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Small Is Beautiful? How the Introduction of Mini Futures Contracts Affects the Regular Contract

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Small Is Beautiful? How the Introduction of Mini Futures Contracts Affects the Regular Contract*

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Abstract

We analyze how the introduction of a mini futures contract affects the liquidity of the regular contract. We use a panel data set that covers more than 20 years and more than 20 contracts. We use a traditional difference-in-differences methodology as well as a synthetic control group approach (Abadie and Gardeazabal (2003), Abadie, Diamond and Hainmueller (2015)). We find that the liquidity of the regular contracts increases and the volatility decreases upon the introduction of a mini futures contract when the regular contract is traded electronically whereas the reverse is true when it is floor-traded. While total trading volume increases upon the introduction of the mini contract, the volume of the regular contracts does not change significantly. Overall, our results imply that the introduction of mini futures contracts is beneficial. They also confirm the superiority of electronic trading over floor-based trading.

JEL classification: G10, G15

Key words: Stock index futures, Mini futures, Liquidity, Market quality

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1 Introduction

In September 1997 the Chicago Mercantile Exchange (CME) introduced the S&P E-mini futures contract. The new contract was identical to the regular S&P 500 futures contract with two exceptions. First, the E-mini futures is a smaller-sized contract because it is valued at only 50 times the level of the S&P 500 index (as opposed to 250 times for the regular futures). Second, the E-mini futures is traded on the electronic Globex system while the regular futures contract, in 1997, was traded in an open outcry market. The E-mini futures was highly successful. The average daily dollar volume surpassed that of the regular contract in 2002 and it became the most heavily traded futures contract on the CME. Subsequently other derivatives exchanges also introduced mini futures contracts. However, not all of these introductions have been as successful as the S&P 500 E-mini contract.

In this paper we analyze how the introduction of a mini futures contract affects the trading activity, liquidity and volatility of the regular contract. This is an important question for several reasons. First, the revenue of derivatives exchanges depends on execution fees generated by the new mini futures contracts and on the changes in the fees generated by the regular contracts. The fee revenue, in turn, depends on the number and size of the trades. Second, investors are obviously interested in the liquidity of the contracts they trade. If the liquidity of both the regular and the mini contract after the introduction of the latter are lower than the pre-introduction liquidity of the regular contract, investors may be worse off after the introduction of the mini futures. Finally, the question of how the menu of available derivatives on the same underlying affects market quality should be of interest to exchange operators, market participants and regulators.

Our analysis also sheds light on the more general question of how fragmentation of trading affects liquidity. This question has been analyzed extensively in the context of competition between trading venues that trade identical assets. In this setting there is a trade-off. According to the liquidity externality hypothesis one consolidated market should be most liquid. On the other hand, competition between several trading venues may eliminate rents earned by a monopolist venue, spur efficiency and innovation, and may ultimately lead to higher liquidity.[1] The setting we analyze is different in that we do not analyze identical instruments traded on different venues but rather (almost) identical instruments traded on the same venue. In this setting the pressure exerted by a competing venue operator is absent.

Previous papers (to be surveyed briefly in section 2) have only considered individual contracts but

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[1] Gomber, Sagade, Theissen, Weber and Westheide (2017) provide a survey of the literature on fragmentation.

have not analyzed an international data set. In contrast, we compile an international panel data set spanning more than 23 years and comprising 30 regular stock index futures contracts and 21 mini contracts, all of which were launched during our sample period. The scope of our data set allows us to exploit the cross-sectional variation in the data. We conduct a difference-in-differences analysis and also apply the synthetic control group approach proposed by Abadie and Gardeazabal (2003) and Abadie, Diamond and Hainmueller (2010). A drawback of using such an extensive data set is that intraday data is unavailable. Our analysis is, therefore, based on daily data.

Our results indicate that, on average, the introduction of a mini futures contract does not significantly affect the trading volume of the regular contract, but does reduce the bid-ask spread and the return volatility of the regular contract. A more disaggregated analysis yields more differentiated results. The mini futures introductions in our sample can be categorized into two groups. While all mini futures were traded electronically right from the start, the regular contract was floor-traded at the time of the launch of the mini contract in some cases and was traded electronically in other cases. We find that in those cases where the regular contract is traded electronically, its bid-ask spread and volatility decrease. In contrast, when the regular contract is floor-traded, its bid-ask spread increases.

Our results have important implications. First, they imply that exchange revenue can be expected to increase upon introduction of a mini futures contract. Second, they imply that market quality improves. Thus, the introduction of a mini contract is beneficial to exchange operators and investors alike. Finally, the results indicate a revealed preference of investors for electronic trading over traditional open outcry floor trading.

The remainder of the paper is organized as follows. In section 2 we provide a brief survey of the relevant literature and discuss alternative hypotheses on the implications of introducing a mini contract. Section 3 describes data and methodology. The results are presented in section 4, section 5 concludes.

2 Literature and Hypotheses

Theoretical research on the optimal contract menu chosen by a derivatives exchange is scant. Duffie and Jackson (1989) develop a formal model to show that a volume-maximizing exchange would design additional contracts such that they maximize the residual hedging benefit, i.e. they allow to hedge the portion of the risk that is not spanned by the existing futures contracts. The mini futures contracts we analyze obviously do not satisfy this condition because they are perfectly correlated with the regular contracts and thus provide no residual hedging benefits beyond their better scalability. However, Smales (2016) finds that traders react differently to stimuli such as past returns in the regular and E-mini S&P 500 contract. This result is consistent with these contracts catering to the needs of different investor groups. Lazarov and Koch (2007) analyze how the trading volume of index options is distributed across options with different strike prices. While this question is similar to the issue we address, there are two important differences. First, and most importantly, Lazarov and Koch (2007) do not analyze how the introduction of new strike prices affects liquidity and trading volume of the existing contracts. Second, while options with different strike prices are close substitutes to each other, they are not identical.[2]

Silber (1981) argues that additional futures contracts may result in fragmentation and, consequently, a reduction in trading volume and liquidity, a concern also raised by Huang and Stoll (1998). However, Silber (1981) also points out that arbitrage may restore the impaired liquidity. There is thus no unambiguous prediction as to the effect on the liquidity of the regular contract of the introduction of a mini contract. The existing empirical results are also ambiguous. Ates and Wang (2004) analyze the introduction of the S&P 500 and Nasdaq 100 mini futures contracts and conclude that there were no significant effects on the trading volume and bid-ask spreads of the regular contracts. Garcia and McMillan (2008) provide evidence that the volume of the Spanish IBEX-35 futures contract decreased upon introduction of a mini contracts (but do not perform formal statistical tests). Given these ambiguities we formulate two competing hypotheses.

Hypothesis 1a: The trading volume and liquidity of the regular contract decrease upon the introduction of a mini contract.

Hypothesis 1b: The trading volume and liquidity of the regular contract increase upon the introduction of a mini contract.

Hypothesis 1 is only concerned with the trading volume of the regular contract. While this is an important topic in itself, it is not necessarily the objective of the exchange to maximize the volume of the regular contract. The exchange may rather maximize total volume. A mini futures contract will then only be introduced when the exchange expects the joint post-introduction volume of both contracts to exceed the pre-introduction volume of the regular contract. This leads to the following hypothesis.

Hypothesis 2: The joint trading volume of the regular and the mini contract is higher than the

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[2] For example, certain trading strategies such as bull and bear spreads require the existence of options on the same underlying with different strikes.

volume of the regular contract before the introduction of the mini contract.

As noted previously, all mini futures contracts were traded electronically right from the start. Some of the regular contracts, on the other hand, were still floor-traded at the time when the respective mini contracts were introduced. Electronic trading is more cost-efficient and allows traders to access the market without establishing a physical presence (e.g. Domowitz and Steil (1999)). We therefore expect that the liquidity of floor-traded regular contracts will be more negatively affected by the introduction of a mini contract as compared to screen-traded regular contracts. We thus have

Hypothesis 3: The trading volume and liquidity of floor-traded regular contracts are more negatively affected by the introduction of a mini contract than the trading volume and liquidity of screen-traded regular contracts.

Several papers have analyzed how the introduction of a futures contract affects the volatility of the spot market (e.g. Bessembinder and Seguin (1992), Galloway and Miller (1997), Gulen and Mayhew (2000), Faff and McKenzie (2002), Xie and Mo (2014)). The evidence suggests that volatility is, if anything, lower after the introduction of a futures contract. While the introduction of a second, smaller-sized futures contract is qualitatively different from the introduction of the first futures contract, the aforementioned results might still carry over, suggesting a reduction in the volatility of the regular contract after the introduction of a mini contract. However, Tu and Wang (2007) find that the introduction of the E-mini futures contract on the S&P 500 *increased* the volatility of S&P 500 futures. In a similar vein, McMillan and Garcia (2008) find that the introduction of a mini-contract in Spain resulted in less efficient price discovery and a longer memory in the volatility process. Given these ambiguous results we once again formulate two competing hypotheses.

Hypothesis 4a: The volatility of the regular contract decreases upon the introduction of a mini contract.

Hypothesis 4b: The volatility of the regular contract increases upon the introduction of a mini contract.

3 Data and Methodology

3.1 Data

For this study we construct a panel data set of regular and mini stock index futures covering a broad set of global equity indices. To focus on the most liquid instruments we limit the sample to contracts which are traded in the denominated currency of the underlying index. Moreover, we discard index futures with an average trading volume of less than 1,000 contracts per day and more than 10% of trading days with zero volume over the entire sample period, or for at least three consecutive years. We end up with 30 regular and 21 mini futures in total. Appendix A provides a full list of included contracts. The sample period ranges from January 1, 1994, three years prior to the launch of the first mini futures, to August 31, 2017. For this period we collect daily information on settlement, high and low prices (in domestic currency and USD), and the number of traded contracts from Datastream. For each futures contract we construct a continuous price series based on a standard rollover strategy (e.g. Smales, 2016). We take prices of the contract with the closest maturity and switch to the second-nearest contract on the first trading day of the delivery month.

While we collect our data at the daily frequency we aggregate it to the monthly level for our main difference-in-differences analysis. We have re-estimated all specifications with a daily panel and obtained consistent results. We compute three measures of market quality, trading volume, bid-ask spread, and price volatility. Trading volume is measured by the average daily number of traded contracts in a given month. Because we do not have access to data on bid and ask quotes we resort to low-frequency estimators of the bid-ask spread. Based on the current literature on the subject (Marshall, Nguyen and Visaltanachoti, 2012; Abdi and Ranaldo, 2017; Fong, Holden and Trzcinka, 2017; Johann and Theissen, 2019), we select proxies which have been shown to perform well in matching the level and the time-series characteristics of the effective bid-ask spread. In particular, we compute for each month of the sample period the effective tick estimator of Holden (2009), the high-low estimator of Corwin and Schultz (2012), the high-low-close estimator of Abdi and Ranaldo (2017), and the constant percent quoted spread cost volatility-over-volume measure, $VoV(\%Spread)$, used in Fong, Holden and Tobek (2018). These estimators are conceptually very different and may therefore capture different aspects of liquidity. We therefore follow Johann and Theissen (2019) and additionally construct a composite spread estimator. We extract the first principal component of the low-frequency estimators and then calculate a weighted average of the estimators where the weights are the loadings of the estimators on the first principal component. Details on the calculation of the spread estimators are provided in Appendix B.[3] Finally, we calculate measures of monthly return volatility using the sum of squared daily returns and the high-low estimator of Parkinson (1980).

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[3] When calculating the trading volume we take into account changes in the contract multiplier. For example, the multiplier of the S&P 500 futures contract was reduced from 500 to 250 in 1997. We take this into account by multiplying by 2 the pre-change trading volume. Calculation of the effective tick estimator of the bid-ask spread depends on the minimum tick size of the contract. We track changes in the minimum tick size and adjust the estimator accordingly.

The trading volume and liquidity of a contract may depend on whether the contract is traded electronically or on a trading floor. We therefore collect information on the trading environment for each contract. While there is variation among the regular contracts (i.e. some are floor-traded while others are traded electronically), all mini futures contracts are traded electronically right from the inception of the contract.

3.2 Difference-in-Differences

The main results of this paper are based on a difference-in-differences approach. This setup enables us to exploit the staggered introduction of mini futures over time to identify their effect on the liquidity of an existing contract. The following equation shows our baseline specification.

$$Y_{i,t} = \alpha + \boldsymbol{\beta} \cdot \boldsymbol{Mini} + \gamma_i X_{i,t-1} + FE + \epsilon_{i,t} \tag{1}$$

where $Y_{i,t}$ is one of our measures of market quality. $Mini$ is the primary variable of interest. It is a dummy equal to one for contract i in the months after the introduction of a corresponding mini futures, and zero otherwise. $X_{i,t-1}$ is a vector of controls. Note that we do not include separate dummies for treated futures and post-treatment periods because we control for contract and time fixed effects. Furthermore, we follow Chou, Wang and Wang (2015) and include only lagged variables as controls to account for a potential simultaneity bias when estimating the parameters with OLS.[4] The choice of controls in the baseline specification follows Wang and Yau (2000). In particular, we control for lagged values of (1) trading volume, the composite spread estimator, price volatility, and the lagged change in open interest (measured by the number of open contracts at the end of the month) when the dependent variable is the trading volume; (2) lagged values of the composite spread, trading volume, price volatility and the lagged change in settlement price when the dependent variable is the composite spread; (3) lagged values of price volatility, trading volume, and the composite spread when the dependent variable is price volatility. Analogous to other studies (e.g. Wang and Yau (2000), Ates and Wang (2004)), we take first differences instead of levels for open interest and settlement prices to avoid spurious correlation between the variables due to a unit root in those time series, as indicated by an augmented Dickey-Fuller test.

In a second version of equation (1), we augment our baseline specification with dummy variables.

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[4] A simultaneity bias may arise due to the fact that trading volume, bid-ask spread, and price volatility are jointly determined (see Wang and Yau, 2000).

The first dummy variable is set to one if the observation is taken from the expiration month of the contract. The second dummy is set to one if an ETF is traded on the same equity index on which the futures contract is written. The third dummy variable is set to one if the regular contract is traded electronically during regular trading hours (either exclusively or side-by-side with floor trading), and zero if it is exclusively floor-traded during regular trading hours. Moreover, we add a categorical variable to capture differences in the ownership status of the exchange (0: non-private, 1: private, 2: private and exchange-listed).[5]

Next, we introduce another variation of the baseline equation with respect to the time periods before and after the mini futures introduction. For this, we split up the DiD coefficient into pre- and post-treatment dummies to shed some more light on potential pre-treatment trends as well as short- and long-term effects due to the launch of the mini futures:

$$Y_{i,t} = \alpha + \sum_{s=-3}^{3} \boldsymbol{\beta_s \cdot Mini_{sY}} + \boldsymbol{\beta_7 \cdot Mini_{>3Y}} + \gamma_i X_{i,t-1} + FE + \epsilon_{i,t} \tag{2}$$

where $Mini_{sY}$ are dummy variables to represent separate leads and lags for one, two and three years relative to the introduction of a mini futures corresponding to contract i. The dummy variable $Mini_{>3Y}$ takes a value of one when the mini futures was introduced more than three years ago, and zero otherwise. We include the same controls as in the augmented baseline specification.

Finally, we split up our binary treatment indicator, $Mini$, according to whether trading in the regular futures during normal trading hours is exclusively floor-based or not. Since, as noted previously, all mini futures are exclusively screen-traded, we thereby test if a different trading environment of the regular contract affects the treatment effect (i.e. the effect of the introduction of the mini contract):

$$Y_{i,t} = \alpha + \boldsymbol{\beta_1 \cdot Mini_{Electronic}} + \boldsymbol{\beta_2 \cdot Mini_{Floor}} + \gamma_i X_{i,t-1} + FE + \epsilon_{i,t} \tag{3}$$

where $Mini_{Electronic}$ is equal to one for contract i in the months after the introduction of a corresponding mini futures, conditional on contract i being traded on an electronic platform during regular trading hours in month t (either exclusively or side-by-side). $Mini_{Floor}$ is defined analogously but conditional on contract i being exclusively floor-traded during regular trading hours in month t. $X_{i,t-1}$ includes the same controls as in the augmented baseline specification.

Besides the effects on the liquidity of the regular contract, an exchange might also be interested in

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[5] Our model contains contract fixed effects. Therefore, identification of the coefficients on the dummy variables is based on those contracts that experienced a change in the respective characteristic.

the consequences of a mini futures introduction in terms of overall trading activity. For this reason, we also analyze combined trading volume, that is, the sum of trading activity in both contracts. We measure trading activity by the number of contracts but adjust the figures for the mini contracts to account for the different contract multipliers. We estimate a model that is similar to our augmented baseline specification, but now we control for combined open interest, combined composite spread and combined price volatility. Combined spread and volatility are weighted averages of the regular and mini futures' spread and volatility, with weights reflecting the relative trading volume in the month under consideration.

In all cases, we estimate the parameters using ordinary least squares. Standard errors are robust to heteroskedasticity and clustered at the quarterly level.[6]

3.3 Synthetic Control Group Approach

A central assumption of the difference-in-differences setup is that treated and control units would have followed similar paths absent the treatment. The (in)significance of the pre-treatment dummies in equation (2) is an indication, though not a direct test, that the parallel trends assumption holds. An alternative way to address this issue is the synthetic control group method proposed by Abadie and Gardeazabal (2003) and Abadie et al. (2010). They match treated and control units on pre-intervention outcome and use a weighted combination of control group elements to mimic the pre-treatment path of the treated unit. As shown by the authors, the matching helps to control for observed and unobserved heterogeneity between the two groups and should lead to an improved estimate of the unknown counterfactual, in line with the parallel trends assumption. Importantly, this method is suitable for samples with a limited number of treated and control units, as evident in the work of Abadie and Gardeazabal (2003) and Abadie et al. (2010). With a staggered treatment of 21 futures and a cross-section of only 30 regular futures, the synthetic control method gives us a valid alternative to evaluate the impact of a mini futures on the liquidity of the regular contract during a specified event window. In particular, we estimate three alternative specifications with post-event windows of 1, 3 and 5 years.

To implement the synthetic control group method we first need to define a donor pool of potential

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[6] In unreported results, we alternatively employ panel-corrected standard errors (Beck and Katz, 1995) to control for panel heteroscedasticity, contemporaneous cross-unit correlation and serial correlation. Importantly, this type of standard errors is often used in the context of time-series cross-section data and takes into account the small N, large T nature of our sample (with a maximum of 30 cross-sectional units, but several years of data for each unit). The main results remain unchanged.

controls for each mini futures introduction. For each event, we limit this pool to all regular contracts without a mini futures introduction in the next 1 year, 3 years, or 5 years relative to the event month. We refine the control group by dropping futures which start trading within the pre-event period, stop trading before the end of the event window, or have missing values for the variable of interest within the event window. We then calculate the weights of the synthetic control group by minimizing the mean squared prediction error between a vector of characteristics of treated futures and control group elements in a pre-treatment window of three years. The characteristics we match upon are the average daily number of contracts traded, the composite spread estimator, and price volatility based on the high-low estimator.[7] With the weights in place, we compute the average difference in the dependent variable of the treated futures and its synthetic counterfactual in the post-intervention period. Like Acemoglu, Johnson, Kermani, Kwak and Mitton (2016), we then aggregate the individual treatment effects TE_i to an average treatment effect as follows:

$$ATE = \sum_i \frac{TE_i}{RMSPE_i} / \sum_i \frac{1}{RMSPE_i} \tag{4}$$

where $RMSPE_i$ is the pre-treatment root mean squared prediction error for each event.

To test the statistical significance of the treatment effect, we conduct 'in-time' placebo tests, as suggested by Abadie et al. (2015). For each treated futures, we assign the launch of its mini futures to placebo months, that is, months in which it was not actually launched. To avoid an overlap with the true event, we restrict this exercise to all months within the sample period, which are at least 5 years, 3 years, or 1 year prior to the true introduction of the mini futures (depending on the chosen post-event window). Also, all placebo months need to allow for a long enough pre- and post-treatment window. Next, we conduct the synthetic control group method for all placebo events of a certain contract. We then randomly draw one placebo effect for each futures to get an equally large sample as in the original case and aggregate the individual treatment effects as described above. We repeat this procedure 1,000 times to compute confidence intervals for our average treatment effect. The comparison between the treatment effect based on the real introduction months and the distribution of placebo effects allows us to assess the significance of the synthetic control group estimates.

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[7] We match upon trends when the outcome variable is the daily number of contracts traded by normalizing the characteristics to unity in the month of the treatment. This ensures that the treatment effect is not driven by different levels of trading volume for the treated unit and its synthetic control. For the composite spread estimator and price volatility, we achieve a better match quality when we use the untransformed instead of the normalized variables.

4 Results

4.1 Descriptive Statistics

Table 1 shows descriptive statistics for our market quality measures. On average over all contracts the daily trading volume amounts to 76,730 contracts, corresponding to 5.00 billion US dollar. The distribution of trading volume has very high standard deviation and is heavily skewed.

The four spread estimators yield different conclusions on the average size of the spread. The estimates range from 0.039 (effective tick estimator) to 0.505 (Abdi and Ranaldo's measure). However, what matters for our regression analysis is whether these measures capture the time-series variation in the effective spread, not whether they provide accurate estimates of the spread level.

The two volatility measures yield roughly consistent estimates of 1.11% (Parkinson estimator) and 1.38% (squared returns).

[Insert Table 1 about here.]

Table 2 presents descriptive statistics for each year of the sample period. In 1994 our sample comprises 16 regular futures contracts. This number increases over the following years, reaching its maximum level of 30 contracts in 2005. In 2015, the regular contracts on the Nasdaq 100 and the Dow Jones Industrial Index were discontinued. Consequently, the number of regular contracts in our sample drops to 28. The first mini contract, the S&P 500 mini, was launched in 1997. Subsequently the number of mini contracts increases steadily and reaches its maximum in 2015. Three mini contracts were discontinued, the FTSE 100 in 2003, the CNX Nifty in 2014 and the VIX in 2015.

The average trading volume in US dollars has roughly doubled between 1994 and 2017. It peaked during the crisis years of 2007 and 2008. Volatility does not exhibit a clear trend. Unsurprisingly, it reached its highest levels in 2008 and 2009.

We use the yearly averages of the spread estimators to calculate their correlations (not tabulated). The effective tick estimator is essentially uncorrelated with the three other estimators, with correlations ranging from -0.07 to 0.04. The three other measures are significantly positively correlated with each other. Correlations range from 0.60 (Corwin/Schultz and Fong et al.) to 0.96 (Corwin/Schultz and Abdi/Ranaldo).

[Insert Table 2 about here.]

Table 3 presents a comparison between regular and mini contracts. It is based on a sample that only comprises contract-months in which a regular and a mini contract on the same underlying index co-existed. Trading volume in terms of the number of contracts is significantly higher for the mini contracts. This is partly a consequence of the lower contract multiplier. However, the dollar trading volume is also higher for the mini contracts. The liquidity estimators yield inconclusive results. Two of the estimators indicate higher spreads for the mini contract while the other two estimators yield the opposite conclusion. The composite spread estimator displays almost identical values for regular and mini contracts (0.141% as compared to 0.139%) with a t-statistic below 1. Results for volatility are also ambiguous. While the Parkinson estimator indicates slightly but significantly lower volatility for the mini contracts (1.09% as compared to 1.14%), the squared return estimators for the two contract types are not significantly different from each other.

[Insert Table 3 about here.]

4.2 Difference-in-Differences Analysis

We start by analyzing how the introduction of a mini contract affects the trading volume (measured by the number of contracts) of the regular contract. The results are shown in Table 4. The coefficient on the mini dummy[8] in our base model is insignificant, implying that the introduction of a mini contract does not affect the trading volume of the regular contracts. The coefficients on the control variables indicate that trading volume is highly serially correlated. Volume is positively related to the composite spread estimator and to the lagged change in open interest and the T-bill rate. It is negatively related to lagged volatility.

The second model includes further control variables. The results are fully consistent with those of the first model. The coefficients on the additional control variables indicate that trading volume is significantly higher when an ETF on the underlying index is traded, when the regular contract is traded electronically, and is also significantly higher in the expiration month of the contract. The ownership structure of the exchange does not affect the trading volume. Model 3 tracks the impact of the introduction of a mini contract on the trading volume of the regular contract over individual years before and after the introduction of the mini contract. The only significant effect is found more than three years after the launch of the mini contract. The insignificant coefficients in the pre-launch period are supportive of the parallel trends assumption.

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[8] Remember that all our regression models include contract and time fixed effects. Therefore we include neither treatment dummies nor post-dummies.

In model 4 we split the mini variable in order to obtain separate estimates for cases in which both regular and mini contracts are traded electronically and those cases in which the regular contract is floor-traded. While the first coefficient is significantly positive, the second one is significantly negative. Thus, when both the regular and the mini contract are traded electronically, the introduction of the mini contract results in an *increase* in the trading volume of the regular contract. A potential reason may be arbitrage trades, possibly by high frequency traders. On the other hand, when the regular contract is floor-traded the introduction of a (screen-traded) mini contract reduces its volume, possibly because traders prefer electronic trading because of its speed and efficiency.

In conclusion, the introduction of a mini contract does not affect the trading volume of the regular contract *on average*. The picture changes when the trading protocol of the regular contract is taken into account. When the contract is traded electronically [on the floor], its trading volume increases [decreases] upon the introduction of a mini contract.[9]

[Insert Table 4 about here.]

Exchange operators may also be interested in the total trading volume, i.e. the joint trading volume of the regular and the mini contract. We therefore reestimated all four models using the total trading volume, again measured by the number of contracts, as dependent variable. The results are shown in Table 5. Given the result, presented above, that the volume of the regular contract is unaffected by the introduction of the mini contract, it comes as no surprise that the *combined* trading volume increases. What is more surprising is the result of model 4. The combined volume increases both in the case where the regular contract is traded electronically and in the case where it is floor-traded. However, the increase is more pronounced in the latter case. Thus, it appears to be the case that the newly introduced mini contract attracts more volume when the regular contract is floor-traded. This finding adds to the evidence that traders have a revealed preference for electronic trading.

[Insert Table 5 about here.]

We next analyze the implications for the bid-ask spread of the regular contract of the introduction of a mini contract. We use the composite estimator introduced in section 3.1 to estimate the spread.[10] The results are presented in Table 6. Models 1 and 2 both suggest that the spreads of the regular

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[9] Remember that all mini contracts in our sample are traded electronically. We are therefore unable to analyze whether what matters is *electronic* trading of both contracts or trading of both contracts in the *same* environment.

[10] We have reestimated all models using the four individual spread estimators instead. Two of them (the high-low estimator and the volatility-over-volume estimator) yield results which are very similar to those reported in the text while the two other estimators yield insignificant results. Even in those cases the sign of the main effect is negative.

contract decrease significantly (at the 1% level) upon the introduction of the mini contract. The coefficients on the control variables imply that the bid-ask spread is significantly positively serially correlated, that the spread is positively related to lagged volume and volatility, and that it is inversely related to the change in the settlement price. The latter finding is consistent with the well established result that liquidity decreases after price declines (e.g. Hameed, Kang and Viswanathan (2010)). The results of model 2 imply that spreads are lower for contracts traded electronically, and are lower in the expiration months, possibly because the rollover activity results in a surge of uninformed trading. Somewhat surprisingly (but consistent in models 2, 3 and 4) we find that spreads are higher when the exchange is itself a listed corporation. The existence of an ETF on the underlying index of the futures contract has a positive impact on the spread which is (marginally) insignificant in model 2 but is significant in models 3 and 4.

Model 3 tracks the evolution of the spread across individual years around the launch of the mini contract. All coefficients are negative, but only one of the pre-launch coefficients is significant at the 10% level. In the launch year and the year after, the reduction in the spread of the regular contract is much larger and significant at the 1% level. Thus, model 3 confirms the result of models 1 and 2 that spreads of the regular contract decrease upon the introduction of the mini contract.

Model 4 provides separate estimates for regular contracts traded electronically and on the floor, respectively. Consistent with the result for trading volume discussed above we find that spreads decrease significantly upon the introduction of a mini contract when the regular contract is traded electronically, but actually increase when the regular contract is floor-traded.

[Insert Table 6 about here.]

Our final measure of market quality is return volatility (measured by the Parkinson (1980) high-low estimator[11]). The results, shown in Table 7, imply that volatility decreases significantly (at the 1% level) upon the introduction of the mini contract. The coefficients on the control variables are consistent across all model specifications and indicate that volatility is positively serially correlated and is positively related to lagged spreads and trading volume. Volatility is lower for contracts that are traded electronically, is lower during the expiration month, and is higher when an ETF on the underlying index exists. Model 3 suggests that before the launch of the mini contract there are no volatility differences between those regular contracts that are augmented by a mini contract and those

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[11] Using the volatility estimator based on squared returns instead yields similar results but slightly lower levels of significance.

that are not. This is again supportive of the parallel trends assumption. In the years after the launch the coefficient turns negative. It marginally fails to be significant (t-statistic 1.60) in year 1 and is significant thereafter. Model 4 illustrates that the reduction in volatility is entirely driven by those regular contracts that are traded electronically. The diff-in-diff coefficient for the floor-traded contracts is positive (but insignificant).

[Insert Table 7 about here.]

4.3 Synthetic Control Group

As laid out in section 3.3 the synthetic control group approach provides an alternative test of the impact on the regular futures contract of the introduction of a mini contract. Rather than using all non-treated contracts as control groups it constructs a synthetic control group which is a linear combination of the contracts in a pre-specified donor pool. This linear combination is determined such that the synthetic control group matches the pre-treatment path of the treated contracts as closely as possible. A characteristic of the methodology is that it provides an estimate of the treatment effect but does not deliver coefficients for the control variables. These variables are only used in the matching process.

The results of the difference-in-differences analysis presented in the previous section demonstrated that there are important differences between those regular contracts that are screen-traded and those that are floor-traded. We therefore estimate three versions of the model, one in which we consider all treated regular contracts, one in which we only consider floor-traded contracts and one in which we only consider screen-traded contracts. The results are shown in Table 8. As noted previously, we choose three different event windows (1, 3 and 5 years) and define the donor pool for the construction of the synthetic control group accordingly. Specifically, we select into the donor pool the regular contracts without introduction of a mini contract in the next 1 year (results shown in Panel A of Table 8), 3 years (Panel B) and 5 years (Panel C).

The coefficient for the trading volume is always negative but never significant. Thus, and in contrast to the results presented in the previous section, the introduction of a mini contract apparently has no significant impact on the trading volume of the regular contract.[12] The results for the bid-ask spread are insignificant when we consider all treated contracts jointly. However, when we consider

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[12] We note that the synthetic control group approach has the worst fit (in terms of the pre-treatment behavior of the synthetic control group relative to that of the treatment group) in the analysis of trading volume. The fit is much better in the spread and volatility analyses.

only floor-traded and only screen-traded contracts we find results that are fully consistent with those reported in section 4.2. The bid-ask spread of screen-traded regular contracts decreases significantly upon the introduction of a mini contract while the bid-ask spreads of floor-traded regular contracts increase significantly.

The results for volatility are also largely consistent with those of the simple difference-in-differences analysis presented in the previous section. The overall impact on volatility of the introduction of a mini contract is negative, but is significant only when we consider a 5-year event window (Panel C). The results in columns 2 and 3 provide an explanation for the weak overall result. The volatility of floor-traded regular contracts increases significantly upon the introduction of a mini contract while the volatility of screen-traded regular contracts decreases significantly. In column 1 the positive and negative effects partially cancel out, yielding a small (and sometimes insignificant) overall effect.

[Insert Table 8 about here.]

5 Conclusion

In this paper we analyze how the introduction of a mini futures contract affects the trading activity, liquidity and volatility of the regular contract. We compile a dataset that covers 30 regular and 21 mini contracts. We perform a difference-in-differences analysis using both standard methodology and the synthetic control group approach pioneered by Abadie and Gardeazabal (2003) and Abadie et al. (2015).

Our results imply that the introduction of a mini contract does not significantly affect the trading volume of the regular contract on average while the combined trading volume of both contracts increases. Consequently, the mini contract does not "cannibalize" the regular contract but rather results in higher overall trading volume and, consequently, in higher fee revenue for the exchange.

We further find that the spreads of regular contracts increase after the introduction of a mini contract when the regular contract is floor-traded but decrease when the regular contract is screen-traded. This finding is mirrored in the results for volatility. The volatility of floor-traded regular contracts increases upon the introduction of a mini contract while the volatility of screen-traded regular contracts decreases. A potential explanation for these findings is that arbitrage between two screen-traded contracts keeps prices in the two markets aligned, thus resulting in lower volatility, and keeps spreads low.[13]

Overall our results imply that increased fragmentation of liquidity is not necessarily harmful to market quality. In fact, when all instruments are screen-traded, market quality is higher in the more fragmented setting after the introduction of a mini contract. By implication, our results also indicate that screen trading is superior to floor trading in terms of liquidity and volatility.

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[13] Remember that all mini contracts in our sample are screen-traded.

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6 Tables

Table 1:
Descriptive Statistics - Main Variables

This table provides summary statistics for the main variables used in the subsequent analysis. For the sample period between January 1994 and August 2017, we report the number of monthly observations, mean, median, and standard deviation as well as 5%, 25%, 75% and 95% percentiles. The first two lines contain statistics for the daily number of contracts traded and daily dollar volume. Line 3-7 are low-frequency spread estimators, where *Composite Spread* is a combination of the four proxies above, weighted by the respective first principal component. For details on the calculation of the spread estimators, we refer to Appendix B. The last two lines report measures of price volatility based on the high-low estimator of Parkinson (1980) and squared daily returns. The unit of measurement is given in brackets.

	N	**Mean**	**Median**	**SD**	**5%**	**25%**	**75%**	**95%**
# Contracts Traded ($\times 10^3$)	7387	76.73	23.82	199.04	0.66	7.56	73.12	227.69
Dollar Volume ($\times 10^6$)	7387	5000.38	1642.09	10275.92	10.83	200.36	4531.54	25841.54
Effective Tick (in %)	7387	0.039	0.023	0.065	0.005	0.012	0.045	0.108
Corwin-Schultz (in %)	7172	0.330	0.267	0.264	0.066	0.170	0.403	0.824
Abdi-Ranaldo (in %)	7172	0.505	0.408	0.388	0.163	0.281	0.605	1.161
VoV(%Spread) (in %)	7171	0.053	0.032	0.070	0.011	0.020	0.059	0.162
Composite Spread (in %)	7384	0.154	0.124	0.127	0.055	0.092	0.175	0.346
Price Volatility-Parkinson (in %)	7172	1.11	0.91	1.34	0.43	0.65	1.28	2.44
Price Volatility-Squared Returns (in %)	7387	1.38	1.13	1.08	0.54	0.82	1.61	3.04

Table 2:
Descriptive Statistics & Mini Futures - Annual Breakup

For the sample period between January 1994 and August 2017, this table (Column 2-10) displays mean values of the main variables of interest for each year. *VM* and *DVM* are the daily number of traded contracts and daily dollar volume, respectively. *EffTick, Corwin, Abdi, VoV* and *Composite* are low-frequency spread estimators as detailed in Appendix B. *VolaPark* and *VolaRet* are measures of price volatility based on the high-low estimator of Parkinson (1980) and squared daily returns. The units of measurement are the same as specified in Table 1. Column 11 and 12 depict the number of regular and mini futures at the end of each year of the sample period. The last two columns contains a timeline of the introduction and suspension of stock index mini futures. Column 13 holds the index name and country (in brackets) for which a new mini futures is introduced. Column 14 displays the index name and country (in brackets) for which a mini futures is suspended.

Year	**VM**	**DVM**	**EffTick**	**Corwin**	**Abdi**	**VoV**	**Composite**	**VolaPark**	**VolaRet**	**Regular Futures**	**Mini Futures**	**New Mini**	**Suspended Mini**
1994	22.21	3225.42	0.103	0.302	0.489	0.050	0.209	1.04	1.42	16	0	-	-
1995	22.65	3521.97	0.060	0.273	0.383	0.045	0.154	0.93	1.15	17	0	-	-
1996	21.46	4017.84	0.051	0.204	0.325	0.042	0.122	0.72	0.94	18	0	-	-
1997	22.74	4501.31	0.048	0.326	0.536	0.058	0.172	1.19	1.89	19	1	S&P 500 (US)	-
1998	21.97	3015.37	0.046	0.401	0.732	0.067	0.204	1.46	1.94	21	1	-	-
1999	23.36	3103.72	0.045	0.365	0.527	0.057	0.172	1.17	1.47	25	2	Nasdaq 100 (US)	-
2000	20.61	2787.93	0.036	0.346	0.573	0.080	0.169	1.25	1.61	27	5	Hang Seng (HK), FTSE MIB (IT), FTSE 100 (UK)	-
2001	27.48	2471.58	0.037	0.367	0.592	0.073	0.179	1.26	1.59	27	7	IBEX 35 (ES), TAIEX (TW)	-
2002	38.11	2444.92	0.041	0.365	0.585	0.069	0.176	1.22	1.57	27	7	-	-
2003	50.67	2604.60	0.038	0.313	0.455	0.054	0.148	0.99	1.27	27	7	Dow Jones (US)	FTSE 100 (UK)
2004	56.86	3046.62	0.034	0.243	0.374	0.057	0.121	1.09	1.01	28	7	-	-
2005	61.91	3582.14	0.031	0.193	0.289	0.043	0.101	0.66	0.85	30	8	Bovespa (BR)	-
2006	85.74	5502.52	0.026	0.244	0.389	0.042	0.116	0.85	1.17	30	9	OSX Nikkei 225 (JP)	-
2007	112.34	8790.06	0.022	0.273	0.453	0.040	0.124	1.01	1.26	30	10	SGX Nikkei 225 (SG)	-
2008	135.70	8320.92	0.029	0.547	0.913	0.061	0.220	1.87	2.39	30	13	CNX Nifty (IN), FTSE/JSE 40 (ZA), TOPIX (JP)	-
2009	113.03	5057.90	0.037	0.457	0.676	0.061	0.197	1.46	1.76	30	14	VIX (US)	-
2010	113.14	5936.06	0.033	0.335	0.469	0.047	0.146	1.10	1.31	30	14	-	-
2011	120.58	6519.53	0.037	0.386	0.562	0.052	0.166	1.35	1.54	30	15	S&P/TSX (CA)	-
2012	102.57	5308.16	0.041	0.334	0.484	0.052	0.152	1.02	1.24	30	15	-	-
2013	97.92	5904.49	0.039	0.299	0.420	0.042	0.132	0.91	1.10	30	17	AEX (NL), CAC 40 (FR)	-
2014	100.13	6487.39	0.038	0.289	0.393	0.040	0.125	0.92	1.04	30	17	IPC (MX)	CNX Nifty (IN)
2015	114.64	7004.72	0.035	0.371	0.530	0.049	0.165	1.13	1.36	28	18	DAX (DE), SPI 200 (AU)	VIX (US)
2016	126.70	6980.23	0.035	0.345	0.523	0.047	0.146	1.11	1.34	28	18	-	-
2017	104.12	6465.24	0.033	0.220	0.301	0.032	0.097	0.69	0.79	28	18	-	-

Table 3:
Descriptive Statistics - Regular vs. Mini Futures

This table provides a comparison of average trading volume, spread, and price volatility for regular and mini futures. The underlying sample only includes futures for which a mini futures exists and is limited to months in which regular and mini contract are both traded. The first two lines contain information on the average daily number of contracts traded and daily dollar volume. Line 3-7 are low-frequency spread estimators where *Composite Spread* is a combination of the four proxies above, weighted by the respective first principal component. For details on the calculation of the spread estimators, we refer to Appendix B. The last two lines report measures of price volatility based on the high-low estimator of Parkinson (1980) and squared daily returns. The unit of measurement is given in brackets. *Regular Futures* and *Mini Futures* contain the mean for the respective type of contract. t-values for a test of difference in means are reported in the last column. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	N	**Regular Futures**	**Mini Futures**	**Difference**	**t-Statistic**
# Contracts Traded ($\times 10^3$)	2206	65.15	224.96	-159.81***	-14.68
Dollar Volume ($\times 10^6$)	2207	5886.33	11813.72	-5927.38***	-7.94
Effective Tick (in %)	2206	0.031	0.038	-0.007***	-8.70
Corwin-Schultz (in %)	2034	0.370	0.322	0.048***	10.40
Abdi-Ranaldo (in %)	2043	0.512	0.497	0.015***	3.25
VoV(%Spread) (in %)	2034	0.031	0.116	-0.085***	-15.66
Composite Spread (in %)	2197	0.141	0.139	0.001	0.87
Price Volatility-Parkinson (in %)	2034	1.14	1.09	0.05***	3.55
Price Volatility-Squared Returns (in %)	2206	1.37	1.39	-0.01	-1.25

Table 4:
Effect of Mini Futures on the Trading Volume of Regular Contracts

This table presents results of the difference-in-differences analysis for trading volume of the regular contract as the dependent variable. The first column displays the baseline specification with the DiD coefficient, $Mini$: It is equal to one for a particular contract in the months after the mini futures introduction, and zero otherwise. We control for lagged values of trading volume, spread, volatility, and the difference in open interest. All continuous variables are logarithmized. The second column adds additional control variables. Column 3 splits up the DiD coefficient into different time periods. $Mini_{1Y}$ is defined as a dummy equal to one for regular contracts and months in the first year after the corresponding mini futures is introduced and zero otherwise. The other variables are defined accordingly. Finally, the fourth column differentiates the DiD coefficient with respect to the trading environment of the regular futures. $Mini_{Electronic}$ is equal to $Mini$ for cases in which the affected regular futures can be traded electronically during regular trading hours. $Mini_{Floor}$ is equal to $Mini$ when trading in the affected regular futures is exclusively floor-based during regular trading hours. The sample period is January 1994 until August 2017. All variables are measured at the monthly frequency. Standard errors are clustered at the quarterly level. t-values are reported in parentheses. *, **, and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	VM_{Base}	$VM_{Extended}$	$VM_{Dynamic}$	$VM_{Platform}$
$Mini$	0.0017	-0.0107		
	(0.18)	(-1.09)		
$Mini_{-3Y}$			0.0007	
			(0.04)	
$Mini_{-2Y}$			-0.0123	
			(-0.65)	
$Mini_{-1Y}$			-0.0064	
			(-0.30)	
$Mini_{1Y}$			-0.0109	
			(-0.66)	
$Mini_{2Y}$			0.0166	
			(1.01)	
$Mini_{3Y}$			0.0046	
			(0.24)	
$Mini_{>3Y}$			-0.0583***	
			(-3.91)	
$Mini_{Electronic}$				0.0264***
				(2.64)
$Mini_{Floor}$				-0.2059***
				(-6.81)
VM_{t-1}	0.8653***	0.8603***	0.8308***	0.8531***
	(92.10)	(95.30)	(77.91)	(90.94)
$Spread_{t-1}$	-0.0550**	-0.0638**	-0.1196***	-0.0634**
	(-2.04)	(-2.48)	(-4.60)	(-2.43)
$Vola_{t-1}$	0.1010***	0.0994***	0.0783***	0.1049***
	(3.88)	(3.80)	(2.69)	(4.02)
ΔOI_{t-1}	0.0125	-0.1056***	-0.1803***	-0.1082***
	(0.44)	(-3.05)	(-4.20)	(-3.10)
ETF		0.1068***	0.1567***	0.0901***
		(9.94)	(13.17)	(8.58)
Expiry		0.5554***	0.6380***	0.5565***
		(23.42)	(21.64)	(23.59)
Electronic		0.0531***	0.0607***	0.0175
		(3.76)	(3.61)	(1.22)
R^2	0.9500	0.9571	0.9461	0.9574
Obs	7124	7124	7124	7124
Contract FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	No	Yes

Table 5:
Effect of Mini Futures on the Combined Trading Volume of Both Contracts

This table presents results of the difference-in-differences analysis for the combined trading volume (number of contracts, adjusted for different contract multiplier of mini and regular futures) of both contracts as the dependent variable. The first column displays the baseline specification with the DiD coefficient, $Mini$: It is equal to one for a particular contract in the months after the mini futures introduction, and zero otherwise. We control for lagged values of combined trading volume, combined spread and volatility (volume-weighted), and the difference in combined open interest. All continuous variables are logarithmized. The second column adds additional control variables. Column 3 splits up the DiD coefficient into different time periods. $Mini_{1Y}$ is defined as a dummy equal to one for regular contracts and months in the first year after the corresponding mini futures is introduced and zero otherwise. The other variables are defined accordingly. Finally, the fourth column differentiates the DiD coefficient with respect to the trading environment of the regular futures. $Mini_{Electronic}$ is equal to $Mini$ for cases in which the affected regular futures can be traded electronically during regular trading hours. $Mini_{Floor}$ is equal to $Mini$ when trading in the affected regular futures is exclusively floor-based during regular trading hours. The sample period is January 1994 until August 2017. All variables are measured at the monthly frequency. Standard errors are clustered at the quarterly level. t-values are reported in parentheses. *, **, and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	$CombVM_{Base}$	$CombVM_{Extended}$	$CombVM_{Dynamic}$	$CombVM_{Platform}$
$Mini$	0.0325***	0.0291***		
	(3.19)	(2.79)		
$Mini_{-3Y}$			-0.0070	
			(-0.33)	
$Mini_{-2Y}$			-0.0028	
			(-0.17)	
$Mini_{-1Y}$			0.0154	
			(0.76)	
$Mini_{1Y}$			0.0256	
			(1.47)	
$Mini_{2Y}$			0.0565***	
			(3.55)	
$Mini_{3Y}$			0.0464**	
			(2.51)	
$Mini_{>3Y}$			0.0774***	
			(4.79)	
$Mini_{Electronic}$				0.0215*
				(1.90)
$Mini_{Floor}$				0.0716***
				(3.95)
VM_{t-1}	0.8350***	0.8343***	0.8263***	0.8336***
	(67.14)	(71.94)	(70.28)	(71.73)
$Spread_{t-1}$	-0.0025***	-0.0026***	-0.0030***	-0.0025***
	(-3.61)	(-3.41)	(-3.49)	(-3.36)
$Vola_{t-1}$	0.0020*	-0.0000	-0.0041**	0.0006
	(1.82)	(-0.00)	(-2.62)	(0.45)
ΔOI_{t-1}	-0.0272	-0.1178***	-0.1602***	-0.1179***
	(-0.81)	(-2.71)	(-3.33)	(-2.72)
ETF		0.0811***	0.1563***	0.0846***
		(6.81)	(13.21)	(7.09)
Expiry		0.4590***	0.5008***	0.4584***
		(23.74)	(19.69)	(23.65)
Electronic		-0.0128	-0.0060	-0.0034
		(-0.91)	(-0.37)	(-0.23)
R^2	0.9573	0.9621	0.9544	0.9621
Obs	6180	6180	6180	6180
Contract FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	No	Yes

Table 6: Effect of Mini Futures on the Spread of Regular Contracts

This table presents results of the difference-in-differences analysis for the spread of the regular contract as the dependent variable. We measure the spread by the composite spread estimator defined in Section 3. The first column displays the baseline specification with the DiD coefficient, $Mini$: It is equal to one for a particular contract in the months after the mini futures introduction, and zero otherwise. We control for lagged values of trading volume, spread, volatility, and the difference in settlement price. All continuous variables are logarithmized. The second column adds additional control variables. Column 3 splits up the DiD coefficient into different time periods. $Mini_{1Y}$ is defined as a dummy equal to one for regular contracts and months in the first year after the corresponding mini futures is introduced and zero otherwise. The other variables are defined accordingly. Finally, the fourth column differentiates the DiD coefficient with respect to the trading environment of the regular futures. $Mini_{Electronic}$ is equal to $Mini$ for cases in which the affected regular futures can be traded electronically during regular trading hours. $Mini_{Floor}$ is equal to $Mini$ when trading in the affected regular futures is exclusively floor-based during regular trading hours. Each specification includes time and contract fixed effects. The sample period is January 1994 until August 2017. All variables are measured at the monthly frequency. Standard errors are clustered at the quarterly level. t-values are reported in parentheses. *, **, and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	$Composite_{Base}$	$Composite_{Extended}$	$Composite_{Dynamic}$	$Composite_{Platform}$
$Mini$	-0.0305***	-0.0297***		
	(-3.27)	(-3.04)		
$Mini_{-3Y}$			0.0075	
			(0.47)	
$Mini_{-2Y}$			-0.0170	
			(-0.90)	
$Mini_{-1Y}$			-0.0056	
			(-0.33)	
$Mini_{1Y}$			-0.0038	
			(-0.23)	
$Mini_{2Y}$			-0.0311	
			(-1.63)	
$Mini_{3Y}$			-0.0340*	
			(-1.89)	
$Mini_{>3Y}$			-0.1179***	
			(-6.69)	
$Mini_{Electronic}$				-0.0338***
				(-3.10)
$Mini_{Floor}$				-0.0082
				(-0.43)
$Spread_{t-1}$	0.3268***	0.3195***	0.3572***	0.3195***
	(16.38)	(16.41)	(17.54)	(16.42)
VM_{t-1}	-0.0074	-0.0062	-0.0215***	-0.0054
	(-1.61)	(-1.28)	(-3.73)	(-1.11)
$Vola_{t-1}$	0.2769***	0.2716***	0.3066***	0.2710***
	(12.08)	(11.93)	(11.86)	(11.89)
ΔPS_{t-1}	-0.2135**	-0.2175**	-0.3691***	-0.2173**
	(-2.45)	(-2.55)	(-3.47)	(-2.55)
ETF		0.0274**	-0.0042	0.0292***
		(2.49)	(-0.33)	(2.66)
Expiry		-0.0509***	-0.0745***	-0.0510***
		(-4.47)	(-3.78)	(-4.48)
Electronic		-0.0937***	-0.0773***	-0.0897***
		(-4.91)	(-4.44)	(-4.62)
R^2	0.7685	0.7709	0.6644	0.7710
Obs	7117	7117	7117	7117
Contract FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	No	Yes

Table 7:
Effect of Mini Futures on the Price Volatility of Regular Contracts

This table presents results of the difference-in-differences analysis for the price volatility of the regular contract as the dependent variable. We measure volatility by the high-low estimator of Parkinson (1980). The first column displays the baseline specification with the DiD coefficient, $Mini$: It is equal to one for a particular contract in the months after the mini futures introduction, and zero otherwise. We control for lagged values of trading volume (one and two months), spread, and volatility. All continuous variables are logarithmized. The second column adds additional control variables. Column 3 splits up the DiD coefficient into different time periods. $Mini_{1Y}$ is defined as a dummy equal to one for regular contracts and months in the first year after the corresponding mini futures is introduced and zero otherwise. The other variables are defined accordingly. Finally, the fourth column differentiates the DiD coefficient with respect to the trading environment of the regular futures. $Mini_{Electronic}$ is equal to $Mini$ for cases in which the affected regular futures can be traded electronically during regular trading hours. $Mini_{Floor}$ is equal to $Mini$ when trading in the affected regular futures is exclusively floor-based during regular trading hours. The sample period is January 1994 until August 2017. All variables are measured at the monthly frequency. Standard errors are clustered at the quarterly level. t-values are reported in parentheses. *, **, and *** indicate significance at the 10%, 5% and 1% levels, respectively.

	$VolaPark_{Base}$	$VolaPark_{Extended}$	$VolaPark_{Platform}$	$VolaPark_{Dynamic}$
$Mini$	-0.0373***	-0.0380***		
	(-3.59)	(-3.62)		
$Mini_{-3Y}$			0.0184	
			(0.80)	
$Mini_{-2Y}$			-0.0054	
			(-0.28)	
$Mini_{-1Y}$			0.0336*	
			(1.84)	
$Mini_{1Y}$			0.0016	
			(0.08)	
$Mini_{2Y}$			-0.0301	
			(-1.66)	
$Mini_{3Y}$			-0.0518**	
			(-2.36)	
$Mini_{>3Y}$			-0.0722***	
			(-3.70)	
$Mini_{Electronic}$				-0.0464***
				(-4.02)
$Mini_{Floor}$				0.0058
				(0.30)
$Vola_{t-1}$	0.5269***	0.5238***	0.5934***	0.5225***
	(15.77)	(15.84)	(15.65)	(15.88)
VM_{t-1}	0.0397***	0.0403***	0.0351**	0.0413***
	(4.83)	(5.06)	(2.03)	(5.16)
VM_{t-2}	0.0009	0.0007	-0.0021	0.0014
	(0.12)	(0.09)	(-0.11)	(0.18)
$Spread_{t-1}$	0.1083***	0.1011***	0.1118***	0.1011***
	(4.41)	(4.15)	(3.61)	(4.16)
ETF		0.0268**	0.0193	0.0305**
		(2.32)	(1.09)	(2.58)
Expiry		-0.0643***	-0.0854***	-0.0645***
		(-5.08)	(-3.41)	(-5.10)
Electronic		-0.0794***	-0.0566***	-0.0712***
		(-5.08)	(-2.90)	(-4.42)
R^2	0.8020	0.8042	0.6299	0.8043
Obs	7014	7014	7014	7014
Contract FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	No	Yes

Table 8:
Effects of Mini Futures on the Regular Contract - Synthetic Control Group

This table provides the results of the synthetic control group method. For each mini futures introduction, we construct a synthetic control match for the affected regular futures as a weighted combination of potential control units. The weights are determined by minimizing the mean squared prediction error between a vector of characteristics of treated and control futures during a pre-treatment period of three years relative to the launch of the particular mini futures. The characteristics we match upon are the number of contracts traded, the composite spread estimator and price volatility based on the high-low estimator of Parkinson (1980). For the rows *Spread (in bps)* and *Volatility (in %)*, we match upon untransformed values of the characteristics. For the row *Trading Volume*, we match upon trends by normalizing the characteristics to unity in the month of the treatment. We then calculate the average treatement effect (ATE) following Acemoglu et al. (2016) as a weighted average of individual treatment effect with weights given by the inverse of the corresponding mean squared prediction error. We compute the ATE for all affected regular futures (Column 1), and separately for cases in which the treated futures is exclusively floor-traded (Column 2) or also screen-traded during trading hours (Column 3). Panel A displays results for the first year after the mini futures introduction. Panel B and C show results for a post-event window of 3 and 5 years, respectively. The 95% confidence interval, based on the placebo test described in Section 3.3, is displayed in brackets next to the estimated treatment effects. *, **, and *** then indicate significance at the 10%, 5% and 1% levels, respectively.

	All Treated Futures		**Floor-Traded Futures**		**Screen-Traded Futures**	
Panel A: 1 Year after the introduction of a mini futures						
Trading Volume	-0.11	[-0.20,0.09]	-0.30	[-0.90,0.16]	-0.04	[-0.18,0.13]
Spread (in bps)	-1.94	[-3.48,2.48]	8.57***	[-8.17,5.44]	-3.70**	[-3.64,3.09]
Volatility (in %)	-0.05	[-0.11,0.39]	0.32***	[-0.29,0.20]	-0.13**	[-0.12,0.51]
Panel B: 3 Years after the introduction of a mini futures						
Trading Volume	-0.22	[-0.38, 0.11]	-0.51	[-1.86, -0.20]	-0.08	[-0.34, 0.19]
Spread (in bps)	-1.79	[-3.42, 1.80]	6.31***	[-9.74, 2.59]	-3.14*	[-3.43, 2.49]
Volatility (in %)	-0.07	[-0.12, 0.14]	0.24***	[-0.36, 0.13]	-0.14**	[-0.12, 0.20]
Panel C: 5 Years after the introduction of a mini futures						
Trading Volume	-0.27	[-0.39,0.60]	-0.68	[-2.51,-0.23]	-0.11	[-0.30,0.79]
Spread (in bps)	-2.19	[-3.24,2.09]	4.31***	[-8.10,2.87]	-3.55**	[-3.22,2.68]
Volatility (in %)	-0.15***	[-0.10,0.17]	0.13**	[-0.38,0.10]	-0.21***	[-0.09,0.22]

Appendix A - Sample Overview

Stock Index Futures - Regular and Mini Futures Contracts

This table summarizes information about regular and mini stock index futures contained in the main sample. It displays the names of the futures contracts and the country of their underlying stock index. Start (end) dates refer to dates for which the first (last) price observation of a particular contract is available in Datastream. For most index futures, the end date is set to August 31, 2017, corresponding to the end of the sample period. Columns 1 to 4 display information on regular index futures contracts. Columns 5 to 7 display information for the respective mini index futures contracts, if existent.

Regular Futures				Mini Futures		
Futures Name	Index Country	Inception Date	End Date	Status	Inception Date	End Date
ADEX-FTSE/ASE-20	Greece	8/30/1999	8/31/2017	-	-	-
BMF-BOVESPA INDEX	Brazil	2/14/1986	8/31/2017	Active	2/18/2005	8/31/2017
CBOT-DJ INDUSTRIALS	USA	10/6/1997	6/18/2015	Active	12/9/2002	8/31/2017
CFE-VIX INDEX	USA	3/26/2004	5/31/2017	Dead	3/2/2009	1/21/2014
CME-NASDAQ 100 INDEX	USA	4/10/1996	6/19/2015	Active	8/27/1999	8/31/2017
CME-S&P 500 INDEX	USA	7/1/1982	5/31/2017	Active	9/9/1997	8/31/2017
EUREX-AEX INDEX	Netherlands	10/26/1988	5/31/2017	Active	9/2/2013	8/31/2017
EUREX-ATX INDEX	Austria	8/7/1992	8/31/2017	-	-	-
EUREX-EURO STOXX 50	Europe	6/22/1998	8/31/2017	-	-	-
EUREX-DAX INDEX	Germany	11/23/1990	8/31/2017	Active	10/28/2015	8/31/2017
EUREX-MDAX INDEX	Germany	3/16/2005	8/31/2017	-	-	-
EUREX-SMI	Switzerland	11/9/1990	8/31/2017	-	-	-
FUTOP-OMXC20 INDEX	Denmark	6/1/1992	1/19/2012	-	-	-
HKFE-HANG SENG INDEX	Hong Kong	5/6/1986	8/31/2017	Active	9/10/2000	8/31/2017
IDEM-FTSE MIB	Italy	11/28/1994	8/31/2017	Active	7/3/2000	8/31/2017
KLSE-KLCI INDEX	Malaysia	12/15/1995	8/31/2017	-	-	-
LIFFE-FTSE 100 INDEX	Great Britain	5/3/1984	8/31/2017	Dead	10/17/2000	6/21/2002
MEFF-IBEX 35 PLUS INDEX	Spain	4/20/1992	8/31/2017	Active	11/22/2001	8/31/2017
ME-S&P CANADA 60 INDEX	Canada	9/7/1999	8/31/2017	Active	5/6/2011	8/31/2017
MEXDER-IPC INDEX	Mexico	6/1/1999	6/1/1999	Active	10/27/2014	8/31/2017
MONEP-CAC 40 INDEX	France	1/8/1999	8/31/2017	Active	9/2/2013	8/31/2017
NSE-S&P CNX NIFTY	India	6/12/2000	8/31/2017	Dead	1/1/2008	1/31/2013
OMX-OMXS30 INDEX	Sweden	2/15/2005	8/31/2017	-	-	-
OSLO-OBX INDEX	Norway	9/4/1992	8/31/2017	-	-	-
OSX-NIKKEI 225 INDEX	Japan	9/6/1988	8/31/2017	Active	7/18/2006	8/31/2017
SAFEX-ALL SHARE 40 INDEX	South Africa	5/2/1990	5/31/2017	Active	6/3/2008	8/31/2017
SFE-SPI 200 INDEX	Australia	5/2/2000	8/31/2017	Active	10/12/2015	8/31/2017
SGX DT-NIKKEI 225 INDEX	Japan	1/6/1987	8/31/2017	Active	11/19/2007	8/31/2017
TAIFEX-TAIEX INDEX	Tawain	7/21/1998	8/31/2017	Active	4/9/2001	8/31/2017
TSE-TOPIX INDEX	Japan	9/5/1988	8/31/2017	Active	7/22/2008	8/31/2017

Appendix B - Calculation of Low-Frequency Spread Estimators

Effective Tick Size

For the effective tick size estimator, we first calculate price grids based on possible spread sizes (see Holden (2009) and in particular `https://kelley.iu.edu/cholden/examples.pdf`). The possible spread sizes are based on the empirical distribution of settlement prices and account for different minimum tick size rules for each index futures. Next, we count the number of settlement prices corresponding to a particular spread size in each month and combine this empirical frequency with the price grid to compute conditional and unconditional probabilities of the respective spread. The probability-weighted average of each spread size, divided by the average monthly settlement price, yields the effective tick size estimator. For more details, we refer to Holden (2009) and Marshall et al. (2012).

High-Low Estimator

For the calculation of the high-low estimator proposed by Corwin and Schultz (2012), we observe daily high and low prices for each index futures. Then, we compute:

$$\beta = \sum_{j=0}^{1} \left[ln \left(\frac{PH_{t+j}}{PL_{t+j}} \right) \right]^2 \tag{5}$$

$$\gamma = \left[ln \left(\frac{PH_{t,t+1}}{PL_{t,t+1}} \right) \right]^2 \tag{6}$$

where PH_{t+j} and PL_{t+j} are high and low prices on days t and $t+1$. $PH_{t,t+1}$ ($PL_{t,t+1}$) is the highest (lowest) price over the two days t and $t+1$. The spread estimator is then given by:

$$Spread_{Corwin-Schultz} = \frac{2(e^{\alpha}-1)}{1+e^{\alpha}} \tag{7}$$

$$\alpha = \frac{\sqrt{2\beta}-\sqrt{\beta}}{3-2\sqrt{2}} - \sqrt{\frac{\gamma}{3-2\sqrt{2}}}. \tag{8}$$

We use high and low prices if available and set the estimator to missing if the high price is equal to the low price or if one of the two is unavailable.

High-Low-Close Estimator

Abdi and Ranaldo (2017) propose another estimator which is based on high, low and settlement prices. Again, we use high and low prices if available and set the estimator to missing if the high price is equal to the low price or if one of the two is unavailable. The spread estimator is then given as:

$$Spread_{Abdi-Ranaldo} = \sqrt{4E[(PS_t - midrange_t)(PS_t - midrange_{t+1})]} \tag{9}$$

$$midrange = \frac{ln(PH_t) + ln(PL_t)}{2} \tag{10}$$

where the expected value is replaced by monthly averages. We also calculate alternative versions of the Corwin-Schultz and Abdi-Ranaldo estimator where we take the most recent valid high and low price and adjust them for infrequent trading and overnight returns as described in Corwin and Schultz (2012) in order to replace missing values. Results remain unchanged.

Volatility-over-Volume Estimator

The calculation of the volatility-over-volume estimator follows Fong et al. (2018). More specifically, the spread estimator is given by:

$$VoV(\%Spread) = \frac{a\sigma_{park}^{\frac{2}{3}}}{DVM^{\frac{1}{3}}} \tag{11}$$

where $a = 8$, as in Fong et al. (2018), σ_{park} is a measure of price volatility based on the high-low estimator of Parkinson (1980), and DVM is the dollar volume of the index futures. We use monthly averages of daily price volatility and dollar volume to get a monthly estimate for the spread.

Composite Spread Estimator

For the main analysis, we combine the information of the individual spread estimators, following the procedure in Johann and Theissen (2019). First, we extract principal components of the logarithmized spread estimators over the full sample period. Second, we compute the loadings of each spread estimator on the first principal component and use these loadings as weights. Finally, we get the composite spread estimator as the weighted average of all non-missing individual proxies in each month t.

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