Internationalization of Futures Markets: Lessons from China

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Abstract

Foreign access to China's commodity futures markets was obstructed until 2018. This paper is the first to examine the impact of internationalization on the quality of Chinese iron ore and purified terephthalic acid (PTA) futures markets. We compare market quality in terms of trading activities, costs and price volatilities before and after internalization. Using a difference-in-difference framework, we find that internationalization improves market quality for PTA futures, while the opposite effect is observed for iron ore futures. Such divergence is not caused by the activity of hedgers and speculators. Instead, decreases in market quality for iron ore are largely explained by the erosion of locational arbitrage opportunities. Overall, the effects of internationalization appear to differ on commodities, thus its success must be assessed cautiously on a case-by-case basis.

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1. Introduction

China's commodity futures market has been a closed shop until the launch of the new crude oil contract in March 2018. For the first time, foreign individual investors were allowed to directly participate in a yuan-denominated commodity market. However, less known to the world, existing products such as PTA (purified terephthalic acid) and iron ore were subsequently opened to investors outside of mainland China. This opening is a part of the government's larger plan to internationalize its commodity futures markets. By the end of 2020, foreign investors will likely be granted access to more than 10 commodity futures products.[1] In this paper, we examine the impact of internationalization on the market quality of PTA and iron ore futures in China.

Commodities play a key role in the growth of the real economy, which is of particular importance to China due to the transition from a manufacturing to a consumption-based economy. A well-functioning futures market not only facilitates the effective risk-transfer between producers/consumers and speculators, but also ensures the efficient price discovery of physical commodities. Due to its strategic and economic significance, the development of the country's commodity futures markets has long been kept under close scrutiny by the government. However, reasons such as the rapid accumulation of debts, the structural reforms of state-owned-enterprises (SOEs), along with the increasing political pressure, the unprecedented growth once experienced by the world's second largest economy has slowed substantially in recent years. To address these challenges, the Chinese government has taken a series of concrete steps towards accelerating the liberalization of its capital markets, such as the abolishment of the investment quota restrictions for Qualified Foreign Institutional

[1] Products internationalized in 2018 include: crude oil (March), iron ore (May), PTA (November). In 2019: STR rubber (August), fuel oil (December). Products under discussion include methanol, soybeans, palm oil, LLDPE, PP, copper, aluminum, nickel, zinc, lead and tin.

Investors (QFII) and the RMB QFII in 2019, the removal of window guidance for banks' deposit rates in 2018, and the easing of foreign ownership limits in the financial sector in 2017.

The internationalization of the commodity futures market is another item on the agenda of ongoing efforts. The rationale behind the internationalization is three-fold. First, while China remains the world's largest consumer of major commodities, it has been a price-taker through much of its modern history (Fung *et al.*, 2003; Liu & An, 2011). Thus, internationalizing its futures markets is expected to improve China's influence on the pricing of global commodities. Second, internationalized markets are likely to provide a risk management tool tailored for Chinese corporations (both the SOEs or privately-owned), which are increasingly expanding their reach overseas. Third, the decision on internationalization complements the development of the ambitious infrastructure project–"One-Belt-One-Road (OBOR)"[2]. The core of the OBOR involves economic aids in the form of fixed-term debts to governments and corporations along with the routes of the OBOR. Consequently, an internationalized futures market will provide the much-needed platform for debt holders to hedge the price risk of its key production in- or outputs (Smith & Stulz, 1985), thereby reducing the default risk on loans. A smooth and successful internationalization of the commodity futures market is hence paramount for the Chinese government in achieving the objectives discussed above.

While the literature is scant on the effect of internationalization in commodity futures markets, the abundant empirical evidence on emerging stock markets generally praises the increased openness for two reasons. First, foreign ownership reduces the volatility of local stocks due to improved risk-sharing (Li *et al.*, 2011), reduced cost of equity capital (Henry,

[2] There are two main components to the OBOR. The first is the development of the land-based "Silk Road Economic Belt", connecting China with central Asia, Eastern and Western Europe. The second part is revival of the "Maritime Silk Road", connecting China's southern coast to the Mediterranean, Africa, Southeast and Central Asia. The "Belt" refers to a network of roads, and the "Road" represents the sea route. The OBOR also includes oil refineries, industrial parks, power plants, mines, and fiber-optic networks, all designed to make it easier for the world to trade with China.

2000) and enhanced corporate governance (Leuz *et al.*, 2008). Second, the increased presence of foreign investors positively contributes to the liquidity and price discovery of local stocks (He & Shen, 2014; Lee & Chung, 2018; Ng *et al.*, 2015). However, studies also raise concerns about the aggressive liquidity demand of foreign investors in the short-run (Bae *et al.*, 2004) and the role of foreign speculative capital as a major cause of financial crises (Stiglitz, 2002). In the case of equity markets in China specifically, Schuppli & Bohl (2009) document that foreign institutions have a stabilizing effect and contribute positively to market efficiency. Chen *et al.* (2013) show that ownership by foreign institutions increases firm-level stock return volatility, while foreign individual shareholdings reduce volatility. More recently, Ding *et al.* (2017) find foreign investor participation to improve the liquidity of affected stocks by enhancing trading activities and price discovery, particularly for stocks covered under the QFII.

This paper examines the impact on market quality of the foreign investor introduction in China's iron ore and PTA futures markets on May 5, 2018, and November 30, 2018, respectively. Based on an extensive set of ultra-high frequency data on iron ore and PTA futures, as well as a control group for each of these commodities, and additional controls for business cycle variations, we construct market quality measures such as quote spreads, market depth, order size, volume and realized volatility. We start with a univariate analysis before moving on to a difference-in-difference approach. Subsequently, additional tests are conducted to shed further light on the results, followed by a battery of robustness tests.

Our proposed tests are important for the literature for three main reasons. First, commodity prices are driven by the inventory and hedging pressure dynamics, and hence, one cannot simply draw inferences based on findings from stocks given the large institutional differences. Second, as a retail-dominant market with unique regulatory settings, the Chinese commodity futures market is characterized by excessive speculation and strong behavioral biases (Fan & Zhang, 2019). Consequently, foreign investors with higher levels of presumed experience, rationality and information may improve the market quality for PTA and iron ore futures.[3] Otherwise, foreign investors could aggressively demand liquidity in the short run (Bae *et al.*, 2004) or expose these commodities to international shocks that local investors were shielded from before the market opening (Stiglitz, 2002), and accordingly, affect the behavior of local investors. Third, since the Chinese commodity futures market has been a segmented market until 2018, this paper offers "first-hand" evidence in assessing the effectiveness of the internationalization decision. Our findings are of immediate relevance to regulators for the design and implementation of the remaining commodity markets yet to be opened to foreign investors. Therefore, if adverse effects are detected, the current policy must be revised to prevent further escalation and the spread to other non-internationalized markets.

We present several key findings to the literature. First, we find that internationalization has improved the market quality of PTA futures. After market-opening, the PTA market exhibits an increase in trading volume and number of trades without any notable effect on trading cost. For example, the volume increased by 869 thousand contracts on average and the number of trades increased by 5,640 trades on average post-internationalization. The new trades were larger in size and the bid-ask depths significantly increased. Furthermore, the volatility of PTA futures has increased, likely due to the higher market activity documented. The positive effects of internationalization on PTA futures are consistent with the existing literature showing that a stronger presence of foreign investors is associated with an improved liquidity of local markets (e.g., He & Shen, 2014; Lee & Chung, 2018; Ng *et al.*, 2015).

Second, in contrast, internationalization appears to have the opposite effect on the iron ore market. We find that iron ore market has become less active in terms of trading volume,

[3] For instance, the Iron Ore futures contracts traded on the SGX (TSI Iron Ore 62%) and NYMEX (TIO: Iron Ore 62% Fe, CFR China (TSI)) have been available to global investors for a considerable period, while PTA futures contracts are only traded in China at the time of writing.

number of trades, and is more costly to trade as evident from the increased quoted and effective spreads. For example, the percentage of small trades increased by 13%, while the medium and large trades deceased by 6-7%. The realized spread has decreased but the price impact has strongly increased post to market-opening, suggesting that traders who left the market were, in relative terms, less informed. The deterioration in market activity is driven by a decrease in the revenue for liquidity providers and, in relative terms, an increase in adverse selection. Our findings also reveal that currency and US-China interest rate-spread play a larger role in the pricing of iron ore compared to the PTA futures.

Our third main finding emerges from the investigation of the driving forces behind the puzzling contradiction. We do not find conclusive evidence suggesting the divergent reactions to market-opening are due to hedgers' and speculators' activities. Instead, we observe that he decreases in market activity and quality for iron ore futures are largely explained by the eroded arbitrage opportunities. Our findings suggest that large local arbitrageurs had withdrawn from the market in China due to significantly diminished arbitrage profits, as a result of the increased participation by foreign arbitrageurs post-internationalization. This notion is consistent with previous literature observing arbitrage opportunities in emerging markets with trading barriers (Ansotegui *et al.*, 2013) and a higher extent of mispricing in markets segmented by foreign investment barriers (Gagnon & Karolyi, 2006).

The paper is structured as follows. Section 2 provides an overview of the Chinese iron ore and PTA markets. Section 3 presents the data, methodology and results. Section 4 contains further analysis and discussion of the results. Section 5 conducts the robustness test and Section 6 concludes the paper with policy recommendations.

2. Institutional Settings

2.1. Iron Ore (62% Fe Fines)

Iron ores are rocks and minerals mined from the earth's crust. Iron is extracted from iron ore to produce steel–a fundamental input for the production of automobiles, ships, railways, roads, buildings, appliances and seaports, airports and other infrastructures. Needless to mention, iron ore as a raw material has played a significant role in the rapid expansion of the Chinese economy over the past decades. China has been the world's largest producer and consumer of steel since early 2000, with more than half of the world's production in 2017 (China Futures Association, 2018). Due to the colossal demand on steel, China dominates the global iron ore trade. However, to source iron ore, China has been relying heavily on imports from Australia, Brazil, South Africa and India. According to Mysteel.com–a leading data provider for the Chinese steels industry, China's iron ore foreign dependence is as high as 88.7% in 2018.

The price of spot iron ore was once determined by long-term forward contracts, which rendered futures contracts unnecessary. Since the introduction of the benchmark price index–the Platts Iron Ore Index in 2008, spot price volatility presents a new challenge for producers and manufacturers. The world's first iron ore swaps contract launched on the Singapore Exchange (SGX) in 2009, and the futures contract launched in 2013. To address the hedging demand of domestic companies, China launched its iron ore futures contract on the Dalian Commodity Exchange (DCE) in 2013. In the following year, NYMEX launched a third iron ore contract on December 8, 2014. The DCE contract has since become the world's most actively traded iron ore market. However, due to DCE's closed nature, Goldman Sachs (2016) note that the SGX contract has more pricing power, even though the DCE volume is 20 times larger. Motivated by the development of the OBOR, China moved to internationalize its iron futures market in 2018 and launched its crude oil futures contract in the same year. This decision marks the first step towards improving China's pricing power of global commodities.

The iron futures contract officially opened to foreign investors on May 4, 2018. As of July 2019, 150 international investors from more than 12 countries opened trading accounts including Singapore, the UK, Australia, France and Japan (China Securities Daily, 2019a). Although the DCE and regulators claimed "fivefold" increases in foreign trading volumes (Xinhuanet, 2019), international investors only accounted for 2% and 1% of the daily trading volume and open interest, respectively (China Securities Daily, 2019a). This is likely explained by the existence of rival exchanges in Singapore and New York, which trade iron ore contracts of the same grade. Appendix A details the contract specifications of top iron ore exchanges. The DCE stands out as the only exchange which requires physical settlement (like the majority of other commodities in China). Other noticeable differences include the settlement currency, a more strict position limit in the spot month, and a unique pattern of time-variant margins, i.e. margin requirements are substantially higher in delivery months.

2.2. PTA

Purified Terephthalic Acid (a.k.a. PTA), is a key raw material used in the production of plastics such as polyester fiber, PET (polyethylene terephthalate) bottle resin and polyester film. It is also widely used in the manufacturing of clothing, general metal, appliances, automotive and industrial maintenance. The origin of PTA can be traced to naphtha, produced from petroleum distillates and natural gas condensates. The paraxylene (PX) is derived through the reforming of naphtha, which is then oxidized to produce PTA.[4] Due to its heavy usage in the petrochemical (the upstream market) and textile industries (the downstream market), PTA is one of the most important commodities for the Chinese economy.

[4] Refer to www.hitachi.com/businesses/infrastructure/product_site/ip/process/pta.html

China is the world's largest producer and consumer of PTA. In 2017, China produced 55% of the world's PTA, in which six of the top ten global manufacturers are based in China (Plastics Insight, 2019). However, back in 2006, when the PTA futures contract was first introduced on the Zhengzhou commodity exchange, the PTA industry in China was unequivocally reliant on imports (more than 50%). By the end of 2017, this reliance was down to merely 1.5%, and the country has now become a top four exporter of PTA (Plastics Insight, 2019). Nevertheless, the majority of PX is still imported (China Industry Research, 2018).

Given the rapid rise of the industry, the PTA production chain in China is relatively mature. The decision to internationalize the PTA futures market is owing to three facts. First, a large volume of international trades exists in both the upstream and downstream markets. Second, since PTA futures are not traded elsewhere, the internationalized contract will meet the hedging demand of producers and consumers outside of China (e.g. G.S.I. Global Service and British Petroleum). Third, the market has been in operation for more than 12 years, and 90% of the PTA and 80% of PX firms reportedly use futures contracts for hedging purposes (China Economic Daily, 2018).

The PTA futures market was officially opened to foreign investors on November 30, 2018. As of July 2019, 104 international accounts were opened, of which 92 were institutional, comprised of corporations and financial institutions from Singapore, the UK, New Zealand, Australia and special jurisdictions Hong Kong and Taiwan (China Securities Daily, 2019a). These international investors accounted for 7.83% (1%) of the daily trading volume (open interest). However, due to the lack of understanding of the ZCE and trading rules, international PTA hedgers are reluctant to participate. Although the trading volume and open interest of foreign investors are still relatively small, this is expected to improve over time. Overall, the level of international participation meets the initial expectation of the regulators (China Futures Daily, 2019).

3. Methodology and Results

3.1. Data

Our choice of sample period is dictated by the event of internationalization. To test the impact of the event on market quality, we must employ data prior and post to the internationalization. At the time of writing, PTA and iron ore are the only existing contracts opened to foreign investors, as the crude oil contract launched in March 2018 and the STR rubber contract launched in August 2019 were made available to foreign investors from day one. By the end of 2018, the iron ore and the PTA contracts are the second and the fourth most active commodity futures traded in China, following the steel rebar and soybean meal contracts, respectively (FIA, 2019).[5]

We focus on iron ore (ticker symbol DCIO) and PTA (ticker symbol CTA) futures. Iron ore contracts are traded on the DCE while PTA contracts are traded on the ZCE. Our sample period is from January 2017 to June 2019, but an event window of 6-month prior to and post internationalization is employed in the main test. Daytime trading in these futures occurs between 9:00 and 11:30 am and between 1:30 and 3:00 pm China Standard Time, while night trading occurs between 9:00 and 11:30 pm. We consider a trading day from 3:00 pm on day *d*-1 to 3:00 pm on day *d*. The futures contracts have twelve maturities per year. We focus on the most liquid contracts, and each contract is rolled over to the second-most liquid contract when its volume exceeds the volume of the former.

We obtain transaction-level data for prices, volume, bid-ask quotes, and bid-ask depths from Thomson Reuters Tick History (TRTH). These data contain all activities observed at the top of the limit order book, which includes transactions and revisions in bid and ask prices and depths, time-stamped to the nearest millisecond. We treat multiple trades executed at the exact

[5] Refer to https://fia.org/articles/fia-releases-annual-trading-statistics-showing-record-etd-volume-2018

same time as one trade, as they typically reflect a trade initiated by one market participant but executed against the limit orders of multiple market participants. In such cases, we use the value-weighted average price and aggregate the traded volume. Trades are classified into buyer- and seller-initiated trades on the basis of the prevailing quotes prior to the trade. We use Lee and Ready's (1991) trade indicator where a trade is classified as buyer-(seller-)initiated if it is above (below) the midpoint of these quotes (midquote). Trades at the midquote are considered undetermined. We clean our data from obvious outliers using the filters proposed by Chordia *et al.* (2001): (i) quoted spread (the difference between the ask and bid price) > RMB35; (ii) effective spread (twice the absolute difference between the transaction price and the quote midpoint)/quoted spread > 4.0; (iii) quoted spread/transaction price > 40%; and (iv) price is higher (lower) than the daily mean plus (minus) five times the daily standard deviation.

We also obtain data from TRTH to construct a control group for both the iron ore and the PTA, applying the same steps explained above and matching the sample period. For iron ore, we include ferrosilicon, silicon manganese, thermal coal, coke, coking coal and steel rebar, due to their common usage in the steel and other industrial production. These commodities are also known as the 'black metals'. As for PTA, we include all futures products within the PTA production complex, comprising of crude oil (upstream), and downstream products such as PP (polypropylene), PVC (polyvinyl chloride) and LLDPE (Linear Low Density Polyethylene).[6] We also include flat glass and natural rubber due to their common industrial usage. Appendix B lists all commodities employed and the exchanges they are traded on.

[6] Although foreigners can trade in the Chinese crude oil futures markets in our event window, we add this commodity to the industrials group to control for any migration of traders from crude oil to PTA after the internationalization.

3.2. Market quality measures

The first set of market quality measures accounts for market activity and includes the total daily volume and the total daily number of trades. Following Ryu (2013), we group trades into three size groups by the number of contracts, small (<5), medium (5 to 50) and large (>50), and report the percentage of small, medium and large trades over the trading day.[7] We also measure the total daily average bid/ask depths.

The second set of market quality measures reflects the cost of trading. We follow Hendershott *et al.* (2011) and employ the quoted spread (QS), effective spread (ES), realized spread (RS) and price impact (PI). The quoted spread is calculated as the ask price minus the bid price divided by the mid-quote prevailing at the *s*-th trade. The effective spread is calculated as

$$ES_{i,s} = 2 \cdot q_{i,s}(p_{i,s} - m_{i,s})/m_{i,s}, \tag{1}$$

where $q_{i,s}$ is the Lee and Ready's (1991) trade indicator (+1 for buys, -1 for sells and 0 undefined), $p_{i,s}$ is the transaction price, and $m_{i,s}$ is the mid-quote prevailing at the *s*-th trade. As in Hendershott *et al.* (2011), the daily QS is time-weighted whereas the daily ES are volume-weighted.

The effective spread can be decomposed into realized spread (RS) and price impact (PI) which reflect transaction costs due to liquidity and adverse selection, respectively. RS assumes liquidity providers are able to close their positions at the mid-quote one minute after the trade and is calculated as

$$RS_{i,s} = 2 \cdot \frac{q_{i,s} \cdot (p_{i,s} - m_{i,s+1min})}{m_{i,s}}\ , \tag{2}$$

[7] We also grouped the orders into three size groups by the number of contracts, small (<10), medium (10 to 100) and large (>100) but the results are qualitatively similar. These results are available from the authors.

where $m_{i,s+1min}$ is the quote midpoint one minute after the s-th trade. Similarly, we measure the gross losses to liquidity demanders due to adverse selection using the 1-minute price impact of a trade as

$$PI_{i,s} = 2 \cdot \frac{q_{i,s} \cdot (m_{i,s+1min} - m_{i,s})}{m_{i,s}}. \quad (3)$$

To match all the market quality measures with RS and PI, we skip the last minute of each trading session. Finally, we assess volatility as our last market characteristic. We compute realized volatility using returns at 1-minute frequency by applying the following equation:

$$RV_{i,d} = \sqrt{\frac{382}{S} \cdot \sum_{s=1}^{S} r_{i,s}^2}, \quad (4)$$

where S is the total number of minutes in the trading session.[8] All the above market quality measures are winsorized at the 1% and 99% level.

3.3. Univariate approach

We first present results of the univariate tests and then move on to the difference-in-difference analysis. Figures 1 and 2 plot the daily evolution of the volume, number of trades, effective spread, and realized volatility in the event-window for iron ore and PTA, respectively. The first month after internationalization is highlighted in grey. Figure 1 indicates that the internationalization has led to a reduction in volume, number of trades, and realized volatility; and an increase in effective spread. Figure 2, on the other hand, shows that trading activity

[8] To have comparable realized volatilities across commodities and time, we have multiplied them by 382 minutes per trading session. We also skip the last minute of the day- and the last minute of the night-trading session because the commodity futures trading stops in-between the daytime session (11:30am to 1:30pm), and in preparation for the night trading session (3:00pm to 9:00pm). As robustness, we also sample returns at 5-minute frequency and obtain similar results.

improves slightly after the internationalization (e.g., higher volume and number of trades); however, neither effective spread nor realized volatility exhibit any clear change. The volume of PTA experienced dramatic movements around August 2018, before the internationalization on November 30, 2018. This volume pattern can be attributed to the price spikes around July-August 2018, during which PTA price was pushed up by more than 40% to a 5-year high. This is largely explained by fundamental reasons such as a depleting inventory, high PX price, and RMB depreciation which puts pressure on the price of PTA (China Securities Daily, 2019b).[9]

[INSERT FIGURES 1 AND 2 HERE]

These figures provide us *prima facie* of the impact of internationalization on market quality for iron ore and PTA, but we are interested in testing if there is any *causal* relationship in these market quality measures due to the event of internationalization. To do so, we first compare the mean of each market quality measure before and after the internationalization of iron ore and PTA, respectively, by means of a univariate approach. Namely, we test their differences using the Newey-West *t*-statistics. Likewise, in order to control for non-normality, we also apply the Wilcoxon test for differences in medians. Table 1 reports these results.

Panel A of Table 1 reports the results for iron ore. Confirming the findings in Figure 1, trading activity in iron ore significantly decreased after the event, e.g., the volume decreased by 1,264 thousand contracts, the number of trades by 11,080 trades. The bid and ask depths also decreased after internationalization, but their differences are not statistically significant. Interestingly, the percentage of small trades increased by 13%, while the medium and large trades deceased by 6-7%. Hence, the decrease in volume and number of trades seem to be

[9] Refer to http://www.sohu.com/a/251768946_668012, retrieved on 13 September 2019.

related with a decrease in medium- and large-sized trades. Consequently, the cost of trading as measured by the quoted and effective spreads increased after the internationalization. When we decompose the effective spread into realized spread (i.e. the component due to liquidity) and price impact (i.e. the component due to adverse selection), we observe that the realized spread has decreased but the price impact has strongly increased after the market opened to international investors. These statistics suggest that traders who left the market after the internationalization were, in relative terms, less informed which may explain why the price impact strongly increased. In terms of volatility, we observe that it has decreased, which can be related to a decrease in trading activity overall.

[INSERT TABLE 1 HERE]

Panel B of Table 1 shows an entirely different picture. The trading activity of PTA increased after the internationalization, e.g., volume increased by 869 thousands of contracts on average and the number of trades increased by 5,640 trades on average. The new trades were larger in terms of size. The bid and ask depths also significantly increased. This increase in market activity, however, had no significant impact on the effective spreads although the quoted spread significantly increased by 0.002%. Internalization has no impact on realized volatility of PTA futures. In short, the market quality of PTA improved after the internationalization, in a way that after the event, the market is more active without any significant effect on trading costs or volatility.

3.4. Difference-in-difference approach

The univariate approach shows how the impact of the internationalization on market characteristics differ from iron ore to PTA futures. To account for these results, we examine the causal effect in a quasi-experimental setting in which we compare the effect of internationalization on the market quality measures of iron ore or PTA (i.e. the treatment commodities) relative to a comparable set of control commodities, for each treatment commodity. The key assumption in a difference-in-difference (DD) approach is the *parallel trends* of both the treatment and control commodities before the event. In other words, in the absence of treatment, the average change in the response variable would have been the same for both the treatment and control groups. Recognizing the limitations of directly testing this assumption, we overcome this difficulty by choosing commodities within the same sector. Matching in this way provides us with an economic justification of the control group, because cross-hedging pressure from within the sector of commodities are known to significantly affect futures risk premia (De Roon *et al.*, 2000). Meanwhile, speculators tend to consider commodities within a same sector as a unity, but not across sectors (Belousova & Dorfleitner, 2012; Erb & Harvey, 2006), unless an investor follows a passive long-only index such as the S&P-GSCI, in which case the broad market is viewed as an asset class (Pouliasis & Papapostolou, 2018).

In our DD framework, we regress each market quality measure $y_{i,t}$ with a post-internationalization dummy variable ($Post_t$), a treatment dummy (IO_t or PTA_t), and the post-internationalization dummy interacted with the treatment dummy ($Post_t \cdot IO_t$ or $Post_t \cdot PTA_t$) as follows:

$$y_{i,t} = \alpha + \beta_1 \cdot Post_t + \beta_2 \cdot Post_t \cdot IO_t + CommFE_i + MonthFE_t + Controls + \varepsilon_{i,t}\ , \quad (5)$$

$$y_{i,t} = \alpha + \theta_1 \cdot Post_t + \theta_2 \cdot Post_t \cdot PTA_t + CommFE_i + MonthFE_t + Controls + \epsilon_{i,t,} \quad (6)$$

for iron ore and PTA, respectively. We include commodity fixed effects to account for time invariant heterogeneity in the commodities (e.g., contract specifications or commodity uses);

and monthly fixed effects to account for any seasonality or changes in fundamentals.[10,11] Finally, we control for log changes in RMB/USD exchange rate and the yield differences on 10-year sovereign bonds between China and the US. The data are downloaded from *Thomson Reuters Datastream*.[12] To make the DD more comparable across commodities, we normalize the market quality measures.[13] Equations (5) and (6) are estimated using fixed effects with clustered standard errors so that the t-statistics are robust to heteroscedasticity. The $Post_t$ dummy controls for common trends in commodities after the internationalization. The key coefficients of interest in determining whether the treated commodities experienced any difference in terms of market quality measures after the internationalization are β_2 for iron ore and θ_2 for PTA, i.e., the coefficients on the interaction terms. The magnitude and sign of the coefficient of this term indicate how market quality of the treated commodities were affected by internationalization relative to control commodities.

To check the suitability of these control groups, Figures 3 and 4 plot the daily evolution of normalized volume, number of trades, effective spread, and realized volatility for iron ore and PTA, respectively, along with the average of those measures in the control group. Reassuringly, both figures seem to confirm a common trend in those market quality measures

[10] These monthly dummies also control for the trade war between China and the US commenced in the first quarter of 2018. For instance, the US imposed a 25% tariff on 50 billion of Chinese goods in June 2018, and an additional 10% tariffs on another 200 billion of goods in September 2018. China responded with tariffs on $34 billion of US goods in June and $60 billion in September 2018. The trade war creates uncertainties for producers and manufacturers, causing them to dial down their operations, hence contributing to the slowdown of global growth.

[11] We drop the treated commodities dummies from the commodity fixed effect and the January dummy of the event window in the monthly effects.

[12] According to the Economic Daily (China's state-run media), the import reliance on iron ore has reached 88.4% in 2017. On the other hand, the PTA import is as low as 1.5%, which is effectively self-sufficient. Taking this into account, the RMB/USD exchange rate is expected to have more impact on the iron ore than the PTA prices in China. Similarly, China-US interest rate-spread influences iron ore prices (Shao *et al.*, 2018), due to currency carry trade and finance. For example, when the spread is less than the trade costs plus the price differential between Chinese and international iron ore prices, trade finance becomes profitable (i.e. cheaper short-term credit/guarantee for iron ore imports). Therefore, we control for RMB/USD and US-China interest rate-spread.

[13] Volume, number of trades, bid/ask depth and RV are in logs.

before the internationalization which seems to depart after the event, though this departure is less pronounced for the realized volatility.

[INSERT FIGURES 3 AND 4 HERE]

Table 2 reports the Pearson correlations between the daily market quality measures before the internationalization for each treatment commodity and the constituents within its control group. Most of the correlations are positive and significant which confirms these control groups properly fulfill the parallel trends assumption. These figures and correlations provide evidence that investors did not face considerable differences in market quality measures between the treatment commodities and the control groups before the internationalization.

[INSERT TABLE 2 HERE]

Once we confirm the suitability of the control groups, Table 3 reports the DD results. For brevity, we only report the $Post_t$ and the interaction coefficients. The results confirm the findings of the univariate test reported in Table 1. Specifically, the market has become less active (decrease in volume and number of trades) and more costly (increase in quoted and effective spreads) after the event. The decrease in market activity comes with a decrease in the revenue for liquidity providers (realized spread) and, in relative terms, an increase in adverse selection (price impact). Meanwhile, the PTA market is more active (increase in trading volume and number of trades) without any significant effect on trading cost. Interestingly, the DD can uncover the impact of the event on the realized volatility of PTA which increased after the internationalization, which may be related to the higher market activity after the internationalization.[14] Overall, the positive effects of internationalization on PTA futures is consistent with the literature that suggests an increased presence of foreign investors positively contribute to the liquidity of local markets (e.g., Ding *et al.*, 2017; He & Shen, 2014; Lee & Chung, 2018; Ng *et al.*, 2015). However, the negative effects of internalization on iron ore futures represent a puzzle. We examine this further in the following sections.

[INSERT TABLE 3 HERE]

A brief note is warranted regarding the unreported control variables. We observe that an increase in the RMB/USD exchange rates is associated with a reduction in market activity (volume and number of trades) and an increase in the cost of trading (effective and quoted spreads) in the black metals; however, this significantly increases the realized volatility in industrials only. Otherwise, increases in the 10-year sovereign bond yield differences between China and US are associated with increases in trading activity (volume and number of trades) and reduction in the cost of trading (effective and quoted spreads) in both the black metals' and industrials' markets. Thus, our results indeed suggest that currency and interest rate-spread play a larger role in the pricing of iron ore compared to the PTA futures contracts. As RMB depreciates against the USD, demand for USD-settled iron ore decreases leading to the decrease in futures trading, and elevates the cost of trading. Meanwhile, a widening of the interest rate spread encourages the uptake of trade finance, thus leading to an increase in futures trading and decrease in costs.

[14] The DD results of the 5-minute frequency are qualitatively the same than those with the 1-minute frequency.

4. What Explains the Results?

In this section, we aim to explain the seemingly contradictory impact of internationalization on the market quality of iron ore and PTA through the activities of the three main group of participants in futures markets: speculators, hedgers and arbitrageurs.

4.1. The effect of speculators and hedgers

The two main economic agents in futures markets are the speculators and hedgers. Hedgers typically enter into net short (or long) position in order to obtain a price insurance on their production output or input. The insurance premium is awarded to speculators who are willing to assume such risks by taking on the opposite of the trade. Thus, in order to keep speculators within the futures markets, they need to receive a positive risk premium. This insurance mechanism is referred as the hedging pressure hypothesis (Cootner, 1960; Hirshleifer, 1988).

To test whether speculators and hedgers activities explain the changes in the market quality measures after the internationalization, we employ a “triple difference” (DDD) approach. Before explaining this DDD approach, we define the speculative and hedging activity proxies. We follow the literature (Fan & Zhang, 2019; Wellenreuther & Voelzke, 2019) and proxy the activity of likely speculators and hedgers as:

$$Ratio_{i,t}^{Spec} = \frac{Volume_{i,t}}{OI_{i,t}}, \tag{7}$$

$$Ratio_{i,t}^{Hedg} = \frac{\Delta OI_{i,t}}{Volume_{i,t}}, \tag{8}$$

where $Ratio_{i,t}^{Spec}$ $\left(Ratio_{i,t}^{Hedg}\right)$ is the speculation (hedging) ratio, $Volume_{i,t}$ is the daily total volume, and $OI_{i,t}$ is the daily open interest for commodity *i* on day *t*.

Figure 5 plots the daily evolution of these ratios in our event window. Speculation ratios are persistent with high first autocorrelation (0.48 for iron ore and 0.76 for PTA) and can capture episodes of high speculative activity such as the July-August 2018 run-up in PTA’s speculative activity which triggered an increase in margin requirements by the Chinese markets regulators as a response to curb speculative activity.[15] Instead, the hedging ratios are less persistent with short periods of high hedging activity followed by periods of low hedging activity.

[INSERT FIGURE 5 HERE]

These measures are known to be noisy proxies of speculative and hedging activity in futures markets (Manera *et al.*, 2013).[16] As such, we create a high speculative (hedging) activity dummy variable equal one if the $Ratio_{i,t}^{Spec}$ ($Ratio_{i,t}^{Hedg}$) is higher than its event window mean, zero otherwise. These dummy variables allow us to split the event window in periods of high versus low speculative and hedging activity.

Equipped with high speculative and high hedging activity dummy variables, we apply a DDD approach to test if there is any change in the relationship between the activity of speculators/hedgers and the market quality measures after the internationalization in the treated commodities. To avoid endogeneity issues, we lag the high speculative and high hedging activity dummy variables. The DDD regressions explain an outcome variable $y_{i,t}$ with a post-internationalization variable ($Post_t$), a treatment dummy (IO_t or PTA_t), and a high speculative/hedging activity dummy (e.g., $High\_SPEC\_IO_{i,t-1}$ or $High\_HEDG\_IO_{i,t-1}$), the double interaction terms (e.g., $High\_SPEC\_IO_{i,t-1} \cdot Post_t$, $High\_SPEC\_IO_{i,t-1} \cdot IO_t$ and $Post_t \cdot IO_t$) and the triple interaction term ($High\_SPEC\_IO_{i,t-1} \cdot Post_t \cdot IO_t$). Specifically, the DDD regressions for iron ore (similar for PTA) are as follows,

[15] https://af.reuters.com/article/energyOilNews/idAFB9N1V6006

[16] Chinese derivative markets do not provide information about the open interest of non-commercials (or speculators) and commercials (or hedgers) like the Commitment of Traders report of the Commodity Futures Trading Commission in US derivative markets.

$$y_{i,t} = \alpha + \beta_1 \cdot High\_SPEC\_IO_{i,t-1} \cdot Post_t \cdot IO_t + \beta_2 \cdot High\_SPEC\_IO_{i,t-1} \cdot Post_t + \beta_3 \cdot High\_SPEC\_IO_{i,t-1} \cdot IO_t + \beta_4 \cdot High\_SPEC\_IO_{i,t-1} + \beta_5 \cdot Post_t + \beta_6 \cdot Post_t \cdot IO_t + MonthFE_t + CommFE_i + Controls + \varepsilon_{i,t} \tag{9}$$

$$y_{i,t} = \alpha + \theta_1 \cdot High\_HEDG\_IO_{i,t-1} \cdot Post_t \cdot IO_t + \theta_2 \cdot High\_HEDG\_IO_{i,t-1} \cdot Post_t + \theta_3 \cdot High\_HEDG\_IO_{i,t-1} \cdot IO_t + \theta_4 \cdot High\_HEDG\_IO_{i,t-1} + \theta_5 \cdot Post_t + \theta_6 \cdot Post_t \cdot IO_t + MonthFE_t + CommFE_i + Controls + \varepsilon_{i,t} \tag{10}$$

We employ commodity fixed effects to account for time invariant heterogeneity in the commodities; monthly fixed effects to account for any seasonality or changes in fundamentals in the commodities, and for log changes in RMB/USD exchange rate and 10-year sovereign bond yield differences between China and the US. Equations (9) and (10) are estimated using fixed effects with clustered standard errors and *t*-statistics robust to heteroscedasticity. The key coefficients of interests, in determining whether the relationship between the activities of speculators/hedgers and the market quality of the treated commodities have changed after the internationalization, are β_1 for high speculative periods and θ_1 for high hedging periods, i.e., the coefficients on the triple interaction terms. If there is any significant change in this relationship, we could attribute it to either the activity of 'new' speculators or hedgers which could either be foreign investors or locals that behave differently post-internationalization. We cannot disentangle the effect of these individual groups, as the triple interaction term captures any change in this relationship post internationalization in the treatment commodities. We report the results for the high speculative periods in Table 4 and for the high hedging periods in Table 5.

[INSERT TABLES 4 AND 5 HERE]

Panel A of Table 4 shows how the periods of high speculative activity in iron ore after the internationalization came hand-in-hand with a decrease in the realized spread and increase in the price impact whose net effect is a significant decrease in the effective spread (and quoted spread). So, the 'new' speculators help to reduce the costs of trading in iron ore after the internationalization. In relative terms, the 'new' speculators in iron ore increase the realized volatility and strongly decrease bid/ask depth.

Panel B in Table 4 shows that periods of high speculative activity in PTA are associated with low market activity (lower volume and number of trades) and an increase in small trades. We also observe a similar relationship between the cost of trading and the periods of high speculative activity in PTA post internationalization, i.e., a decrease in the realized spread and increase in the price impact. However, the net effect in the effective spread (and quoted spread) offset such effects. In short, the results in Table 4 suggest that the activity of the 'new' speculators does not explain the impact of internationalization in both iron ore and PTA.

Panel A of Table 5 reports the DDD regressions for iron ore's high hedging activity periods. In relative terms, the periods of high hedging activity in iron ore are associated with an increase in the cost of trading (effective spread and quoted spread). When we decompose the effective spread, the increase in the cost of trading comes from a higher increase in the price impact rather than the decrease in realized spread. These results suggest that the 'new' hedgers in iron ore are more informed which may partially explain why the cost of trading in iron ore increased after the internationalization. Nevertheless, the periods of high hedging activity in iron ore are also associated with a higher market activity (volume, number of trades) and higher bid/ask depth which is the opposite of the main results of Table 3. Last, hedgers in iron ore appear to be involved in significantly more medium size trades and less small size trades compared to the period prior to internationalization.

Panel B of Table 5 shows a somewhat different story. The periods of high hedging activity in PTA are associated with a decrease in market activity (lower volume and lower number of trades) and realized volatility. Although the effect on the cost of trading is similar than that in iron ore, the relationship is weaker. Finally, the 'new' hedgers trade in small trade sizes, reducing their large trade sizes. To sum up, the results of Table 5 suggest that the activity of the 'new' hedgers in iron ore may partially explain the increase in the cost of trading; however, they do not seem to explain the decrease in market activity of iron ore, while the results for PTA are overall inconclusive.

4.2. Mispricing and arbitrage opportunities

In the previous section, we find the changes in market activity, cost of trading, and volatility after the internationalization cannot be fully explained by the activities of hedgers and speculators. In this section, we assess whether these changes can be explained by the activity of arbitrageurs.

As explained in Section 2, while PTA futures are not traded anywhere else in the world, iron ore futures are traded on both the SGX (TSI Iron Ore 62%) and the NYMEX (TIO: Iron Ore 62% Fe, CFR China (TSI)), the former being more liquid than the latter. Therefore, the differences in the impact of internationalization between iron ore and PTA could possibly be related to the activities of arbitrageurs in iron ore futures markets.

To examine the above relation, we compare the degree of mispricing in iron ore futures between the contracts traded on the SGX and contracts traded on the DCE. The degree of mispricing measures the potential arbitrage opportunities between both iron ore futures contracts (Gagnon and Karolyi, 2010). We collect intraday-data of the SGX iron ore futures contracts from TRTH (ticker symbol SZZF). We follow the same approach and focus on the most liquid SGX iron ore futures contracts. Given that SGX and DCE share the same time zone, we match prices from the two futures markets at a one-minute frequency. Finally, we convert the SGX iron ore futures prices into Chinese Yuan using the RMB/SGD exchange rate at one-minute frequency obtained from TRTH.

We measure the mispricing daily using the sum of squared (log) differences in prices between the two markets. The higher the mispricing, the larger arbitrage opportunities exist between both iron ore futures contracts. Our sample period is 6-months before and 6-months after the internationalization of iron ore on May 4, 2018. We skip the first month after the event so the pre-event (post-) period is from November 1, 2017 to May 3, 2018 (from June 1, 2018 to November 31, 2018).

Figure 6 plots the degree of mispricing over time with the shaded area representing the first month after internationalization in iron ore. The figure shows a pronounced decrease in mispricing after the internationalization. This finding is confirmed in Panel A of Table 6 where the results of the univariate difference-in-difference in mispricing are reported. One plausible explanation for this finding is the decrease in arbitrage opportunities. More specifically, once the Chinese iron ore futures market is opened to foreigners, competition between arbitrageurs decreases mispricing and subsequently erode arbitrage profits between the DCE and the SGX.

[INSERT FIGURE 6 HERE]

To assess the causal effect of the mispricing on the market quality measures, Panel B of Table 6 reports multivariate regression results. We regress various market quality measures on the mispricing variable and monthly dummy variables in order to control for seasonalities. As endogeneity could be an issue in our setting, we regress the market quality measures on the lagged mispricing variable.[17] Specifically, we estimate the following regression using OLS:

$$y_t = \alpha + \beta \cdot Mispr_{t-1} + Controls + \varepsilon_t \ , \tag{11}$$

where y_t are the various market quality measures of iron ore on day t, $Mispr_t$ is the mispricing variable and $Controls$ includes monthly dummies. We normalize all the dependent variables to ease interpretation.

[INSERT TABLE 6 HERE]

Panel B of Table 6 shows the estimation results for Equation (11). It becomes clear that the decrease in mispricing is significantly associated with a drop in volume, number of trades, and an increase in small trades at the cost of a decrease in medium and large trades. However, the mispricing has no effect on the cost of trading variables. We interpret these results as large arbitrageurs being active in the Chinese iron ore futures market prior to the internationalization, profiting from the price differences between these futures markets and the SGX iron ore futures contracts.[18] Once the market was opened to foreigners, more arbitrageurs are likely to enter the market, leading to a significant decrease in arbitrage opportunities. This notion is in line with extant studies which document that arbitrage opportunities exist in emerging markets with trading barriers (Ansotegui *et al.*, 2013) and that markets move together less when they are

[17] The lagged mispricing measure can be a good instrument as this measure is persistent with a first autocorrelation coefficient of 0.94.

[18] https://www.reuters.com/article/china-futures-ironore/rpt-china-opens-iron-ore-market-to-the-world-in-pricing-image-push-idUSL3N1SA27C

segmented from each other by foreign investment barriers (Gagnon & Karolyi, 2006). When trading barriers are removed, foreign investors are likely to act as sophisticated arbitrageurs and eliminate existing mispricing (He & Shen, 2014). Consequently, large arbitrageurs may have left the market which explains the decrease in volume, number of transactions, medium and large trades, volatility, and the increase in small trades.

5. Robustness tests

In the following, we describe the various tests employed to ensure the robustness of the results presented above.

5.1. Shorter event window

In this robustness test, we apply the aforementioned analysis to a sample period of 1-month before and 1-month after the internalization event which is May 4, 2018 for iron ore and November 30, 2018 for PTA. We skip the first month after the event so the pre-event (post-) periods are from April 1, 2018 to May 3, 2018 (from June 1, 2018 to June 30, 2018) for iron ore and from October 31, 2018 to November 29, 2018 (from January 1, 2019 to January 31, 2019) for PTA, respectively. To avoid perfect collinearity between the monthly dummies and the *Post* dummy, we do not employ monthly fixed effects. Appendix C reports the DD results for this shorter event window. The results are broadly in line with the main results of this paper. Interestingly, once we reduce the event window, the effective spread in PTA decreases after the internationalization, due to the decrease in price impact.

5.2. Pre-event window

The actual dates of the internationalization of iron ore and PTA were known well in advance. So, the investors in these commodities could start taking positions in the weeks before the event date. To eliminate this effect in the pre-event window, we skip one month before the actual dates. Specifically, we consider 6-month before and 6-month after the internationalization event which is May 4, 2018 for iron ore and November 30, 2018 for PTA. We skip both the first month before and the first month after the event so the pre-event (post-) periods are from October 10, 2017 to March 31, 2018 (from June 01, 2018 to November 31, 2018) for iron ore and from April 30, 2018 to October 31, 2018 (from January 01, 2019 to June 28, 2019) for PTA, respectively. Appendix D reports the DD results for this alternative event window. These results are in line with the main results of the paper.

5.3. Placebo test

In this robustness check, we apply a placebo test. Specifically, we consider a false treatment commodity and apply the DD regressions in Equations (5) and (6), skipping the treated commodities, i.e., iron ore and PTA. The false treatment commodities are those with the high average correlation with either iron ore or PTA in the pre-event window (c.f. Table 2), and a strong economic link. We consider steel rebar as the false treatment commodity for iron ore and LLDPE for PTA.[19] The production of steel rebar depends critically on iron ore, a major raw material input in the manufacturing process. In addition, steel rebar is the most active futures contract in the world (Indriawan *et al.*, 2019). As for PTA, we consider LLDPE as the production of plastic-related materials share the same upstream market, i.e. naphtha (a crude oil derivative) and the downstream market, i.e. clothing and textile. Due to these connections in the production chain, the correlations with our treatment commodities are high (Table 2). We expect to see no impact of internationalization in those false treatment commodities.

[19] PTA is intrinsically related to the chemical commodities, LLDPE, PP and PVC. We chose LLDPE because it has the highest average correlation with PTA in the pre-event window. The results are qualitative similar when we use another chemical commodity such as PVC. These results are available from the authors.

[INSERT TABLE 7 HERE]

Table 7 report the results of the placebo test. In Panel A of Table 7, we can observe that the market characteristics of steel rebar are not statistically different after the internationalization of iron ore. We only observe a significant decrease in the realized spread of steel rebar but neither the cost of trading nor the market activity seem to be affected by the internationalization of iron ore. Panel B of Table 7 shows a significant increase of the cost of trading in LLDPE after the internationalization of PTA; nevertheless, the market activity of LLDPE was not affected by the internationalization of PTA.

Overall, the results in Table 7 suggest that the market quality variables in the false treated commodities did not exhibit any major change due to the internationalization of iron ore or PTA. Thus, the placebo test provides further support for our main findings.

5.4. Night-trading sessions

Finally, we investigate whether there is any difference in the impact of internationalization during the day- and night-trading sessions. The literature on the impact of the gradual introduction of night trading sessions for Chinese futures contracts since 2013 is scarce (e.g, Fung *et al.*, 2016; Klein & Todorova, 2019) but it is known that night trading sessions have an important role for the price discovery and market quality of Chinese gold markets (Jin *et al.*, 2018; Xu & Zhang, 2019) and the volatility of non-ferrous metal futures markets (Klein & Todorova, 2019). To that end, we split the whole day trading session into the day-trading session and night-trading session, and apply the DD regressions of Equations (5) and (6).[20] The

[20] We consider the day-time session as any trading from midnight until 3:00 pm Chinese local time, and night-time session as trading from 3:00 pm Chinese local time until midnight. This classification corresponds with the actual night- vs day-trading for the most of the Chinese commodity futures contracts. However, we recognize some commodities do not have night-time trading session (e.g. ferrosilicon and silicon manganese) while others have night-trading sessions going beyond midnight. For example, the night-session for steel rebar lasts until 1:00

results for the day- and night-trading sessions are in Appendices E and F, respectively. It is evident that the main results of this paper hold for both day- and night-trading sessions. Therefore, there are no differences in the impact of internationalization during the day- and night-trading sessions.

6. Conclusion

Following the Chinese government's plan to internationalize its commodity futures markets, the PTA and iron ore futures contracts, traded on the Zhengzhou and Dalian commodity exchanges respectively, have become accessible to foreign investors in 2018. This is the first study to investigate how market quality, trading activity and volatility react to this milestone event. Based on an extensive set of ultra-high frequency data, we analyzed the impact of internationalization on bid-ask spreads, price impact, volume, trade size and realized volatility. Starting with a univariate analysis, the impact of market liberalization was then assessed through a difference-in-difference approach, followed by possible explanations and various robustness checks.

We found conclusive evidence suggesting that internationalization has led to an improvement in the market quality of PTA futures. Post-internationalization, the trading volume and number of trades increased while the trading cost was largely unaffected. The observed positive effects on PTA futures are in line with the existing literature, documenting that a stronger presence of foreign investors improves the liquidity of local markets. In contrast, iron ore futures exhibit a puzzling pattern at the first glance. Trading volume and number of trades have decreased, while the trading cost increased. The documented decrease in market

am Chinese local time (Fung *et al.*, 2016). For simplicity, we apply the same classification across all commodities which have night-time trading.

activity is associated with a reduced revenue for liquidity providers and an increased adverse selection. Whilst the pronounced deterioration is unlikely to be caused by the activities of new hedgers and speculators entering the market, an analysis of the mispricing between the SGX and DCE iron ore reveals a plausible explanation. Backed up by the documented significant decline of large trades in the Chinese iron ore market, large arbitrageurs have ceased their trading activities due to the profitability erosion following the entrance of foreign arbitrageurs post-internationalization.

Our findings shed lights on the ongoing market liberalization in China. The evidence on PTA supports China's decision to accelerate the internationalization of unopened markets. It also offers fresh insights for other emerging markets, not yet open to foreigners (e.g. India). The increasing participation by foreign institutions are expected to further improve the market quality. Recent experience from the Tokyo Commodity Exchange reveals that the foreign volume has grown from 9.7% to 44.5% in 2008-2014 (METI, 2015). However, lessons from the iron ore markets suggest a more thorough investigation of the domestic dynamics may be warranted, prior to the introduction of foreign investors. For example, as one of the world's most liquid futures, the iron ore market once had the largest depth among the black metals in China, while the non-individuals accounted for less than 3% of the total accounts. Although large arbitrageurs exited the market due to the erosion of arbitrage profits post-internationalization, it might be worthwhile to consider why these orders were initiated at the first place. A closer investigation into large orders by non-individuals may shed further light on the deterioration of market quality. Finally, we recommend the regulators to improve the transparency of traders' positions data by business purposes and classifications.

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Appendix A. Iron ore futures contracts

Exchange	NYMEX[1]	DCE[2]	SGX[3]
Contract Unit	500 MT/Lot	100 MT/Lot	100 MT/Lot
Price Quotation	USD/MT	RMB/MT	USD/MT
Trading Hours	Sunday - Friday 6:00 p.m. - 5:00 p.m. 60-minute break at 5 p.m.	Monday - Friday 9:00 - 11:30 a.m. 1:30 - 3:00 p.m. 9:00 - 11:00 p.m.	Daily 7:25 a.m.- 7:55 p.m. 8:15 p.m.- 4:45 a.m.
Min Price Fluctuation	$0.01 / MT	0.5 CNY/MT	$0.01 / MT
Price Limit	Levels 1-4: 1,200; 2,400; 3,600; 4,800	Levels 1-3: 4%; 7%; 9%	None
Position Limit	Spot Month: 15,000	Spot Month: 2,000	None
Margin	Tier 1-4: 2,795; 4,100; 3,700; 3,200	Tier 1-4: 16,330; 7,290; 6,555; 6,035; 5795	Tier 1-5: 1,100;|1,078; 924; 902; 792
Settlement Method	Cash	Physical	Cash
Maturity Month	All	All	All

[1] https://www.cmegroup.com/trading/metals/ferrous/iron-ore-62pct-fe-cfr-china-tsi-swap-futures_contract_specifications.html
[2] http://www.dce.com.cn/DCE/Products/Industrial/Iron%20Ore/491886/index.html
[3] https://www2.sgx.com/derivatives/products/iron-ore?cc=FEF#Contract%20Specifications

Appendix B. Chinese commodity futures list

Commodity	Symbol	Exchange
Panel A: Black Metals		
Iron ore	DCIO	Dalian Commodity Exchange (DCE)
Ferrosilicon	CESF	Zhengzhou Commodity Exchange (ZCE)
Silicon manganese	CESM	Zhengzhou Commodity Exchange (ZCE)
Thermal coal	CZC	Zhengzhou Commodity Exchange(ZCE)
Coke	DCJ	Dalian Commodity Exchange (DCE)
Coking coal	DJM	Dalian Commodity Exchange (DCE)
Steel rebar	SRB	Shanghai Futures Exchange (SHFE)
Panel B: Plastics & Industrials:		
PTA	CTA	Zhengzhou Commodity Exchange (ZCE)
Flat glass	CFG	Zhengzhou Commodity Exchange (ZCE)
PP	DCC	Dalian Commodity Exchange (DCE)
LLDPE	DLL	Dalian Commodity Exchange (DCE)
PVC	DPV	Dalian Commodity Exchange (DCE)
Crude oil	ISC	Shanghai International Energy Exchange (INE)
Natural rubber	SNR	Shanghai Futures Exchange (SHFE)

Appendix C. Robustness: Shorter event window

This table reports the results from the difference-in-difference approach for Iron ore (Panel A) and PTA (Panel B). We consider 6-month before and 6-month after the internalization event which is May 4, 2018 for iron ore and November 30, 2018 for PTA. We skip the first month after the event. The pre-event periods are from November 1, 2017 to May 3, 2018 (from May 31, 2018 to November 29, 2018) for iron ore (PTA). The post-event period is from June 1, 2018 to November 31, 2018 (from January 1, 2019 to June 28, 2019) for iron ore (PTA). The first row shows the various market quality as dependent variables: *Volume* (total daily volume), *Trade* (total daily number of trades), *Small* (the percentage of trade with less than 5 contracts), *Medium* (the percentage of trade with contracts between 5 and 50), *Large* (the percentage of trade with more than 50 contracts), *QS* (quoted spread), *ES* (effective spread), *RS* (realized spread), *PI* (price impact), and *RV* (the daily realized volatility). Volume, trade, bid/ask depth and RV are in logs. *IO* (*PTA*) is an indicator variable which equals to 1 for iron ore (PTA) and 0 otherwise. *Post* is an indicator variable which equals to 1 after June 1, 2018 (January 1, 2019) for iron ore (PTA) and 0 otherwise. *Controls* includes the log changes in RMB/USD and the difference in 10-Year Bonds between China and US. We employ commodity fixed effects. Figures in parentheses are t-statistics robust to heteroscedasticity and clustered by commodity. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Volume	*Trade*	*Small*	*Medium*	*Large*	*Bid depth*	*Ask depth*	*QS*	*ES*	*RS*	*PI*	*RV*
Panel A: Iron Ore												
Post	-0.39	-0.09	0.34	-0.15	-0.27	0.01	-0.39	-0.88***	-0.77***	0.23	-0.43**	-0.26
	(-0.84)	(-0.27)	(1.00)	(-0.45)	(-0.57)	(0.02)	(-0.94)	(-4.16)	(-3.69)	(0.96)	(-2.38)	(-0.95)
*IO * Post*	-1.78***	-1.86***	1.45***	-1.53***	-1.62***	0.14	0.38	0.63***	0.91***	-0.26*	0.48***	-0.97***
	(-4.52)	(-7.24)	(4.70)	(-3.99)	(-4.81)	(0.53)	(1.41)	(3.61)	(4.70)	(-1.88)	(5.22)	(-5.48)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Month FE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Commodity FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj-R^2	9.3%	16.1%	7.6%	3.0%	8.2%	5.8%	8.2%	41.4%	24.2%	-2.0%	3.1%	8.0%
Obs.	280	280	280	280	280	280	280	280	280	280	280	280
Panel B: PTA												
Post	-0.21	-0.25	1.47***	-1.66***	-0.68	2.38***	1.91***	-1.83**	-1.88***	0.79**	-1.29***	-1.69***
	(-0.91)	(-0.50)	(6.40)	(-7.36)	(-1.36)	(5.01)	(6.42)	(-2.31)	(-4.48)	(1.98)	(-3.97)	(-4.89)
*PTA * Post*	1.85***	1.53***	-1.92***	0.47**	1.88***	0.54***	0.58***	-0.04	-0.80**	0.19	-0.55***	-0.12
	(6.16)	(4.99)	(-8.34)	(2.42)	(4.85)	(4.66)	(4.34)	(-0.09)	(-2.19)	(1.10)	(-3.18)	(-0.86)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Month FE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Commodity FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj-R^2	6.2%	2.0%	8.1%	-0.1%	6.6%	51.4%	47.5%	3.3%	8.5%	1.0%	5.5%	20.1%
Obs.	308	308	308	308	308	308	308	308	308	308	308	308

Appendix D. Robustness: Skipping one month before event

This table reports the results from the difference-in-difference approach for Iron ore (Panel A) and PTA (Panel B). We consider 6-month before and 6-month after the internalization event which is May 4, 2018 for iron ore and November 30, 2018 for PTA. We skip the first month after the event. The pre-event periods are from November 1, 2017 to May 3, 2018 (from May 31, 2018 to November 29, 2018) for iron ore (PTA). The post-event period is from June 1, 2018 to November 31, 2018 (from January 1, 2019 to June 28, 2019) for iron ore (PTA). The first row shows the various market quality as dependent variables: *Volume* (total daily volume), *Trade* (total daily number of trades), *Small* (the percentage of trade with less than 5 contracts), *Medium* (the percentage of trade with contracts between 5 and 50), *Large* (the percentage of trade with more than 50 contracts), *QS* (quoted spread), *ES* (effective spread), *RS* (realized spread), *PI* (price impact), and *RV* (the daily realized volatility). Volume, trade, bid/ask depth and RV are in logs. *IO* (*PTA*) is an indicator variable which equals to 1 for iron ore (PTA) and 0 otherwise. *Post* is an indicator variable which equals to 1 after June 1, 2018 (January 1, 2019) for iron ore (PTA) and 0 otherwise. *Controls* includes the log changes in RMB/USD and the difference in 10-Year Bonds between China and US. We employ both month and commodity fixed effects. Figures in parentheses are t-statistics robust to heteroscedasticity and clustered by commodity. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Volume	*Trade*	*Small*	*Medium*	*Large*	*Bid depth*	*Ask depth*	*QS*	*ES*	*RS*	*PI*	*RV*
Panel A: Iron Ore												
Post	0.14	0.51	0.52	-0.40	-0.50	1.06	1.07	-4.08***	-3.85***	0.42	-1.92***	-2.55***
	(0.28)	(1.02)	(1.04)	(-0.69)	(-1.08)	(1.55)	(1.29)	(-11.96)	(-8.27)	(1.31)	(-12.58)	(-5.75)
*IO*Post*	-1.60***	-1.64***	1.48***	-1.47***	-1.44***	-0.35	-0.32	0.75***	1.17***	-0.25***	0.81***	-0.60***
	(-5.34)	(-6.52)	(4.93)	(-5.93)	(-4.34)	(-1.07)	(-0.95)	(2.80)	(5.33)	(-4.29)	(7.24)	(-5.35)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Commodity FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj-R^2	16.4%	17.8%	20.0%	15.9%	12.8%	28.5%	29.7%	34.0%	33.3%	3.3%	9.1%	34.9%
Obs.	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700	1700
Panel B: PTA												
Post	1.10***	0.93**	-0.79***	0.48**	0.92***	0.60*	0.60*	0.40	0.14	-0.23	0.28	0.23
	(3.04)	(2.38)	(-3.18)	(2.20)	(3.06)	(1.74)	(1.78)	(0.97)	(0.31)	(-1.23)	(1.07)	(0.96)
*PTA*Post*	0.80***	0.76***	-0.57***	0.52***	0.46*	0.23	0.29	-0.22	0.04	0.00	0.02	0.70***
	(2.82)	(2.51)	(-3.12)	(5.62)	(1.69)	(0.98)	(1.38)	(-0.66)	(0.12)	(-0.01)	(0.08)	(3.49)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Commodity FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj-R^2	24.4%	21.7%	15.3%	10.8%	14.9%	37.3%	35.5%	17.9%	8.1%	1.7%	1.4%	19.2%
Obs.	1681	1681	1681	1681	1681	1681	1681	1681	1681	1681	1681	1681

Appendix E. Robustness: Day-trading session

This table reports the results from the difference-in-difference approach for Iron ore (Panel A) and PTA (Panel B) for the day-trading session only. We consider 6-month before and 6-month after the internalization event which is May 4, 2018 for iron ore and November 30, 2018 for PTA. We skip the first month after the event. The pre-event periods are from November 1, 2017 to May 3, 2018 (from May 31, 2018 to November 29, 2018) for iron ore (PTA). The post-event period is from June 1, 2018 to November 31, 2018 (from January 1, 2019 to June 28, 2019) for iron ore (PTA). The first row shows the various market quality as dependent variables: *Volume* (total daily volume), *Trade* (total daily number of trades), *Small* (the percentage of trade with less than 5 contracts), *Medium* (the percentage of trade with contracts between 5 and 50), *Large* (the percentage of trade with more than 50 contracts), *QS* (quoted spread), *ES* (effective spread), *RS* (realized spread), *PI* (price impact), and *RV* (the daily realized volatility). Volume, trade, bid/ask depth and RV are in logs. *IO* (*PTA*) is an indicator variable which equals to 1 for iron ore (PTA) and 0 otherwise. *Post* is an indicator variable which equals to 1 after June 1, 2018 (January 1, 2019) for iron ore (PTA) and 0 otherwise. *Controls* includes the log changes in RMB/USD and the difference in 10-Year Bonds between China and US. We employ both Month and commodity fixed effects. Figures in parentheses are t-statistics robust to heteroscedasticity and clustered by commodity. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Volume	*Trade*	*Small*	*Medium*	*Large*	*Bid depth*	*Ask depth*	*QS*	*ES*	*RS*	*PI*	*RV*
Panel A: Iron Ore												
Post	1.13*	1.41**	-0.86	0.57	0.82	1.01*	0.13	-1.57**	-1.90***	0.50	-1.16***	-0.59**
	(1.68)	(2.34)	(-1.44)	(0.88)	(1.45)	(1.91)	(0.21)	(-2.24)	(-3.95)	(1.36)	(-4.31)	(-2.35)
*IO*Post*	-1.60***	-1.82***	1.48***	-1.50***	-1.40***	-0.32	-0.28	0.78***	1.04***	-0.33***	0.75***	-0.73***
	(-5.88)	(-7.48)	(5.33)	(-6.12)	(-4.71)	(-1.12)	(-0.97)	(3.07)	(5.08)	(-5.55)	(9.05)	(-6.36)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Commodity FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj-R^2	14.5%	19.4%	17.4%	13.9%	11.1%	26.4%	27.6%	33.5%	25.1%	2.3%	5.0%	25.5%
Obs.	1721	1721	1721	1721	1721	1721	1721	1721	1721	1721	1721	1721
Panel B: PTA												
Post	0.47	0.00	-0.87**	0.65***	0.91**	0.33	0.44	1.03	0.41	-0.42	0.54*	0.41
	(1.00)	(0.00)	(-2.33)	(2.51)	(2.11)	(0.86)	(1.27)	(2.41)	(1.07)	(-1.58)	(1.67)	(0.96)
*PTA*Post*	1.02***	1.06***	-0.57***	0.42***	0.46**	0.38*	0.43**	0.04	0.19	0.01	0.03	0.59***
	(4.34)	(4.02)	(-3.66)	(4.39)	(1.97)	(1.88)	(2.30)	(0.11)	(0.54)	(0.07)	(0.18)	(3.31)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Commodity FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj-R^2	18.0%	18.3%	12.3%	10.0%	11.8%	41.8%	40.4%	23.4%	12.9%	2.1%	3.9%	22.6%
Obs.	1681	1681	1681	1681	1681	1681	1681	1680	1681	1681	1681	1681

Appendix F. Robustness: Night-trading session

This table reports the results from the difference-in-difference approach for Iron ore (Panel A) and PTA (Panel B) for the night-trading session only. We consider 6-month before and 6-month after the internalization event which is May 4, 2018 for iron ore and November 30, 2018 for PTA. We skip the first month after the event. The pre-event periods are from November 1, 2017 to May 3, 2018 (from May 31, 2018 to November 29, 2018) for iron ore (PTA). The post-event period is from June 1, 2018 to November 31, 2018 (from January 1, 2019 to June 28, 2019) for iron ore (PTA). The first row shows the various market quality as dependent variables: *Volume* (total daily volume), *Trade* (total daily number of trades), *Small* (the percentage of trade with less than 5 contracts), *Medium* (the percentage of trade with contracts between 5 and 50), *Large* (the percentage of trade with more than 50 contracts), *QS* (quoted spread), *ES* (effective spread), *RS* (realized spread), *PI* (price impact), and *RV* (the daily realized volatility). Volume, trade, bid/ask depth and RV are in logs. *IO* (*PTA*) is an indicator variable which equals to 1 for iron ore (PTA) and 0 otherwise. *Post* is an indicator variable which equals to 1 after June 1, 2018 (January 1, 2019) for iron ore (PTA) and 0 otherwise. *Controls* includes the log changes in RMB/USD and the difference in 10-Year Bonds between China and US. We employ both Month and commodity fixed effects. Figures in parentheses are t-statistics robust to heteroscedasticity and clustered by commodity. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Volume	*Trade*	*Small*	*Medium*	*Large*	*Bid depth*	*Ask depth*	*QS*	*ES*	*RS*	*PI*	*RV*
Panel A: Iron Ore												
Post	-0.09	0.12	0.12	-0.01	-0.07	0.32*	0.68*	-2.40***	-2.98***	1.39***	-2.29***	-1.42***
	(-0.20)	(0.29)	(0.22)	(-0.03)	(-0.13)	(1.78)	(1.75)	(-5.61)	(-10.49)	(4.65)	(-7.34)	(-6.43)
*IO*Post*	-1.58***	-1.70***	1.45***	-1.42***	-1.48***	-0.97***	-0.94***	0.88***	1.08***	0.05	0.38**	-0.61***
	(-4.78)	(-5.44)	(4.34)	(-4.27)	(-4.95)	(-4.39)	(-4.19)	(2.77)	(4.06)	(0.58)	(2.21)	(-3.00)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Commodity FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj-R^2	18.8%	23.1%	23.2%	15.1%	16.3%	43.4%	43.7%	43.3%	32.0%	2.6%	6.0%	31.1%
Obs.	1195	1195	1195	1195	1195	1195	1195	1195	1195	1195	1195	1195
Panel B: PTA												
Post	0.53*	0.30	-0.88***	0.81**	0.84***	-0.42	-0.41	0.89**	0.64*	-0.17	0.32	0.77**
	(1.75)	(0.78)	(-2.77)	(2.09)	(2.77)	(-0.88)	(-0.82)	(1.96)	(1.94)	(-0.55)	(0.97)	(2.00)
*PTA*Post*	0.97***	0.93***	-0.48***	0.17	0.39**	0.85***	0.87***	0.22	-0.12	0.05	-0.14	-0.01
	(13.57)	(12.63)	(-4.98)	(1.55)	(2.06)	(4.18)	(4.67)	(0.52)	(-0.33)	(0.33)	(-0.92)	(-0.13)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Commodity FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj-R^2	20.3%	21.3%	15.3%	10.9%	13.5%	29.2%	28.5%	24.0%	16.1%	-0.2%	2.1%	16.5%
Obs.	1099	1099	1099	1099	1099	1099	1099	1099	1099	1099	1099	1098

Table 1. Univariate analysis of the impact of internationalization

This table reports the differences in trading for iron ore (Panel A) and PTA futures (Panel B) before and after internalization. We consider 6-month before and 6-month after the internalization event which is May 4, 2018 for iron ore and November 30, 2018 for PTA. We skip the first month after the event. The pre-event periods are from November 1, 2017 to May 3, 2018 (from May 31, 2018 to November 29, 2018) for iron ore (PTA). The post-event period is from June 1, 2018 to November 31, 2018 (from January 1, 2019 to June 28, 2019) for iron ore (PTA). *Volume* is the average daily trading volume, *Trade* is the average total number of trades, *Small* represents the proportion of trades with less than 5 contracts, *Medium* for trades between 5 and 50 contracts, and L*arge* for trades with 50 contracts and above. *QS* is the average daily percentage quoted spread, *ES* is the average daily percentage effective spread, *RS* is the average daily realized spread, *PI* is the average daily price impact, and *RV* is the daily realized volatility constructed using returns at 1-minute frequency. *** denotes statistical significance at the 1% level.

	Before	After	Mean Difference	t-stat	Median Difference	Wilcoxon test p-value
Panel A: Iron Ore						
Volume ('000)	2369.49	1104.94	-1264.54***	(-9.91)	-1190.26***	{0.00}
Trade ('000)	30.72	19.64	-11.08***	(-12.71)	-11.41***	{0.00}
Small (n < 5)	34.4%	47.5%	13.0%***	(11.53)	12.7%***	{0.00}
Medium (5 ≤ n < 50)	46.7%	40.0%	-6.7%***	(-12.43)	-6.9%***	{0.00}
Large (n ≥ 50)	18.9%	12.6%	-6.3%***	(-9.51)	-5.9%***	{0.00}
Bid depth	1495.16	1483.98	-11.18	(-0.10)	-102.10	{0.34}
Ask depth	1516.21	1534.66	18.46	(0.15)	-105.64	{0.48}
QS	0.101%	0.102%	0.001%	(0.71)	0.003%**	{0.03}
ES	0.109%	0.113%	0.004%*	(1.88)	0.007%***	{0.00}
RS	0.025%	0.022%	-0.003%*	(-1.80)	-0.003%**	{0.03}
PI	0.084%	0.091%	0.007%***	(3.10)	0.005%***	{0.00}
RV	0.0012	0.0010	-0.0003***	(-5.19)	-0.0003***	{0.00}
Panel B: PTA						
Volume ('000)	1290.01	2159.76	869.76***	(3.95)	1146.58***	{0.00}
Trade ('000)	26.48	32.12	5.64***	(3.09)	6.39***	{0.00}
Small (n < 5)	36.8%	29.5%	-7%***	(-3.09)	-8.1%***	{0.00}
Medium (5 ≤ n < 50)	44.5%	46.1%	2%	(1.62)	0.2%	{0.46}
Large (n ≥ 50)	18.6%	24.4%	6%***	(3.45)	7.7%***	{0.00}
Bid depth	183.99	312.85	128.86***	(7.51)	173.58***	{0.00}
Ask depth	181.98	311.15	129.17***	(7.99)	161.47***	{0.00}
QS	0.032%	0.034%	0.002%**	(2.03)	0.001%***	{0.00}
ES	0.038%	0.038%	0.001%	(0.81)	0.001%	{0.24}
RS	0.008%	0.009%	0.001%	(1.12)	0.000%	{0.48}
PI	0.029%	0.029%	-0.000%	(-0.19)	-0.001%	{0.96}
RV	0.0009	0.0008	-0.0000	(-0.47)	-0.0000	{0.96}

Table 2. Correlations between treatment and control commodities

This table reports the Pearson correlations and p-values between the market quality of iron ore (Panel A) and PTA futures (Panel B) and their respective control commodities in the 6-month before the internalization event which is May 4, 2018 for iron ore and November 30, 2018 for PTA. *Volume* is the average daily trading volume, *Trade* is the average total number of trades, *Small* represents the proportion of trades with less than 5 contracts, *Medium* for trades between 5 and 50 contracts, and L*arge* for trades with 50 contracts and above. *QS* is the average daily percentage quoted spread, *ES* is the average daily percentage effective spread, *RS* is the average daily realized spread, *PI* is the average daily price impact, and *RV* is the daily realized volatility constructed using returns at 1-minute frequency. The last column (row) of each panel reports the average correlation between each market quality. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively

	Volume	*Trade*	*Small*	*Medium*	*Large*	*Bid depth*	*Ask depth*	*QS*	*ES*	*RS*	*PI*	*RV*	*Average*
Panel A: Iron Ore													
Coke	0.75***	0.79***	0.80***	0.62***	0.71***	0.68***	0.67***	0.81***	0.73***	0.19**	0.21**	0.82***	*0.65*
Coking Coal	0.63***	0.76***	0.69***	0.54***	0.43***	0.65***	0.72***	0.81***	0.64***	0.14	0.21**	0.81***	*0.59*
Steel rebar	0.81***	0.73***	0.74***	-0.38***	0.80***	0.69***	0.70***	0.86***	0.74***	0.18**	0.31***	0.80***	*0.58*
Thermal Coal	0.09	0.12	0.05	0.12	-0.15*	0.70***	0.66***	0.69***	0.60***	0.04	0.04	0.53***	*0.29*
Ferrosilicon	0.31***	0.44***	0.36***	0.41***	0.25***	0.22**	0.33***	0.60***	0.47***	-0.08	0.01	0.36***	*0.31*
Silicon manganese	0.13	0.24**	0.27***	0.28***	0.11	-0.14	-0.06	0.19**	0.19**	0.10	0.10	0.45***	*0.15*
Average	*0.45*	*0.51*	*0.49*	*0.26*	*0.36*	*0.47*	*0.50*	*0.66*	*0.56*	*0.09*	*0.15*	*0.63*	
Panel B: PTA													
LLDPE	0.34***	0.26***	0.43***	-0.07	0.44***	0.31***	0.26***	0.61***	0.50***	0.16*	0.32***	0.58***	*0.35*
PVC	0.30***	0.28***	0.36***	0.23**	0.50***	0.25***	0.17*	0.24**	0.38***	0.11	0.19**	0.52***	*0.29*
PP	0.16*	0.50***	0.48***	0.70***	0.16*	0.27***	0.24**	0.45***	0.32***	0.15	0.17*	0.64***	*0.35*
Natural rubber	0.27***	0.28***	0.28***	0.19**	0.25**	0.70***	0.67***	0.75***	0.59***	0.20**	0.25***	0.33***	*0.40*
Flat glass	0.36***	0.36***	0.21**	-0.02	0.35***	-0.03	0.01	-0.11	0.26***	0.01	0.08	0.45***	*0.16*
Crude oil	-0.05	0.24**	0.16*	0.32****	-0.22**	0.29***	0.26***	0.61***	0.47***	0.16*	0.26***	0.34***	*0.24*
Average	*0.23*	*0.32*	*0.32*	*0.22*	*0.24*	*0.30*	*0.27*	*0.43*	*0.42*	*0.13*	*0.21*	*0.48*	

Table 3. Difference-in-difference analysis of the impact of internationalization

This table reports the results from the difference-in-difference analysis for Iron ore (Panel A) and PTA (Panel B). We consider 6-month before and 6-month after the internalization event which is May 4, 2018 for iron ore and November 30, 2018 for PTA. We skip the first month after the event. The pre-event periods are from November 1, 2017 to May 3, 2018 (from May 31, 2018 to November 29, 2018) for iron ore (PTA). The post-event period is from June 1, 2018 to November 31, 2018 (from January 1, 2019 to June 28, 2019) for iron ore (PTA). The first row shows the various market quality as dependent variables: *Volume* (total daily volume), *Trade* (total daily number of trades), *Small* (the percentage of trade with less than 5 contracts), *Medium* (the percentage of trade with contracts between 5 and 50), *Large* (the percentage of trade with more than 50 contracts), *QS* (quoted spread), *ES* (effective spread), *RS* (realized spread), *PI* (price impact), and *RV* (the daily realized volatility). Volume, trade, bid/ask depth and RV are in logs. *IO* (*PTA*) is an indicator variable which equals to 1 for iron ore (PTA) and 0 otherwise. *Post* is an indicator variable which equals to 1 after June 1, 2018 (January 1, 2019) for iron ore (PTA) and 0 otherwise. *Controls* includes the log changes in RMB/USD and the difference in 10-Year Bonds between China and US. We employ both month and commodity fixed effects. Figures in parentheses are t-statistics robust to heteroscedasticity and clustered by commodity. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Volume	*Trade*	*Small*	*Medium*	*Large*	*Bid depth*	*Ask depth*	*QS*	*ES*	*RS*	*PI*	*RV*
Panel A: Iron Ore												
Post	0.96	1.22**	-0.52	0.40	0.45	0.81*	0.18	-1.68**	-2.29***	1.15***	-1.93***	-1.01***
	(1.44)	(2.06)	(-0.83)	(0.61)	(0.82)	(1.85)	(0.28)	(-2.33)	(-4.37)	(6.44)	(-10.74)	(-3.81)
*IO*Post*	-1.63***	-1.72***	1.49***	-1.52***	-1.46***	-0.46	-0.41	0.81***	1.11***	-0.30***	0.80***	-0.68***
	(-5.77)	(-7.22)	(5.14)	(-5.86)	(-4.77)	(-1.57)	(-1.37)	(3.26)	(5.32)	(-4.48)	(7.19)	(-5.65)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Commodity FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj-R^2	16.7%	18.9%	20.7%	16.0%	13.5%	27.8%	29.4%	34.2%	28.3%	4.0%	8.1%	30.4%
Obs.	1721	1721	1721	1721	1721	1721	1721	1721	1721	1721	1721	1721
Panel B: PTA												
Post	0.95**	0.76	-0.87**	0.66**	0.94**	0.29	0.36	0.99**	0.46	-0.39	0.55*	0.45
	(2.13)	(1.58)	(-2.45)	(2.27)	(2.30)	(0.79)	(1.07)	(2.32)	(1.17)	(-1.46)	(1.67)	(1.18)
*PTA*Post*	0.83***	0.66***	-0.62***	0.38***	0.54**	0.40**	0.46***	0.05	0.06	0.02	-0.01	0.47***
	(3.55)	(2.43)	(-4.51)	(3.85)	(2.43)	(2.06)	(2.61)	(0.15)	(0.16)	(0.18)	(-0.06)	(2.76)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Commodity FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj-R^2	24.4%	21.9%	14.6%	11.7%	13.0%	42.8%	41.0%	23.2%	13.5%	2.3%	4.2%	23.3%
Obs.	1681	1681	1681	1681	1681	1681	1681	1681	1681	1681	1681	1681

Table 4. Effect of the speculative activity

This table reports the results from the difference-in-difference approach for Iron ore (Panel A) and PTA (Panel B). We consider 6-month before and 6-month after the internalization event which is May 4, 2018 for iron ore and November 30, 2018 for PTA. We skip the first month after the event. The pre-event periods are from November 1, 2017 to May 3, 2018 (from May 31, 2018 to November 29, 2018) for iron ore (PTA). The post-event period is from June 1, 2018 to November 31, 2018 (from January 1, 2019 to June 28, 2019) for iron ore (PTA). *High_SPEC* is an indicator variable which equals to 1 when speculative pressure is higher than its full sample mean and 0 otherwise. *Post* is an indicator variable which equals to 1 after June 01, 2018 (January 01, 2019) for iron ore (PTA) and 0 otherwise. Volume, trade, bid/ask depth and RV are in logs. *Controls* includes the log changes in RMB/USD and the difference in 10-Year Bonds between China and US. We employ both month and commodity fixed effects. Figures in parentheses are t-statistics robust to heteroscedasticity and clustered by commodity. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Volume	*Trade*	*Small*	*Medium*	*Large*	*Bid depth*	*Ask depth*	*QS*	*ES*	*RS*	*PI*	*RV*
Panel A: Iron Ore												
*High_SPEC * IO * Post*	0.01	0.15	-0.12	0.10	-0.20	-0.84***	-0.84***	-0.58***	-0.54***	-0.84***	0.20***	0.31***
	(0.04)	(1.20)	(-0.51)	(0.42)	(-0.72)	(-3.79)	(-4.01)	(-3.19)	(-4.92)	(-8.42)	(2.85)	(4.79)
*High_SPEC * Post*	-0.14	-0.21	-0.01	0.00	0.13	0.11	0.20	-0.17	-0.02	-0.09	0.05	-0.09
	(-0.71)	(-1.33)	(-0.05)	(0.02)	(0.48)	(0.45)	(0.79)	(-1.20)	(-0.19)	(-0.58)	(0.36)	(-0.77)
*High_SPEC *IO*	-0.45***	-0.54***	0.43***	-0.21	-0.10	0.06	0.12	0.20	0.05	0.09	0.16*	-0.18**
	(-3.55)	(-7.15)	(2.80)	(-0.60)	(-0.46)	(0.31)	(0.74)	(1.19)	(0.40)	(0.91)	(1.69)	(-2.23)
High_SPEC	0.63***	0.65***	-0.52**	0.33	0.41	-0.07	-0.18	0.16	0.16	0.13	-0.03	0.49***
	(3.22)	(3.93)	(-2.25)	(1.38)	(1.46)	(-0.29)	(-0.70)	(1.04)	(1.45)	(1.06)	(-0.27)	(4.19)
Post	1.06**	1.37***	-0.51	0.42	0.39	0.78	0.08	-1.45**	-2.19***	1.22***	-1.92***	-0.94***
	(2.22)	(3.28)	(-1.15)	(0.78)	(0.92)	(1.61)	(0.12)	(-1.97)	(-4.13)	(10.53)	(-9.20)	(-5.27)
*IO * Post*	-1.64***	-1.80***	1.55***	-1.56***	-1.35***	-0.14	-0.09	1.07***	1.33***	0.04	0.75***	-0.78***
	(-7.20)	(-9.45)	(5.90)	(-8.07)	(-5.00)	(-0.43)	(-0.27)	(4.28)	(6.63)	(0.41)	(5.97)	(-8.20)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Commodity FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj-R^2	22.7%	24.6%	25.8%	18.0%	17.8%	28.7%	30.3%	34.5%	28.6%	4.8%	8.0%	34.5%
Obs.	1714	1714	1714	1714	1714	1714	1714	1714	1714	1714	1714	1714

(Cont.) Table 4. Effect of the speculative activity

	Volume	*Trade*	*Small*	*Medium*	*Large*	*Bid depth*	*Ask depth*	*QS*	*ES*	*RS*	*PI*	*RV*
Panel B: PTA												
*High_SPEC * PTA * Post*	-1.14***	-0.87***	1.33***	-0.65***	-1.34***	-0.28	-0.37	-0.44	-0.37	-1.05***	0.75***	-0.98***
	(-3.78)	(-3.21)	(5.80)	(-3.37)	(-3.77)	(-0.93)	(-1.11)	(-0.82)	(-0.90)	(-5.53)	(3.48)	(-5.32)
*High_SPEC * Post*	0.31***	0.37***	-0.19	0.19	0.19	-0.01	0.01	0.05	0.16	0.00	0.09	0.16
	(3.75)	(3.58)	(-1.16)	(1.05)	(1.50)	(-0.04)	(0.07)	(0.21)	(0.89)	(-0.01)	(0.53)	(0.97)
*High_SPEC * PTA*	1.55***	1.29***	-1.63***	0.80***	1.69***	0.54***	0.63***	-0.76**	-0.70***	0.53***	-0.82***	1.07***
	(10.58)	(15.15)	(-9.33)	(6.12)	(6.43)	(2.88)	(2.74)	(-2.31)	(-2.61)	(4.13)	(-5.41)	(6.02)
High_SPEC	0.11	0.15	-0.06	-0.02	0.09	-0.20	-0.23	-0.15	-0.25*	0.06	-0.15	0.12
	(0.93)	(1.16)	(-0.57)	(-0.29)	(0.67)	(-1.50)	(-1.72)	(-1.01)	(-1.83)	(0.44)	(-0.85)	(0.76)
Post	0.71	0.46	-0.83*	0.69*	0.79*	0.24	0.40	1.19***	0.67	-0.62*	0.82*	0.39
	(1.58)	(1.13)	(-1.81)	(1.82)	(1.68)	(0.66)	(1.06)	(2.60)	(1.47)	(-1.82)	(1.87)	(0.89)
*PTA * Post*	0.80***	0.54**	-0.74***	0.43**	0.62***	0.46**	0.54**	0.69	0.64	0.44***	-0.11	0.57***
	(3.33)	(2.00)	(-4.26)	(2.33)	(3.71)	(2.03)	(2.36)	(1.64)	(1.45)	(3.15)	(-0.48)	(3.93)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Commodity FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj-R^2	30.5%	28.5%	19.1%	13.0%	18.0%	44.0%	42.2%	27.3%	17.5%	3.1%	5.8%	26.1%
Obs.	1674	1674	1674	1674	1674	1674	1674	1674	1674	1674	1674	1674

Table 5. Effect of the hedging activity

This table reports the results from the difference-in-difference approach for Iron ore (Panel A) and PTA (Panel B). We consider 6-month before and 6-month after the internalization event which is May 4, 2018 for iron ore and November 30, 2018 for PTA. We skip the first month after the event. The pre-event periods are from November 1, 2017 to May 3, 2018 (from May 31, 2018 to November 29, 2018) for iron ore (PTA). The post-event period is from June 1, 2018 to November 31, 2018 (from January 1, 2019 to June 28, 2019) for iron ore (PTA). *High_HEDG* is an indicator variable which equals to 1 when hedging pressure is higher than its full sample mean and 0 otherwise. *Post* is an indicator variable which equals to 1 after June 01, 2018 (January 01, 2019) for iron ore (PTA) and 0 otherwise. Volume, trade, bid/ask depth and RV are in logs. *Controls* includes the log changes in RMB/USD and the difference in 10-Year Bonds between China and US. We employ both month and commodity fixed effects. Figures in parentheses are t-statistics robust to heteroscedasticity and clustered by commodity. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Volume	*Trade*	*Small*	*Medium*	*Large*	*Bid depth*	*Ask depth*	*QS*	*ES*	*RS*	*PI*	*RV*
Panel A: Iron Ore												
*High_HEDG * IO * Post*	0.40***	0.42***	-0.17**	0.27***	0.04	0.30***	0.23**	0.14***	0.40***	-0.23***	0.46***	0.02
	(3.44)	(3.22)	(-2.02)	(3.32)	(0.41)	(4.67)	(2.17)	(2.95)	(5.81)	(-5.90)	(9.50)	(0.22)
*High_HEDG * Post*	-0.12	-0.15	0.01	-0.02	-0.05	0.00	-0.08	0.02	0.00	-0.05	0.05	0.05
	(-1.27)	(-1.35)	(0.16)	(-0.40)	(-0.55)	(0.06)	(-0.85)	(0.39)	(-0.01)	(-1.46)	(1.09)	(0.68)
*High_HEDG * IO*	-0.41***	-0.49***	0.27***	-0.21***	-0.20***	-0.11***	-0.18***	-0.17***	-0.18***	0.07	-0.21***	-0.08
	(-6.62)	(-8.21)	(5.62)	(-2.67)	(-2.90)	(-2.71)	(-3.72)	(-2.83)	(-4.78)	(1.21)	(-3.43)	(-1.11)
High_HEDG	0.32***	0.35***	-0.17***	0.09*	0.22***	0.11**	0.17***	-0.11**	-0.13***	0.13**	-0.16***	-0.02
	(7.05)	(7.66)	(-5.25)	(1.86)	(4.94)	(2.43)	(3.58)	(-2.19)	(-6.28)	(2.05)	(-2.69)	(-0.52)
Post	1.10*	1.40***	-0.54	0.45	0.51	0.83*	0.26	-1.63**	-2.25***	1.17***	-1.94***	-1.04***
	(1.73)	(2.50)	(-0.93)	(0.71)	(1.08)	(1.77)	(0.39)	(-2.43)	(-4.39)	(6.99)	(-14.01)	(-3.58)
*IO * Post*	-1.83***	-1.92***	1.58***	-1.65***	-1.48***	-0.59*	-0.52	0.74***	0.91***	-0.18***	0.57***	-0.70***
	(-7.18)	(-8.34)	(6.01)	(-6.68)	(-5.80)	(-1.84)	(-1.59)	(3.19)	(4.49)	(-2.59)	(5.27)	(-5.95)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Commodity FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj-R^2	18.1%	20.6%	21.2%	16.0%	14.1%	28.1%	29.7%	34.2%	28.4%	4.1%	8.4%	30.2%
Obs.	1714	1714	1714	1714	1714	1714	1714	1714	1714	1714	1714	1714

(Cont.) Table 5. Effect of the hedging activity

	Volume	*Trade*	*Small*	*Medium*	*Large*	*Bid depth*	*Ask depth*	*QS*	*ES*	*RS*	*PI*	*RV*
Panel B: PTA												
*High_HEDG * PTA * Post*	-0.56***	-0.56***	0.33***	-0.08	-0.34***	0.04	0.02	0.23***	0.04	-0.21*	0.16	-0.59***
	(-7.39)	(-9.88)	(2.93)	(-0.71)	(-2.52)	(0.30)	(0.23)	(2.85)	(0.56)	(-1.81)	(1.47)	(-8.36)
*High_HEDG * Post*	0.17**	0.21***	0.01	-0.05	-0.03	0.07	0.05	0.03	-0.04	0.04	-0.05	0.10*
	(2.24)	(5.20)	(0.09)	(-0.38)	(-0.18)	(0.67)	(0.64)	(0.28)	(-0.39)	(0.35)	(-0.45)	(1.69)
*High_HEDG * PTA*	0.47***	0.50***	-0.38***	0.23***	0.32***	0.04	0.06	-0.05	0.02	0.40***	-0.34***	0.39***
	(7.84)	(11.04)	(-5.61)	(4.32)	(3.52)	(0.30)	(0.58)	(-0.80)	(0.30)	(3.58)	(-3.37)	(7.56)
High_HEDG	0.01	0.02	-0.01	-0.01	0.07	-0.01	0.01	-0.10	-0.06	-0.03	0.02	0.00
	(0.14)	(0.52)	(-0.19)	(-0.16)	(0.63)	(-0.07)	(0.08)	(-1.19)	(-0.77)	(-0.30)	(0.26)	(-0.08)
Post	0.90*	0.68	-1.00**	0.83***	0.99**	0.15	0.33	1.11**	0.65	-0.61**	0.83**	0.50
	(1.84)	(1.33)	(-2.46)	(2.60)	(2.18)	(0.44)	(0.92)	(2.41)	(1.43)	(-2.15)	(2.17)	(1.11)
*PTA * Post*	1.07***	0.88***	-0.76***	0.39***	0.69***	0.38*	0.44**	-0.06	0.05	0.08	-0.05	0.75***
	(4.65)	(3.18)	(-6.55)	(4.50)	(2.98)	(1.95)	(2.45)	(-0.19)	(0.13)	(0.54)	(-0.28)	(3.98)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Commodity FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj-R^2	25.0%	22.9%	14.9%	12.0%	13.1%	43.1%	41.1%	23.6%	13.8%	2.7%	4.7%	23.7%
Obs.	1674	1674	1674	1674	1674	1674	1674	1674	1674	1674	1674	1674

Table 6. Mispricing

This table reports the differences in mispricing (Panel A) and multivariate regression analysis for Iron ore (Panel B). We consider 6-month before and 6-month after the internalization event which is May 4, 2018 for iron ore and November 30, 2018 for PTA. We skip the first month after the event. The pre-event periods are from November 1, 2017 to May 3, 2018 (from May 31, 2018 to November 29, 2018) for iron ore (PTA). The post-event period is from June 1, 2018 to November 31, 2018 (from January 1, 2019 to June 28, 2019) for iron ore (PTA). Volume, trade, bid/ask depth and RV are in logs. *Controls* includes monthly dummies. Figures in parentheses (brackets) are the Newey-West robust t-statistics (Wilcoxon test p-values). ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Before	After	Mean Difference	t-stat	Median Difference	Wilcoxon test p-value
Panel A: Univariate analysis						
Mispricing	142.43	131.32	-11.11***	(-2.89)	-6.94***	{0.00}

	Volume	*Trade*	*Small*	*Medium*	*Large*	*Bid depth*	*Ask depth*	*QS*	*ES*	*RS*	*PI*	*RV*
Panel B: Multivariate analysis												
Constant	0.78***	0.80***	-1.13***	0.92***	1.27***	-0.93***	-0.89***	-1.02***	-0.95***	-0.26	-0.40	0.99***
	(3.99)	(4.06)	(-5.33)	(4.11)	(5.97)	(-4.84)	(-4.93)	(-4.75)	(-5.89)	(-0.90)	(-1.39)	(4.72)
Mispricing	0.33***	0.33***	-0.26***	0.26***	0.24***	0.14**	0.09	0.12	0.10	0.08	-0.01	0.19***
	(5.79)	(5.51)	(-4.10)	(3.55)	(4.40)	(2.12)	(1.58)	(1.05)	(1.03)	(1.20)	(-0.11)	(2.65)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj-R^2	69.8%	67.2%	72.5%	69.4%	67.3%	61.5%	60.9%	64.1%	56.1%	13.8%	18.9%	47.4%
Obs.	243	243	243	243	243	243	243	243	243	243	243	243

Table 7. Placebo test

This table reports the results from the difference-in-difference approach for steel rebar (Panel A) and LLDPE (Panel B) used as false treated commodity for iron ore and PTA, respectively. We consider 6-month before and 6-month after the internalization event which is May 4, 2018 for iron ore and November 30, 2018 for PTA. We skip the first month after the event. The pre-event periods are from November 1, 2017 to May 3, 2018 (from May 31, 2018 to November 29, 2018) for iron ore (PTA). The post-event period is from June 1, 2018 to November 31, 2018 (from January 1, 2019 to June 28, 2019) for iron ore (PTA). *IO* (*PTA*) is an indicator variable which equals to 1 for iron ore (PTA) and 0 otherwise. *Post* is an indicator variable which equals to 1 after June 1, 2018 (January 1, 2019) for iron ore (PTA) and 0 otherwise. Volume, trade, bid/ask depth and RV are in logs. *Controls* includes the log changes in RMB/USD and the difference in 10-Year Bonds between China and US. We employ both month and commodity fixed effects. Figures in parentheses are t-statistics robust to heteroscedasticity and clustered by commodity. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Volume	*Trade*	*Small*	*Medium*	*Large*	*Bid depth*	*Ask depth*	*QS*	*ES*	*RS*	*PI*	*RV*
Panel A: Steel rebar												
Post	1.08	1.22*	-0.49	0.30	0.48	1.06**	0.34	-1.60*	-2.12***	1.31***	-1.91***	-1.11***
	(1.39)	(1.73)	(-0.66)	(0.37)	(0.72)	(2.20)	(0.45)	(-1.86)	(-3.51)	(7.36)	(-8.96)	(-3.38)
*Steel rebar*Post*	-0.11	0.12	-0.34	0.64**	-0.09	-0.41	-0.41	-0.44	-0.41*	-0.22***	0.00	0.26*
	(-0.33)	(0.42)	(-0.97)	(2.23)	(-0.25)	(-1.17)	(-1.16)	(-1.51)	(-1.73)	(-3.17)	(-0.03)	(1.92)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Commodity FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj-R^2	8.1%	10.5%	11.9%	8.1%	4.8%	26.2%	27.1%	32.6%	28.5%	3.5%	7.5%	27.5%
Obs.	1475	1475	1475	1475	1475	1475	1475	1475	1475	1475	1475	1475
Panel B: LLDPE												
Post	0.81	0.57	-0.80**	0.50*	0.95*	0.28	0.32	0.85***	0.19	-0.48	0.51	0.26
	(1.61)	(1.03)	(-1.96)	(1.78)	(1.88)	(0.67)	(0.82)	(2.49)	(0.70)	(-1.47)	(1.42)	(0.67)
*LLDPE*Post*	0.45*	0.41	0.04	0.10	-0.29	0.45**	0.39*	1.32***	1.52***	0.25*	0.41**	0.27
	(1.68)	(1.27)	(0.26)	(0.85)	(-1.10)	(2.06)	(1.90)	(4.33)	(4.87)	(1.87)	(2.10)	(1.31)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Commodity FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Adj-R^2	24.4%	23.2%	11.2%	8.7%	10.7%	39.6%	37.7%	28.3%	18.9%	2.6%	3.9%	21.9%
Obs.	1446	1446	1446	1446	1446	1446	1446	1446	1446	1446	1446	1445

Figure 1. Evolution of volume, trades, effective spread, and RV for iron ore

These figures plot the daily evolution of volume, number of trades, effective spread and realized volatility (RV) for iron ore in the event window. The first month after the event is highlighted in grey.

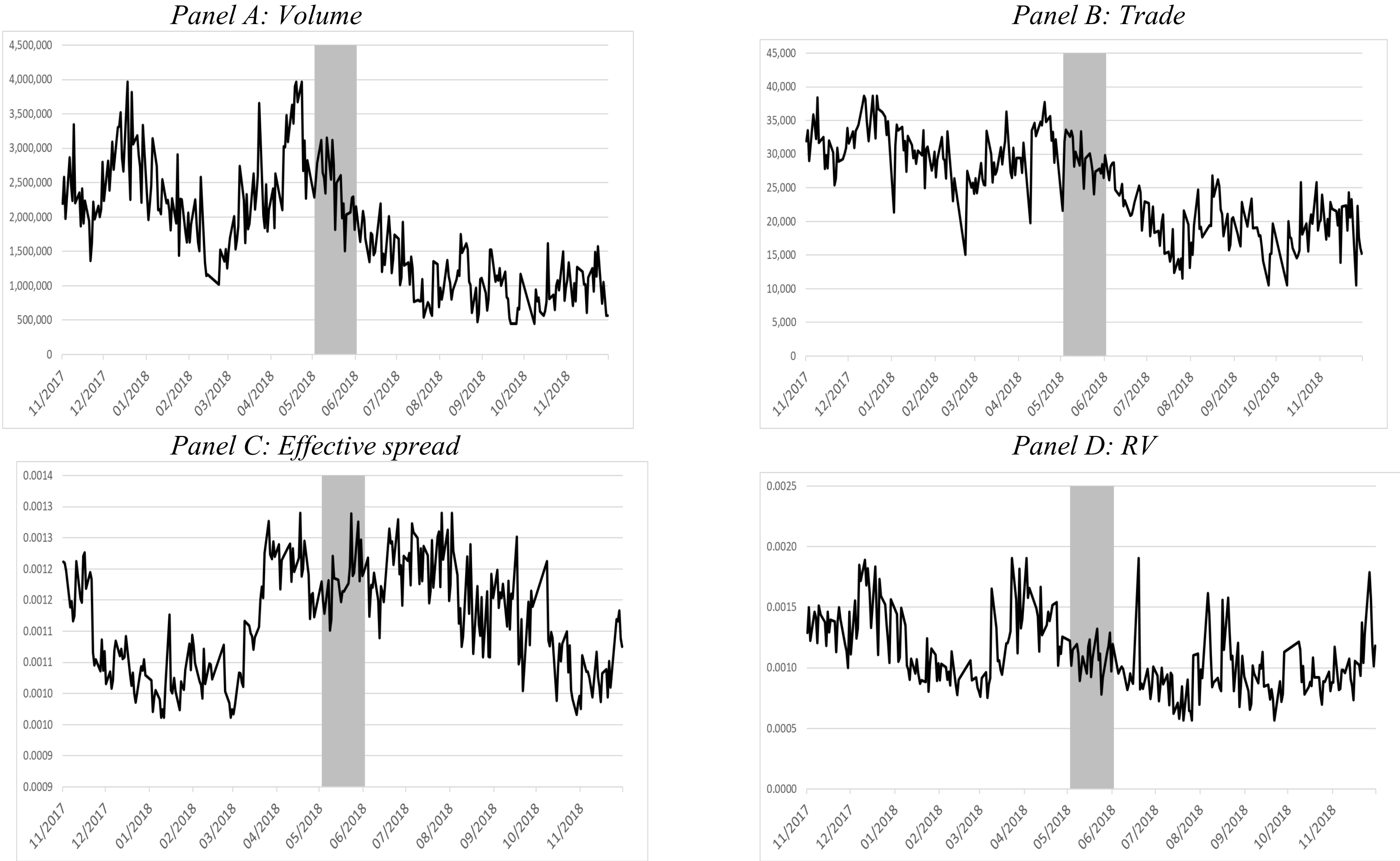


Figure 2. Evolution of volume, trades, effective spread, and RV for PTA

These figures plot the daily evolution of volume, number of trades, effective spread and realized volatility (RV) for iron ore in the event window. The first month after the event is highlighted in grey.

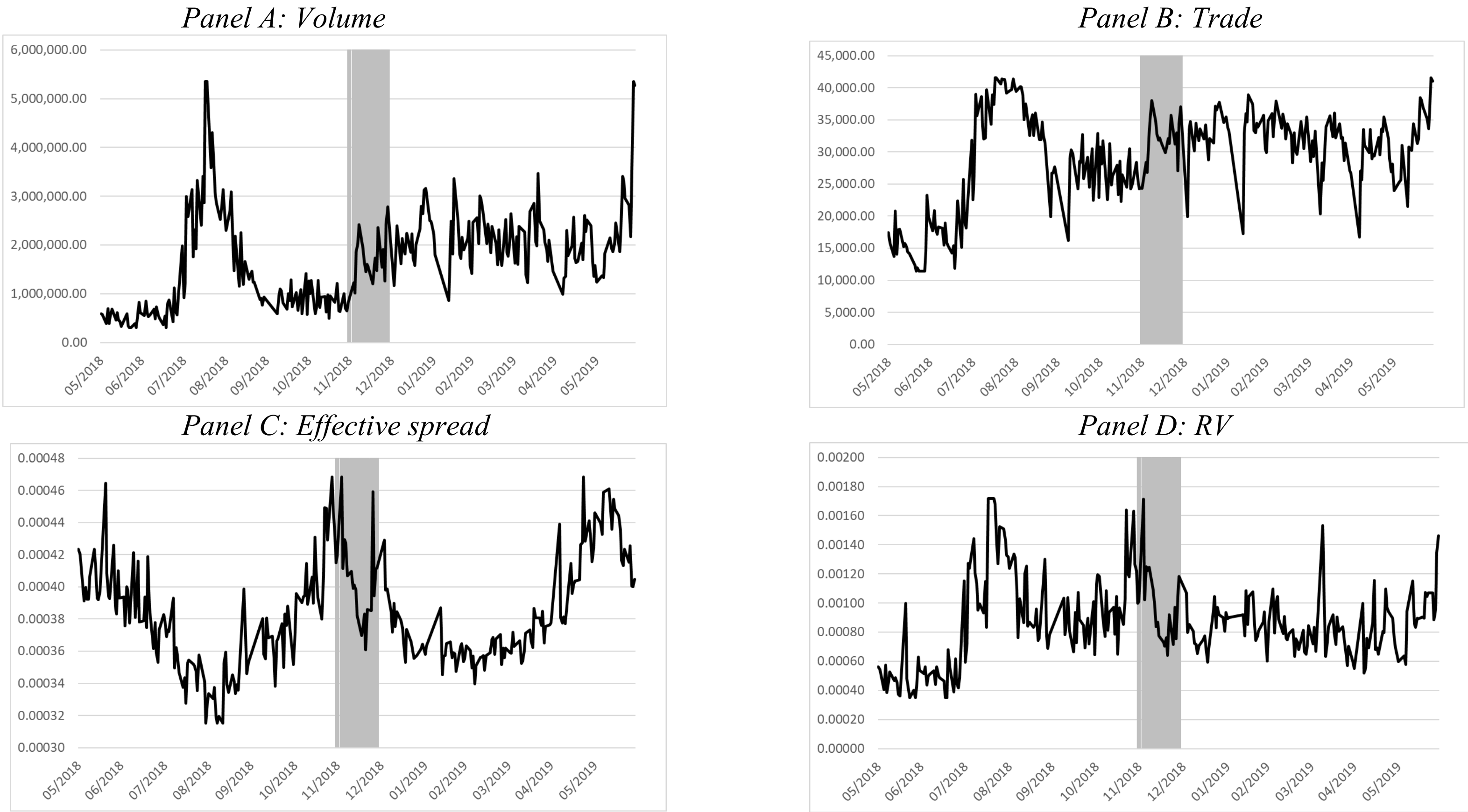
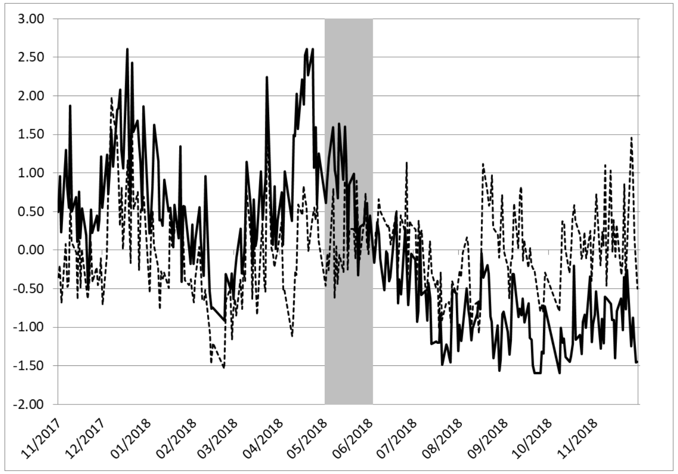


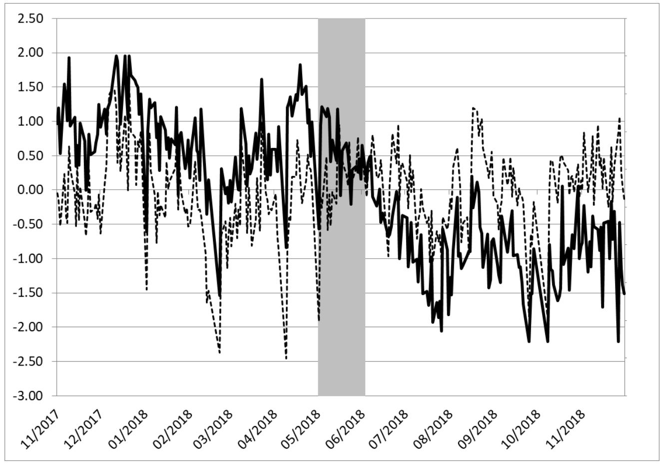
Figure 3. Parallel trends in iron ore

These figures plot the daily evolution of volume, number of trades, effective spread and realized volatility (RV) for iron ore (black line) and the control commodities (dashed line) in the event window. The first month after the event is highlighted in grey.

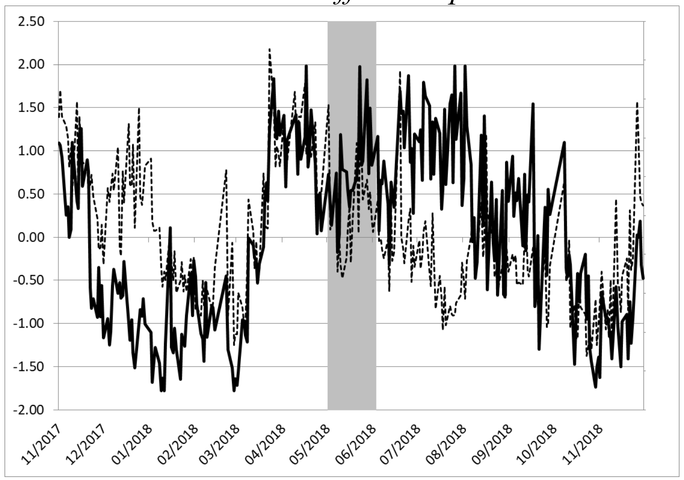
Panel A: Volume



Panel B: Trade



Panel C: Effective spread



Panel D: RV

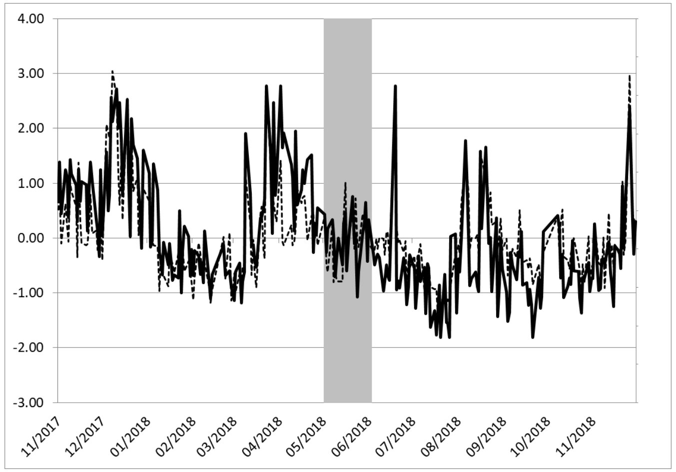


Figure 4. Parallel trends in PTA

These figures plot the daily evolution of volume, number of trades, effective spread and realized volatility (RV) for iron ore (black line) and the control commodities (dashed line) in the event window. The first month after the event is highlighted in grey.

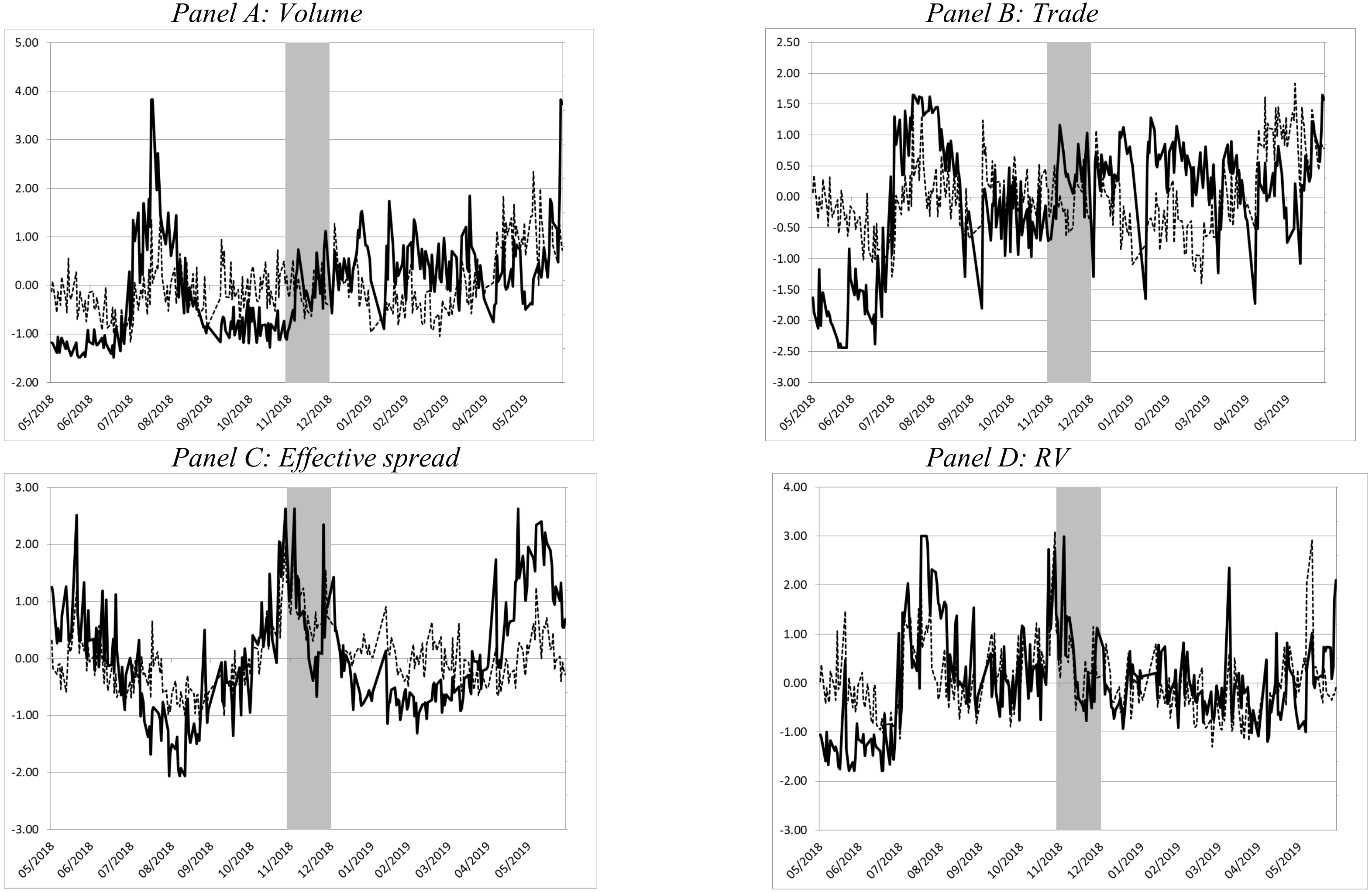
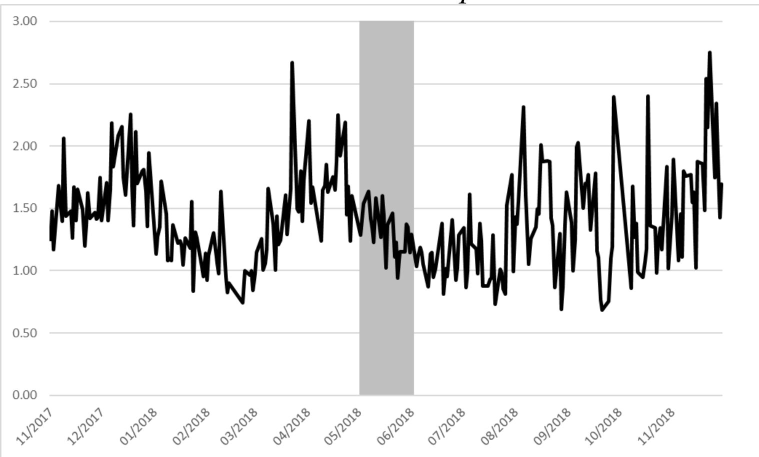


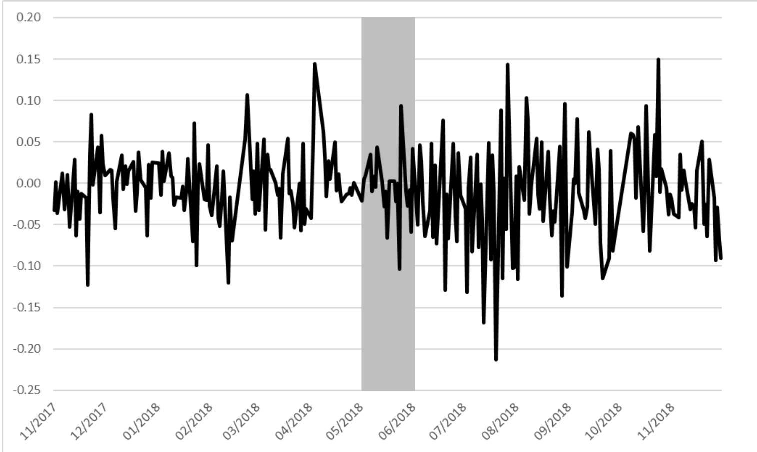
Figure 5. Evolution of speculative and hedging ratio

These figures plot the daily evolution of speculative and hedging ratio for iron ore (Panels A and B) and PTA (Panels C and D) in the event window. The first month after the event is highlighted in grey.

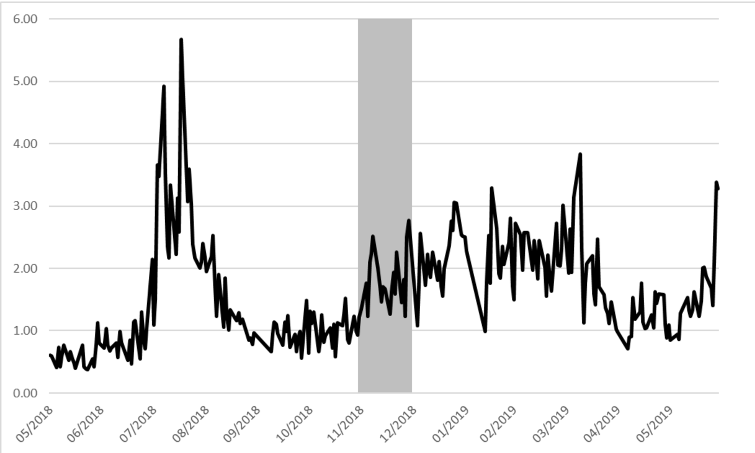
Panel A: Iron ore's speculative ratio



Panel B: Iron ore's hedging ratio



Panel C: PTA's speculative ratio



Panel B: PTA's hedging ratio

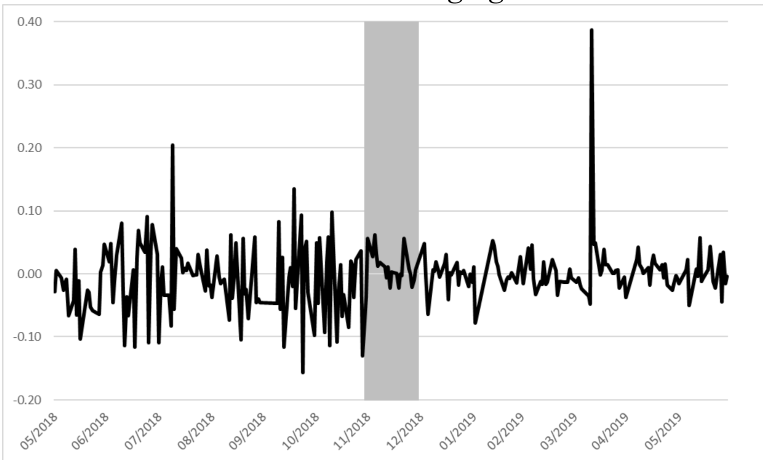


Figure 6. Iron ore mispricing between SGX and DCE

These figures plot the daily mispricing in iron ore futures between the SGX and DCE. Mispricing is defined as the sum of squared (log) differences in prices between the two markets. The first month after the event is highlighted in grey.