock lending market studies (e.g., D'Avolio, 2002; Geczy et al., 2002).

Results from Table 4 Models 2 and 3 imply that stocks with greater OTC stock lending market activity exhibit lower illiquidity (i.e., a lower bid-ask spread) and less positive skewness, suggesting lower frequency of extreme positive price swings. Although higher OTC short selling seems to be associated with higher return volatility, the economic impact is relatively negligible compared to the centralized market. Regarding the higher moments (Models 5–7), we find limited evidence that the OTC market has any significant impact. In Model 8, with the price delay measure, the significant positive coefficient on *OTC_SIR* implies that stock price carries more non-macro firm specific information, which is consistent with prior U.S. studies that short sales facilitated through the OTC market are relatively informed trades (Boehmer et al. 2008; Boehmer and Wu, 2013). Taken together, we find that greater OTC stock lending activity on average is associated with greater liquidity and information discovery.

11 The results that demand drives lending fees are almost trivial.

The results from Table 4 Models 2–4 show that the centralized market activity is associated with somewhat lower bid-ask spreads, as well as significantly higher price spreads and return volatility. The results from Models 5 and 6 suggest that centralized market activity is also associated with higher skewness and kurtosis. Lastly, negative coefficient on *Centr_SIR* in Model 7 and the positive coefficient in Model 8 imply that greater centralized stock lending is associated with a slower response to market information and larger price delay. We can interpret these findings that the stock prices of stocks with greater centralized market activity are expected to reveal more firm-specific or idiosyncratic information.

Overall, we provide supportive evidence for *H2A* that on average the OTC market activity has a significant positive pricing efficiency effect in terms of liquidity, short-term volatility, and price discovery. We also provide some evidence to support *H2B*. We show that the centralized lending market also promotes pricing efficiency to some extent at least by supporting the incorporation of private firm-specific information, which is expected as the centralized lending market enables the trading of less connected short sellers who most likely would not be able to participate otherwise. But the results also suggest that with the centralized market, facilitating larger trader pool, short-term and longer-term volatility increase, which may be considered as a cost and an additional risk for traders in the market, and could be also a concern for regulators.

5.2. Pricing efficiency and alternative lending markets: Matched firm approach

We also run non-parametric tests using matched firm approach to determine how stock borrowing demand in the nonregulated OTC and centralized market may influence stock liquidity and pricing efficiency. In our matched firm analysis, we compare the pricing efficiency measure of a specific stock ($Stock_{i,t}$) with the average pricing efficiency of similar stocks during the same week *t* within the same market capitalization, institutional ownership, and turnover

tercile, excluding firms from the same industry, using one-to-many matching. The comparisons of individual stock-specific pricing efficiency measures with their respective benchmark measures are shown in Appendix 4, providing supporting evidence for the validity of our matching. Only the lending fee is significantly different but we do not focus on that measure as a key pricing efficiency indicator.

We are concerned with specific stock characteristics such as size, institutional ownership and turnover because stocks with a small market capitalization and relatively low institutional ownership may have binding short-sale constraints in the OTC market due to their limited supply (Duffie et al., 2002) which could result in persistent mispricing in the presence of high dispersion of investors' opinions (Miller, 1977). Turnover is also a major concern because less liquid stocks are less efficiently priced and short sellers might prefer trading in more liquid stocks where they are unlikely to get caught in a short squeeze and can trade at relatively low cost and risk (Angel et al., 2003; Diether et al., 2009).

[Table 5 about here]

In Table 5, we test the market efficiency implications of the centralized and OTC stock lending activity by quartiles. In Panel A, we report the mean differences of the key pricing efficiency measures of the benchmark firms relative to its benchmark for each quartile of the centralized market activity and for each quartile of the OTC market activity. Consistent with Table 4 results, we find that the relatively higher centralized market activity is associated with lower bid-ask spreads within quartiles but the effect is nonlinear. The nonlinearity is even more pronounced with the price spread (*HLspread*), as we find that the adverse effect of centralized stock lending on price spread is primarily driven by the highest quartile.

In Table 5 Panel A, we examine the market efficiency implications of the OTC market and find that the liquidity improvement in terms of bid-ask spread is concentrated in the top quartile. We also find some evidence of lower skewness and lower cross-correlation with greater OTC stock lending activity. Note that since we matched on turnover to find similar stocks, our matching may have already absorbed some of the benefits of the OTC market activity. Overall, we find some support for our *H2A* that OTC stock lending activity on average promotes pricing efficiency and liquidity, but mixed evidence with the centralized market where higher centralized lending activity implies slightly lower bid-ask spreads in quarters 3 and 4, as well as significantly higher price spreads. While for an average stocks, with good OTC stock lending supply, the centralized market may not play important role, the centralized market may play a major role when the OTC market is constrained, as suggested by Jones and Lamont (2002).

In Table 5 Panel B, in the subsample of stocks with high OTC demand (i.e., for stocks with OTC borrowing activity from the top quartile), we find the centralized lending market does improve liquidity implied by the lower *BAspread* and *HLspreads* in the second and third quartiles. However, this liquidity benefit is not found in the fourth quartile. This finding suggests that if the OTC stock borrowing is high, the centralized market can alleviate the pressure on average but when the centralized market demand is also high, pricing efficiency benefits cannot be realized. We also find s similar pattern with return standard deviation and skewness.

In Table 5 Panel C, we focus on the subsample of small market capitalization stocks, where stocks are included from the lowest quartile of the size distribution each week. The results are largely consistent with those in Panel B. While the centralized stock lending market is shown to alleviate short-sale constraints to some degree, captured by the lower fees, lower bid-ask spreads,

and daily price volatility in quartiles 2 and 3, the benefits are less clear in the top quartile with excessive borrowing pressure.

Taken together, we find that on average that the OTC stock lending market promotes pricing efficiency as likely the relatively informed traders prefer this venue to convey their private information to the market. We also find some evidence that the centralized market promotes pricing efficiency with reduced illiquidity, especially for small market capitalization stocks where the OTC market search costs may pose a greater impediment for short sellers.

5.3. Robustness tests

In Table 6, we present simultaneous regression results on the pricing efficiency implications of the alternative stock lending market. In the regressions, we address the inherent endogeneity that the traders' choice for a specific securities lending market lends support for stock borrowing. We also examine whether the short sale (which is facilitated either through OTC or centralized stock market borrowing) is influenced by stock pricing efficiency. We adopt Hasbrouck and Saar's (2013) equation 4 to test the impact of pricing efficiency of the alternative stock lending market activity in the same vein as they test the impact of market quality of low-latency trading or algorithm trades.

Our system of equations to test for the impact of centralized stock lending market activity is as follows:[12]

$$MQM_{i,t} = a_1 Centr\_SIR_{i,t} + a_2 MQMInstrument_{i,t} + e_{1,i,t} \quad (6)$$

$$Centr\_SIR_{i,t} = b_1 MQM_{i,t} + b_2 CentrSIRInstrument_{i,t} + e_{2,i,t} \quad (7)$$

[12] We use a similar system specification for testing the market impact of OTC stock lending market activity with the following equations: (eq. 6b) $MQM_{i,t} = c_1 OTC\_SIR_{i,t} + c_2 MQMInstrument_{i,t} + \hat{e}_{1t}$ and (eq. 7b) $OTC\_SIR_{i,t} = d_1 MQM_{i,t} + d_2 OTC\_SIRInstrument_{i,t} + \hat{e}_{2t}$.

As before with the matched firms approach in Table 5, we use instruments based on the average stock characteristics of firms within the same market capitalization, IO, and turnover terciles.[13] Hasbrouck and Saar (2013) use market quality measure (MQM) instrument based on the same stocks across different market environment. Unfortunately, we are not able to observe trading outcome, such as price or liquidity outcome, for the same stocks in different markets because the stock lending activity is just a supporting role for a specific type of trade. Therefore, we have to rely on instrumental variables based on similar stocks.[14]

[Table 6 about here]

Table 6 reports the results from the simultaneous equation model. On the left side of the table, we examine the pricing efficiency implications of the centralized lending market and on the right side we examine the OTC market. The positive significant coefficients on a_2 and b_2 (c_2 and d_2) suggest that the stocks make good instruments for examining the centralized market (OTC) market, satisfying the inclusion restriction. In focusing our attention on testing our research hypothesis, the coefficient a_1 measures the effect of centralized lending on the market quality in the left side of Table 5 and the coefficient c_1 measures the effect of OTC stock lending on the market quality in the right side.

The results in Table 6 provide further support for our hypothesis by showing that on average the centralized lending (proxied with *Centr_SIR*) does not reduce lending fees nor the bid-ask spread, suggested by the insignificant a_1 coefficient in Model 1 and the positive coefficient in Model 2. In Models 3 and 4, the significant positive coefficients on a_1 are 0.081 and 0.054 with

[13] In previous versions of the paper, we also used instruments based on stocks within the same size, BtoM and turnover terciles, and the results are consistent.

[14] In instrumenting for stock lending market activity, we exlude firms from the same industry as mentioned with the matched firm approach for Table 4 because short sellers and active traders are known to trade on industry information (Hasbrouck and Saar, 2003; Huszar et al., 2017) and we do not want to have our benchmark measure contaiminated with firm and industry information.

HLspread and *STDev*, suggesting that centralized stock borrowing is associated with higher price volatility and return standard deviation. In terms of skewness, kurtosis, cross-correlation, and price delay, our results are inconclusive; only the kurtosis seems to be significantly higher with centralized stock lending.[15] Focusing on the OTC market implications, the significant negative coefficients on c_1 in the *BAspread* and *HLspread* regressions strongly suggest that short selling facilitated via OTC borrowing improves liquidity and reduces within-day extreme price swings. The OTC stock lending activity also seems to increase price delay, as suggested by the positive c_1 coefficients in the last regression (in Model 8) with the price delay measure.

Overall, the results in Table 6 provide further support for our second sets of hypothesis (*H2A* an *H2B*) that the alternative markets have significantly different impacts on liquidity and stock-level pricing efficiency.

6. Conclusion

Lending transactions are traditionally arranged in the nontransparent OTC market among large institutional investors worldwide. Although the OTC market serves well for the large liquid stocks that are readily available from institutional lenders, in developing countries with low institutional ownerships, regulators often consider operating centralized lending market to provide liquidity while maintaining regulatory oversight.

In this study, we are one of the first to examine the functioning of centralized and OTC stock lending markets side by side. In the context of TSE listed stock from July 2006 to December 2009, we find that the alternative securities lending markets have complementary roles. Specifically, we show that the demand drivers of the two markets are different, which suggest

15 Saffi and Sigurdsson (2011) suggest that higher skewness is associated with lower supply (in the form of short-sale constraints), but higher positive skewness is also associated with lower returns (Conrad et al., 2009). Normally, low skewness lottery-type stocks are associated with retail investors on the buy side, but on the short side there is no prior evidence to our knowledge.

some market segmentation. In general, the unregulated OTC market facilitates price discovery by reducing short-term price volatility, and facilitating liquidity. On the other hand, the centralized lending market activity tends to increase volatility, potentially by allowing less-connected and less-informed traders to participate. We also note that the centralized market relaxes short-sale constraints by offering a substitute-short sale venue and promotes liquidity for small stocks, but fails to substitute for the OTC market's price discovery role.

Overall, we show that on average the pricing efficiency benefits of centralized market is limited to a subset of stocks where the OTC market is likely to be constrained. With these results we also call for regulatory caution in further restricting OTC stock lending market activity because relatively informed traders likely to abstain from trading completely rather than to move over to centralized markets. We hope that our research gives regulators and researchers a better understanding of the implications of different market settings and encourage future research.

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Table 1
Summary Statistics of Tokyo Stock Exchange (TSE) First Session Stocks for July 2006 to December 2009

The summary statistics are shown for key stock and market characteristics. *Centr_SIR* and *OTC_SIR* are the number of shares out on loan relative to the total number of shares in the centralized lending market and the OTC market, respectively. *MarketshareCentr* is the percentage of the centralized market of the total stock lending. *Supply* is the percentage of total shares available for borrowing as reported by Markit, and *Allfee* is the value-weighted average annualized lending fee on all contracts outstanding as reported by Markit in basis points. $BAspread_{-1w}$ and $HLspread_{-1w}$ are the previous week's average daily bid-ask spread relative to the average daily bid-ask price and the daily highest and lowest price spread, scaled by the daily high price, while *LogBAspread* and *LogHLspread* are the natural logarithm of the previous measures. The *Stdev*, *Skew*, and *Kurt* are the return standard deviation, skewness and kurtosis calculated based on the last 60 trading days. *Crosscorr* is the cross-autocorrelation between individual stock returns and market returns (TOPIX) lagged by one week, and *LnCross* is the natural logarithm of the *Crosscorr* measure. *Delay*, the price delay measure, is adopted from Hou and Moskowitz (2005), based on the regression of daily stock returns on the contemporaneous returns of a world index and the local index (TOPIX) and four lags of the local index using a moving window of 60 trading days. *RawRet* is the one-week holding period returns in percent. *Size* is the natural logarithm of the firm's stock market capitalization in million ¥. *MtoB* is the firm's stock market capitalization relative to the firm's book value of equity. *Turnover* is the daily number of shares traded relative to the total shares outstanding.

	Both markets (162,608)				Only OTC market (44,978)				Only Centralized market (43,894)			
	Mean	p25	p50	p75	Mean	p25	p50	p75	Mean	p25	p50	p75
Centr_SIR	0.274	0.063	0.139	0.308	0.000	0.000	0.000	0.000	0.676	0.088	0.214	0.688
OTC_SIR	1.200	0.216	0.632	1.559	0.886	0.069	0.310	1.024	0.000	0.000	0.000	0.000
MarketshareCentr	27.596	8.525	19.198	40.421	0.000	0.000	0.000	0.000	100.000	100.000	100.000	100.000
Supply	5.325	2.299	4.431	7.550	2.507	0.491	1.545	3.532	2.385	0.601	1.751	3.306
Allfee	108.010	23.467	54.183	159.953	193.754	58.881	167.048	300.000	154.101	37.742	98.138	237.313
BAspread	0.005	0.003	0.004	0.006	0.011	0.005	0.008	0.012	0.007	0.004	0.005	0.009
HLspread	0.030	0.020	0.027	0.036	0.034	0.020	0.029	0.041	0.031	0.019	0.027	0.038
LogBAspread	1.175	0.448	0.916	1.748	2.239	1.099	1.887	2.649	0.930	0.301	0.717	1.332
LogHLspread	3.131	2.393	3.099	3.796	3.563	2.336	3.231	4.120	2.507	1.795	2.426	3.105
Stdev	0.025	0.017	0.023	0.030	0.028	0.019	0.025	0.034	0.026	0.017	0.023	0.032
Skew	0.144	–0.203	0.131	0.482	0.275	–0.166	0.210	0.637	0.258	–0.201	0.190	0.650
Kurt	1.574	0.081	0.777	2.028	2.306	0.382	1.264	2.905	2.301	0.327	1.222	2.900
Crosscorr	0.581	0.494	0.594	0.681	0.429	0.344	0.433	0.518	0.540	0.452	0.548	0.636
LnCross	1.412	1.114	1.407	1.709	0.964	0.736	0.952	1.179	1.280	1.001	1.264	1.546
Delay	0.355	0.265	0.342	0.429	0.434	0.331	0.420	0.525	0.380	0.285	0.366	0.460
RawRet	-0.288	–3.163	–0.335	2.545	–0.145	–3.247	–0.293	2.526	0.516	–2.623	0.000	3.065
Size	11.517	10.409	11.378	12.513	10.115	9.204	10.015	10.937	10.087	9.312	9.961	10.715
MtoB	1.326	0.798	1.136	1.698	1.747	0.726	1.090	1.796	1.153	0.652	0.916	1.384
IO	0.139	0.058	0.121	0.198	0.117	0.025	0.076	0.174	0.070	0.023	0.046	0.098
Insider	0.363	0.246	0.345	0.473	0.437	0.328	0.446	0.566	0.413	0.302	0.408	0.531
Turnover	0.048	0.001	0.003	0.006	0.118	0.001	0.002	0.006	0.053	0.001	0.002	0.005

Table 2

Panel regression analyses of the intensity of centralized and OTC stock lending market activity

The dependent variables are the fraction of the total securities lending executed in the central market (*MarketshareCentr*) or the OTC lending (*OTC_SIR*) and the centralized lending (*Centr_SIR*) relative to the total shares outstanding. The explanatory variables are a natural logarithm of the total market capitalization (*Size*), book-to-market ratio, institutional ownership (*IO*) and insider ownerships (*Insider*) as a percentage of the total shares outstanding, bid-ask spread (*BAspread*), high and low price spread (*HLspread*), and the previous week's cumulative return (*LagRet*). The variables (both dependent and explanatory variables) are standardized with mean zero and unit standard deviation. The coefficient estimates with the corresponding *t*-stats in parenthesis are from panel regression analyses with time fixed effect and double clustered standard errors at the week and firm level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(Model 1)	(Model 2) MarketshareCentr	(Model 3)	(Model 4)	(Model 5) Centr_SIR	(Model 6)	(Model 7)	(Model 8) OTC_SIR	(Model 9)
$HighCentralSIR_{t-1}$		0.448***	–0.039		0.832***	0.340***		–0.135***	–0.159***
		(20.90)	(–1.34)		(25.03)	(6.30)		(–6.58)	(–6.41)
$HighOTCSIR_{t-1}$		–0.453***	–0.080***		0.049**	0.041**		0.923***	–0.050
		(–21.39)	(–3.91)		(2.48)	(2.01)		(27.35)	(–0.67)
$MarketshareCentr_{t-1}$			1.140***						
			(41.54)						
$Centr\_SIR_{t-1}$						0.319***			
						(7.75)			
OTC_SIR_{t-1}									0.257***
									(10.09)
Size	0.045	0.040	0.022	0.002	0.015	0.004	–0.079	–0.052	–0.033
	(1.00)	(1.02)	(0.70)	(0.03)	(0.33)	(0.10)	(–1.43)	(–1.11)	(–0.73)
BtoM	–0.051*	–0.046*	–0.029	–0.058*	–0.050*	–0.052**	0.032	0.030	0.013
	(–1.72)	(–1.85)	(–1.48)	(–1.66)	(–1.83)	(–2.04)	(0.99)	(1.07)	(0.49)
IO	–1.944***	–1.612***	–1.363***	0.055	0.155	0.153	2.915***	2.330***	1.792***
	(–7.58)	(–6.85)	(–6.72)	(0.22)	(0.72)	(0.75)	(9.71)	(8.74)	(6.98)
Insider	–0.494**	–0.380*	–0.378**	–0.354*	–0.236	–0.231	0.339	0.238	0.123
	(–2.21)	(–1.89)	(–2.35)	(–1.65)	(–1.32)	(–1.34)	(1.17)	(0.97)	(0.53)
BAspread	–0.023***	–0.019***	–0.018***	–0.085***	–0.073***	–0.068***	–0.030***	–0.030***	–0.029***
	(–3.88)	(–3.22)	(–2.78)	(–12.58)	(–11.71)	(–10.97)	(–4.39)	(–4.64)	(–4.89)
HLspread	0.116***	0.103***	0.099***	0.251***	0.223***	0.209***	–0.004	–0.002	–0.006
	(13.12)	(13.05)	(13.64)	(16.44)	(17.01)	(16.75)	(–0.54)	(–0.33)	(–0.84)
LagRet	1.198***	1.056***	0.778***	1.770***	1.567***	1.449***	–0.518***	–0.420***	–0.363***
	(14.26)	(13.17)	(11.12)	(15.84)	(14.70)	(13.72)	(–7.03)	(–6.27)	(–5.41)
Constant	0.104***	0.312***	–0.124***	0.068***	0.106***	0.044***	0.027**	–0.319***	–0.456***
	(10.42)	(31.13)	(–9.62)	(5.07)	(8.27)	(3.24)	(2.20)	(–30.90)	(–25.89)
R^2	0.079	0.121	0.294	0.069	0.143	0.169	0.077	0.156	0.221
Observations	251,480	247,689	247,689	251,480	247,689	247,689	251,480	247,689	247,689

Table 3

Logistic regression analyses for explaining the coexistence of alternative stock lending markets

The dependent variable, *BothMarket*, takes the value of 1 if the stock in a specific week has securities lending activities in both the centralized and the offshore markets. The two dummy variables $HighCentralSIR_{-1}$ and $HighOTCSIR_{-1}$ enter as zero or one variables, capturing whether the stocks had high stock borrowing, from the top decile of the distribution, in the respective stock lending market last week. $BothD_{-1}$, $OTConly_{-1}$ and $Centronly_{-1}$ dummies take on the value of one for stocks with both markets active, only OTC market active, or only centralized market active during the previous week, respectively. The explanatory variables are *Size*, *BtoM*, *IO*, *Insider*, *BAspread*, *HLspread*, and *LagRet* as defined in Table 2. All variables are standardized with mean zero and unit standard deviation. The coefficient estimates with the corresponding *t*-stats in parenthesis are obtained from panel regression analyses with time fixed effect and double clustered standard errors at the week and firm level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(Model 1) BothMarket	(Model 2) BothMarket	(Model 3) BothMarket	(Model 4) Centronly	(Model 5) Centronly	(Model 6) Centronly	(Model 7) OTConly	(Model 8) OTConly	(Model 9) OTConly
$HighCentralSIR_{t-1}$		–0.478***	0.107*		1.783***	0.676***		–7.993***	–2.860***
		(–5.09)	(1.81)		(18.88)	(12.14)		(–11.30)	(–3.95)
$HighOTCSIR_{t-1}$		1.196***	0.579***		–6.431***	–4.094***		–0.065	0.020
		(7.66)	(7.18)		(–23.74)	(–15.26)		(–0.42)	(0.19)
$BothD_{t-1}$			6.090***						
			(98.53)						
$Centronly_{t-1}$						5.444***			
						(121.34)			
$OTConly_{t-1}$									12.066***
									(36.58)
Size	–0.380***	–0.364***	–0.136***	0.244**	0.246***	0.083	0.347***	0.348***	–0.140
	(–4.66)	(–4.74)	(–3.27)	(2.53)	(2.83)	(1.57)	(4.60)	(3.93)	(–0.65)
BtoM	0.086*	0.075*	–0.001	–0.129*	–0.079	–0.015	–0.011	–0.026	0.102
	(1.77)	(1.72)	(–0.06)	(–1.79)	(–1.32)	(–0.45)	(–0.28)	(–0.53)	(0.49)
IO	1.258***	0.605*	0.536***	–1.963***	–0.876*	–0.921***	0.009	–0.131	0.071
	(4.20)	(1.91)	(2.91)	(–4.65)	(–1.75)	(–2.91)	(0.04)	(–0.51)	(0.17)
Insider	0.822**	0.691**	0.564***	–0.499	–0.088	–0.241	–0.788***	–1.103***	–1.075**
	(2.55)	(2.11)	(3.20)	(–1.08)	(–0.17)	(–0.84)	(–2.96)	(–3.78)	(–2.09)
BAspread	0.021**	0.016*	0.020*	–0.040***	–0.011	–0.020	0.007	–0.011*	–0.043
	(2.56)	(1.94)	(1.86)	(–3.33)	(–0.88)	(–1.54)	(1.15)	(–1.78)	(–0.96)
HLspread	–0.057***	–0.044***	–0.210***	0.142***	0.078***	0.233***	–0.055***	–0.012	–0.082
	(–5.67)	(–4.36)	(–12.79)	(10.07)	(5.52)	(14.12)	(–5.95)	(–1.16)	(–0.96)
LagRet	–0.888***	–0.698***	0.890***	1.441***	0.905***	–0.832***	–0.113**	0.210***	0.785
	(–13.72)	(–10.44)	(5.51)	(16.39)	(9.49)	(–4.44)	(–2.17)	(3.29)	(0.96)
Constant	0.642***	0.843***	–2.316***	–1.453***	–2.225***	–4.231***	–1.700***	–1.367***	–7.307***
	(9.67)	(13.08)	(–16.86)	(–18.62)	(–23.06)	(–27.16)	(–19.43)	(–19.07)	(–8.41)
Pseudo R^2	0.011	0.03	0.727	0.019	0.116	0.660	0.003	0.046	0.970
Observations	251,480	247,689	247,689	251,480	247,689	247,689	251,480	247,689	247,689

Table 4

Panel regression analyses for examining the pricing efficiency implications of the alternative lending markets

The dependent variables are alternative short-sale constraints, liquidity and market efficiency measures such as natural logarithm of annualized lending fees in basis points (*Logallfee*), bid-ask spread (*BAspread*), high and low price spread (*HLspread*), moving average 60-day return standard deviation (*Stdev*), moving average 60-day return skewness (*Skew*) and kurtosis (*Kurt*), the natural logarithm of the stock return cross-correlation with the market index using the 60-day moving window (*LnCross*) and the price delay measure (*Delay*) adopted from Hou and Moskowitz (2005). The explanatory firm characteristics, *Size*, *BtoM*, *IO*, *Insider*, and *LagRet*, are defined in Table 2. All dependent and explanatory variables are standardized with mean zero and unit standard deviation. The coefficient estimates with the corresponding *t*-stats are obtained from panel regression analyses allowing for clustering of the standard errors at the week and firm level and weekly time fixed effect. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	(Model 1) Logallfee	(Model 2) BAspread	(Model 3) HLspread	(Model 4) Stdev	(Model 5) Skew	(Model 6) Kurt	(Model 7) LnCross	(Model 8) Delay
Centr_SIR	0.124***	–0.031***	0.135***	0.119***	0.026***	0.054***	–0.006*	0.049***
	(15.34)	(–5.64)	(24.30)	(21.31)	(3.70)	(7.76)	(–1.93)	(8.05)
OTC_SIR	0.158***	–0.022***	–0.002	0.021***	–0.016**	0.004	0.000	0.012**
	(16.51)	(–4.76)	(–0.56)	(5.04)	(–2.56)	(0.76)	(0.11)	(2.37)
Size	–0.510***	–0.447***	–0.138***	–0.136***	0.182***	–0.078**	0.002	0.248***
	(–10.02)	(–10.69)	(–3.98)	(–3.68)	(4.43)	(–2.14)	(0.12)	(5.97)
BtoM	–0.141***	0.052*	–0.026	–0.049**	0.031	–0.004	0.008	0.107***
	(–3.67)	(1.83)	(–1.18)	(–2.10)	(1.26)	(–0.21)	(0.88)	(4.27)
IO	–0.808***	–0.005	0.217*	–0.012	–0.537**	0.070	–0.000	0.067
	(–2.91)	(–0.03)	(1.77)	(–0.08)	(–2.56)	(0.34)	(–0.00)	(0.33)
Insider	0.395	0.507***	–0.105	–0.107	0.298*	0.376**	–0.011	0.271
	(1.59)	(3.12)	(–0.94)	(–0.76)	(1.70)	(2.31)	(–0.28)	(1.64)
LagRet	0.373***	0.156	0.264	0.277**	1.462***	0.093	–0.148*	0.109
	(6.05)	(1.54)	(1.25)	(2.43)	(9.66)	(0.88)	(–1.92)	(0.98)
Constant	0.200***	0.043***	–0.120***	–0.317***	–0.106***	–0.045***	–0.312***	–0.260***
	(15.30)	(4.20)	(–13.66)	(–35.40)	(–9.66)	(–4.82)	(–52.18)	(–26.52)
R^2	0.189	0.355	0.541	0.688	0.060	0.071	0.274	0.122
Observations	251,480	251,480	251,480	251,480	251,480	251,480	251,480	251,480

Table 5
Matched Firm Approach for Examining the Implications of Alternative Stock Lending Markets
The table shows the mean differences (with *t*-statistics in parenthesis) of key pricing efficiency measures for stocks by securities lending activity quartiles relative to their matched firms. The matched firms are identified within the same market capitalization, institutional ownership, and turnover tercile during the previous week excluding the focal firm's industry for the matching. The pricing efficiency measures (*LogAllFees*, *BASpread*, *HLSpread*, *Stdev*, *Skewness*, *Kurtosis*, *Lncross*, and *Delay*) are defined in Table 1. Panel A reports the full sample results, Panel B reports the subsample results based on stocks with high OTC stock borrowing, with demand from the top quartile and Panel C reports the subsample results based on small stocks, stocks from the bottom size quartile. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Full Sample Results

Efficiency Measures		*Centr_SIR* Q=1	Q2	Q3	*Centr_SIR* Q=4
LogAllFees	Mean Diff	–0.275***	–0.608***	–0.432***	–0.048***
	(*t*-stats)	(–75.13)	(–202)	(–140)	(–14.79)
BASpread (in %)	Mean Diff	0.238***	–0.106***	–0.092***	–0.039***
	(*t*-stats)	(42.49)	(–59.41)	(–64.68)	(–24.35)
HLspread (in %)	Mean Diff	0.073***	–0.220***	–0.078***	0.239***
	(*t*-stats)	(10.41)	(–58.94)	(–18.86)	(41.13)
Stdev	Mean Diff	0.074***	–0.202***	–0.073***	0.213***
	(*t*-stats)	(17.08)	(–81.07)	(–26.33)	(59.18)
Skewness	Mean Diff	0.030***	–0.051***	–0.015***	0.035***
	(*t*-stats)	(9.92)	(–19.92)	(–5.33)	(10.87)
Kurtosis	Mean Diff	0.033***	–0.220***	–0.008	0.177***
	(*t*-stats)	(2.61)	(–23.29)	(–0.70)	(13.78v
Lncross	Mean Diff	–0.164***	0.072***	0.056***	0.050***
	(*t*-stats)	(–110.00)	(48.00)	(37.54)	(35.10)
Delay	Mean Diff	0.030***	–0.016***	–0.011***	–0.006***
	(*t*-stats)	(56.35)	(–33.98)	(–23.14)	(–12.20)
Efficiency Measures		*OTC_SIR* Q=1	Q2	Q3	*OTC_SIR* Q=4
LogAllFees	Mean Diff	–0.529***	–0.400***	–0.294***	–0.138***
	t-value	(–140)	(–132)	(–94.09)	(–40.13)
BASpread (in %)	Mean Diff	–0.017***	0.041***	0.005**	–0.026***
	t-value	(–4.65)	(9.73)	(1.97)	(–18.83)
HLspread (in %)	Mean Diff	–0.023***	–0.055***	0.001	0.089***
	t-value	(–3.97)	(–9.97)	(0.26)	(17.74)
Stdev	Mean Diff	–0.045***	–0.046***	0.014***	0.089***
	t-value	(–12.56)	(–12.86)	(4.39)	(27.00)
Skewness	Mean Diff	0.006*	–0.010***	–0.005*	0.009***
	t-value	(1.83)	(–3.40)	(–1.83)	(3.14)
Kurtosis	Mean Diff	–0.032**	–0.084***	0.024**	0.076
	t-value	(–2.43)	(–7.45)	(2.13)	(7.18v
Lncross	Mean Diff	0.050***	0.006***	–0.003*	–0.040***
	t-value	(36.37)	(3.63)	(–1.78)	(–25.57)
Delay	Mean Diff	–0.009***	0.000	0.001	0.006***
	t-value	(–17.78)	(–0.16)	(1.27)	(11.04)

Table 5 continued

Panel B. Subsample results based on stocks with high OTC_SIR

Efficiency Measures		*CentrSIR* Q=1	Q2	Q3	*CentrSIR* Q=4
LogAllFees	Mean Diff	0.091***	–0.418***	–0.332***	–0.023***
	(*t*-stats)	(11.53)	(–57.07)	(–56.02)	(3.86)
BASpread (in %)	Mean Diff	0.081***	–0.069***	–0.064***	–0.036***
	(*t*-stats)	(17.00)	(–22.35)	(–34.70)	(–19.30)
HLspread (in %)	Mean Diff	0.446***	–0.265***	–0.096***	0.203***
	(*t*-stats)	(30.32)	(–28.95)	(–13.21)	(23.46)
Stdev	Mean Diff	0.375***	–0.224***	–0.071***	0.203***
	(*t*-stats)	(41.76)	(–34.97)	(–14.51v	(36.16)
Skewness	Mean Diff	0.074***	–0.024***	–0.011**	0.004
	(*t*-stats)	(11.35)	(–3.92)	(–2.28)	(0.73)
Kurtosis	Mean Diff	0.039	–0.059***	0.055***	0.177***
	(*t*-stats)	(1.54)	(–2.58)	(2.96)	(9.43)
Lncross	Mean Diff	–0.214***	–0.009***	–0.009***	0.021***
	(*t*-stats)	(–65.62)	(–2.24)	(–3.15)	(8.50)
Delay	Mean Diff	0.036***	–0.004***	–0.001	–0.002***
	(*t*-stats)	(29.71)	(–2.98)	(–1.10)	(–2.74)

Panel C. Subsample results with small stocks

Efficiency Measures		*Centr_SIR* Q=1	Q2	Q3	*Centr_SIR* Q=4
LogAllFees	Mean Diff	–0.219***	–0.614***	–0.350***	–0.040***
	(*t*-stats)	(–37.02)	(–72.48)	(–42.51)	(7.46)
BASpread (in %)	Mean Diff	0.410***	–0.165***	–0.139***	–0.004
	(*t*-stats)	(30.61)	(–26.80)	(–25.19)	(0.73)
HLspread (in %)	Mean Diff	0.191***	–0.330***	–0.170***	0.330***
	(*t*-stats)	(12.57)	(–33.25)	(–14.22)	(23.09)
Stdev	Mean Diff	0.168***	–0.278***	–0.147***	0.255***
	(*t*-stats)	(17.88)	(–42.98)	(–19.44)	(31.44)
Skewness	Mean Diff	0.070***	–0.087***	–0.086***	0.016**
	(*t*-stats)	(11.70)	(–12.46)	(–9.67)	(1.97)
Kurtosis	Mean Diff	0.273***	–0.271***	0.111***	0.470***
	(*t*-stats)	(10.38)	(–9.86)	(2.94)	(14.20)
Lncross	Mean Diff	–0.156***	0.052***	0.027***	–0.001***
	(*t*-stats)	(–79.19)	(19.39	(9.28)	(–0.56)
Delay	Mean Diff	0.032***	–0.015***	–0.013***	0.003***
	(*t*-stats)	(36.36)	(–13.94)	(–11.07)	(2.90)

Table 6

Simultaneous regression analyses of the pricing efficiency implications of the centralized and OTC lending market activity

In each model, two equations run simultaneously, one using a pricing efficiency measure for the stock and another capturing the short sale activity in the centralized market or in the OTC market for the specific stock in a specific week (*t*). In each model, the MQM_i is the stock-specific pricing efficiency measure (as defined in Table 4) and *MQMInstrument* is the average pricing efficiency measure based on similar stocks outside of the host industry. $Centr\_SIR_i$ $(OTC\_SIR_{,i})$ is the stock borrowing activity in the centralized market to support short sales while $CentrSIRInstrument_{i,}$ $(OTCSIRInstrument_i)$ is the average borrowing activity by other similar stocks in the market of the benchmark stocks where benchmark stocks are identified as stocks within the same market capitalization, institutional ownership and turnover tercile outside of the focal firm industry. The coefficient estimates are reported with the *p*-values in parentheses.

Simultaneous Equations for Testing the Pricing Efficiency Implications of the Central Lending Market:

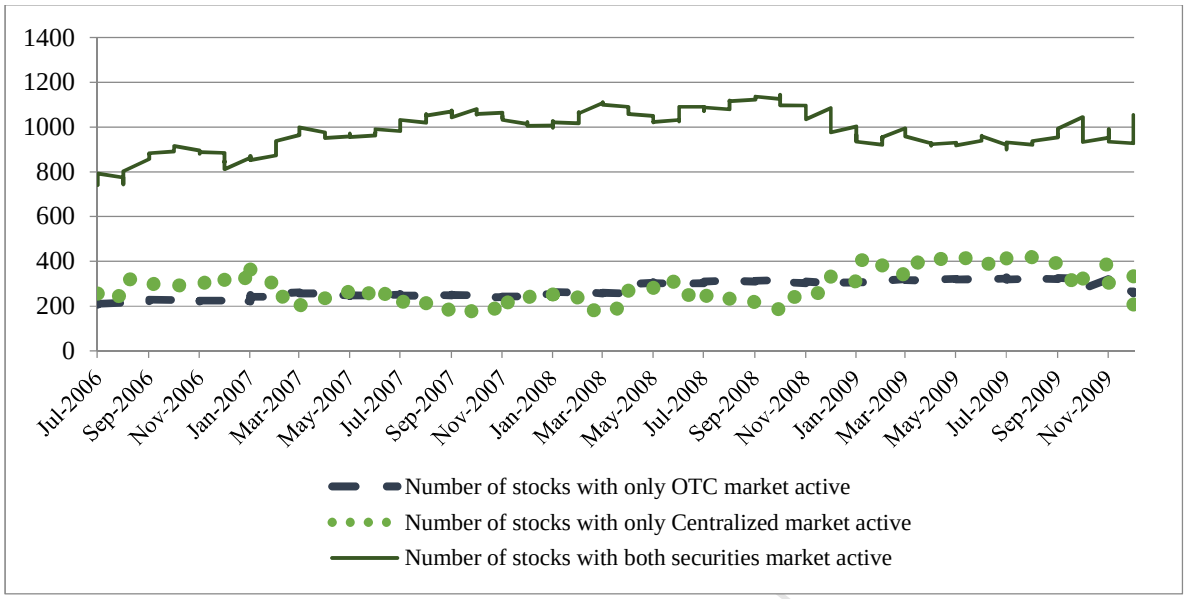
$MQM_{i,t} = a_1\, Centr\_SIR_{i,t} + a_2\, MQMInstrument_{i,t} + e_{1t}$ and $Centr\_SIR_{i,t} = b_1\, MQM_{i,t} + b_2\, CentrSIRInstrument_{i,t} + e_{2t}$.

Simultaneous Equations for Testing the Pricing Efficiency Implications of the OTC Lending Market:

$MQM_{i,t} = c_1\, OTC\_SIR_{i,t} + c_2\, MQMInstrument_{i,t} + \hat{e}_{1t}$ and $OTC\_SIR_{i,t} = d_1\, MQM_{i,t} + d_2\, OTCSIRInstrument_{i,t} + \hat{e}_{2t}$.

		Central lending market and pricing efficiency				OTC lending market and pricing efficiency				
		a_1	a_2	b_1	b_2		c_1	c_2	d_1	d_2
Model 1:	*LogAllfee*	–0.006	0.292	0.092	0.199	*LogAllfee*	0.208	0.271	–0.030	0.197
		(0.732)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.222)	(0.000)
Model 2:	*BAspread*	0.026	0.525	–0.554	0.198	*BAspread*	–0.024	0.523	0.020	0.193
		(0.004)	(0.000)	(0.000)	(0.000)		(0.006)	(0.000)	(0.082)	(0.000)
Model 3:	*HLspread*	0.081	0.729	0.009	0.205	*HLspread*	–0.023	0.730	0.035	0.190
		(0.000)	(0.000)	(0.160)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
Model 4:	*Stdev*	0.054	0.826	0.021	0.205	*Stdev*	0.013	0.827	–0.005	0.191
		(0.000)	(0.000)	(0.005)	(0.000)		(0.003)	(0.000)	(0.552)	(0.000)
Model 5:	*Skew*	0.008	0.209	0.018	0.204	*Skew*	0.122	0.223	–0.150	0.180
		(0.623)	(0.000)	(0.184)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)
Model 6:	*Kurt*	0098	0.235	–0.047	0.207	*Kurt*	0.036	0.234	–0.031	0.193
		(0.000)	(0.000)	(0.000)	(0.000)		(0.035)	(0.000)	(0.059)	(0.000)
Model 7:	*LnCross*	0.012	0.442	–0.016	0.205	*LnCross*	0.012	0.443	–0.024	0.191
		(0.057)	(0.000)	(0.004)	(0.000)		(0.054)	(0.000)	(0.000)	(0.000)
Model 8:	*Delay*	0.028	0.324	0.018	0.205	*Delay*	0.160	0.342	–0.171	0.177
		(0.054)	(0.000)	(0.153)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)

Panel A. Time series of the total number of TSE stocks with active alternative stock lending markets



Panel B. Time series of the percentage of the total market capitalization of TSE stocks with active alternative stock lending markets

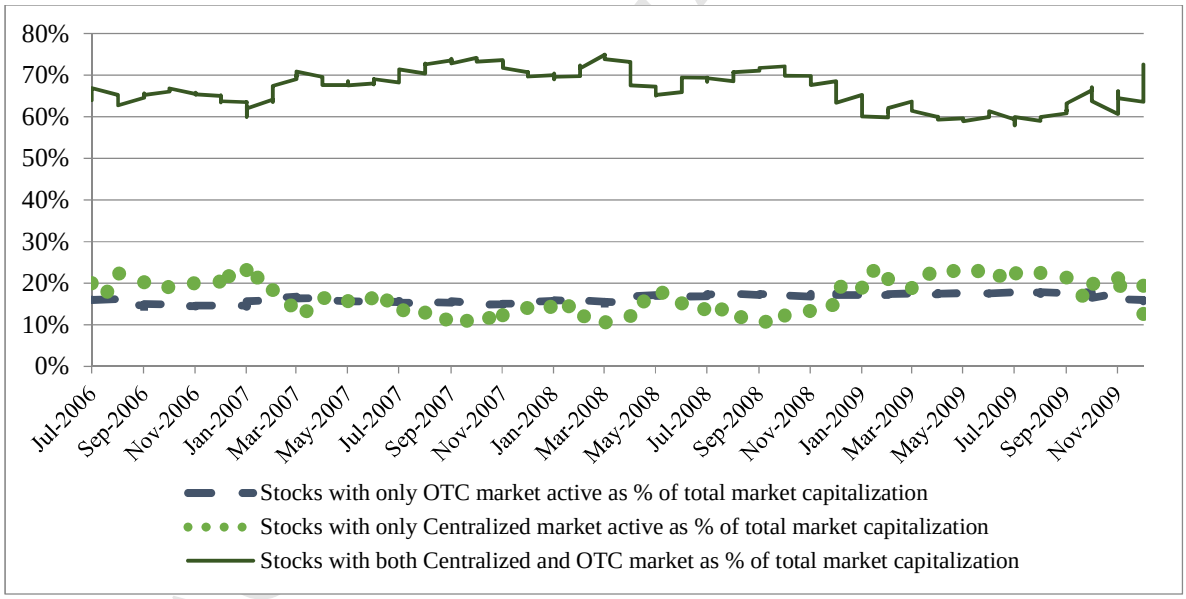
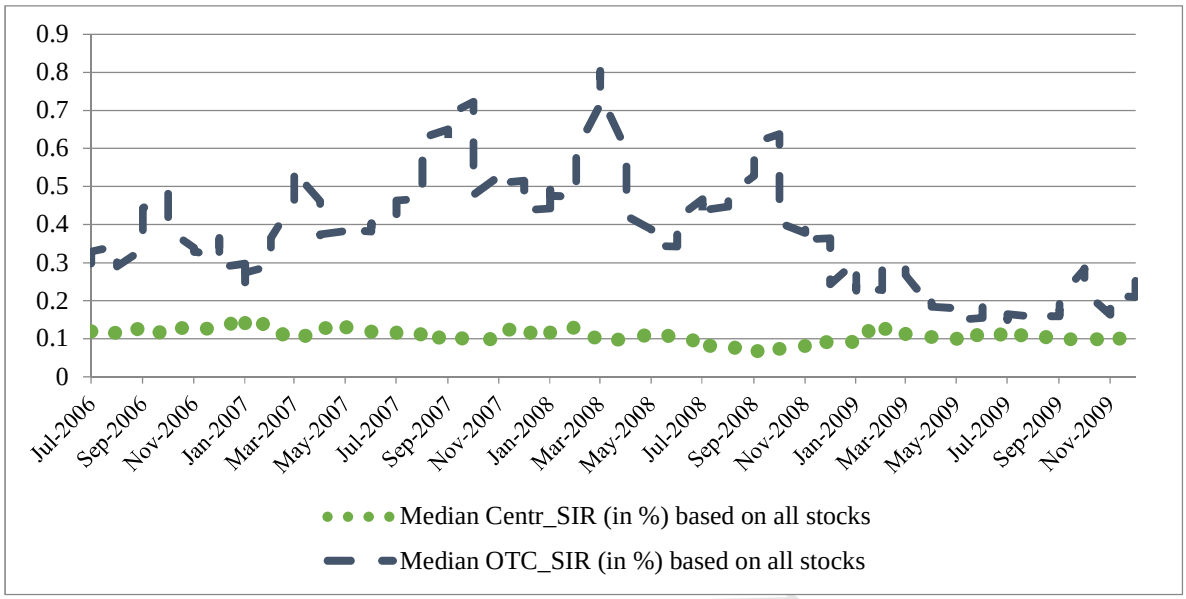


Figure 1

OTC and the centralized stock lending market coverage for TSE stocks from July 2006 to December 2009

Panel A. Time-series of median SIR of stocks with active centralized and OTC stock lending markets



Panel B. Time-series of the 90th percentile SIR based on centralized and OTC stock lending

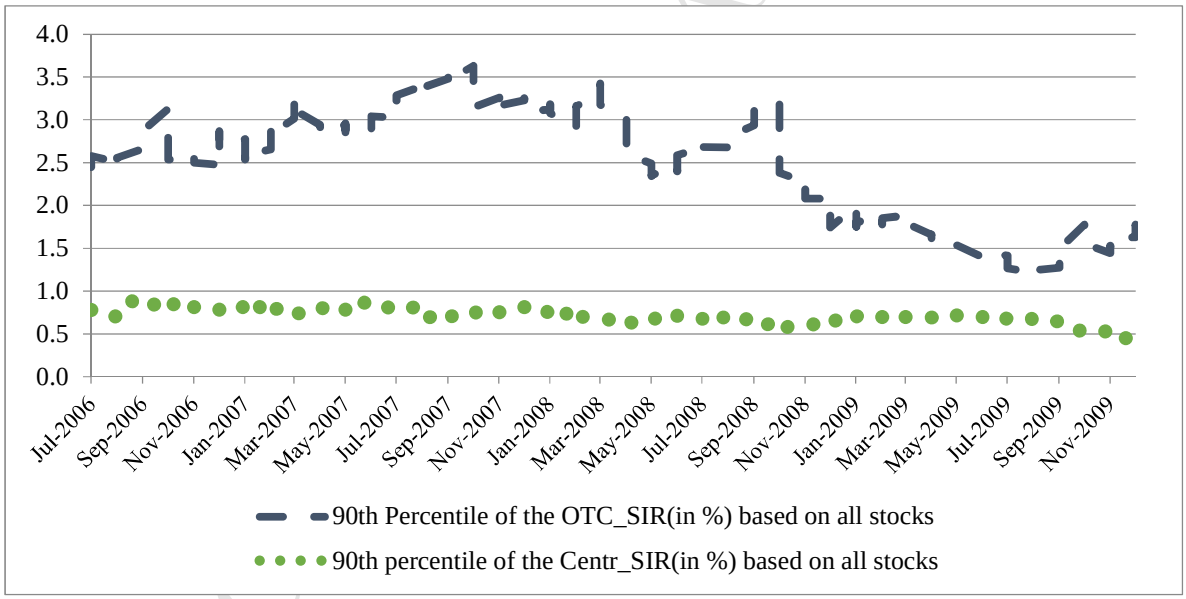
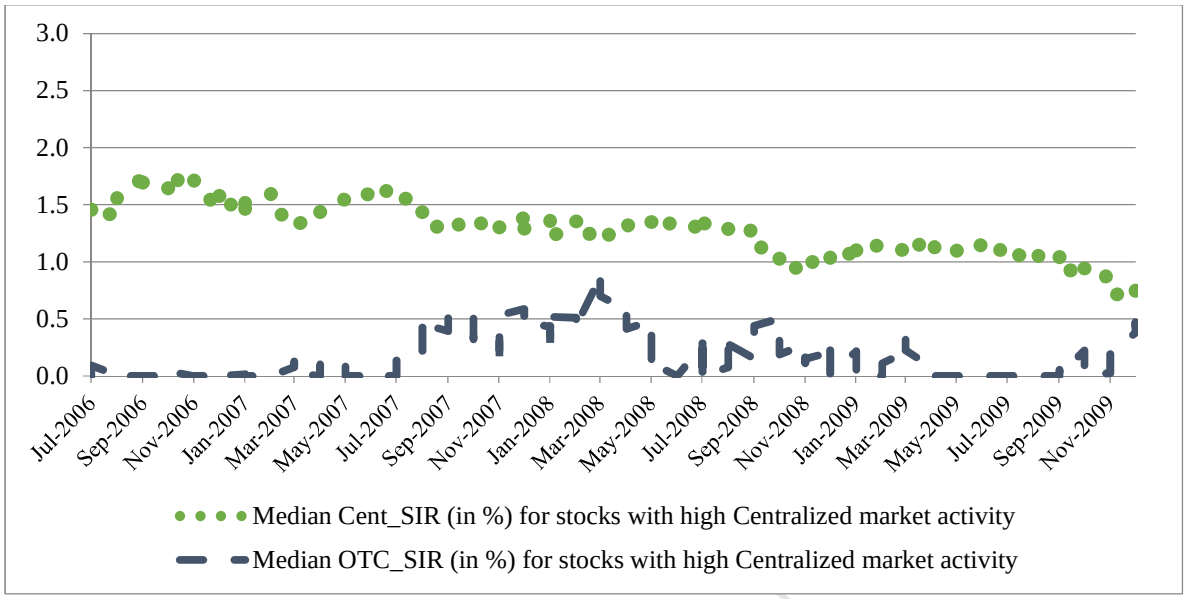


Figure 2
Market activity of the OTC and centralized stock lending for TSE stocks from July 2006 to December 2009

Panel A. Time series of the median centralized market SIR (Centr_SIR) and OTC market SIR (OTC_SIR) based on stock from the top decile of the centralized stock lending



Panel B. Time series of the median centralized market SIR (Centr_SIR) and OTC market SIR (OTC_SIR) based on stock from the top decile of the OTC stock lending

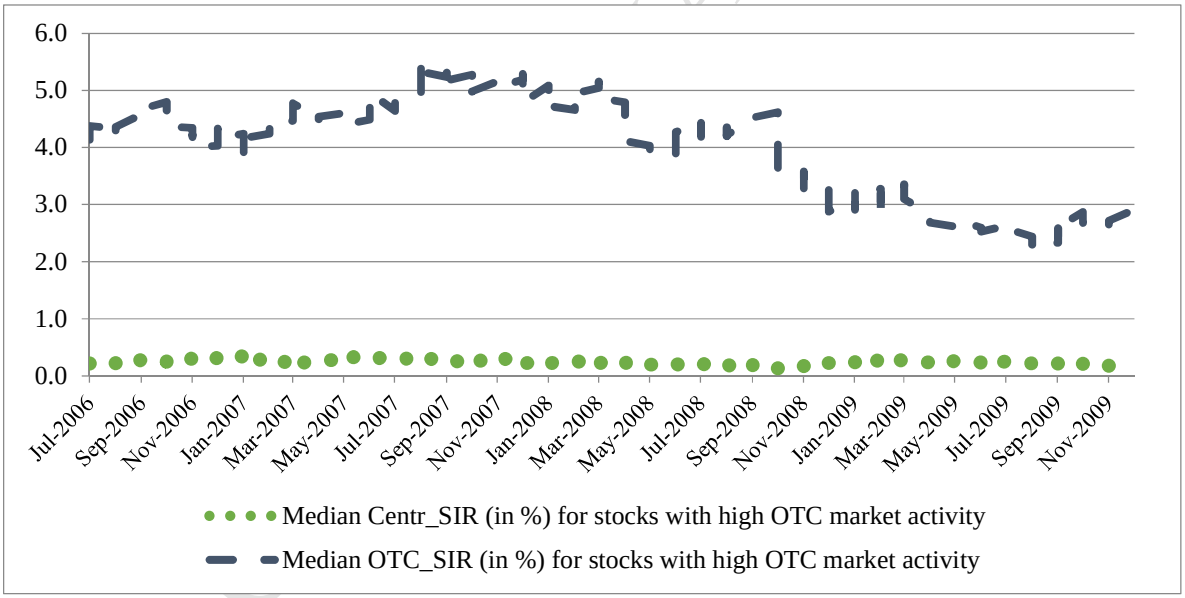


Figure 3

Time series of the market activity of the OTC and centralized stock lending markets for the subsample of stocks with high demand in either market, from July 2006 to December 2009

Appendix 1
Summary of private centralized stock lending markets and exchange operated centrally cleared stock lending markets around the world

Exchanges	Functioning and brief description
Bursa Malaysia Derivatives Clearing Berhad (BMDC), in Malaysia (Centralized and OTC lending)	The SBL Central Lending Agency (SBL CLA) model was introduced in January 2007 as the first phase of the securities borrowing and lending framework. It acts as the central lending agency for all securities borrowing and lending (SBL) activities conducted in Malaysia, and participants must comply with the terms and conditions as directed by Bursa Clearing (S). On August 4, 2009, Burse Malaysia announced the introduction of Securities Borrowing and Lending - Negotiated Transaction (SBLNT), an enhanced securities borrowing and lending (SBL) model that offers an option to borrow and lend securities on an over-the-counter (OTC) basis in addition to the centralized system. *Source: Burse Malaysia News (Issue 3, Vol 1), Oct. 2009, http://bursa.listedcompany.com/newsroom/BursaBytes_3Q09.pdf)*
Central Depository (Pvt.) Ltd. for SGX, Singapore	The Central Depository (Pvt.) Ltd. (CDP) is a wholly owned subsidiary of the Singapore Exchange Ltd. (SGX), providing integrated clearing, settlement, and depository facilities for the Singapore Securities Market, including both equities and fixed-income instruments. As a clearinghouse, CDP also clears and settles all transactions in the stock market through its book-entry settlement system. In August 2010, SGX rolled out an improved version of their Securities Borrowing and Lending Program, with the objective of raising the overall liquidity on the local bourse. In the past, the number of stocks eligible for lending or borrowing via CDP hovered around 150. With the enhancement, this pool of stocks has now expanded to over 600, representing more than 80% of the total listed stocks on the SGX Mainboard and Catalist. The fees/costs are standardized and fixed (about 4% to lenders and 6% to borrowers) through CDP in Singapore and are generally higher than the industry norm. *Source: SGX Website, https://www1.cdp.sgx.com/sgx-cdp-web/login* *Chua, 2010.*
SBL, Taiwan Stock Exchange SBL facilities, in Taiwan	The Taiwan Stock Exchange acts as the clearinghouse for all trades executed in the TWSE's market. All participants must comply with the various regulations of the Securities and Exchange Act (SEA), as well as with the chapters and articles of "Clearing and Settlement" of TWSE. To accommodate the Taiwan market to a developed one, TWSE launched a centralized securities borrowing and lending (SBL) system in June 2003 to meet the needs of qualified institutional investors while TWSE serves as an intermediary. This system provides three kinds of transactions: fixed-rate, competitive bid, and negotiated transaction. In terms of SBL trading volume for 2011, competitive bid transactions accounted for 32% and negotiated transactions accounted for 68%. Starting in July 2007, qualified securities firms and securities finance companies are allowed to conduct SBL business acting as principal. Investors thus have additional options, borrowing not only from the existing TWSE SBL system but also from qualified securities firms and securities finance companies (TWSE, 2012). *Source: TWSE Website, http://www.twse.com.tw/en/clearing/rules.php*
SecFINEX, EU markets prior to 2011	Initially known as PPA Capital Limited, later as SecFINEX, a subsidiary of the Euronext supported centralized lending through an electronic stock lending and borrowing platform from 2000 to 2011. The trading platform covered Dutch, French, German, Irish, Italian, Japanese, Spanish, Swedish, Swiss, UK, and U.S. equities, and the transactions were cleared through LCH Clearnet and SIX x-clear. SecFINEX was dismantled in 2011, primarily because of low liquidity as the shareholders struggled financially support the functioning of the company in the prevailing economic climate turmoil. *Source: SecFinex Company Overview- Bloomberg* *http://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=72*

	4670; SecFINEX shutdown- Bloomberg, http://www.bloomberg.com/news/articles/2011-11-30/nyse-euronext-to-close-secfinex-stock-lending-business
Eurex Clearing for Germany, Switzerland, with growing EU and global coverage	Eurex Clearing AG was granted authorization as a Central Counterparty (CCP) under the European Market Infrastructure Regulation (EMIR) on April 10, 2014. The authorization as an EMIR-compliant CCP also determines Eurex Clearing as a qualifying CCP (QCCP) under Basel III / CRD IV. Eurex Clearing provides clearing services for the broadest range of products, including derivatives, equities, bonds, and secured funding, for both the listed products and the OTC market. It is a licensed credit institution under supervision of the BaFin pursuant to the Banking Act, and also authorized under European Market Infrastructure Regulation (EMIR). It has partnered with the Irish Stock Exchange, Global Markets Exchange Group, and the European Association of Clearing Houses to provide a full range of market services, including transaction management, risk management, and collateral management. (*Source: Eurex Clearing Website, http://www.eurexclearing.com/clearing-en/about-us/* Eurex clearing is effectively taking over SecFinex's market positon but in collaboration with Clearstream. Clearstream's liquidity hub provides tri-party services and collateral management, in conjunction with securities lending. In the automated platform market, participants (lenders, borrower, custodial firms, and banks) can easily manage their lending/borrowing needs/costs and collateral requirements.
BM&FBOVESPA S.A. in Brazil (central clearing)	BM&FBOVESPA's main objectives are to manage organized markets for clearing and settlement services, acting mainly as a central counterparty for the financial settlement of transactions carried out in the markets it manages. Acting as the CCP, Brazilian Clearing and Depository Corporation (CBLC), CBLC is responsible for the settlement of all securities lending transactions. The country's securities lending facility (locally known as BTC) is fully integrated into the CCP environment; although the contracts are still tailor-made based on agreement among brokerages (or other registered users) and fees/costs vary (Chague et al. JFE 2017). Authorized investment funds are permitted to act as both lenders and borrowers, where the CBCL will be clearing the transactions. In addition, securities lending positions can be used as collateral for other transactions since they are held by the CCP. Another advantage of BTC is the processing of significant corporate events in the lifecycle of transactions for lenders, such as dividends. In terms of market size, in 2015 June, 123,285 transactions were executed with a financial volume amounting to BRL 61.64 billion. *(Source: BM&FBOVESPA Investor Relations, Group Companies and Services, http://ir.bmfbovespa.com.br/static/enu/empresas-do-grupo.asp?idioma=enu)* *Source: Nicol(2015), Country focus - Brazil*
New Zealand Clearing and Depository Ltd. In New Zealand	New Zealand Clearing and Depository Corporation Limited (NZCDC) provides securities safe-keeping services, stock lending and borrowing, and settlement of transactions between participants. Every Clearing participant is required to be a Depository participant. Participation is intended for institutional investors, including brokers, custodians, and fund managers; it does not cater to retail participation. Clearing Participants can act as borrowers (e.g., borrow securities from the lending pool, subject to the provision of eligible collateral) or lenders (place securities in the lending pool and be selected to lend securities). *(Source: New Zealand Stock Exchange, Clearing house participants, https://www.nzx.com/services/participant_types)*
Option Clearing Corporation (OCC) central clearing of stock loan transactions	On December 16, 2010, the Options Clearing Corporation ("OCC") filed with the Securities and Exchange Commission a proposed rule change pursuant to Section 19(b)(1) of the Securities Exchange Act of 1934 ("Act") with regard to the OCC role in clearing securities lending transactions. When a stock loan

	transaction is submitted to and accepted by OCC for clearance, OCC substitutes itself as the lender to the borrower and as the borrower to the lender, thus serving a function for the stock loan market similar to the one it serves for the listed options market. OCC guarantees the future daily mark-to-market payments, which are effected through OCC's cash settlement system, between the lending clearing member and borrowing clearing member, and guarantees the return of the loaned stock to the lending clearing member and the return of the collateral to the borrowing clearing member on close-out of the stock loan transaction. One advantage of submitting stock loan transactions to OCC is that the stock loan and stock borrow positions then reside in the clearing member's options account at OCC and, to the extent that they offset the risk of options positions carried in the same account, may reduce the clearing member's margin requirement in the account. Under the OCC stock loan program, the loaned securities are moved to the account of the borrower against cash collateral (normally 102%) through the facilities of the Depository Trust Company ("DTC"). DTC notifies OCC that the movement has occurred at the time the transaction is submitted for clearance. The securities are returned to the lender against return of the cash collateral through the same mechanism. This OCC margin requirement is in addition to the cash collateral that is transferred to the stock lender and may be deposited in any form constituting acceptable margin collateral under OCC Rule 604. (SEC, 2011) The OCC role as CCP in securities lending has been booming in 2016. During the first months of the year, a relative increase of over 40% was reported over the previous year. The average daily loan value at OCC in March 2016 was about $145 billion. (OCC, 2016)

Appendix 2

Review of the Japanese stock borrowing and lending markets

Short selling has been active for decades in Japan, where traders represent all types of investors, including retail investors, local institutions, and foreign institutions. To promote liquidity and development of the stock market, Japan Securities Finance Co. (JSFC) launched its securities lending services in 1977 to generate liquidity by attracting retail investors to securities lending and short selling without significant counterparty risk. JSFC facilitates the centralized (or standardized) market. For the exact definition of standard margin contracts, visit the Japan Exchange Group website: http://www.jpx.co.jp/english/equities/trading/margin/outline/.

For the regulated centralized market, most stock borrowings are filled internally from margin accounts at low rates published weekly. However if the demand exceeds the internal stock loan supply, the demand is met through an auction market (Hirose et al., 2009). Each day the JSFC publishes the borrowing requirements of market participants so that holders of stocks can submit their best offers in an effort to capture those lending opportunities. In this procurement, the securities finance company holds an auction to decide the lender of the stock and the fee the securities finance company pays to the lender, where the fee is referred to as the "premium charge." For more information and technical details, consult the reports by Sungard, which has provided infrastructure support for the daily auctions in Japan since 2012 (Lawson, 2012). The information for these so-called standardized and negotiated margin shorts (literal translation from Japanese) is available at the end of the week at the stock level from NEEDS. NEEDS provides the end of the week outstanding margin shorts information for standardized and negotiated contracts separately. These data are available to regulators and the public alike.

On the other hand, the OTC facilitated stock borrowings are nontransparent, the Japanese regulators have little if any oversight of a stock borrowing contract of Toyota Shares between two U.S. funds This lack of transparency is the major concern for regulators, which makes short selling hard to control and regulate as the short sellers act as a legal owner selling a stock on the TSE that is borrowed in an OTC contract. In OTC lending/borrowing setting, "usual" bilateral or tripartite stock lending arrangements can be made with foreign brokerages or custodians, these transactions are generally beyond regulatory oversight. The borrower and/or borrower's agent arrange these contracts; significant search costs could be relevant if the stock in question is not readily available from major custodial firms (e.g., State Street). For more information on "traditional" OTC lending/borrowing, see Duffie et al. (2002) or Geczy et al. (2002).

The TSE first section consists of large liquid Japanese stocks with significant institutional and retail ownership. Each stock any point in time can be borrowed either in the OTC or in the centralized market.

Note on variable construction:
Centralized (scandalized) shorts are measured based on the data reported by NEEDS. Following Saffi and Sigurdsson (2011) and the extant short-sale literature which takes Dataexplorer (IHS Markit) data as the securities lending market domain, we assume that Dataexplorer data captures the full universe and we calculate OTC (offshore) shorts as the total stock borrowing reported by Markit – NEEDS reported margin shorts. While we may underestimate the OTC market this way, our calculation has no effect at all on the centralized market measure. We truncate this measure and set all observations zero when the NEEDS reported margin shorts exceed the stock borrowing reported by Markit because in these cases were are unable to infer whether the centralized market is not captured fully or whether there are truly some OTC contracts executed. In robustness analysis, we defined the OTC market as the raw Dataexplorer data without subtracting the NEEDS short position. Our analyses are available upon request, with findings economically and statistically comparable to those reported in the main table of this text.

Appendix 3

A. Table 7 The return predictability of OTC and centralized stock lending activity

The dependent variables are: In Models 1–4, the contemporaneous weekly cumulative raw and market excess returns are *RawRet* and *ExcRet*, respectively. In Models 5–8, the dependent variables are the next week's cumulative raw returns (*L1RawRet*) and excess returns (*L1ExcRet*). The variables are all standardized with the exception of the dummy variables, *HighCentrSIR* and *HighOTCSIR*, which take on the value of one for stock-week observations when the stock is from the top decile of the distribution of centralized or OTC stock lending market activity. The explanatory variables are *Size*, *BtoM*, *IO*, *Insider*, *BAspread*, *HLspread*, and *LagRet* as defined in Table 2. All variables are standardized with mean zero and unit standard deviation. The coefficient estimates with the corresponding *t*-stats in parenthesis are obtained from panel regressions with adjusted with time fixed effect and double clustered standard errors at the week and firm level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively

	(Model 1)	(Model 2)	(Model 3)	(Model 4)	(Model 5)	(Model 6)	(Model 7)	(Model 8)
	RawRet	ExcRet	Rawret	ExcRet	L1RawRet	L1ExcRet	L1RawRet	L1ExcRet
HighCentrSIR	0.083***	0.100***	0.078***	0.095***	0.019	0.371	0.018	0.358
	(5.79)	(5.61)	(5.54)	(5.35)	(1.33)	(1.03)	(1.23)	(1.01)
HighOTCSIR	-0.038***	-0.041***	-0.028**	-0.030**	-0.014	-0.196	-0.011	-0.180
	(-3.08)	(-2.88)	(-2.36)	(-2.23)	(-1.19)	(-0.73)	(-0.98)	(-0.68)
BothD			-0.046***	-0.047***			-0.012	-0.064
			(-4.48)	(-4.76)			(-1.14)	(-0.30)
Size	0.129***	0.141***	0.126***	0.137***	-0.244***	-4.528***	-0.243***	-4.504***
	(3.87)	(2.98)	(3.81)	(2.93)	(-6.98)	(-4.58)	(-6.98)	(-4.60)
BtoM	0.023	0.019	0.023	0.021	0.093***	1.842***	0.093***	1.858***
	(1.59)	(1.05)	(1.64)	(1.12)	(5.39)	(4.41)	(5.54)	(4.54)
IO	-0.017	-0.018	-0.032	-0.033	0.498***	9.846***	0.496***	9.952***
	(-0.23)	(-0.20)	(-0.43)	(-0.36)	(6.80)	(6.41)	(6.80)	(6.49)
Insider	0.096*	0.096	0.099*	0.099	0.175***	2.309*	0.176***	2.366*
	(1.81)	(1.55)	(1.87)	(1.59)	(3.00)	(1.79)	(3.05)	(1.85)
BAspread	0.003	0.004	0.003	0.004	-0.002	0.019	-0.001	0.035
	(0.75)	(0.85)	(0.76)	(0.89)	(-0.57)	(0.21)	(-0.34)	(0.39)
HLspread	0.134***	0.147***	0.134***	0.147***	0.014*	0.273	0.013*	0.248
	(6.88)	(6.96)	(6.92)	(6.97)	(1.94)	(1.62)	(1.83)	(1.49)
LagRet	-0.799***	-0.864***	-0.803***	-0.869***	0.062	-0.647	0.065	-0.423
	(-7.59)	(-7.14)	(-7.73)	(-7.23)	(0.66)	(-0.29)	(0.71)	(-0.18)
Constant	0.051	0.034	0.077*	0.062*	-0.027	-1.004	-0.020	-0.949
	(1.25)	(0.98)	(1.97)	(1.69)	(-0.63)	(-1.41)	(-0.49)	(-1.30)
R^2	0.091	0.096	0.097	0.100	0.048	0.051	0.053	0.055
Observations	251,480	251,480	251,480	251,480	248,368	248,368	248,368	248,368

Appendix 4

A. Table 8 Testing the validity of the benchmark pricing efficiency measures

This table presents the results for the comparison of the pricing efficiency measures of a specific borrowed stock with that of the instruments or benchmark measures, where the benchmarks established based on the averages of similar stocks within the same market capitalization, institutional ownership, and turnover tercile, excluding firms from the same industry, using one-to-many matching. We report the pooled means (with standard deviation in parenthesis) for the key stock characteristics, the pooled means for the benchmarks, and the mean differences with the mean difference *t*-tests. The specific stock characteristics are : the natural logarithm of annualized lending fees in basis points (*Logallfee*), bid-ask spread (*BAspread*), high and low price spread (*HLspread*), moving average 60-day return standard deviation (*Stdev*), moving average 60-day return skewness (*Skew*), and kurtosis (*Kurt*), the natural logarithm of the stock return cross-correlation with the market index using the 60-day moving window (*LnCross*) and the price delay measure (*Delay*) adopted from Hou and Moskowitz (2005).

Pricing Efficiency Measures	Observations	Stock (i) Mean (Std. dev)	Benchmark Mean (Std. dev)	Mean-Difference (*t*-statistics)
Logallfee	252320	4.345	4.685	-0.340
		(0.002)	(0.001)	(-200.000)
BAspread	252803	0.006	0.006	0.000
		(0.000)	(0.000)	(0.235)
HLspread	252803	0.031	0.031	0.000
		(0.000)	(0.000)	(1.279)
Stdev	252803	0.026	0.026	0.000
		(0.000)	(0.000)	(1.812)
Skew	252803	0.187	0.187	0.000
		(0.002)	(0.000)	(-0.034)
Kurt	252803	1.839	1.844	-0.004
		(0.006)	(0.002)	(-0.775)
Lncross	252803	1.308	1.305	0.004
		(0.001)	(0.000)	(4.598)
Delay	252803	0.373	0.374	-0.001
		(0.000)	(0.000)	(-2.604)

Highlights for JFM_2017_77

"An Analysis of Over-the-Counter and Centralized Stock Lending Markets"

This study provides insights into :

- functioning of centralized and OTC stock lending
- pricing efficiency implications of centralized and OTC stock lending
- the potential costs and benefits of centralized stock lending
- regulatory debates about moving towards centralized lending