Financialization, Intraday Institutional Trading, and Commodity Market Quality

by

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. **Abstract**

We investigate the impact on market liquidity and pricing efficiency of an important, albeit hitherto unexplored, aspect of the financialization of commodities: the massive growth in intraday trading by "non-commercial" institutional traders. First, we use the introduction of electronic trading in U.S. crude oil futures as an instrument to establish a causally and significantly beneficial effect of institutional financial trading on key metrics of market quality. We exploit large differences in post-electronification growth rates of institutional financial trading in futures with different maturities to tease out the respective roles of electronification *vs*. financialization. Next, having established causality, we use structural vector autoregression analyses to further examine the endogenous relationship between institutional financial trading and market quality. We find that increased institutional financial trading contemporaneously reduces the variance of pricing errors, narrows bid-ask spreads, and cuts customer trade imbalances. Finally, we show that, in the causal link between financialization and the improvement in market quality, both fast (automated) and other, non-fast, institutional financial traders play separate and important roles for different attributes of market quality.

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1. **Introduction**

In the early 2000's, institutional financial actors, driven purely by "non-commercial" financial motives, started assuming a sharply greater role in commodity markets. This development, known as the "financialization" of commodities (UNCTAD, 2011; Cheng and Xiong, 2014), has spawned a substantial amount of academic research. Much of the focus to date, however, has been on the positions held overnight and on the longer-term trading strategies of commodity index traders (CITs) and managed money traders (hedge funds), and on their relevance to select aspects of the daily, weekly, monthly, or even quarterly distributions of commodity returns: risk premia (e.g., Acharya, Lochstoer, and Ramadorai, 2013; Singleton, 2014; Hamilton and Wu, 2015), price levels (e.g., Henderson, Pearson, and Wang, 2014; Sockin and Xiong, 2015), volatility (e.g., Kim, 2015; Brunetti, Büyükşahin, and Harris, 2016), and co-movements between markets (e.g., Tang and Xiong, 2012; Büyükşahin and Robe, 2014; Cheng, Kirilenko, and Xiong, 2015; Başak and Pavlova, 2016).

In contrast, surprisingly little attention has been paid to another major manifestation of financialization – the massive growth in short-horizon trading by institutional financial traders, with positions held largely *intraday* rather than overnight. This growth reflects these traders' sharply greater role in providing liquidity and their active trading on short-term information (e.g., information in the order flow). Our paper is the first to empirically investigate the impact of this aspect of financialization on the quality of commodity markets.[1]

We test hypotheses about the impact of financialization on intraday pricing efficiency by examining the variance of "pricing errors," i.e., the deviations of market prices from informationally efficient "fundamental" values (Hasbrouck, 1993; Boehmer and Kelley, 2009; Fotak, Raman, and Yadav, 2014). We also test hypotheses regarding the impact of

[1] Accordingly, unless otherwise indicated, our use of the term "financialization" in this paper signifies the growth in *intraday* trading and positions of institutional financial traders.

financialization on bid-ask spreads, the Amihud (2002) measure of depth, and the absolute magnitude of customers' trade imbalances (i.e., the difference between customer buys and customer sells). Overall, we find unequivocally strong evidence that institutional financial trading has a significant beneficial impact on each of these four measures of market quality.

Our empirical findings are based on a comprehensive, non-public regulatory dataset of trading activity at the world's largest commodity market – the New York Mercantile Exchange's (NYMEX) West Texas Intermediate (WTI) sweet crude oil futures market. This market underwent a major structural change with electronification, i.e., the onset of trading on the electronic Globex platform starting September 5^{th}, 2006.

Before electronification, WTI futures trading was physically confined to the pits during business hours. It was intermediated largely by "Locals," i.e., by individual traders functioning as scalpers (Silber, 1984) and acting as voluntary providers of immediacy and liquidity in the market (Manaster and Mann, 1996). After electronification, trading on Globex started coexisting alongside face-to-face trading in the pits. Importantly, Globex trading also resulted in a transformative easing of access for traders without physical access to the trading pits, with any such trader able to trade directly on the electronic system – and thereby to compete with Locals in the supply of liquidity (through the posting of limit orders to buy or sell) or otherwise (for example, through short-horizon trading on information in the order flow). Consistent with evidence on structural reforms at the NASDAQ (Barclay *et al*., 2000) and the London Stock Exchange (Naik and Yadav, 2003) that allowed public traders to compete with traditional market makers in supplying liquidity, and consistent with evidence on the benefits of electronification in equity markets (e.g., Jain, 2005), we document that electronification results in significantly higher commodity pricing efficiency and significantly lower trading costs.

That said, our paper's focus is not on electronification but on financialization. We identify institutional financial traders – whose intraday activity forms the basis for our measure of financialization – using the comprehensive, confidential, trader-level dataset obtained from the market regulator (the U.S. Commodity Futures Trading Commission or CFTC). We then use the introduction of electronic trading in the WTI market as an instrument to extract the component of institutional financial trading that is exogenous to market conditions.

Not unexpectedly, we find that electronification brings about a sharp increase in the volume of trading by institutional financial traders and in their aggregate share of the total trading volume relative to Locals. What is particularly relevant from our perspective, though, is that financialization – the entry of new intraday institutional financial traders after electronification – takes place chiefly in the two nearest-dated futures and the three nearest December futures. In the WTI market, those five contract maturities account for the preponderance of intraday directional and calendar spread trading.[2] We exploit the large differences between the growth rates of institutional financial trading along the futures term structure to distinguish between the respective effects of electronification and financialization. Using data from January 2006 to March 2007, we extend the two-stage regression methodology of Hendershott, Jones, and Menkveld (2011) to establish a causal link between financialization (i.e., intraday institutional financial trading) and significant improvements in our measures of market liquidity (bid-ask spreads, depth, and customer trade imbalances) and of pricing efficiency (variance of pricing errors).

Having established causality from financialization to improvements in liquidity and pricing efficiency, we then carry out a structural vector auto-regression analysis (SVAR) to further examine the endogenous relationship between the participation of institutional financial traders and market quality. Using information from the same trader-level regulatory dataset between April 2007 and May 2008, we show that increases in institutional financial trading

[2] These five contracts also correspond to the maturities most commonly held overnight or for longer periods by commercial crude oil traders (producers, refiners, wholesalers, etc.) both before (Neuberger, 1999; Ederington and Lee, 2002) and after (Büyükşahin, Haigh, Harris, Overdahl, and Robe, 2015) electronification.

contemporaneously narrow bid-ask spreads, curtail customer trade imbalances, and cut the variance of pricing errors – all of which are unequivocally healthy developments.

Finally, we investigate the respective roles of fast (automated) and of other, non-fast, institutional financial traders in the causal impact of financialization on market quality. To do so, we modify our two-stage procedure by using a narrower measure of financialization that excludes the trading activity of fast algorithmic traders, while still retaining the trading activity of these fast machine traders as a control variable. Importantly, we find that non-fast institutional financial trading activity significantly improves each of our metrics of liquidity: it reduces bid-ask spreads, increases market depth, and reduces the imbalances between customer buys and customer sells. At the same time, it is fast (automated) institutional financial trading that significantly reduces the variance of pricing errors. Fast algorithmic trading also contributes to reducing spreads and trade imbalances, but we find no evidence that it contributes to market depth.[3] These results are consistent with liquidity improvements' being driven by the flow of institutional risk capital into intraday liquidity provision rather than just the activities of fast automated traders *per se*.

The roadmap for the rest of the paper is as follows. Section 2 summarizes our contribution to the literature. Section 3 motivates our empirical hypotheses. Section 4 describes our rich regulatory dataset, and defines the specific measures of intraday pricing efficiency and liquidity that we investigate. Section 5 documents the hugely beneficial impact of electronification on measures of intraday market quality and provides evidence of the crude oil market's intraday financialization subsequent to electronification. Specifically, it identifies the large increase in the trading activity of institutional financial traders, thanks to the entry of new players; and highlights variations in the growth of institutional financial trading across the

[3] Our evidence relating specifically to fast algorithmic traders is consistent with Brogaard, Hendershott, and Riordan (2014, equities) and Chaboud, Chiquoine, Hjalmarsson, and Vega (2014, currencies) for pricing efficiency, and with Hendershott, Jones, and Menkveld (2011, equities) for spreads.

futures term structure. Sections 6 formally analyzes the impact of financialization on market quality. In particular, it undertakes a two-stage procedure for identifying the causal link from financialization to pricing efficiency and liquidity, and it presents a structural VAR analysis tying changes in market quality to changes in institutional trading activity. Section 7 presents evidence that, in the causal link between financialization and the improvement in market quality, both fast (automated), and other non-fast, institutional financial traders play separate and important roles for different attributes of market quality. Section 8 concludes and outlines avenues for further research.

2. **Research Contribution**

We investigate the impact of the *intraday* financialization of commodity markets – the growth in institutional financial (i.e., "non-commercial") traders with intraday horizons and intraday holding periods – on intraday measures of pricing efficiency and liquidity. Our findings contribute principally to two strands of the financial economics literature.

The first strand is the fast-growing body of work on the financialization of commodity markets, reviewed, for example, in Cheng and Xiong (2014).[4] Prior research in this area examines relatively long-horizon traders and its empirical results are based entirely on daily, weekly, monthly, or even quarterly data regarding the ownership of end-of-day futures positions. As such, this extant work abstracts away from the existence of numerous financial traders who do not carry positions overnight. Our paper adds significantly to this literature because it is the first to study the futures-market impact of institutional traders who not only do not have any commercial interest in the underlying physical commodity but also enter and

[4] In addition to articles already cited, examples of research in this area include Bessembinder, Carrion, Tuttle, and Venkataraman (2016), Brunetti and Reiffen (2014), Bruno, Büyükşahin, and Robe (2016), Etula (2013), Hamilton (2009), Hong and Yogo (2012), Kilian and Murphy (2014), Knittel and Pindyck (2016), Korniotis (2009), Sanders, Irwin, and Merrin (2010), Stoll and Whaley (2010), etc.

exit their derivatives positions on the same day. Specifically, we find that the financialization of intraday commodity futures trading contributes statistically and economically significantly to both market liquidity and pricing efficiency.

The second strand of the finance literature to which we contribute deals with the impact of institutional trading on market quality. Our research complements extensive prior work on the impact of relatively long-horizon institutional trading on relatively long-horizon measures of market efficiency.[5] It also complements prior work on the impact of intraday-focused institutional traders on the intraday efficiency of commodity prices and on the short-horizon liquidity of the associated markets. Extant research at intraday horizons is confined to the impact of high frequency machine traders (HFTs) in equity and currency markets.[6] This part of the HFT literature is relevant since such fast algorithmic traders could potentially be institutional traders. The present paper is the first to address and investigate the impact on intraday pricing efficiency and liquidity provision of the short intraday horizon trading of both fast and non-fast institutional financial traders, and to show that each group contributes to intraday market quality – albeit in different ways.

Even though our findings pertain to commodity markets, they are directly relevant to all electronic order-driven markets where liquidity provision is voluntary. In contrast to the well-known dealer markets of the last century (e.g., the New York Stock Exchange and the London Stock Exchange), the vast majority of equity and other financial markets globally are now organized as electronic order-driven markets with voluntary liquidity provision. Our results on the beneficial impact of the flow of institutional risk capital into liquidity provision and short-horizon trading (irrespective of whether or not the traders involved are high speed machine traders) are thus potentially of wide applicability.

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[5] We discuss this extant research in more detail in Section 3.

[6] See, e.g., Hendershott, Jones, and Menkveld (2011), Brogaard, Hendershott, and Riordan (2014), and Chaboud, Chiquoine, Hjalmarsson, and Vega (2014).

3. <u>Research Questions</u>

In this Section, we outline testable hypotheses and place them within the literature.

3.1. Intraday Pricing Efficiency

Our first research question is whether financialization improves intraday pricing efficiency, and in particular, the variance of "pricing errors", i.e., the deviations of observed market prices from information-efficient random-walk or "fundamental" values, as in Hasbrouck (1993), Boehmer and Kelley (2009), or Fotak, Raman, and Yadav (2014).

For commodity markets, Singleton (2014) and Sockin and Xiong (2015) argue theoretically that, amid the globalization of world economic activity, commodity market participants face severely heightened informational frictions (about physical supply, demand, and inventories) and that these frictions, and the associated financial speculation, may cause the magnitude of pricing errors to increase for extended periods. The focus of these two papers, however, is on pricing errors that may persist over periods of weeks or months rather than on intraday pricing errors.[7] Similarly, there exist several empirical studies on whether trading activities related to commodity index derivatives or other commodity-linked financial products have deleterious effects on prices at daily or longer horizons.[8] However, while those papers make an important contribution to the literature, their relevance to the present paper is relatively limited given that our focus is entirely *intraday*. Indeed, ours is the first study of intraday institutional financial traders' impact on the efficiency of commodity prices.

For equity markets, there is extensive empirical evidence suggesting that institutional investors are more informed relative to other investors.[9] However, this evidence is largely

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[7] See also Goldstein and Yang (2016) and other recent theoretical papers cited therein.
[8] See, e.g., Hamilton and Wu (2015), Henderson, Pearson, and Wang (2015), and Irwin and Sanders (2012).
[9] For example, Hendershott, Lidvan, and Schürhoff (2015) document that institutional investors anticipate the nature of news announcements prior to their release. Boehmer and Kelley (2009) find a positive relation between institutional shareholdings and the relative informational efficiency of stock prices. Badrinath, Kale, and Noe (1995) find that the returns of stocks with high institutional ownership lead those with low institutional ownership.

focused on institutional *investors* (typically, investors with stock holdings and who engage in fundamental research on earnings and other news and announcements) rather than on institutional *traders* – who are the focus of the present paper. As such, this prior work does not deal with intraday-focused institutional traders who are engaged primarily in short-horizon liquidity provision and trading on the order flow. In such a scenario, the literature on institutional investors with daily (or quarterly) horizons may be informative but it is not necessarily conclusive.

More directly relevant to the present paper is the extant research on fast or automated traders showing that, on average, these fast traders – who likely are institutional – improve price discovery in equity markets (e.g. Brogaard, Hendershott, and Riordan, 2014) and pricing efficiency in currency markets (e.g., Chaboud, Chiquoine, Hjalmarsson, and Vega, 2014). In the context of intraday-focused institutional traders, one can argue, following Hendershott, Lidvan, and Schürhoff (2015), that institutions should be better informed because of superior information (in terms of access, gathering, and processing skills) and better financial and analytical resources. Thus, increased intraday trading by institutional financial traders in commodity markets should reduce informational imperfections and pricing errors at intraday horizons. At the same time, however, we know from De Long, Shleifer, Summers, and Waldman (1990) and the associated later literature that short-horizon investors could have adverse effects on pricing efficiency because of "short-termism" (namely, a reluctance to arbitrage pricing inefficiencies as the latter may last beyond the arbitrageurs' trading horizon, causing pricing errors to persist).

Irrespective of which of these two effects dominates, the financialization of intraday trading should clearly increase the amount of capital available for financial traders to fulfill

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Chordia, Roll, and Subrahmanyam (2011) find empirical evidence that institutional trading results in an overall increase in information-based trading. Campbell, Ramadorai, and Schwartz (2009) show that institutions arbitrage stock mispricings around earnings announcements.

more continually the risk-sharing role of futures markets (i.e., the capacity to absorb the other side of the hedging-related futures positions taken by commercially-motivated or "commercial" traders). From this perspective, the financialization of commodity futures markets should also reduce the variance of pricing errors by making risk-sharing more efficient.

In short, it is an empirical question whether institutional financial trading increases pricing efficiency. Providing an answer is of more than academic interest: it is important for regulators and market participants, since the role of institutional traders has skyrocketed with the growth of voluntary market-making needs in the wake of changing financial market architectures. Given extant findings that high frequency trading improves price discovery in other financial markets, and given that HFTs may be organized as institutional traders, we test for the beneficial effects on the variance of pricing errors of increases in (i) overall institutional financial trading, as well as (ii) a narrow measure of financialization that only considers non-automated traders (i.e., that subtracts from overall institutional financial trading all observations related to fast machine traders).

In view of the above, our first hypothesis, for both measures of financialization, is:

H1: Financialization lowers the variance of intraday pricing errors.

3.2. Intraday Liquidity

Our second research question is whether financialization – and hence the flow of institutional risk capital into intraday commodity futures trading – improves market liquidity as manifested in bid-ask spreads, depth, and the imbalances between customer buys and customer sells. Ours is the first paper to shed light on this important topic.

The reasons to expect a beneficial impact of financialization on intraday liquidity arise from factors that are largely similar to those cited by Hendershott, Lidvan, and Schürhoff (2015, pp. 249-250) for institutional traders to be relatively more informed. First, insofar as institutional financial traders have better cash resources than individual traders do, their entry into intraday trading and liquidity provision should significantly increase the access to, and the overall availability of, capital available for liquidity provision – thereby increasing depth and reducing customer trade imbalances. Second, insofar as institutional financial traders have greater direct access to information, and greater resources for processing information, they are better able at estimating short-term price changes based on information and liquidity flows and have a greater ability to effectively manage their inventories and control risks. Consequently, they can take greater position risks in individual liquidity-provision trades and can supply liquidity at lower costs. This should reduce spreads and increase depth. Third, an increase in institutional financial trading necessarily increases competition among liquidity providers, potentially leading to more aggressive pricing and participation, again reducing spreads and customer trade imbalances.

In addition, to the extent that institutional traders are better informed than other market participants over intraday horizons, financialization (in the form of increased intraday financial institutional trading) should arguably increase the extent of information-based trading. The theoretical models of Boulatov and George (2008, 2013) and Goettler, Parlour, and Rajan (2009) show that informed agents gravitate towards supplying liquidity rather than taking liquidity, a prediction that is also consistent with the earlier empirical results of Kannel and Liu (2006). When the (more informed) institutional financial traders gravitate toward supplying (rather than demanding) liquidity, they should be able to do so at lower cost since they need to make a relatively lower provision for adverse selection losses to more informed traders (Glosten and Harris, 1988). This competitive advantage in liquidity provision should also mean that the presence of (the relatively more informed) institutional financial traders in the market should, at the margin, lead to greater depth and lower trade imbalances. Finally, as is the case for pricing efficiency, there is evidence (e.g., Hendershott, Jones, and Menkveld, 2011) that, on average, algorithmic trading improves intraday liquidity in equity markets. Hence, given that algorithmic traders may be organized as institutional traders, we here also undertake tests that identify the beneficial impact on market liquidity of two alternative measures of financialization: (i) an overall measure that includes fast algorithmic traders, and (ii) a narrower measure that excludes them.

Overall, in view of the above, our second set of hypotheses, for both our measures of financialization, are:

H2: Financialization reduces bid-ask spreads.

H3: Financialization increases market depth.

H4: Financialization reduces the absolute magnitude of customer trade imbalances.

4. Data: Measuring Institutional Financial Trading and Market Quality

For the purposes of this paper, we were granted access to non-public regulatory data from January 2006 to May 2008 for the world's largest commodity market – the New York Mercantile Exchange's (NYMEX) West Texas Intermediate (WTI) light sweet crude oil futures market. The NYMEX introduced electronic trading of WTI futures (alongside face-to-face pit trading) on September 5th, 2006. The intraday data we use originate with the market regulator, the U.S. Commodity Futures Trading Commission (CFTC).

4.1. Data

The CFTC collects data on every WTI futures transaction at the NYMEX, and for every trading account in that market. Each futures trade is recorded twice in the dataset, once for the buyer and once for the seller. The buyer and the seller are each identified only by an identity code. Those anonymizing codes are assigned by the CFTC to each trading account so as to conceal the actual identities of market participants. Hence, while the data to which we had access provides a complete WTI trading history for every trader in our sample, each trader's true identity remains confidential and unknown to us.

The CFTC dataset includes transaction details such as the commodity and delivery month, the quantity traded, the trade type (outrights, spreads, trades at settlement, etc.), the trade price and direction (i.e., whether the transaction was a buy or sell), and the transaction date and time. For electronic trades on the Globex platform, the latter is the time stamp assigned to a trade when both sides were matched. For open outcry trades that were done in the pits, it is the imputed trade time stamp. For our analysis, we use (*pre*-electronification) pit trades time-stamped during business hours and (*post*-electronification) Globex trades time-stamped between 9AM-2:30PM.[10]

The dataset classifies the traders on each side of each transaction using one of four customer type indicators ("CTI"). The three main categories, comprising approximately 95 percent of all trades, are Locals (CTI-1 or *individual* exchange members trading for accounts they own or control), *institutional* exchange members trading for accounts they own or control (CTI-2), and non-member customers of the exchange or external traders (CTI-4). Finally, about four percent of all trades in our sample are classified as CTI-3 (individual member trading on behalf of another member): these trades are largely not relevant for this paper.

In our analysis, we aggregate the account-level data across multiple contracts and by CTI trader category. Each category comprises dozens, hundreds, or thousands of trading accounts. Hence, consistent with the confidentiality statutes under which the CFTC operates, no single or multiple set of information that we provide in this paper could allow anyone to uniquely identify any trader's underlying position(s) or trade secrets and strategies.

[10] Pits used to be open from 10AM-2:30PM prior to January 31, 2007. Starting February 1, 2007, pit business hours were increased to 9AM-10:30PM. We exclude from the sample the Friday immediately after Thanksgiving as well as the entire week from Christmas to New Year (starting the last full trading day before Christmas and ending the first trading day after New Year). Before aggregating the data, we carry out a number of quality checks; for example, we exclude transactions whose reported prices are clearly erroneous.

4.2. Institutional Financial Trading

The trader category that is of primary interest to us is CTI-2, which captures the participation of institutional traders whose trading activity is significant enough to warrant corporate exchange membership for their proprietary trading desks. Such corporate exchange membership allows a firm to obtain preferential fees and other benefits on its proprietary futures trading, and is particularly useful for short-horizon trading. CTI-2 traders include hedge funds, commodity pool operators, banks, futures commission merchants, commodity trading advisors, foreign and domestic broker/dealers, introducing brokers, proprietary trading firms and other eligible corporate entities.

Post-electronification, CTI-2 traders are overwhelmingly financial traders, i.e., traders without a commercial exposure to the underlying (physical) commodity.[11] To wit, their focus is on *intraday* trading and liquidity provision: *post*-electronification, the CTI-2 group's median level of hourly inventory turnover is as high as 92% (comparable to an 88% figure for Locals but as against 0% for traders in the customer group). Accordingly, we use the growth in the trading activity of these CTI-2 institutional exchange members to proxy for financialization.

4.3. Measures of Market Quality

We employ several measures to assess market quality: (a) the volatility of pricing errors, i.e., of deviations of prices from their "fundamental" values; (b) the bid-ask spread; (c) the Amihud inverse measure of depth; and (d) the absolute magnitude of customer order (trade) imbalances. On any given day in our sample period, futures contracts with up to 84 different maturities are traded. We start by computing our four market quality variables for each contract maturity on every trading day in five-minute non-overlapping intervals, then we compute daily volume-weighted averages of the five-minute figures during business hours.

[11] Non-financial CTI-2 traders make up only a small fraction of the CTI-2 group *post*-electronification.

We estimate the volatility of pricing errors using Hasbrouck's (1993) widely-used approach. The logarithm of the observed transaction price, p_t , is expressed as the sum of the logarithm of the efficient price, m_t , and the pricing error, s_t, as follows:

$$p_t = m_t + s_t$$

The pricing error is a measure of how efficiently the transaction price tracks the (unobserved) fundamental price, represented by an information-efficient "random walk price." Since the pricing error is a zero-mean process, its absolute magnitude is a good measure of its volatility. We follow Hasbrouck (1993) and Boehmer and Kelly (2009) and estimate the lower bound of the volatility of the pricing error, σ_s, using a VAR system consisting of four variables: Δp_t, trade sign indicator (estimated using Lee and Ready's (1991) "tick test"), signed trading volume, and signed square root of the trading volume. We compute σ_s on every trading day for each contract maturity for which at least 50 trades take place. In our tables, the variable called "*PE_Proportion"* is the daily ratio of the variance of pricing errors (PE), estimated as in Hasbrouck (1993), to the volatility of intraday (log) transaction prices.

We estimate daily bid-ask spreads to approximate the cost of transacting for customers of the exchange. In the absence of order-book information, we estimate bid and asked prices for each contract maturity in each 5-minute interval, after classifying trades as buyer- *vs*. seller-initiated using the Lee and Ready "tick-test."[12] In our tables, the variable called "*Spread"* is the daily volume-weighted average of these 5-minute bid-ask spreads.

We calculate the inverse measure of depth as in Amihud (2002). In our tables, the variable called "*Amihud*" is the daily volume-weighted average of the ratio of absolute return to volume calculated in 5-minute non-overlapping intervals throughout the trading day.

[12] Raman, Robe, and Yadav (2016) verify the accuracy of the tick-test methodology using intraday CFTC data from a time period (post-2009) when "aggressive" traders start being identified by a flag in the CFTC's non-public intraday dataset. In the case of WTI futures, these authors find that the tick-test successfully identifies the (actual) aggressive trader in more than 75% of the cases – similar to the 73% figure found by Theissen (2001) using Frankfurt Stock Exchange data.

We calculate daily volatility as the average of the maximum of customer (i.e., CTI-4) buy price and sell price volatility, calculated using five-minute non-overlapping intervals throughout the trading day. This methodology is meant to eliminate the bid-ask bounce (Manaster and Mann, 1996).

Finally, we measure daily customer trade imbalances, reported in our tables as the variable "*AbsOIB*", as the daily volume-weighted average of the ratio of five-minute absolute trade imbalances (buyer-initiated *minus* seller-initiated trades) to trading volume.

5. The Impact of Electronification

Section 5.1 documents changes in market quality measures around electronification. Sections 5.2 and 5.3 provide similar analyses of the relative contributions to market activity of individual *vs*. institutional financial traders. Section 5.4 shows that the large increases in institutional financial trading (financialization) subsequent to electronification affects short-term futures more than longer-term contracts.

5.1. Market Quality Metrics

Starting September 5th, 2006, the NYMEX introduced electronic trading on Globex in parallel with face-to-face trading in the pits intermediated largely by "Locals." Given that this market reform significantly increased the ease of access for traders without physical access to the trading pits, and correspondingly increased competition in liquidity provision services, one should expect a marked improvement in each of our market quality measures. Table 1 and Figure 1, which present respectively statistical and descriptive analyses of changes in our market quality measures (Section 3.2) surrounding the electronification of WTI futures, show that such is indeed the case.

The sample period for the univariate tests in Table 1 runs from January 3rd, 2006 to March 31st, 2007. *Pre-Electronification* in Table 1 refers to the period from January 3rd, 2006 to September 1st, 2006. *Post-Electronification* refers to the period from September 6th, 2006 to March 31st, 2007. Figure 1 relates to WTI sweet crude-oil futures trading in the pits during the *Pre-Electronification* period, and on the Globex platform after September 5th, 2006.

The t-tests in Table 1 provides statistical evidence of a massive improvement in market quality following electronification. Figure 1 Panels A to D provide strong visual confirmation of our t-tests. Estimated bid-ask spreads drop from an average of 37 basis points to just 3 basis points, a drop of more than 90%. Absolute customer trade imbalances drop by about 40%, from about 24% to about 13%. The ratio of the variance of pricing errors to the variance of log transaction prices falls from about 59% to about 4%, i.e., by more than 90%. Each of these changes is statistically highly significant (p-value < 0.001). The Amihud measure of depth also improves substantially, although the change is not statistically significant.

5.2. Institutional Financial Trading Activity

Following electronification, one also expects an increase in institutional financial traders' contribution to WTI futures market activity. This is exactly what we find. The results are in Table 1 and Figure 2, which describe the nature and respective extents of participation by Locals and by institutional financial traders before *vs*. after September 5th, 2006.

In Table 1 and Figure 2, *FIN* is the proportion of trading volume involving the participation of institutional financial traders (traders classified as CTI-2 traders in the CFTC database). It is our proxy for the extent of financialization.

Figure 2 provides visual trading activity-based evidence of commodity markets' financialization by aggregating the CFTC's account-level intraday information for our three CTI trader categories. Prior to electronification, consistent with Manaster and Mann (1996), Locals dominated pit trading: in the first eight months of 2006, Locals were involved on at least one side of approximately 80% of all WTI futures transactions. In contrast, CTI-2 traders were involved (on at least one side of the transaction) in only about 30% of all pit trades during the same period. In the months following the electronification of the WTI futures market, however, Figure 2 shows that the proportion of CTI-2 trades on Globex approximately doubles, while the proportion of trades with Locals falls to approximately half of its *pre*-electronification value. Over the same period, the overall trading volume increased substantially as well. In other words, financial institutional traders captured a bigger slice of a growing WTI futures pie.

The t-tests reported in Table 1 confirm this visual evidence. They show that the average proportion of trading activity involving institutional financial traders almost doubles, from 29.6% *pre*-electronification to 55.0% *post*-electronification.[13]

5.3. Composition of the Institutional Financial Trader Group

Because electronification allows for new kinds of institutional financial trading (automated order placement and execution, competition with locals with respect to liquidity provision, etc.), one would also expect the characteristics of institutional financial traders to differ before and after electronification. To confirm this conjecture, Table 2 provides information on the average hourly trading volumes, trading frequencies, and closing ratios of Locals (CTI-1), institutional financial traders (CTI-2), and customers (CTI-4) from January 3rd, 2006 to March 31st, 2007. As in Table 1, *Pre-Electronification* in Panel A of Table 2 refers to the period from January 3rd, 2006 to September 1st, 2006 while in Panel B *Post-Electronification* refers to the period from September 6th, 2006 to March 31st, 2007.

[13] The significant increase in the proportion of financial institutional trading after the onset of electronic trading echoes the massive growth of the overnight WTI futures positions held by hedge funds and other financial traders during the same period (Büyükşahin *et al.*, 2015).

Consistent with the expected differences between institutional and individual traders, CTI-2s in the *post*-electronification period trade more than twice as much and twice as often as Locals do. Most notably, comparing Panel A and B in Table 2 shows that the median value of the CTI-2 traders' absolute closing ratio – the average ratio of these traders' ending-of-hour inventory to hourly trading volume – declined sharply after electronification, from 83% *pre*-electronification to only 8% *post*-electronification. This finding indicates that the institutional financial traders that entered the WTI futures market after September 5th, 2006 were focused on much shorter horizon strategies (similar to the strategies of Locals) compared to the institutional financial traders that had been active in the pits prior to electronification.

5.4. Institutional Financial Trading: Short-term *vs*. Long-term Futures Contracts

The findings of Sections 4.1 and 4.2 show that the introduction of electronic trading dramatically improved market quality in the crude oil futures market, as it earlier did in the equity markets (see, e.g., Barclay *et al*., 1999 and Jain, 2005), and was associated with a dramatic financialization of the trading activity. Clearly, however, the above analyses cannot differentiate between the respective impacts of electronification and financialization. Since financialization is the primary focus of this paper, we turn to differences in the participation of institutional financial traders in different parts of the crude oil futures term structure.

5.4.1. Intuition

With a view to distinguishing between the respective impacts of electronification and financialization, we note that electronic trading can improve market quality through three main channels. Firstly, by improving *pre*- and *post*-trade market transparency, it reduces information asymmetry (Boehmer, Saar, and Yu, 2005). Secondly, it reduces fixed labor (pit traders) and curtails other operating and order processing costs. Finally, it drastically cuts the costs of entry into the provision of liquidity services. It enables all exchange members, irrespective of their physical location, to exploit small deviations from fundamental value and to provide liquidity, thereby significantly increasing competition: the open and transparent electronic market, where all traders have an equal opportunity to voluntarily provide and demand liquidity, attracts new groups of traders, particularly institutional financial traders (Jain, 2005).

Of these three channels, the first and the second should equally impact futures contracts regardless of maturity. Both short- and long-term contracts should therefore equally benefit from the improvements in transparency and the reduction of fixed ordering and trading costs.

In contrast, all contract maturities are not expected to experience the same amount of interest from institutional financial traders. First, institutional financial traders have shorter trading horizons than other traders. Intuitively, they should thus trade more in short-term than in long-term contracts (Ederington and Lee, 2002). Second, the two front contract months and the nearest three Decembers account for the preponderance of the intraday directional and calendar spread trading in the WTI futures market. Notably, both before (Neuberger, 1999) and after (Büyükşahin *et al.*, 2015) electronification, positions in these five contracts are those most commonly held overnight or for longer periods by commercial crude oil traders: producers, refiners, and wholesalers, i.e., by key demanders of WTI futures market liquidity. With electronification's attracting new financial traders intent on competing to provide liquidity to such traders, one would therefore expect the make-up of the WTI futures market to evolve differentially at different points of the futures term structure – with financialization taking place chiefly in the two front months and the first few December contracts.

5.4.2. Evidence

To verify this conjecture empirically, we compute the participation rates of institutional financial traders, as well as our four market quality metrics, separately for two groups of futures contracts: short-term contracts *vs*. long-term contracts. Given that approximately half of the WTI futures trading volume involves calendar spread trades in our sample period, we select our "short-term contracts" bin to comprise the two front months (precisely, contracts with less than 62 days to expiration) and the three December contracts with which these two nearest-dated contracts are most often paired for calendar spread trades.[14] Our "long-term contracts" bin consists of the trading activity in the remaining contracts, i.e., up to 79 contracts (on any given day) with more than 62 days to expiration.

Figure 3, Panel A plots the evolution of institutional financial traders' participation in short-term and long-term contracts. Consistent with our intuition, Panel A shows a much stronger rate of financialization for short-term contracts relative to long-term contracts.

Figure 3, Panel B plots the number of new financial institutional traders entering the crude oil futures market in short-term and in long-term contracts. Consistent with the increased CTI-2 participation rates following electronification documented in Section 4.1 above, Panel B shows a significantly greater number of new institutional financial traders entering the trading of short-term rather than long-term contracts after September 5th, 2006. Overall, the bottom line is that the introduction of electronic trading encouraged an influx of new financial institutional traders, albeit largely in the short-term contracts.

Table 3 presents a more formal comparison of the *pre-* and *post*-electronification differences between the proportions of institutional financial traders (i.e., the extent of financialization) in short-term *vs*. long-term futures contracts. The fraction of the total trading volume in short-term contracts accounted for by institutional financial traders (denoted *FIN_Short-Term*) increases from 28.1% in the first eight months of 2006 to 41.4% in the six months following electronification. This increase of almost 45% is highly statistically

[14] In our sample period, crack spread trades account for about 3.7% of all transactions and 1.8% of the trading volume in WTI futures. Calendar spreads account for 22.2% of the WTI futures trade count and 50.1% of the trading volume.

significant (*p*-value < 0.001). During the same period, the equivalent measure for long-term contracts (denoted *FIN_Long-Term*) does not change significantly, remaining at around 36%-37% of the total trading volume at such maturities both *pre*- and *post*- electronification. Consequently, the percentage difference in the contribution of institutional financial trading to the short-dated *vs*. long-dated trading volume, denoted Δ*FIN = (FIN_Short-Term–FIN_Long-Term*)/*FIN_Short-Term*, increases from -30.4% pre-electronification to 9.5% after the electronification of the futures market. This event-related increase is statistically significant at the 1% level.

In sum, the participation rates of institutional financial traders (financialization) in short- and long-term contracts change differentially as a consequence of electronification, an exogenous exchange-mandated intervention. In the next Section, we exploit these differences in the extent of financialization along the futures term structure to formally test, in an econometrically rigorous framework, for the impact of financialization on market quality. Essentially, even though the market quality metrics for all contracts improve post-electronification, what we test empirically is whether the market quality improvements *post*-electronification are greater for contracts with a greater entry of new institutional financial traders, after controlling for any other factors that could be relevant.

6. Financialization and Market Quality

We saw in Section 4 that our market quality metrics improve overall significantly *post*-electronification. We have also seen that financialization in response to this electronification is significantly greater in short-term contracts than that in long-term contracts on the same asset. In this Section, we accordingly examine the causal effect of financialization on market quality by exploiting the observed cross-sectional variation in financialization across different contract maturities following the (exogenous) exchange-mandated electronification of the crude-oil futures market. Our contention is that the *average* improvement in market quality variables across all contracts is the effect of electronification, but the *relative* improvements we find for the short-term contracts are due to the relative greater financialization of the short-term (*vs*. long-term) contracts.

Section 5.1 analyzes the difference, *pre*- and *post*-electronification, in our market quality metrics for short-dated and long-dated futures contracts. It is a simple event study conducted around the introduction of electronic trading. Section 5.2 presents a formal two-stage regression analysis to establish causality between financialization and improvements in market quality. Having done so, Section 5.3 uses a structural vector autoregression (SVAR) model to further examine the endogenous relationship between participation of institutional financial traders and market quality using data between April, 2007 and March, 2008 – i.e., using a period when electronic trading had become well established.

6.1. Descriptive Analysis – Event Study

In this sub-Section, we present results of an event study conducted on a sample comprising all the transaction records for WTI futures on NYMEX between January 3rd, 2006 and March 31st, 2007. We split the period between an eight-month period before and a seven-month period after the onset of electronic trading.

We employ the market quality measures discussed in Section 3. We compute all daily averages separately for two groups of futures: short-term and long-term contracts. Table 4 presents the *pre*- and *post*-electronification values of our market quality variables for short-term and long-term contracts separately, as well as the average percentage differences (Δ) between the daily values of these short- and long-term estimates.

Panels A to D of Figure 4 plot the evolution of the percentage differences (trade-volume weighted for short- *vs*. long-term contracts) in each of these market quality measures. Figure 4 shows that, for every measure, the improvement after electronification benefited short-term futures more than long-term contracts.

First, in Table 4, the *pre*-electronification average ratio of the volatility of pricing errors to the volatility of log transaction prices is 28% wider for short-term contracts than it is for short-term contracts. This difference grows to 132% in the *post*-electronification period. That is, although both long-term and short-term contracts have much lower pricing errors *post*-electronification, the pricing errors of short-term contracts improve five times more than those of long-term contracts (an improvement that is highly statistically significantly, with a *p*-value<0.001).

Second, the *pre*-electronification average bid-ask spread for long-term contracts is about 28% wider than those for short-term contracts. The same variable, in the *post*-electronification period, increases more than ten times in magnitude – to 304%. Again, while both long-term and short-term contracts are more liquid *post*-electronification, the liquidity of short-term contracts improves significantly more than that of long-term contracts (p-value<0.001).

Third, the *pre*-electronification absolute magnitude of customer trade imbalances for long-term contracts is on average about 144% wider than that for short-term contracts. The same variable in the post-electronification period increases significantly to 175%. Here also both long- term and short-term contracts display an improvement (lower customer order imbalances) *post*-electronification, but again the improvement is significantly greater for short-term contracts than it is for long-term contracts (p-value<<0.001).

Finally, consistent with the findings in Section 4.1 for the WTI market as a whole, the *pre*-electronification average depth (inversely measured by the Amihud ratio) is insignificantly different for short-term contracts before and after electronification. Because the changes for short-term and long-term contracts are sufficiently different, however, there is a statistically significant relative worsening of depth for long-term contracts *vs*. short-term ones (*p*-value<0.001).

Overall, as captured by our key market quality metrics, electronification benefits short-term contracts significantly more than it does long-term contracts. Meanwhile, as discussed in Section 4.3.2, the participation of institutional financial traders to the total volume increases significantly in short-term contracts while remaining (statistically) the same in long-term ones.

Together, these results are consistent with our contention that the *average* improvement across all contracts is the effect of electronification, while the relatively greater improvement for the short-term contracts is due to their relatively greater financialization. *Prima facie*, notwithstanding the lack of relevant controls (such as changes in relative trading volume and volatility), it appears that financialization improves market quality over and above the improvement that comes from electronification. The analyses in the following sub-Sections examine this conjecture rigorously in multivariate settings, using two-stage regression (Section 5.2) and SVAR (Section 5.3) analyses.

6.2. Two-Stage Regression Analysis

The introduction of electronic trading by the NYMEX removed barriers to trading crude oil futures and facilitated market participation by financial institutional traders. We have documented a massive increase in financial institutional trader activity *post*-electronification. Under the maintained assumption that the NYMEX's decision to "go electronic" was exogenous with respect to pre-existing crude oil derivatives market conditions, we use the advent of WTI futures market electronification as an instrument to tackle the endogeneity issues between market quality and trading activity of financial institutional traders.

As discussed earlier, our goal is to identify the impact on market quality of financialization – not of electronification. To tease out the impact of financialization, we exploit the exogenous increase due to electronification in the *relative* participation of financial institutional traders in short-term (*vs*. long-term) contracts in order to examine the impact of financialization on different measures of market liquidity and pricing efficiency. Specifically, we use the electronification of the NYMEX WTI crude-oil futures markets as an instrument for the *relative* participation of financial institutional traders in short-term (*vs*. long-term) contracts in that market, as follows:

First Stage: $$\Delta FIN_t = \alpha_1 + \beta_1 Electronification + \gamma_1 C_t + \theta_t$$

Second Stage: $$\Delta M_t = \alpha_2 + \beta_2 \widehat{\Delta FIN}_t + \gamma_2 X_t + \epsilon_t$$

where ΔFIN_t is the percentage (or proportional) difference between the rates of participation of institutional financial traders in short-term and long-term contracts, i.e., Δ*FIN* = *(FIN_Short-Term – FIN_Long-Term*) / *FIN_Short-Term*; $\widehat{\Delta FIN}_t$ is the predicted value obtained from the first stage; ΔM_t is the relative difference between the short-term and long-term contracts' relevant market quality measure (such as bid-ask spreads, depth, etc.), $Electronification$ is a dummy variable equal to 1 after September 5th, 2006 (the date on which electronic WTI futures trading started at the NYMEX) and 0 prior to that day; and X_t and C_t are control variables in the second and first stages, respectively. The coefficient β_2 is our estimate of the (causal) effect of financialization on market quality.

6.2.1. First Stage

In the first stage, we regress the relative difference between financial institutions' rates of participation in trades of short- and long-term futures contracts on the $Electronification$ dummy. We consider specifications without (Model 1) and with (Model 2) control variables. Model 2 controls for macroeconomic uncertainty and market sentiment using equity option-implied volatility (the VIX) and uses binary variables to control for possible differences in trading patterns on: (i) nearby-futures expiration days; (ii) days when the U.S. Department of Energy's (DoE) Energy Information Administration (EIA) releases its weekly reports on petroleum inventories; (iii) the days just prior to EIA news-release days; (iv) the five business days every month when commodity index traders that follow the GSCI indexing methodology roll their nearby-futures positions; (v) and day-of-the-week trading patterns.

Table 5 summarizes the results of the first-stage regressions. Consistent with the univariate and graphical evidence presented in Section 4.3.2, we find a statistically and economically significant link between $Electronification$ and the difference in institutional financial traders' participation in short-term *vs*. long-term contracts. The coefficient β_2 = 0.40 implies that, *post*-electronification, the relative participation of financial traders in short-term contracts increased by as much as 40 percentage points. Prior to electronification, institutional financial traders participated more in the long-term contracts than in the short-term contracts, as indicated by the intercept of -0.30. This results holds whether (Model 2, second column in Table 5) or not (Model 1, first column) we include relevant control variables in the regressions.

Importantly, we find that the $Electronification$ dummy alone explains more than 30 percent of the variation in ΔFIN, indicating that it is a strong instrument for the change in the proportion of institutional financial traders. That the exogenous shock of electronification strongly predicts a significant increase in the financialization of short-term contracts relative to long-term contracts is a necessary condition for the second stage regressions.

6.2.2. Second Stage

In the second stage, we use the predicted values for the percentage difference in institutional financial traders' participation in short-term *vs*. long-term contracts (obtained from Model 2 in the first stage), $\Delta FIN\_Predicted$, as a dependent variable. Precisely, we regress our various measures of market quality (precisely, the percentage differences in depth, bid-ask spreads, customer trade imbalances, and pricing error volatility for short- *vs*. long-term contracts) on $\widehat{\Delta FIN}$ and the binary controls used in Model 2 of the first stage: dummies for nearby-contract expiration days, GSCI roll days, days of (or preceding) the weekly EIA inventory announcements, and Mondays or Fridays.

Our results from the second stage analysis are summarized in Table 6 for the variance of pricing errors, in Table 7 for bid-ask spreads, in Table 8 for depth, and in Table 9 for customer trade imbalances. In line with the results of Breusch-Godfrey serial correlation tests, all of the regressions in Tables 6 to 9 include two lags of the dependent variables. We estimate standard errors using the Newey-West method with two lags.

For each and every market quality metric, Tables 6 to 9 show that Δ*FIN_Predicted* consistently has a negative and statistically highly significant coefficient (p-value < 0.001). To interpret this result, recall that we are analyzing the relation between the percentage difference (for short-term *vs*. long-term contracts) in a given market-quality variable and the corresponding percentage difference in the extent of intraday financialization. In this context, our results mean that an increase in the percentage (or proportional) difference in participation of institutional financial traders in short-term *vs*. long-term contracts causally influences the percentage (or proportional) difference in that market quality variable in short-term *vs*. long-term contracts. That result constitutes strong evidence that financialization improves each of these market quality variables: spreads, the Amihud inverse measure of depth, customer imbalances, and pricing errors all drop substantially.

In robustness checks, we include in the regressions for each market quality markers two variables measuring (i) the percentage difference in return volatilities between short-term and long-term contracts and (ii) the percentage difference in trading volumes. We also introduce a *September_2006* dummy variable to control for possible transitory irregularities during the first month when electronification took place. Still, Tables 6 to 9 show that (even after controlling for the differences in volatility and volume, EIA information announcement days, contract roll and expiration days), when short-term contracts experience a greater degree of financialization than long-term contracts, the market quality variable for short-term contracts improves significantly more than the corresponding market quality variable of long-term contracts.

Let us consider each of the market quality variables separately. Table 6 shows that a one-unit increase in the percentage difference in financialization between short-term and long-term contracts, after controlling for all the relevant variables, further widens the percentage difference in pricing error volatility by 1.03 units in Model 1 (and by 0.44 units on average across all specifications). The standard deviation for the percentage difference in financialization is 36%; hence, a one-standard deviation increase in the percentage difference in the rate of financialization widens the percentage differences in pricing error volatility by 0.35 standard deviations, or 59% of its mean value. Table 6 thus shows that financialization significantly improves pricing efficiency.[15]

For bid-ask spread, the coefficient of -4.22 in Model 1 in Table 7 means that a one-unit increase in the percentage difference in financialization (where the participation of financial traders in short-term contracts increases more than it does in long-term contracts) decreases the percentage differences in bid-ask spreads (where the spreads for short-term contracts decrease more than spreads for long-term contracts) by 4.22 units. The standard deviation for percentage difference in bid-ask spreads is 186%; hence, a one-standard deviation increase in the percentage difference in financialization widens the percentage differences in bid-ask spreads by 0.76 standard deviations, or 94% of its mean value. Table 7 also shows that, as should be expected, the percentage difference in spreads is positively related to the percentage difference in volatilities between short-term and long-term contracts and negatively related to the percentage difference in trading volumes.

[15] In our analysis of the volatility of pricing errors, we follow Boehmer and Kelly (2009) in including the standard deviation of transaction *prices* as control while modeling the volatility of the pricing error. Accordingly, we employ the percentage difference in the volatility of transaction *prices* between short-term and long-term controls while modeling the percentage difference in pricing error volatilities.

Our results from the analysis of the differences in depth (inversely measured by the Amihud ratio) are similarly presented in Table 8. Controlling for all the previously discussed variables, and similar to the bid-ask spread results, we find a consistently negative and statitistically significant relation between the difference in the financialization rate and the difference in Amihud ratios. A one-standard deviation increase in the percentage difference in financialization widens the percentage difference in the Amihud ratios by 0.80 standard deviations, or 28% of its mean value.

The results from the analysis of the differences in customer trade imbalances are presented in Table 9. We again find a negative and statitistically significant relation between the difference in financialization and the difference in customer trade imbalances. A one-standard deviation increase in the relative difference in financialization rates widens the relative differences in the absolute magnitudes of customer trade imbalances by 0.58 standard deviations, or 19% of their mean value.

To summarize, when short-term contracts experience stronger financialization than do long-term contracts, market quality for short-term contracts (measured in terms of bid-ask spreads, depth, customer trade imbalances, or pricing error volatility) improves statistically and economically significantly more than the market quality of long-term contracts.[16]

6.3. SVAR Analysis

We further examine the endogenous relation between participation by financial institutions and intraday market quality through a structural vector autoregression (SVAR)

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[16] The two-stage analysis in Section 5.2 focuses on CTI-2 traders, to the exclusion of Locals (CTI-1 traders). One might expect that a two-stage regression analysis using the volume share of CTI-1s (rather than that of CTI-2s) might produce "mirror" results. In that case, it could be argued (albeit facetiously) that it is the crowding out of CTI-1 traders and of their trading practices in the futures pits (rather than the competition from institutional financial traders) that led to the *post*-electronification increase in market quality. However, this possibility is unlikely since CTI-1 trading volume (as opposed to the CTI-1 *share* of the total volume) actually *increased* following electronification – which indicates that it is indeed greater competition from CTI-2s, rather than the decline of CTI-1s, that drove market quality improvements.

analysis. We rely on the same comprehensive dataset of intraday transactions, but restrict the sample period from April 1st, 2007 to May 31st, 2008. This choice of sample period rules out any overlap with the two-stage regression sample, which ends on March 31st, 2007. It also allows us to test whether the results obtained for the six months immediately following the onset of electronic trading persist even in more mature market conditions.

As in sub-Sections 5.1 and 5.2, we compute the percentage differences (for short-term *vs*. long-term contracts) in the rates of market financialization (ΔFIN), bid-ask spreads ($\Delta Spread$), measures of depth ($\Delta Amihud\ Measure$), and absolute customer imbalances (ΔABS_{OIB}). We proceed analogously for the daily ratio of the variance of pricing errors (PE) to the volatility of intraday (log) transaction prices ($\Delta PE\_Proportion$). As well, we compute the percentage differences in realized return volatilities for short- *vs*. long-term futures ($\Delta Return\_Volatility$).[17]

We propose a 6-variable SVAR model to jointly explain and quantify the roles of volatility and financialization in explaining the behavior of our four liquidity and pricing efficiency variables in 2007–2008. When ordering the variables, we place ΔFIN and $\Delta Return\_Volatility$ before the four market quality variables. This assumption implies that shocks to volatility or institutional financial traders' positions result in instantaneous adjustments in liquidity and pricing efficiency, whereas changes in market quality impact volatility and institutional trading activity with a lag. This ordering allows us to test whether the intensity of institutional financial trading (our proxy for the extent of commodity market financialization) impacts market quality.

We obtain qualitatively similar results independent of whether $\Delta Return\_Volatility$ or ΔFIN is ordered first *vs*. second of the SVAR variables. Similarly, we obtain qualitatively

[17] Augmented Dickey-Fuller (ADF) tests show that the percentage difference of all the variables in our SVARs are stationary. We select the number of lags for the ADF tests according to the Akaike information criteria.

similar results with different orderings of the market quality variables. For tractability, we therefore focus our discussion below on a single specification. Reflecting our focus on the effect of financialization on market quality, we discuss results when ΔFIN is placed first with the following ordering: ΔFIN, $\Delta Return\_Volatility$, $\Delta Spread$, $\Delta Amihud\ Measure$, ΔABS_{OIB}, and $\Delta PE\_Proportion$.

Formally, for the data series $\{y_t\}$ consisting of the vector y_t of our six variables of interest, we consider the following reduced-form representation of the SVAR model:

$$A(L)y_t = \varepsilon_t,$$

where $A(L)$ is a matrix of polynomial in the lag operator L, $\{I - A_1L^1 - A_2L^2 - \ldots A_pL^p\}$, y_t is a (6×1) data vector, and ε_t is a vector of orthogonalized reduced-form disturbances. Specifically, for our six-variable SVAR, we impose the standard Cholesky decomposition of the variance-covariance matrix (i.e., a lower triangular matrix with ones on the diagonal, and a diagonal matrix) to fit a just-identified model. With our structural restrictions, we assume that the extent of financialization is not contemporaneously affected by market volatility or market quality. Likewise, we posit that market volatility is contemporaneously affected by the extent of financialization but not by various aspects of market quality. We also assume that all of our measures of liquidity and pricing efficiency are contemporaneously affected by the rate of financialization and by market volatility, but affect the latter two with a lag.

Panels A to D of Figure 5 present the impulse response functions (IRFs) showing the effect of a one-standard deviation shock to ΔFIN on market quality measures: $\Delta Spread$, $\Delta Amihud\ Measure$, ΔABS_{OIB}, and $\Delta PE\_Proportion$. We obtain qualitatively similar IRFs with different orderings of the market quality variables.

Consistent with the results of our earlier event-study and regression analyses, Panel A shows that an increase in ΔFIN results in a negative and significant effect on (i.e., an improvement in) $\Delta Spread$ on day *t* (contemperaneously) and on day *t+1*. That is, an increase in the relative financialization of short-term contracts leads to a decrease in their relative bid-ask spreads. While the effect of ΔFIN on $\Delta Amihud$ is statistically insignificant (Panel B), we find a negative and significant effect on ΔABS_{OIB} (Panel C) and on the change in pricing errors $\Delta PE\_Proportion$ (Panel D). More specifically, a one-standard deviation increase in ΔFIN leads to a 0.19 and 0.15 standard-deviation decreases in contemperaneous ΔABS_{OIB} and $\Delta PE_{Proportion}$, respectively, and leads to a further 0.13 standard deviation-decrease in $\Delta PE\_Proportion$ on day *t+1*.

7. Are the Financialization Results Driven by Fast Automated Traders?

For equities, Hendershott, Jones, and Menkveld (2011) show that algorithmic trading improves several intraday market liquidity metrics. In a similar vein, we know that high frequency trading improves intraday price discovery for equities (Brogaard, Hendershott, and Riordan, 2014) and pricing efficiency for currencies (Chaboud *et al*. 2014).

For commodities, Section 5 establishes empirically that financialization, as measured by intraday institutional financial trading, improves both liquidity and pricing efficiency metrics. A natural question, then, is whether some of our results are driven wholly or in part by the rise of high-speed algorithmic trading, given that such algorithmic traders could be institutional traders. In this Section, we therefore investigate the effects of participation by each of these two components of intraday financial institutional trading (fast financial institutional traders and of non-fast financial institutional traders) on pricing efficiency and liquidity.

We follow Raman, Robe, and Yadav (2016), whose analysis of "fast" and "slow" traders is based on CFTC non-public intraday data of the kind we use in the present paper, and identify fast automated institutional traders ("FLP" for short) as those CTI-2 traders who trade more than 1,000 times a day, and carry less than 5% of their daily trading volume overnight (making them largely intraday traders). Therefore, intraday financial institutional trading studied in the previous sections is split into two new measures: (i) *FIN_Non_FLP,* which we calculate after removing all fast automated intraday institutional traders from our set of institutional financial traders; and (ii) *FIN_FLP*, the component of financialization that is due to the onset of institutional fast machine trading. Analogous to our preceeding analyses, we employ difference between short-term and long-term contracts for both the measures of financializaiton in the regression analysis.

For the revised two-stage regression analysis, we only apply the first stage procedure (see Section 5.2.1) to the non-automated component of financialization (i.e., excluding fast automated CTI-2 traders). We then run the second stage using the same specification as in Section 5.2.2, but using the predicted level of non-automated financialization (denoted Δ*FIN_Non_FLP_Predicted*) as well as the actual level of fast machine-based financialization. Using predicted values for both financialization variables would introduce unacceptable levels of multicollinearity between them.

Table 10 presents the results from the second-stage of the analysis. It is clear that, for non-fast financial institutional traders, the liquidity results in the columns corresponding to spreads, depth, and absolute customer trade imbalances in Table 10 are qualitatively similar to those corresponding to all institutional financial traders as reported respectively in Tables 6 to 8. We find that for each liquidity metric – bid-ask spreads, depth, and customer order imbalances: (a) Δ*FIN_Non_FLP_Predicted* has a negative and statistically highly significant coefficient (p-value<0.001); (b) the R-squared of the Table 10 regression is higher than the R-squared of the corresponding Model 6 regressions in Tables 6 to 8; and (c) the magnitude of the coefficient corresponding to Δ*FIN_Non_FLP_Predicted* in Table 10 is significantly higher – about double in every case – relative to the corresponding coefficient in the Model 6 regressions in Tables 6 to 8. The impact of non-automated institutional financial trading in Table 10 appears to be at least as strong as the impact of overall institutional financial trading in Tables 6 to 8. It is also clearly robust to the vast variety of specifications and controls we have utilized.

Table 10 also shows that fast/machine institutional traders share some, but not all, of the credit for liquidity improvements. To wit, their trading contributes to the narrowing of bid-ask spreads (statistically highly significant) and curtailing of customer trade imbalances (though the statistical significance is weak). Their activity's impact on depth, however, is statistically insignificant.

The respective roles of fast traders and of other institutional financial traders are reversed in the case of pricing efficiency. Table 9 shows that financialization overall brings about an economically and statistically significant reduction in the variance of pricing errors. Table 10 indicates that, statistically speaking, the improvement in pricing efficiency may be attributed solely to the growth of fast financial institutional traders.

In sum, it is clear that our results on the beneficial impact of financialization on intraday market quality do not come about just because of high speed machine traders. To wit, a financialization measure based only on non-automated institutional financial trading leads to a significant reduction in bid-ask spreads, a significant increase in depth, and a significant reduction in the absolute magnitude of customer trade imbalances. Put differently, our results provide the first evidence that different components of financialization (namely, fast/machine and slow/non-machine institutional financial trading) have contributed in different ways to different aspects of market quality.

8. Conclusions

On September 5th, 2006, the NYMEX introduced electronic trading to its energy futures marketplace and specifically to the world's largest commodity futures market: that for West Texas Intermediate (WTI) light sweet crude oil. We document that this change in the crude oil futures market's structure sharply increased the intraday trading activity of institutional financial traders, i.e., that electronification led to the crude oil market's *intraday* financialization. At the same time, it also led to a relative drop in the activities of Locals, who had been the traditional liquidity providers in this market.

We use this momentous event as an exogenous instrument to document the causal effect of intraday financialization on key measures of market quality: the volatility of intraday pricing errors as well as bid-ask spreads, depth, and the absolute magnitude of customer trade imbalances. Specifically, exploiting cross-sectional variations in the extent of financialization across the futures term structure after electronification, we are able to show economically and statistically significant improvements in all these market quality proxies due to financialization. Importantly, we show that these results are not due solely to the growth of fast machine trading made possible by elctronification. While the activity of fast algorithms has the biggest impact on intraday pricing efficiency, non-automated institutional financial traders have an economically and statistically beneficial impact on market liquidity (bid-ask spreads, depth, and customer buy-sell imbalances) that is robust to different specifications and controls. *Post*-event, a structural VAR analysis of the endogenous relation between institutional financial trading and market quality metrics provides additional strong evidence that greater participation by institutional financial traders brings about statistically significant improvements in pricing efficiency and market liquidity.

Overall, the present paper adds significantly to the financialization literature because it is the first to study the impact of the trading activity and liquidity provision by institutional commodity market financial traders with explicitly short intraday horizons. Our results are consistent with the flow of institutional risk capital into intraday liquidity provision's driving market quality improvements. Our research also complements the extensive literature relating to the impact of institutional trading. In particular, it is the first to investigate the impact of the short intraday horizon trading of both fast and non-fast institutional financial traders, and to show that they both contribute to intraday market quality (albeit in different ways). Finally, while our findings pertain to commodity markets, they are directly relevant to all electronic order-driven markets where liquidity provision is voluntary. Insofar as most equity and other financial markets are now organized as electronic order-driven markets with voluntary liquidity provision, our results on the beneficial impact of the flow of institutional risk capital into liquidity provision and short-horizon trading are potentially of wide applicability.

Our results point to several avenues for future research. First, liquidity provision in U.S. commodity futures markets is entirely voluntary. Given the significant increase that we document in the extent and influence of institutional financial trading, important questions are whether, in periods of stress, institutional financial traders make markets more or less fragile, and whether the financialization of commodity markets affects their resilience to exogenous shocks. Answering those questions would have implications for financial stability and the importance of systemic risk in the presence of electronic trading. Second, Büyükşahin *et al.* (2015) document that the magnitude of the WTI futures positions held overnight by non-commercial traders increased substantially (by one third to one half, depending on the kind of trader) following the onset of electronic trading. Our analyses in the present paper focus on intraday data – without separating the contributions of traders who provide very short-term liquidity from those of longer-term liquidity providers (who might carry inventories overnight). We leave for further research to consider the specific contributions of longer-term liquidity providers to market quality.

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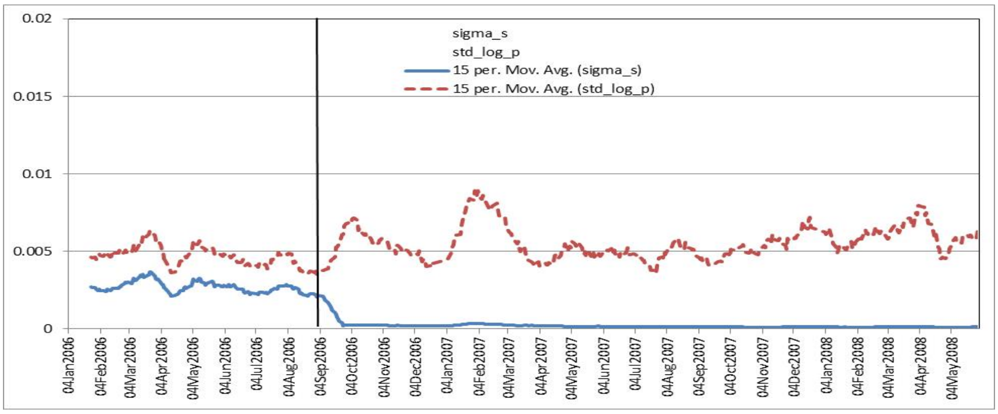
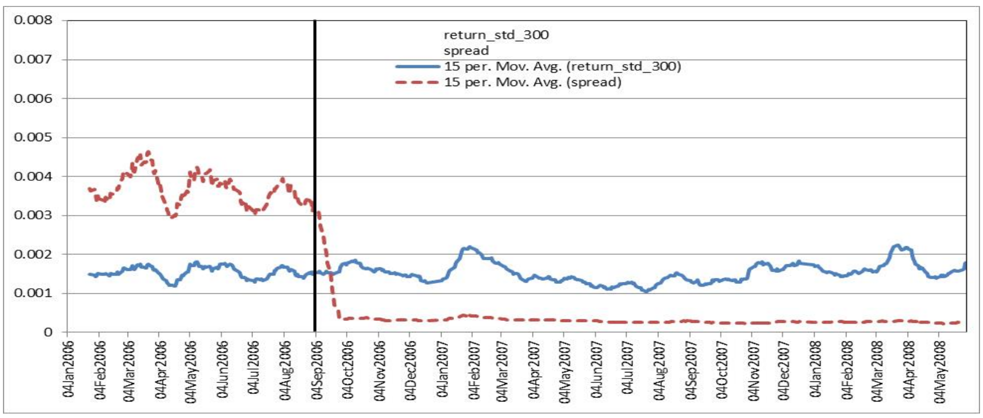
Figure 1: Market Quality Measures, 2006–2008

Figure 1 depicts the evolution of various market quality measures in the New York Mercantile Exchange's (NYMEX) West Texas Intermediate sweet crude oil (WTI) futures market between 2006 and 2008. Measures are computed using pits data for the *pre*-electronification period (January 3rd, 2006 to September 1st, 2006) and data from the Globex platform for the *post*-electronification period (September 5th, 2006 to May 31st, 2008). In **Panel A**, *PE_Variance* or *Sigma_S* is the daily average pricing error variance, estimated as in Hasbrouck (1993). *Price_Volatility* or *Std_Log_P* is the daily average of 5-minute volatility of intraday (log) transaction for each contract maturity in each interval. In **Panel B**, *Spread* is the daily average of 5-minute Bid-Ask spreads, where bid and asked prices are estimated for each contract maturity in each interval (5 minutes) after classifying trades as buyer- *vs*. seller-initiated using the Lee and Ready (1991) tick test. *Volatility* or *Std_Return_300* is the 5-minute (300 seconds) average return volatility. In **Panel C**, *Amihud* is an inverse measure of depth (Amihud, 2002) equal to the daily average of the ratio of absolute return to volume, calculated in 5-minute non-overlapping intervals throughout the trading day. In **Panel D**, *AbsOIB* is the daily average of 5-minute customer trade imbalances (where customers are the traders classified as CTI-4 traders in the CFTC database) calculated as the ratio of five-minute absolute trade imbalances (buyer-initiated *minus* seller-initiated trades) to trading volume. All the measures are estimated for each contract maturity and then volume-weight-averaged across all 84 futures contract maturities, using trades time-stamped during business hours. All four Panels plot moving averages of these daily averages over several days. Source: U.S. Commodity Futures Trading Commission (CFTC) and authors' computations.

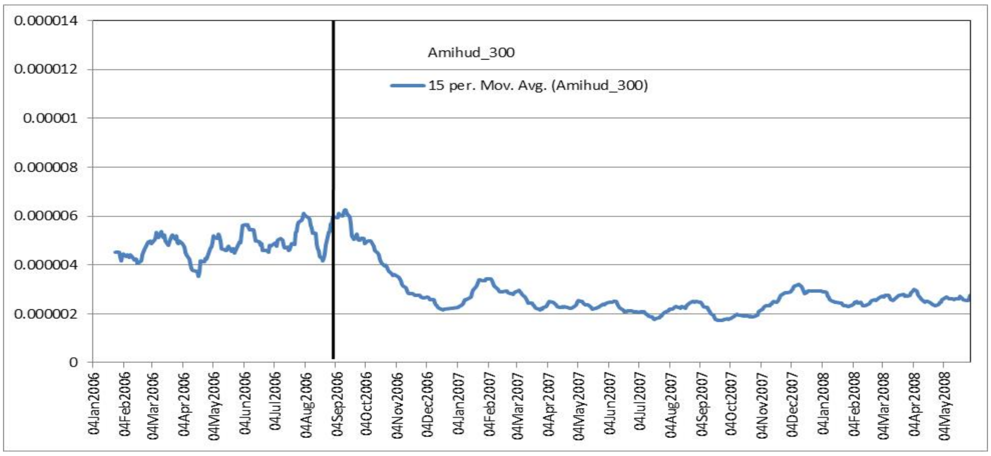
Panel A: Pricing Errors (*PE_Variance* and *Price_Volatility*)



Panel B: *Spread* and *Volatility*



Panel C: Inverse Depth (*Amihud Ratio*)



Panel D: Customer Demand Imbalances (*AbsOIB*)

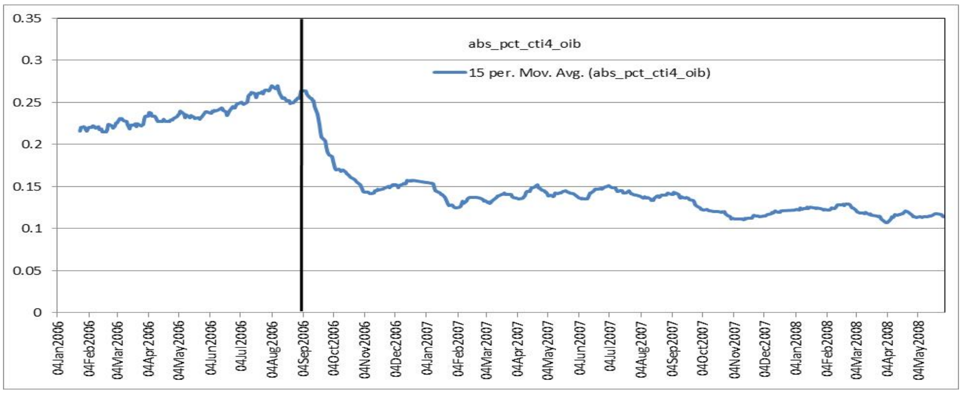


Figure 2: Trading Volume Shares – Locals *vs*. Institutional Financial Traders, 2006 – 2008

Figure 2 compares the respective evolutions between 2006 and 2008 of the fractions of the total trading volume involving institutional financial traders (dashed line) and Locals (solid line) in the NYMEX's WTI sweet crude oil futures market. Volume shares are based on pit data for the *pre*-electronification period (January 3rd, 2006 to September 1st, 2006) and on Globex data for the *post*-electronification period (September 5th, 2006 to May 31st, 2008). *FIN* is the proportion of trades involving the participation of one or two institutional financial traders (traders classified as CTI 2 traders in the CFTC database) in either or both legs of a trade. *Local* is the proportion of the total trading volume involving the participation of one or two "Locals" (i.e., traders classified as CTI-1 traders in the CFTC database) in one or both legs of a trade. Figure 2 plots moving averages of these daily volume shares based on trades time-stamped during business hours. Source: U.S. Commodity Futures Trading Commission (CFTC) and authors' computations.

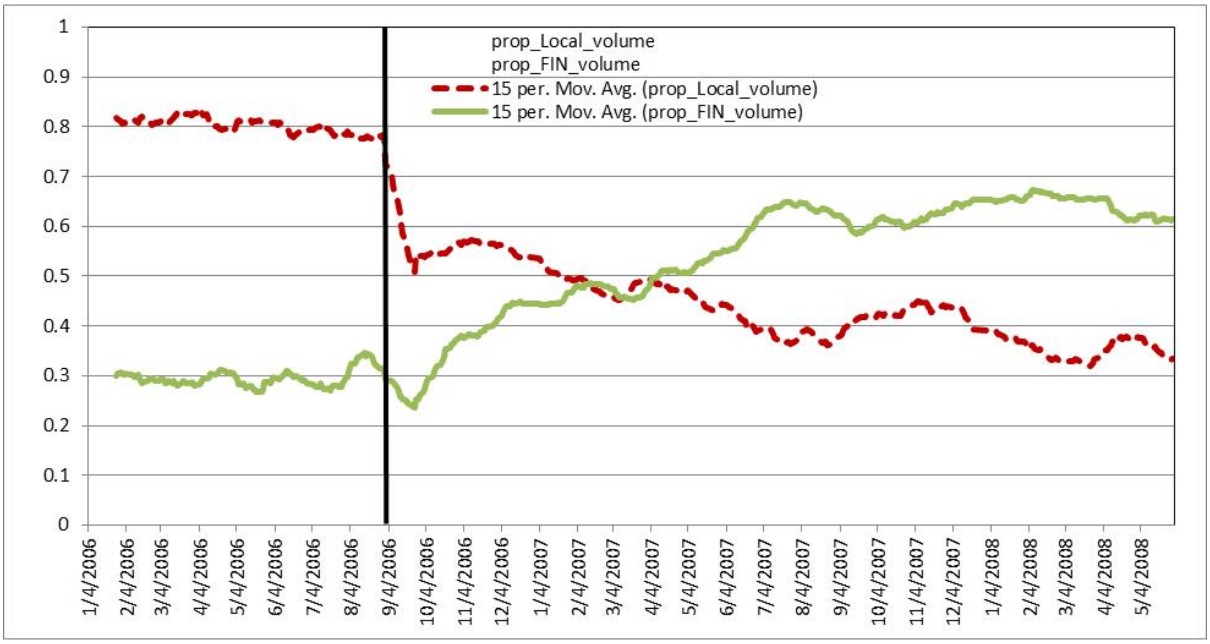
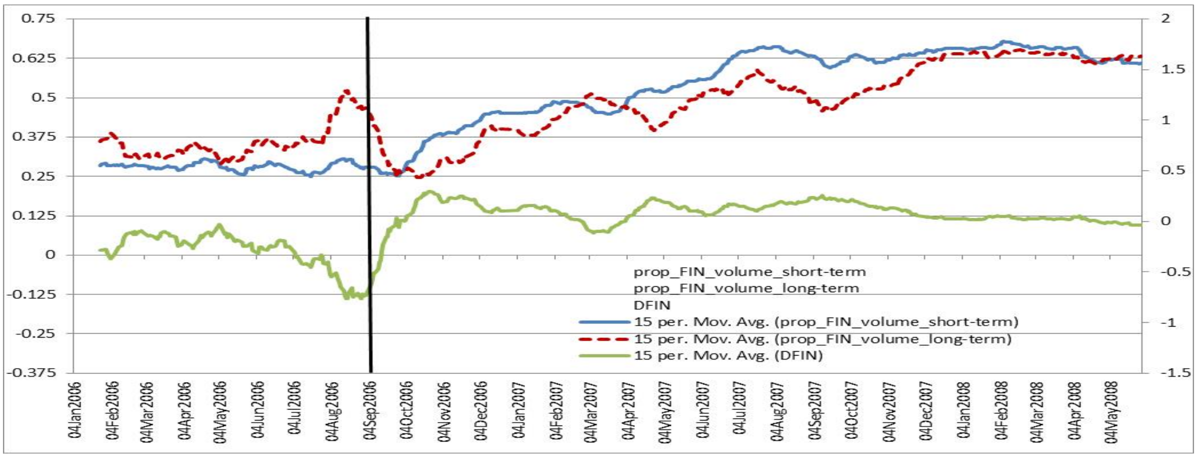


Figure 3: Financial Trading Activity: Short-Term *vs*. Long-Term contracts

Figure 3 compares the evolution of institutional financial trading activity in short-term *vs*. long-term WTI sweet crude oil futures contracts on the NYMEX. **Panel A** compares the proportions of the total trading volume involving institutional financial traders in short-term *vs*. long-term WTI futures; **Panel B** compares the monthly number of new institutional financial traders (i.e., arrivals) in short-term *vs*. long-term WTI futures. The analysis is conducted on pit data for the *pre*-electronification period (January 3rd, 2006 to September 1st, 2006) and Globex data for the *post*-electronification period (September 5th, 2006 to May 31st, 2008). In **Panel A**, *FIN* is the proportion of the trading volume involving one or more institutional financial traders (traders classified as CTI 2 traders in the CFTC database): *FIN_Short-Term* is the daily, trading volume-weighted average of *FIN* across short-term contracts (contracts with up to 62 days to expiration); *FIN_Long-Term* is the daily, volume weighted average of *FIN* for long-term contracts (contracts with more than 62 days left to expiration). Δ*FIN* or *DFIN* is the daily percentage difference between the short- and long-term proportions: *(FIN_Short-Term – FIN_Long-Term*)/ *FIN_Short-Term*. The vertical line in Panel A identifies the date of the introduction of electronic trading – September 5th, 2006. Source: U.S. Commodity Futures Trading Commission (CFTC) and authors' computations.

Panel A: Financial trading volume in short-term *vs*. long-term crude oil contracts



Panel B: Entry of new institutional financial traders in short-term *vs*. long-term WTI crude oil futures

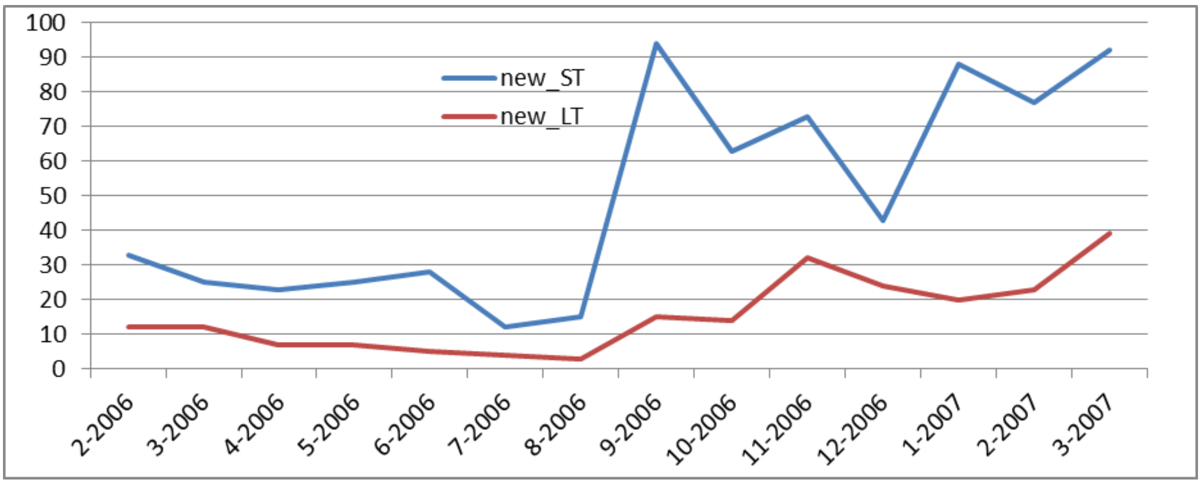
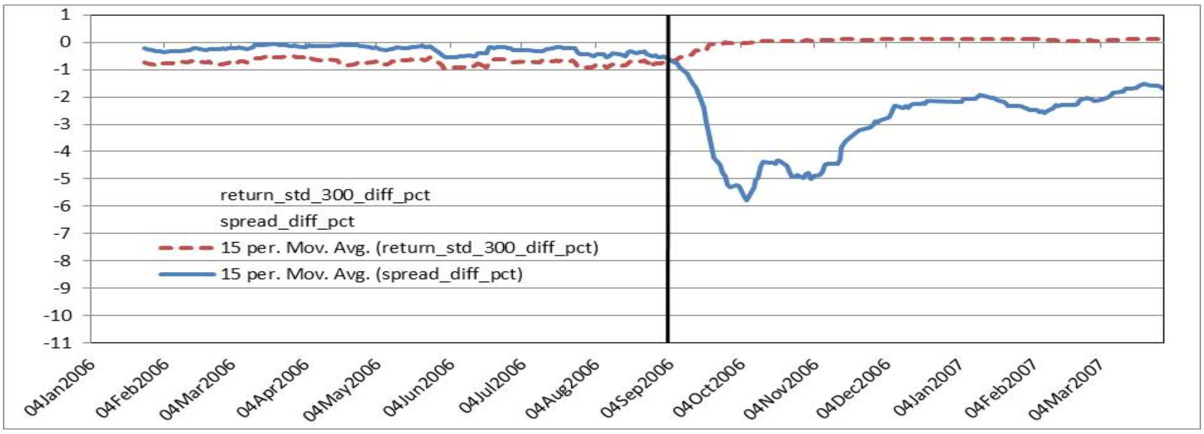


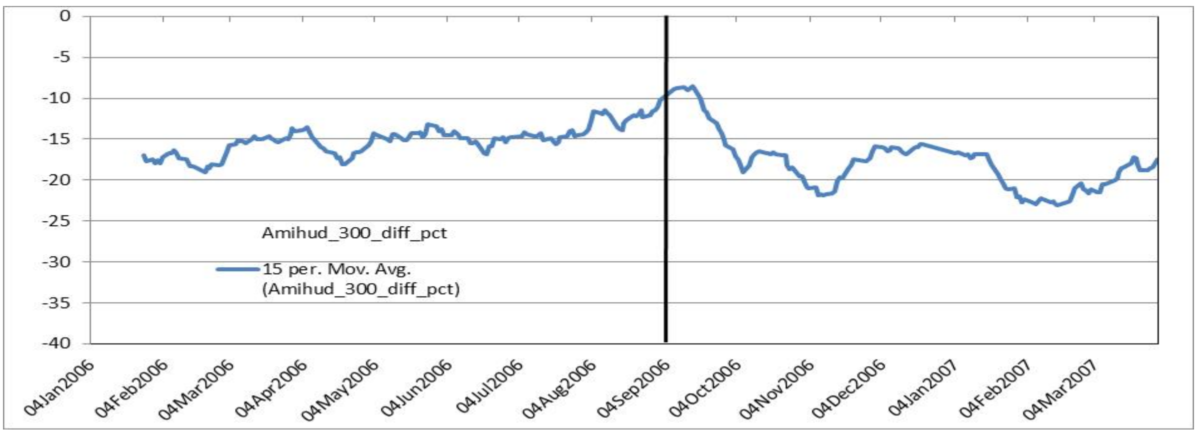
Figure 4: Financial Trading Activity & Market Quality measures: Short-Term *vs*. Long-Term contracts

Figure 4 compares the evolution of various market quality measures in short-term (up to 62 days to expiration) *vs*. longer-term (more than 62 days until expiration) crude oil futures contracts. The analysis is conducted for NYMEX WTI sweet crude oil futures trading during business hours in the NYMEX pits for the *pre*-electronification period (January 3rd, 2006 to September 1st, 2006) and on the Globex platform for the *post*-electronification period (September 5th, 2006 to May 31st, 2008). In each Panel, we plot the daily percentage difference (denoted Δ*)* between the *Short-Term* and *Long-Term* values of the relevant variable(s). In **Panel A**, *Spread* refers to the daily average of 5-minute Bid-Ask spreads obtained using bid and asked prices estimated for each contract maturity in each interval (5 minutes), after classifying trades as buyer- *vs*. seller-initiated using the Lee and Ready (1991) tick test; *Volatility* or *Std_Return_300* refers to the 5-minute (300 seconds) average return volatility. In **Panel B**, *Amihud* refers to an inverse measure of depth (Amihud, 2002) equal to the daily average of the ratio of absolute return to volume calculated in 5-minute non-overlapping intervals throughout the trading day. In **Panel C**, *AbsOIB* refers to the daily average of 5 minute customer (traders classified as CTI 4 traders in the CFTC database) trade imbalances calculated as the ratio of 5-minute absolute trade imbalances (buyer-initiated *minus* seller-initiated trades) to trading volume. In **Panel D**, *PE_Proportion* is the daily ratio of *PE_Variance* and *Price_Volatility*. In **Panel E**, *PE_Variance* refers to the daily pricing error variance, estimated as in Hasbrouck (1993) while *Price_Volatility* refers to the daily average of 5-minute volatility of intraday (log) transaction prices for each contract maturity in each time interval. The dark vertical line in each plot identifies the date of the introduction of electronic trading – September 5th, 2006. Sources: U.S. Commodity Futures Trading Commission (CFTC) and authors' computations.

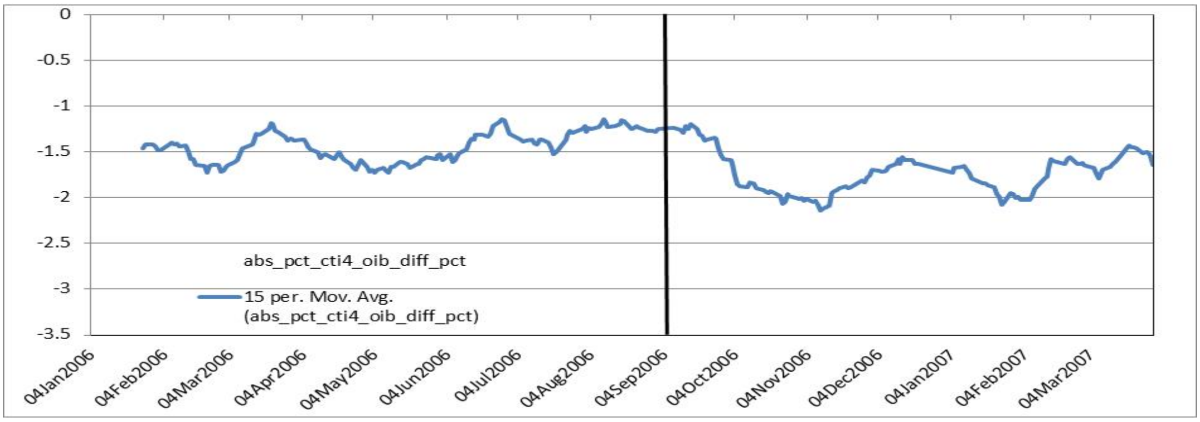
Panel A: Δ*Spread* and Δ*Volatility*



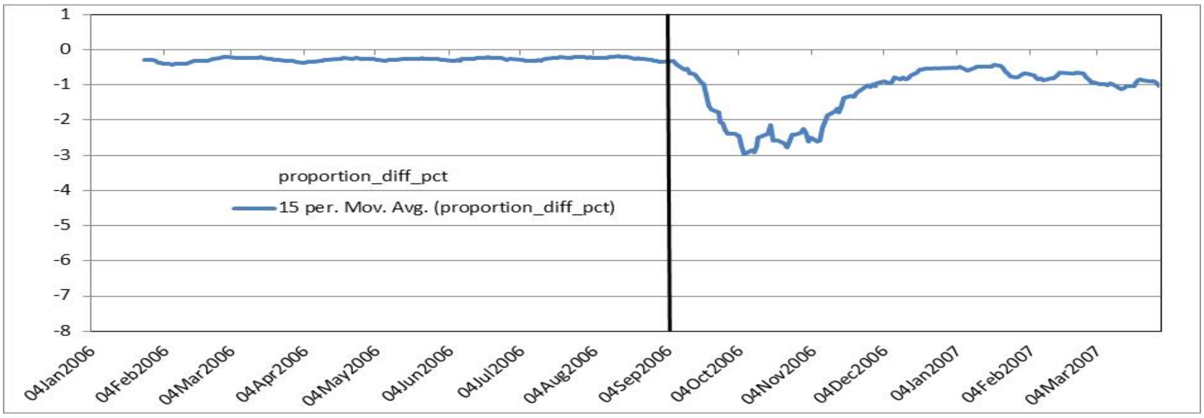
Panel B: Δ*Amihud*



Panel C: Δ*AbsOIB*



Panel D: Δ*PE_Proportion*



Panel E: Δ*PE_Variance* and Δ*Price_Volatility*

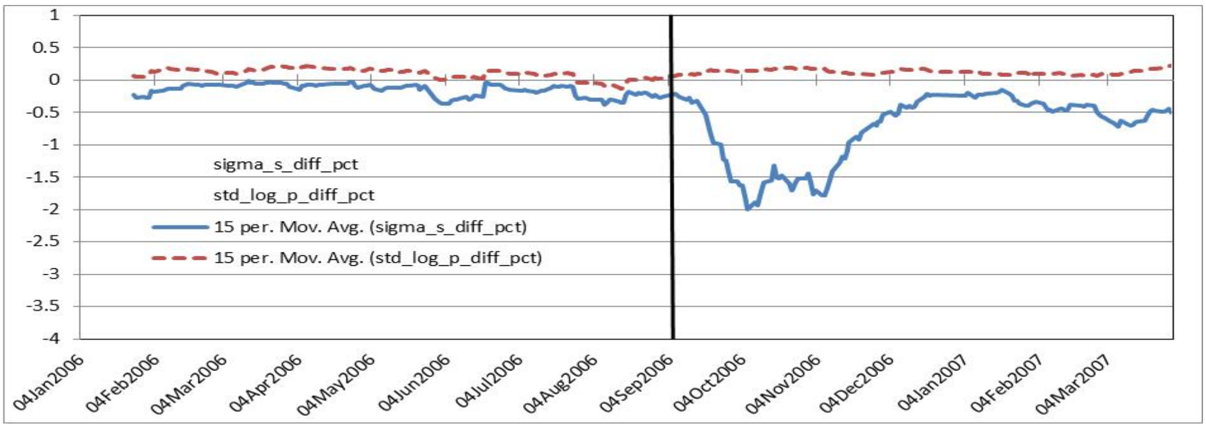
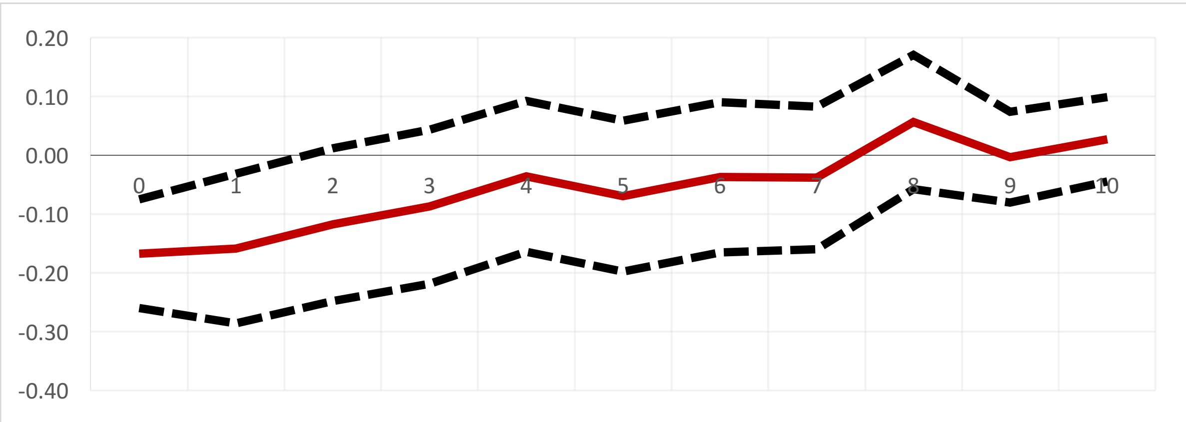


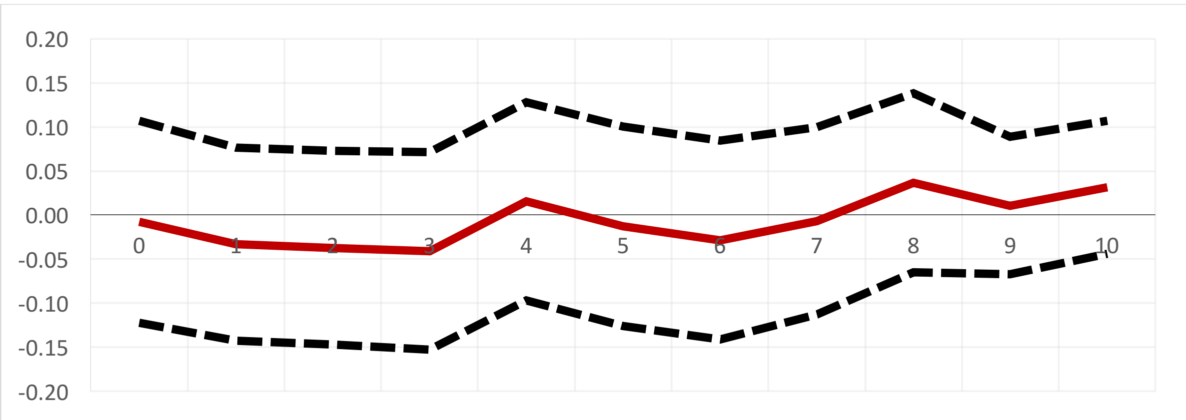
Figure 5 – Effect of Financial Traders: Impulse Response Functions

Figure 5 provides graphs of orthogonalized impulse response functions (red lines) with 10% confidence bands (dotted lines). Each Panel depicts the impact on measures of market quality and pricing efficiency, up to 10 days out, of a one-standard deviation shock to the difference between the trading volume shares of institutional financial traders in short-term *vs*. long-term WTI sweet crude oil futures contracts. The analysis is conducted using Globex data from April 1st, 2007 to May 31st, 2008. In **Panel A**, *Spread* refers to the daily average of 5 minute Bid-Ask spreads obtained using bid and asked prices estimated for each contract maturity in each interval (5 minutes), after classifying trades as buyer- *vs*. seller-initiated using the tick-test. In **Panel B**, *Amihud,* an inverse measure of depth (Amihud, 2002), refers to the daily average of the ratio of absolute return to volume calculated in 5-minute non-overlapping intervals throughout the trading day. In **Panel C**, *AbsOIB* refers to the daily average of 5-minute customer (traders classified as CTI 4 traders in the CFTC database) trade imbalances calculated as the ratio of five-minute absolute trade imbalances (buyer-initiated *minus* seller-initiated trades) to trading volume. In **Panel D**, *PE_Proportion* refers to the daily ratio of the daily pricing error variance, estimated as in Hasbrouck (1993), to the daily average of 5-minute volatility of intraday (log) transaction for each contract maturity in each interval. ***FIN*** is the proportion of the trading volume involving the participation of financial traders (traders classified as CTI 2 traders in the CFTC database). *FIN_Short-Term* is the daily, trading volume-weighted average of *FIN* across short-term contracts (contracts with less than 62 days to expiration). *FIN_Long-Term* is the daily, volume weighted average of *FIN* across long -term contracts (contracts with greater than or equal to 62 days to expiration). ∆***FIN*** is the daily percentage difference in the two: (*FIN_Short-Term – FIN_Long-Term*)/ *FIN_Short-Term*. The market quality and pricing efficiency variables ∆***Spread,*** ∆***Amihud,*** ∆***AbsOIB*** *and* ∆***PE_Proportion*** are defined analogously. Impulse response functions are obtained for a VAR system consisting of 5 lags of ∆*FIN*, ∆*Spread,* ∆*Amihud, and* ∆*AbsOIB and* ∆*PE_Proportion.*

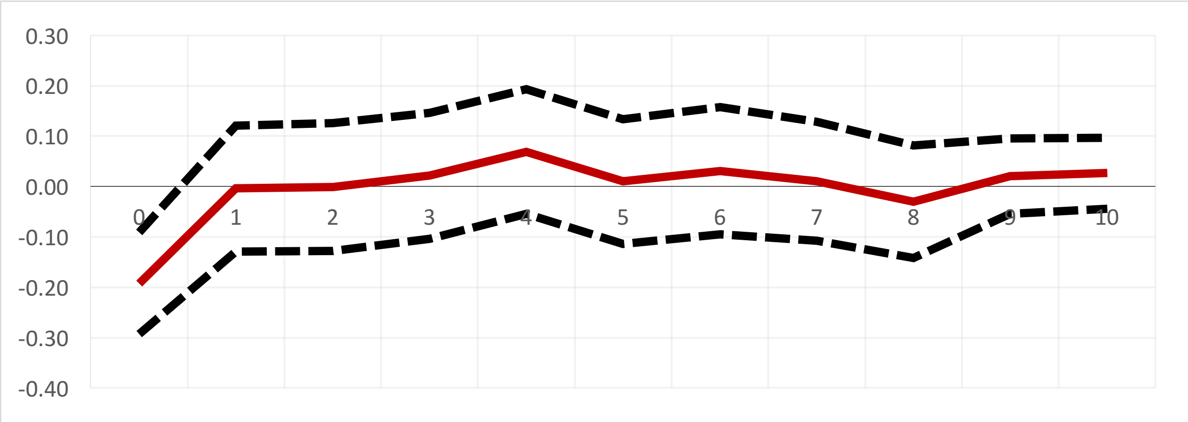
Panel A: Effect of ∆*FIN* on ∆*Spread*



Panel B: Effect of ∆*FIN* on ∆*Amihud*



Panel C: Effect of Δ*FIN* on Δ*ABSOIB*



Panel D: Effect of Δ*FIN* on Δ *PE_Proportion*

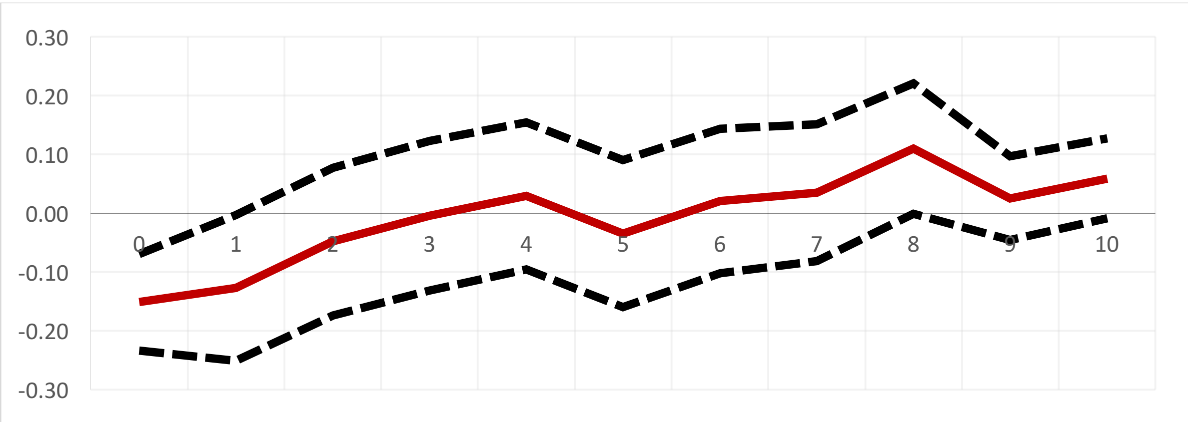


Table 1: Electronic Trading Effect on Financial Institutional Trading and Market Quality – Event-Study

Table 1 presents an analysis of financial traders' participation and measures of market quality surrounding the introduction of electronic trading in WTI sweet crude-oil futures by the NYMEX on September 5th, 2006. The sample period is January 3rd, 2006 to March 31st, 2007. *Pre-Electronification* refers to the period from January 3rd, 2006 to September 1st, 2006; *Post-Electronification* refers to the period from September 5th, 2006 to March 31st, 2007. The analysis is conducted on pit trading data for the *Pre-Electronification* period and on Globex data for the *Post-Electronification* period. ***FIN*** is the proportion of the total trading volume during business hours involving the participation of institutional financial traders (traders classified as CTI-2 traders in the CFTC database). ***Spread*** is the daily average of 5 minute Bid-Ask spreads obtained using bid and asked prices estimated for each contract maturity in each interval (5 minutes), after classifying trades as buyer- *vs*. seller-initiated using the Lee and Ready (1991) tick-test. ***Amihud**,* an inverse measure of depth (Amihud, 2002), is the daily average of the ratio of absolute return to volume calculated in 5-minute non-overlapping intervals throughout the trading day. ***AbsOIB*** is the daily average of 5 minute customer (traders classified as CTI 4 traders in the CFTC database) trade imbalances calculated as the ratio of five-minute absolute trade imbalances (buyer-initiated *minus* seller-initiated trades) to trading volume. ***PE_Proportion*** is the daily ratio of the pricing error variance, estimated as in Hasbrouck (1993), to the volatility of intraday (log) transaction prices. All the variables are estimated for each contract maturity and daily volume-weighted averages of these figures are then computed and employed in the regressions. Two tailed *p-values* are also reported. Source: U.S. Commodity Futures Trading Commission (CFTC) and authors' computations.

	Pre-Electronification	Post-Electronification	Difference	Pct. Difference	p-value
FIN	29.64%	55.01%	25.37%	85.59%	<.001
Spread	0.37%	0.03%	-0.34%	-91.94%	<.001
Amihud	4.90	2.66	-2.24	-45.76%	0.604
AbsOIB	23.85%	13.48%	-10.37%	-43.48%	<.001
PE_Proportion	58.87%	3.73%	-55.14%	-93.66%	<.001

Table 2: Trader Description

Table 2 describes key attributes of three kinds of traders in the NYMEX's WTI sweet crude-oil futures market in 2006–2007. The summary statistics in **Panel A** are based on pits data during the *pre*-electronification period (January 3rd, 2006 to September 1st, 2006); in **Panel B,** the information is based on Globex data from the *post*-electronification period (September 5th, 2006 to March 31st, 2007). *Locals, Financial Institutions* ("*Fin. Inst.*") and *Customers* refer to traders classified respectively as CTI-1, 2 and 4 in the CFTC database. *Abs. Closing Ratio* refers to the average ratio of a trader's ending-of-hour inventory to that trader's hourly trading volume during business hours. Similarly, *Trading Volume* and *Number of Trades* are also hourly averages of a trader's activity. Cross-sectional mean and median are also presented. Source: U.S. Commodity Futures Trading Commission (CFTC) and authors' computations.

Panel A: Pits, *Pre*-electronification (January 3rd, 2006 to September 1st, 2006)

Traders	Trading Volume		Number of Trades		Abs. Closing Ratio	
	Mean	Median	Mean	Median	Mean	Median
Locals	258	85	14	8	22%	3%
Fin. Inst.	269	81	6	3	57%	83%
Customers	87	10	4	2	75%	100%

Panel B: Globex, *Post*-electronification (September 5th, 2006 to March 31st, 2007)

Traders	Trading Volume		Number of Trades		Abs. Closing Ratio	
	Mean	Median	Mean	Median	Mean	Median
Locals	115	36	30	13	32%	12%
Fin. Inst.	298	50	114	19	38%	8%
Customers	77	10	23	4	60%	100%

Table 3: Effect of Electronic Trading on Financial Traders – Short-Term *vs.* Long-Term

Table 3 presents a univariate analysis of institutional financial traders' participation surrounding the introduction of WTI futures electronic trading by the NYMEX on September 5th, 2006. The sample period is January 3rd, 2006 to March 31st, 2007. *Pre-Electronification* refers to the period from January 3rd, 2006 to September 1st, 2006. *Post-Electronification* refers to the period from September 5th, 2006 to March 31st, 2007. The analysis is conducted using pit data in the *Pre-Electronification* period and Globex data in the *Post-Electronification* period. ***FIN*** is the proportion of the futures trading volume during business hours that involves the participation of institutional financial traders (traders classified as CTI 2 traders in the CFTC database). All the variables are estimated for each contract maturity, with daily volume-weighted averages computed separately for (i) *Short-Term* (contracts with up to 62 days to expiration) and (ii) *Long-Term* (contracts with more than 62 days to expiration) futures. ***FIN_Short-Term*** is the daily, volume-weighted average of *FIN* in *Short-Term* contracts. ***FIN_Long-Term*** is the daily, volume-weighted average of *FIN* in *Long -Term* contracts. Δ***FIN*** is the daily percentage difference in the two: Δ*FIN = (FIN_Short-Term – FIN_Long-Term*)/ *FIN_Short-Term*. Two tailed *p-values* are reported in the last column. Source: U.S. Commodity Futures Trading Commission (CFTC) and authors' computations.

	Pre-Electronification	Post-Electronification	Difference	p-value
FIN_Short-Term	28.10%	41.42%	13.32%	<.001
FIN_Long-Term	36.27%	37.48%	1.21%	0.312
Δ*FIN*	-30.42%	9.54%	39.96%	<.001

Table 4: Effect of Electronic Trading on Market Quality – Short-Term vs. Long-Term

Table 4 presents univariate analyses of key measures of market quality surrounding the introduction of WTI futures electronic trading by the NYMEX on September 5th, 2006. The sample period is January 3rd, 2006 to March 31st, 2007. *Pre-Electronification* refers to the period from January 3rd, 2006 to September 1st, 2006; *Post-Electronification* refers to the period from September 5th, 2006 to March 31st, 2007. The analysis is conducted on using pit data in the *Pre-Electronification* period and Globex data in the *Post-Electronification* period. *Spread* is the daily average of 5-minute Bid-Ask spreads obtained using bid and asked prices estimated for each contract maturity in each interval (5 minutes), after classifying trades as buyer- *vs*. seller-initiated using the Lee and Ready (1991) tick-test. *Amihud,* an inverse measure of depth (Amihud, 2002), is the daily average of the ratio of absolute return to volume calculated in 5-minute non-overlapping intervals throughout the trading day. *AbsOIB* is the daily average of 5-minute customer (traders classified as CTI 4 traders in the CFTC database) trade imbalances calculated as the ratio of 5-minute absolute trade imbalances (buyer-initiated *minus* seller-initiated trades) to trading volume. *PE_Proportion* is the daily ratio of the pricing error variance, estimated as in Hasbrouck (1993), to the volatility of intraday (log) transaction prices. All the variables are estimated for each contract maturity with volume weighted averages computed separately for (i) *Short-Term* (contract maturities with less than 62 days to expiration) and (ii) *Long-Term* (contract maturities with greater than or equal to 62 days to expiration) futures. For example, *Spread_Short-Term* is the daily, trading-volume-weighted average of *Spread* across *Short-Term* contracts. *Spread_Long-Term* is the daily, volume weighted average of *Spread* across *Long -Term* contracts. Δ*Spread* is the daily percentage difference between the two: *(Spread_Short-Term – Spread_Long-Term*)/ *Spread_Short-Term*. The other market quality variables are defined analogously. Two tailed *p-values* are reported in the last column. Source: U.S. Commodity Futures Trading Commission (CFTC) and authors' computations.

	Pre-Electronification	Post-Electronification	Difference	p-value
Spread_Short-Term	0.35%	0.03%	-0.32%	<.001
Spread_Long-Term	0.41%	0.10%	-0.31%	<.001
Δ*Spread*	-28%	-304%	-276%	<.001
Amihud_Short-Term	1.04	1.07	0.03	0.604
Amihud_Long-Term	15.00	20.00	5.00	<.001
Δ*Amihud*	-14.87	-18.43	-3.56	<.001
AbsOIB_Short-Term	17.09%	12.36%	-4.73%	<.001
AbsOIB_Long-Term	40.85%	33.19%	-7.66%	<.001
Δ*AbsOIB*	-143.74%	-175.26%	-31.52%	<.001
PE_Proportion_Short-Term	55.35%	4.12%	-51.23%	<.001
PE_Proportion_Long-Term	69.61%	8.90%	-60.71%	<.001
Δ*PE_Proportion*	-27.73%	-132.27%	-104.54%	<.001

Table 5 – Effect of Electronic Trading on Financial Traders

Table 5 presents regression analyses of the impact of the introduction of electronic trading on Δ***FIN***, i.e., on the percentage difference between the daily trading volume shares of institutional financial traders in short-term (less than 62 days to expiration) *vs*. long-term (62 or more days to expiration) WTI sweet crude oil futures contracts. Model 2 constitutes the first stage of the instrumental-variable regressions summarized in Tables 6, 7, 8 and 9. The analyses in Table 5 are conducted using NYMEX pits data for the *pre*-electronification period (January 3rd, 2006 to September 1st, 2006) and Globex data for the *post*-electronification period (September 5th, 2006 to March 31st, 2007). *FIN* is the proportion of trading volume involving the participation of financial traders (traders classified as CTI 2 traders in the CFTC database). Δ***FIN*** is the ***dependent variable*** in Models 1 and 2. ***Electronification*** is a dummy variable equal to 1 in the *post*-electronification period. ***EIA_Inventory*** is a dummy variable set equal to 1 on the day (usually Wednesday, otherwise Thursday) when the U.S. Department of Energy's Energy Information Administration (EIA) releases its weekly report on crude oil stock levels and 0 otherwise. ***Lead_Inventory*** is a dummy variable equal to 1 on the day preceding the EIA announcement day. ***First GSCI Roll*** is a dummy variable set equal to 1 on the five business days when the monthly GSCI roll takes place and 0 otherwise. ***Day of the Week*** are three dummy variables set equal to 1 for Monday, Tuesday, or Friday. Two tailed *p-values* are also reported.

Independent Variable	Model 1		Model 2	
Intercept	-0.30	<.001	-0.08	0.508
Electronification	**0.40**	**<.001**	**0.37**	**<.001**
VIX			-0.02	0.018
EIA_Inventory			0.06	0.247
Lead_Inventory			0.01	0.868
GSCI_Roll			0.07	0.069
Contract_Exp_Day			-0.08	0.313
Day of the Week			YES	
N	299		299	
Adj RSq	30.65%		32.15%	

Table 6 – Effect of Financial Traders on Spreads

Table 6 presents regression analyses of the effect of the percentage difference between the daily trading volume shares of institutional financial traders in short-term *vs*. long-term contracts on the percentage difference between the Bid-Ask spreads for short-term *vs*. long-term contracts. The analysis is conducted on WTI crude-oil futures trading in the NYMEX pits in the *pre*-electronification period (January 3rd, 2006 to September 1st, 2006) and on the Globex platform in the *post*-electronification period (September 5th, 2006 to March 31st, 2007). *FIN* is the proportion of trading volume involving the participation of financial traders (traders classified as CTI 2 traders in the CFTC database). ***Volatility*** is the daily volume-weighted average of the 5-minute volatility of (mid-quote) returns estimated for each contract in each maturity interval. ***Volume*** is the daily volume-weighted average of 5-minute trading volume estimated for each contract in each maturity interval. ***Customer_Volume*** is the daily volume-weighted average of the proportion of 5-minute trading volume involving customers (traders classified as CTI 4 traders in the CFTC database) on at least one side of a trade. ***Spread*** is the daily volume-weighted average of 5 minute Bid-Ask spreads obtained using bid and asked prices estimated for each contract maturity in each interval (5 minutes), after classifying trades as buyer- *vs*. seller-initiated using the Lee and Ready (1991) tick-test. *Spread_Short-Term* is the daily volume-weighted average of *Spread* for short-term contracts (up to 62 days to expiration). *Spread_Long-Term* is the daily, volume weighted average of *Spread* for long-term contracts (more than 62 days to expiration). Δ***Spread*** is the daily percentage difference between the two: *(Spread_Short-Term – Spread Long-Term)/ Spread Short-Term, and is the* ***dependent variable*** *in the analysis.* Δ***FIN,*** Δ***Volatility,*** Δ***Volume*** *and* Δ***Customer_Volume*** are defined analogously. Δ***FIN_Predicted*** is the fitted value of Δ*FIN* obtained from the first-stage regressions (Model 2 in Table 5). ***EIA_Inventory*** is a dummy variable equal to 1 during EIA announcement days. ***Lead_Inventory*** is a dummy variable set equal to 1 during the days prior to the EIA announcements. ***GSCI_Roll*** is a dummy variable equal to 1 on the five business days when a GSCI roll takes place. ***Contract_Exp_Day*** is a dummy variable equal to 1 on the day of the prompt contract's expiration. ***September_2006*** is a dummy variable equal to 1 in the calendar month when electronification took place and 0 otherwise. ***Day of the Week*** are three dummy variables set equal to 1 for Monday, Tuesday, or Friday. Two tailed *p-values,* obtained using Newey-West standard errors with 5 lags, are also reported.

Parameter	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Intercept	-0.95	<.001	1.57	0.019	-1.06	<.001	0.91	0.089	0.89	0.088	1.56	0.016
Δ*FIN_Predicted*	**-4.22**	**<.001**	**-3.64**	**<.001**	**-4.36**	**<.001**	**-3.89**	**<.001**	**-3.89**	**<.001**	**-3.64**	**<.001**
Δ*Volume*			-3.13	<.001			-2.42	<.001	0.80	<.001	-3.12	<.001
Δ*Customer_Volume*									-2.40	<.001	-0.05	0.912
Δ*Volatility*	0.86	<.001	0.81	<.001	0.83	<.001	0.80	<.001	-0.11	0.823	0.81	<.001
EIA_Inventory	0.26	0.165	0.26	0.154	0.28	0.132	0.28	0.129	0.28	0.129	0.26	0.151
Lead_Inventory	0.00	0.998	0.02	0.884	0.02	0.901	0.03	0.824	0.03	0.835	0.02	0.890
GSCI_Roll	0.48	<.001	0.44	0.001	0.53	<.001	0.49	<.001	0.49	0.001	0.44	0.001
Contract_Exp_Day	-0.05	0.788	-0.11	0.547	-0.08	0.689	-0.11	0.513	-0.11	0.543	-0.10	0.570
September_2006					-1.10	0.041	-0.94	0.079	-0.94	0.080		
Dependent Lags	2		2		2		2		2		2	
Day of the Week	YES		YES		YES		YES		YES		YES	
N	299		299		299		299		299		299	
Adj RSq	73.71%		74.75%		75.25%		75.81%		76.80%		75.69%	

Table 7 – Effect of Financial Traders on Depth

Table 7 presents regression analyses of the effect of the percentage difference between the daily trading volume shares of institutional financial traders in short-term *vs*. long-term contracts on the percentage difference in market depth for short-term *vs*. long-term contracts. The analysis is conducted on WTI sweet crude-oil futures trading in the NYMEX pits during the *pre*-electronification period (January 3rd, 2006 to September 1st, 2006) and on the Globex platform for the *post*-electronification period (September 5th, 2006 to March 31st, 2007). *FIN* is the proportion of trading volume involving the participation of financial traders (traders classified as CTI 2 traders in the CFTC database). *Volatility* is the daily average of 5-minute volatility of (mid-quote) returns estimated for each contract in each maturity interval. ***Volume*** is the daily volume-weighted average of 5-minute trading volume estimated for each contract in each maturity interval. ***Customer_Volume*** is the daily average of the proportion of 5-minute trading volume involving customers (traders classified as CTI 4 traders in the CFTC database) on at least one side of a trade. ***Amihud,*** an inverse measure of depth (Amihud, 2002), is the daily average of the ratio of absolute return to volume calculated in 5-minute non-overlapping intervals throughout the trading day. *Amihud_Short-Term* is the daily, volume-weighted average of *Amihud* for short-term contracts (up to 62 days to expiration). *Amihud_Long-Term* is the daily, volume weighted average of *Amihud* for long-term contracts (more than 62 days to expiration). **Δ*Amihud*** is the daily percentage difference between the two: (*Amihud_Short-Term – Amihud_Long-Term*) / *Amihud_Short-Term,* and is the ***dependent variable*** in the analysis. **Δ*FIN,*** **Δ*Volatility,*** **Δ*Volume*** and **Δ*Customer_Volume*** are defined analogously. **Δ*FIN_Predicted*** is the fitted value of Δ*FIN* obtained from the first-stage regressions (Model 2 in Table 5).. ***EIA_Inventory*** is a dummy variable equal to 1 during EIA announcement days. ***Lead_Inventory*** is a dummy variable equal to 1 on the day prior to an EIA announcement day. ***GSCI_Roll*** is a dummy variable equal to 1 on the days of a weekly GSCI roll. ***Contract_Exp_Day*** is a dummy variable equal to 1 on the day of the prompt contract's expiration. ***September_2006*** is a dummy variable equal to 1 in the calendar month when electronification took place and 0 otherwise. ***Day of the Week*** are three dummy variables set equal to 1 for Monday, Tuesday, or Friday. Two tailed *p-values,* obtained using Newey-West standard errors with 5 lags, are also reported.

Parameter	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Intercept	-8.09	<.001	6.66	0.059	-9.01	<.001	9.15	0.010	7.97	0.024	5.51	0.118
Δ*FIN_Predicted*	**-16.17**	**<.001**	**-11.00**	**<.001**	**-17.42**	**<.001**	**-11.76**	**<.001**	**-11.34**	**<.001**	**-10.60**	**<.001**
Δ*Volume*			-17.24	<.001			-22.03	<.001	-5.38	0.022	-15.99	<.001
Δ*Customer_Volume*									5.67	<.001	4.92	0.038
Δ*Volatility*	5.91	<.001	5.62	<.001	5.95	<.001	5.63	<.001	-20.81	<.001	5.66	<.001
EIA_Inventory	0.28	0.736	0.21	0.799	0.32	0.689	0.27	0.732	0.07	0.928	0.02	0.976
Lead_Inventory	-0.72	0.395	-0.62	0.441	-0.71	0.397	-0.58	0.461	-0.66	0.406	-0.70	0.393
GSCI_Roll	-0.29	0.678	-0.72	0.315	-0.26	0.711	-0.78	0.247	-0.62	0.366	-0.57	0.433
Contract_Exp_Day	-2.66	0.019	-2.71	0.030	-2.78	0.011	-2.94	0.014	-2.53	0.033	-2.32	0.060
September_2006					2.63	0.096	4.61	0.008	4.76	0.007		
Dependent Lags	2		2		2		2		2		2	
Day of the Week	YES		YES		YES		YES		YES		YES	
N	299		299		299		299		299		299	
Adj RSq	38.23%		41.81%		39.04%		44.45%		45.35%		42.52%	

Table 8 – Effect of Financial Traders on Customer Order Imbalances

Table 8 presents regression analyses of the effect of the percentage difference between the daily trading volume shares of institutional financial traders in short-term *vs*. long-term contracts on the percentage difference in customer (relative) order imbalances for short-term *vs.* long-term contracts. The analyses are conducted on WTI sweet crude-oil futures trading in the NYMEX pits for the *pre*-electronification period (January 3rd, 2006 to September 1st, 2006) and on the Globex platform for the *post*-electronification period (September 5th, 2006 to March 31st, 2007). *Volatility* is the daily average of 5-minute volatility of (mid-quote) returns estimated for each contract in each maturity interval. *FIN* is the proportion of trading volume involving the participation of financial traders (traders classified as CTI 2 traders in the CFTC database). ***Volume*** is the daily volume-weighted average of 5-minute trading volume estimated for each contract in each maturity interval. ***Customer_Volume*** is the daily weighted average of the proportion of 5-minute trading volume involving customers (traders classified as CTI 4 traders in the CFTC database) on at least one side of a trade. ***AbsOIB*** is the daily average of 5-minute customer (traders classified as CTI 4 traders in the CFTC database) trade imbalances calculated as the ratio of five-minute absolute trade imbalances (buyer-initiated minus seller-initiated trades) to trading volume. *AbsOIB_Short-Term* is the daily, volume weighted average of *AbsOIB* across short-term contracts (up to 62 days to expiration). *AbsOIB_Long-Term* is the daily, volume weighted average of *AbsOIB* across long-term contracts (more than 62 days to expiration). Δ***AbsOIB*** is the daily percentage difference in the two: (*AbsOIB_Short-Term* – *AbsOIB_Long-Term*) / *AbsOIB_Short-Term,* and is the ***dependent variable*** in the analysis. Δ*FIN,* Δ*Volatility*, Δ *Volume* and Δ *Customer Volume* are defined analogously. Δ***FIN_Predicted*** is the fitted value of Δ*FIN* obtained from the first-stage regressions (Model 2 in Table 5). *EIA_Inventory* is a dummy variable equal to 1 during EIA announcement days. *Lead_Inventory* is a dummy variable equal to 1 during the days prior to the EIA announcements*.* ***First GSCI Roll*** is a dummy variable equal to 1 on the five business days when the monthly GSCI roll takes place. ***Contract_Exp_Day*** is a dummy variable equal to 1 on the day of the prompt contract's expiration. ***September_2006*** is a dummy variable equal to 1 in the calendar month when electronification took place and 0 otherwise. ***Day of the Week*** are three dummy variables set equal to 1 for Monday, Tuesday, or Friday. Two tailed *p-values,* obtained using Newey-West standard errors with 5 lags, are also reported.

Parameter	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Intercept	-1.20	<.001	-1.31	<.001	-1.30	<.001	-1.16	<.001	-0.85	0.009	-0.98	0.003
ΔFIN_Predicted	**-0.72**	**<.001**	**-0.76**	**<.001**	**-0.85**	**<.001**	**-0.81**	**<.001**	**-0.94**	**<.001**	**-0.90**	**<.001**
ΔVolume			0.14	0.742			-0.17	0.682	-0.52	0.183	-0.25	0.540
ΔCustomer_Volume									1.54	<.001	1.55	<.001
ΔVolatility	0.06	0.332	0.06	0.325	0.07	0.263	0.06	0.299	0.05	0.368	0.04	0.395
EIA_Inventory	-0.18	0.043	-0.17	0.044	-0.17	0.056	-0.17	0.056	-0.11	0.163	-0.12	0.135
Lead_Inventory	-0.13	0.123	-0.13	0.122	-0.13	0.138	-0.13	0.146	-0.10	0.208	-0.11	0.178
GSCI_Roll	0.17	0.007	0.18	0.007	0.18	0.004	0.18	0.005	0.13	0.031	0.12	0.040
Contract_Exp_Day	-0.20	0.113	-0.20	0.111	-0.03	0.758	-0.21	0.088	-0.33	0.005	-0.32	0.007
September_2006					0.27	0.047	0.28	0.045	0.25	0.084		
Dependent Lags	2		2		2		2		2		2	
Day of the Week	YES		YES		YES		YES		YES		YES	
N	299		299		299		299		299		299	
Adj RSq	17.61%		17.35%		18.72%		18.48%		30.01%		29.10%	

Table 9 – Effect of Financial Traders on Pricing Efficiency

Table 9 presents regression analyses of the effect of the percentage difference between the daily trading volume shares of institutional financial traders in short-term *vs*. long-term contracts on differences in the percentage difference in pricing efficiency for short-term *vs*. long-term contracts. The analyses are conducted on WTI sweet crude-oil futures trading in the NYMEX pits for the *pre*-electronification period (January 3rd, 2006 to September 1st, 2006) and on the Globex platform for the *post*-electronification period (September 5th, 2006 to March 31st, 2007). *FIN* is the proportion of trading volume involving the participation of financial traders (traders classified as CTI 2 traders in the CFTC database). *Price_Volatility* is the daily volume-weighted average of 5-minute volatility of intraday (log) transaction for each contract in each maturity interval. ***Volume*** is the daily weighted average of 5-minute trading volume estimated for each contract in each maturity interval. ***Customer_Volume*** is the daily weighted average of the proportion of 5-minute trading volume involving customers (traders classified as CTI 4 traders in the CFTC database) on at least one side of a trade. ***PE_Variance*** is the average daily pricing error variance, estimated as in Hasbrouck (1993). *PE_Variance_Short-Term* is the daily, volume-weighted average of *PE_Variance* for short-term contracts (up to 62 days to expiration). *PE_Variance_Long-Term* is the daily, volume weighted average of *PE_Variance* for long-term contracts (more than 62 days to expiration). **Δ*PE_Variance*** is the daily percentage difference between the two: (*PE_Variance_Short-Term* – *PE_Variance_Long-Term*)/ *PE_Variance_Short-Term,* and is the ***dependent variable*** in the analysis. **Δ*FIN*, Δ*Price_Volatility*, Δ*Volume*** and **Δ*Customer_Volume*** are defined analogously. **Δ*FIN_Predicted*** is the fitted value of Δ*FIN* obtained from the first-stage regressions (Model 2 in Table 5). ***EIA_Inventory*** is a dummy variable equal to 1 on EIA announcement days. ***Lead_Inventory*** is a dummy variable equal to 1 during on the day prior to the EIA announcement day**.** ***GSCI_Roll*** is a dummy variable equal to 1 on the five business days when the monthly GSCI roll takes place. ***Contract_Exp_Day*** is a dummy variable equal to 1 on the day of the prompt contract's expiration. ***September_2006*** is a dummy variable equal to 1 in the calendar month when electronification took place and 0 otherwise. ***Day of the Week*** are three dummy variables set equal to 1 for Monday, Tuesday, or Friday. Two tailed *p-values,* obtained using Newey-West standard errors with 5 lags, are also reported.

Parameter	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Intercept	-0.68	<.001	0.75	0.072	-0.65	<.001	0.42	0.338	0.37	0.397	0.70	0.086
Δ*FIN_Predicted*	**-1.03**	**<.001**	**-0.64**	**0.002**	**-0.92**	**<.001**	**-0.64**	**0.001**	**-0.61**	**0.003**	**-0.60**	**0.004**
Δ*Volume*			-1.71	0.001			-1.30	0.019	-1.23	0.025	-1.64	0.001
Δ*Customer_Volume*									-0.33	0.244	-0.34	0.231
Δ*Price Volatility*	1.30	<.001	1.28	<.001	1.29	<.001	1.27	<.001	1.26	<.001	1.27	<.001
EIA_Inventory	0.01	0.953	0.01	0.926	0.01	0.908	0.01	0.896	0.00	0.971	0.00	0.998
Lead_Inventory	0.20	0.107	0.21	0.088	0.21	0.086	0.21	0.078	0.21	0.086	0.20	0.098
GSCI_Roll	0.24	0.001	0.21	0.001	0.24	0.001	0.22	0.001	0.23	0.001	0.22	0.001
Contract_Exp_Day	-0.20	0.179	-0.21	0.153	-0.18	0.144	-0.19	0.129	-0.16	0.195	-0.18	0.211
September_2006					-0.53	0.034	-0.43	0.115	-0.42	0.115		
Dependent Lags	2		2		2		2		2		2	
Day of the Week	YES		YES		YES		YES		YES		YES	
N	299		299		299		299		299		299	
Adj RSq	35.32%		37.20%		37.60%		38.49%		38.52%		37.23%	

Table 10 – Effect of Non-Fast and Fast Financial Traders on Market Quality

Table 10 presents regression analyses of the effect of the percentage difference in the trading volume shares of Non-Fast institutional financial traders in short-term *vs*. long-term contracts on various market quality measures' percentage differences of short-term *vs*. long-term contracts. The analyses are conducted on WTI sweet crude-oil futures trading in the NYMEX Pits for the pre-electronification period (January 3rd, 2006 to September 1st, 2006) and on the Globex platform for the post-electronification period (September 5th, 2006 to March 31st, 2007). ***FIN*** is the proportion of trading volume involving the participation of financial traders (traders classified as CTI 2 traders in the CFTC database). ***FIN_Non_FLP*** is the daily weighted average trading-volume share of Non-Fast financial traders, i.e., of institutional financial traders who trade less than 2000 times a day (as in Raman, Robe, and Yadav, 2014). ***FIN_ FLP*** is the daily weighted average trading-volume share of Fast financial traders, i.e., of institutional financial traders who more than 2000 times a day (as in Raman, Robe, and Yadav, 2014). ***Volatility*** is the daily volume-weighted average of 5-minute volatility of (mid-quote) returns estimated for each contract in each maturity interval. ***Volume*** is the daily volume-weighted average of 5-minute trading volume estimated for each contract in each maturity interval. ***Price_Volatility*** is the daily volume-weighted average of 5-minute volatility of intraday (log) transaction for each contract in each maturity interval. ***Customer_Volume*** is the daily weighted average of the proportion of 5-minute trading volume involving customers (traders classified as CTI 4 traders in the CFTC database) on at least one side of a trade. ***PE_Variance*** is the daily pricing error variance, estimated as in Hasbrouck (1993). *PE_Variance_Short-Term* is the daily, volume weighted average of PE_Variance short-term contracts (up to 62 days to expiration). *PE_Variance_Long-Term* is the daily, volume-weighted average of PE_Variance across long-term contracts (more than 62 days to expiration). **Δ*PE_Variance*** is the daily percentage difference between the two: (*PE_Variance_Short-Term – PE_Variance_Long-Term*)/ *PE_Variance_Short-Term*. **Δ*FIN,* Δ*Price_Volatility,* Δ*Volume*** and **Δ*Customer_Volume*** are defined analogously. **Δ*FIN_Non-FLP_Predicted*** is the fitted value of **Δ*FIN_Non-FLP*** obtained from first-stage regressions analogous to Model 2 in Table 5. ***EIA_Inventory*** is a dummy variable equal to 1 during EIA announcement days. ***Lead_Inventory*** is a dummy variable equal to 1 during on the day prior to an EIA announcement day. ***GSCI_Roll*** is a dummy variable equal to 1 on the five business days when the monthly GSCI roll takes place. ***Contract_Exp_Day*** is a dummy variable equal to 1 on the day of the prompt contract's expiration. ***September_2006*** is a dummy variable equal to 1 in the calendar month when electronification took place. ***Day of the Week*** refers to three dummy variables set equal to for Monday, Tuesday, or Friday. Two tailed p-values, obtained using Newey-West standard errors with 5 lags, are also reported.

Parameter	ΔSpread		ΔAmihud		ΔAbsOIB		ΔPE_Variance	
Intercept	0.06	0.923	4.52	0.279	-1.17	<.001	0.40	0.425
ΔFIN_Non_FLP_Predicted	**-6.24**	**<.001**	**-28.21**	**<.001**	**-1.75**	**<.001**	**0.10**	**0.842**
ΔFIN_FLP	-1.24	<.001	1.73	0.085	-0.16	0.107	-0.69	0.002
ΔVolume	-2.72	<.001	-24.68	<.001	-0.57	0.132	-1.01	0.048
ΔCustomer Volume	-0.45	0.333	-5.84	0.014	1.50	<.001	-0.43	0.104
ΔVolatility	0.65	<.001	5.35	<.001	0.03	0.595		
ΔPrice Volatility							1.25	<.001
EIA_Inventory	0.53	0.010	1.68	0.056	-0.03	0.746	-0.04	0.750
Lead_Inventory	0.07	0.655	-0.56	0.482	-0.09	0.261	0.22	0.070
GSCI_Roll	0.98	<.0001	2.00	0.042	0.27	<.001	0.18	0.041
Contract_Exp_Day	-0.43	0.054	-4.51	0.001	-0.42	<.001	-0.08	0.555
September,2006	-0.55	0.321	3.92	0.030	0.34	0.034	-0.14	0.666
Dependent Lags	2		2		2		2	
Day of the Week	YES		YES		YES		YES	
N	299		299		299		300	
Adj RSq	76.66%		45.10%		30.21%		42.27%	