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Lessons from the demise of the Brent Crude oil futures contract on the Singapore Exchange

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Lessons from the Demise of the Brent Crude Oil Futures Contract on the Singapore Exchange

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Abstract: This paper highlights the lessons drawn from the demise of the Brent Crude Oil futures contract that was traded on the Singapore Stock Exchange (SGX). We analyze the market microstructure of the contract prior to its failure—specifically, the number of trades, trading volume, open interest, bid–ask spread, and volatility. We find a steady decline in the mean volume, open interest, and number of trades as the contracts near their demise. The bid–ask spread of the contract also widens. Investigations of the mutual offset feature of the Brent Crude Oil futures contract between SGX and the International Commodity Exchange (ICE) provides evidence that trading volume, open interest, and the number of trades increase significantly during 4:00–5:45 PM local time when mutual offset is available.

Keywords: brent crude futures; contract failure; Singapore exchange

JEL Classification: G13; G15; Q49

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1. Introduction

There has been much research performed on the success and failure of futures contracts. Interestingly, very few futures contracts eventually end up successful (Silber 1981; Carlton 1984; Kolb 1991). Many reasons have been given. Carlton (1984), Tashjian (1995), Black (1986), Johnston and McConnell (1989) and Brorsen and Fofana (2001) identified several features and criteria that can influence the success of futures contracts. Research by Gray (1966) and Cuny (1993) considered the role of liquidity, in contrast to Duffie and Jackson (1989) and Corkish et al. (1997), which dismissed the role of liquidity in contract design and eventual success. Specifically, Sandor (1973), Silber (1981), and Thompson et al. (1996) looked at the failure of a particular futures contract.

Comparatively, less research has been performed in the area of multi-market trading. Admati and Pfleiderer (1988) focused on financial instruments' volume and price variability traded in a single market. Pagano (1989), Chowdhry and Nanda (1991), Domowitz et al. (1998), and Baruch et al. (2007) expanded on the findings to include multi-market traded financial instruments.

Exchanges cite several reasons for failure of contracts. From an exchange's perspective, it is important for them to generate sufficient commission revenue from trading volume (Cuny 1993). Similarly in Silber (1981), Black (1986), Duffie and Jackson (1989), exchanges seek to maximize transaction volume. This is because exchanges charge a preset fee per transaction, thus maximizing transaction volume leads to maximizing their revenue. We can infer from this that exchanges consider a contract as a failure, i.e., delist the contract from the exchange, if it does not manage to generate sufficient interest to sustain a profitable level of trading volume. For financial instruments traded on multiple markets, Chowdhry and Nanda (1991) show that a critical mass of liquidity traders can result in a "winner-takes-most" effect that contributes to the success of the contract. This is because such traders tend to trade together, resulting in concentration of trading volume in a particular exchange.

In the research performed by Thompson et al. (1996) on the demise of the high-fructose corn syrup futures contract, it was suggested that the lawsuit brought about by two large traders for misrepresentation in the market influenced the eventual failure of the contract by inhibiting other traders from entering the market.

In this paper, we seek to explore reasons that led to the demise of the Brent Crude Oil futures contract in the Singapore Stock Exchange (SGX). By examining the reasons that led to its failure, we hope to learn from it and in turn establish the drivers of successful contracts. This can be used by SGX when they design contracts in future to maximize their chances of success. The Brent Crude Oil futures contract is used as a case study because its success on London International Commodity Exchange (ICE) is in stark contrast to its failure on SGX. Also, the mutual offset feature presents an area for research that can provide additional insights into contract design.

Since Brent Crude Oil futures contracts are traded on several exchanges, an area of concern is the effect of multi-market trading. We contribute to the literature in this area concerning futures contracts as much of the existing research focus on the relationship between multi-market trading and trading activity in equity markets.

Brent Crude Oil is a highly versatile commodity. Its products consist of petroleum, liquefied petroleum gas (LPG), naphtha, kerosene, gas oil, and fuel oil, and by-products include plastics, synthetic fibers, synthetic rubbers, detergents, and chemical fertilizers. Indeed, life as we know today would be extremely different without crude oil and its by-products.

While much research has been performed on the determinants of successful future contracts (Silber 1981; Carlton 1984; Black 1986) and multi-market trading of financial instruments (Pagano 1989; Chowdhry and Nanda 1991; Domowitz et al. 1998; Baruch et al. 2007), there has been little research performed on the combination of the two abovementioned areas. We believe that our research will provide insights for SGX in futures contract design that will maximize the potential for success.

We document the microstructure aspects of the Brent Crude Oil futures contract from its inception to failure. Specifically, we look at the bid–ask spreads, trading volume, open interest, volatility, and number of trades. From the information obtained from SGX, we seek to identify the trend of these variables over time to arrive at a plausible set of success and failure determinants which can be applied to SGX.

The paper is organized as follows. The subsequent section provides background information of Brent Crude, SGX and the contract. The following sections outline the literature review, research hypotheses, data sample and methodology, respectively. Following that, the empirical results are discussed before we summarize this article with some concluding remarks.

2. Background and Institutional Details

2.1. Brent Crude Oil

Brent Crude is one of the major classifications of oil consisting of Brent Crude, Brent Sweet Light Crude, Oseberg and Forties. Brent Crude is sourced from the North Sea. Brent blend is a light crude oil. Brent Crude has an API gravity of approximately 38.6. It contains approximately 0.37% of sulfur, classifying it as sweet crude. The adjective sweet refers to small amounts of hydrogen sulfide and carbon dioxide.

Burning crude oil itself is of limited use. To extract the maximum value from crude, it first needs to be refined into petroleum products. The best-known of these is gasoline, or petrol. However, there are many other products that can be obtained when crude oil is refined. These include liquefied petroleum gas (LPG), naphtha, kerosene, gas oil and fuel oil. Other useful products which are not fuels can also be manufactured by refining crude oil, such as lubricants and asphalt. A range of sub-items like perfumes and insecticides are also derived from crude oil.

Furthermore, several of the products listed above which are derived from crude oil, such as naphtha, gas oil, LPG, and ethane, can themselves be used as inputs or feedstock in the production of petrochemicals. There are more than 4000 different petrochemical products, but those which are considered as basic products include ethylene, propylene, butadiene, benzene, ammonia, and methanol. The main groups of petrochemical end-products are plastics, synthetic fibers, synthetic rubbers, detergents, and chemical fertilizers.

2.2. SGX and Derivatives Markets

Financial and commodity markets have witnessed a surge in trading volume of derivative securities as investors have diversified their portfolio and fund managers seek to hedge their instruments in volatile capital markets. In particular, crude oil is the world's most traded commodity as well as the largest volume futures contract trading on a physical commodity. Derivatives are increasingly becoming an important part of the financial landscape. Coupled with globalization, trading has extended beyond national boundaries and led to the emergence of mutual offset trading systems between international futures exchanges. One case in point is the Brent Crude Oil futures contract being traded on a mutual offset system operating between SGX and ICE. McAleer and Sequeira (2004) tested the unbiased expectations hypothesis and cost-of-carry hypothesis specific to SGX Brent Crude Oil futures contracts. They found that models of futures pricing that incorporate price linkages between markets beyond market boundaries into the information set can be expected to be superior empirically.

Locally, SGX has been aggressively trying to divert its income stream away from equities-related instruments to derivative products. However, a look at all the derivative contracts listed so far portrays a worrying trend. Almost half of all the derivative contracts initially listed on SGX have either been delisted or are dormant.[1] While contracts like the NIKKEI 225 futures contract has been around for more than three decades, there are notable failures like the Brent Crude Oil futures contract, which was delisted from the exchange on 14 March 2002. Thus, it is absolutely essential that the exchange design and structure their contracts carefully before bringing the product into the market to minimize wastage of valuable time and resources.

2.3. Contract Specifications[2]

During times when Brent Crude Oil prices are highly uncertain, price setting becomes more difficult. Brent Crude Oil futures market saves transaction costs in price setting as it is relatively easy to peg contracts for physical delivery to futures price. The Brent Crude Oil futures contract, which is a cash-settled futures contract settled against the forward market, was created on 23 June 1988 in response to the growing demand to hedge the risk of uncertain oil prices. However, the futures contracts, used alone in a hedging strategy, are shown to perform unpredictably in the hedging of dated Brent, which is the direct price index for some 16 million barrels per day of crude oil trade, and whose influence, particularly in the Far East, is still expanding.

Brent Crude Oil futures contracts are currently traded on several exchanges, but in this report, we will focus on the futures contract traded on SGX, which is similar to the one traded on ICE. ICE is the leading global, electronic marketplace for trading both futures and OTC energy contracts. Their benchmark contracts offers liquid markets for the world's leading oil benchmarks, Brent Crude futures and West Texas Intermediate Crude futures. SGX trades derivative securities via Singapore Exchange Derivatives Trading Limited (SGX-DT). It currently offers the world's widest range of Asian index futures, on top of other products like interest rates futures/options and single stock futures.

The ICE Brent Crude futures contract provides a highly flexible hedging instrument and trading mechanism. This contract is tailored specifically to meet the oil industry's need for an international crude oil futures contract and is an integral part of the Brent pricing complex, which also includes spot and forward markets and is used to price over 65% of the world's traded crude oil. Brent Crude Oil's unit of trading is 1000 net barrels (42,000 US gallons) and the contract price is quoted in US dollars and cents per barrel. There is neither a limit on the maximum daily price fluctuation nor a limit to the size of positions. The contract listed on SGX is similar to the one traded on ICE, with a mutual offset feature that allows trading to be performed simultaneously on both markets during certain time periods.

3. Literature Review and Hypotheses Development

3.1. Determinants of Success and Failure of Futures Contract

Plenty of work has been performed by researchers to investigate the determinants of successful futures contracts. Characteristics of the underlying commodity and the way the contract is designed plays a important role in determining if the futures contract becomes successful or failure in the long term. Carlton (1984) found that most new futures contract fail within 10 years of their introduction. Silber (1981) estimates that between two-thirds and three-quarters of new contracts fail to attract and sustain a profitable level of trading.

Early research in this area by Black (1986) provides a review of the literature on the success and failure of futures contracts, presenting evidence that the presence or absence of an efficient hedge for the underlying commodity influences the success of a futures contract. Carlton (1984) identified the most important features that a commodity traded on futures exchange should possess to be successful. They are (a) uncertainty, (b) price correlations across different products, (c) large potential number of interested participants and industrial structure, (d) large value of transactions and (e) price freely determined and absence of regulation. Brorsen and Fofana (2001) concluded that cash market attractiveness is essential for the existence of futures contracts. Shao et al. (2019) advocate that commodity futures are essential for effective risk management. The implication is that efforts should be directed towards developing active cash markets and effective grading systems before considering the possibility of futures markets.

Liu and Lee (2021) surmise that the lack of a regional benchmark, coupled by a decline in market participants and trading volume, would lead to the failure of the crude oil futures contract. Gray (1966) mentioned that liquidity of a futures market is important to allow participants to enter and exit the market without significantly affecting prices. This can be accomplished by attracting enough hedgers and speculators. In addition, Gray (1960, 1966) identified the importance of contract design in influencing the success. This was reinforced by Johnston and McConnell (1989) who documented the demise of the GNMR CDR contract which appears to have failed because of the contract design. Relatedly, Yang et al. (2021) highlight the poor design of delivery terms contributed to the failure of US grain futures in 2005–2010.

Cuny (1993) suggests two ways of optimizing liquidity in an exchange by (1) choosing a contract to fill hedging demand not met by other exchanges and (2) using the resulting monopoly power to limit investor entry, keeping fees high. The objective of optimal liquidity is to maximize exchanges' revenue. Conversely, Duffie and Jackson (1989) do not consider the role of liquidity in contract design. They find that, for a monopolistic exchange futures contract to be volume-maximizing, it must provide an "innovation" perfectly correlated with the endowment differential, the difference between the endowments on the long and short sides of the market. However, Agrawal et al. (2019) show that price volatility in both the spot and futures markets of agri-commodity futures contracts is an important contributor to the success of a futures contract.

Corkish et al. (1997) study on LIFFE confirms the existence of a first-mover advantage. They also found that futures volume is correlated with the size of the underlying market as well as its volatility as they serve as proxies for existing hedging demand. However, they found little systematic correlation between bid–ask spreads and futures volume, suggesting that there may be a critical level of trading activity beyond which bid–ask spreads and execution risk vary relatively little. This leads to the conclusion that liquidity seems to be a consequence rather than a cause of contract success (or lack of liquidity a cause of failure). This is contrary to literature that suggests liquidity is a criterion for success of futures contracts.

Measurement of success needs to be defined for the research. However, Corkish et al. (1997) documents contract success cannot easily be inferred from the contract's first years of trading. Brorsen and Fofana (2001) follow Black (1986) and define a successful contract as one that maintains a consistently high volume of trade and open interest.

Nonetheless, initial failure of a futures contract is no indication of future success. Powers (1967) study on pork belly futures shows initial dissatisfaction with provisions of a futures contract might result in low trading volume. Provisions that result in such dissatisfaction specific to pork belly futures include shrinkage allowance, storage time, grading problem, freight allowance, method of storing bellies and time of delivery. However, subsequent changes are closely associated with an increase in trading volume.

In designing the optimal futures contract, Tashjian (1995) mentioned that exchanges must decide what clientele the futures contract will serve and tailor the new contracts accordingly. Thompson et al. (1996) recommend exchanges to carefully research industry pricing practices and market structure to determine optimal contract design and demand for the product as a pricing and risk management instrument. De Blasis et al. (2023) study the stablecoin market, including its derivatives, and conclude that the design of these assets is crucial to avoiding its failure.

However, for contracts that already exist, exchanges should study the effects on those futures contracts already listed. Pennings and Leuthold (2001) discuss the possibility of cannibalism, leading to a volume decrease for those futures contracts currently traded. This volume decrease might lead to decline in liquidity which would ultimately threaten the exchange's viability. Also, while it is important to note that increase in delivery options can increase its general appeal, its hedging effectiveness should not be compromised, mentioned by Johnston and McConnell (1989).

3.2. Multi-Market Trading

McAleer and Sequeira (2004) found strong supporting evidence that models of futures pricing that incorporate price linkages between markets beyond national boundaries can be expected to perform superior empirically. This study was conducted on the Brent Crude Oil futures contract traded on both SGX and ICE.

One of the earlier articles on volume and price variability by Admati and Pfleiderer (1988) focused on financial instruments traded in a single market. Subsequent articles by Pagano (1989), Chowdhry and Nanda (1991), Domowitz et al. (1998), and Baruch et al. (2007) expanded on the findings to include multi-market traded financial instruments.

Chowdhry and Nanda (1991) build on the research by Admati and Pfleiderer (1988) by showing that small liquidity traders with discretion will concentrate, in equilibrium, in the market that has the largest amount of trading by liquidity traders who are unable to move between markets. This market will in turn attract more trading by the informed as well as the large liquidity traders. For financial instruments that trades simultaneously on several locations, this "winner-takes-most" feature results in concentration of trading to the location that has the largest number of traders with no discretion to move between markets. It is mentioned that liquidity traders prefer to trade in markets where their trading has little effect on prices, creating strong incentives for liquidity traders to trade together and for trading to be concentrated.

In Baruch et al. (2007), a model of multi-market trading was developed to explain the variation in the US share of global trading volume across the sample of non-US stocks cross-listed on US exchanges. It differed from previous models in that neither exchange design nor assumptions of differential trading costs play a central role in determining the distribution of trading volume across exchanges.

Tse and Bandyopadhyay (2006) went one step further by focusing on the Eurodollar futures market that is traded on both the London International Financial Futures and Options Exchange (LIFFE) and Chicago Mercantile Exchange (CME). CME uses both an open outcry and electronic trading platform, Globex. As such, this allows the comparison of market dynamics, e.g., trading volume, bid–ask spread and price discovery of cross-listed

Eurodollar futures, and those of open outcry and electronic trading. However, the contracts traded in these two exchanges are competitive in nature, unlike our research where the focus is on complementary contracts which allows mutual offset trading.

3.3. Hypotheses

Liquidity has been widely discussed as one of the major determinants of a contract's success (Gray 1966; Black 1986; Cuny 1993; Brorsen and Fofana 2001). Keynes (1930) wrote that an asset is more liquid than another if it is more certainly realizable at short notice without loss. Similarly, Kolb and Rodriguez (1993) define liquidity as a measure of how easily an asset may be converted into cash without a loss in value.

The link between liquidity—the absorptive capacity of the market—and the volume of trade has been highlighted in several contexts. Yamey (1985) suggests that trading volume and absorptive capacity of the market tends to feed positively on each other. Similarly, Kyle (1981, 1984, 1985, 1986) and Admati and Pfleiderer (1988) used the feedback loop between trading volume and market liquidity to explain the fact that trade tends to concentrate at particular times of the day.

3.3.1. Volume

An illiquid market is characterized by low trading volume. This can be inferred from Kolb and Rodriguez (1993) definition of liquidity as a market with low trading volume makes it more plausible that there will be a loss in value when converting an asset into cash, i.e., liquidating trading position. As mentioned earlier, one of the reasons exchanges will delist a contract is if it does not generate enough trading volume to be profitable. This is inferred from Silber (1981), Black (1986) and Duffie and Jackson (1989) and Cuny (1993). As a contract nears its demise, it becomes less thinly traded, i.e., less liquid. Thus, exchanges find it unprofitable to keep the contract listed due to the lack of trading revenue generated. This leads us to our first hypothesis:

Hypothesis 1a. *Trading volume decreases when a contract nears its demise.*

3.3.2. Number of Trades

Trading volume is often used as a proxy for the liquidity in a market. When volume is not available, the number of trades is used as a proxy. Therefore, we expect the same relationship to hold for number of trades, i.e., as a contract nears its demise and trading volume decreases, the number of trades should also decrease. Therefore, we expect this hypothesis to hold:

Hypothesis 1b. *Number of trades decrease when a contract nears its demise.*

3.3.3. Open Interest

Brorsen and Fofana (2001) and Black (1986) both cite open interest and trading volume as among the characteristics of successful contracts. Therefore, it can be inferred that open interest and trading volume are highly correlated. Bessembinder and Seguin (1992) included open interest as a trading activity variable. Also, Bessembinder et al. (1996)'s research on the S&P 500 futures contract showed results that indicate futures volume are positively and significantly correlated with open interest. All these seem to suggest that when a contract nears its demise, i.e., trading volume decreases, open interest also decreases. Therefore, we propose the following hypothesis.

Hypothesis 2. *Open interest decreases when a contract nears its demise.*

3.3.4. Bid–Ask Spread

Schwartz (1988) describes the bid–ask spread (BAS) as the cost of a round trip transaction. The significance of the BAS lies in its compatibility as a proxy to the measurement of transaction costs and market liquidity. Schwartz (1991) shows that high BAS represents large transaction costs, and thus an illiquid market. McInish and Wood (1992) document that BAS is inversely related to the level of activity and market competition while being directly related to the level of risk and information. This is supported by findings from Tinic and West (1972) and Glosten and Milgrom (1985). Therefore, as a contract nears its demise and the market becomes less liquid, it can be expected that the BAS will widen. We propose the following hypothesis:

Hypothesis 3. *Bid–ask spread widens when a contract nears its demise.*

3.3.5. Volatility

The positive contemporaneous correlation between trading volume and price volatility has been widely documented. Morgan (1976) found that the variance of price change was positively related to trading volume. This relationship was also found to hold for the 17 futures contracts tested by Cornell (1981) and foreign currency futures tested by Grammatikos and Saunders (1986) between changes in volume and changes in the variability of prices. Karpoff (1987) cites 19 separate studies that document this relation in a variety of financial markets including equities, futures, currencies, and Treasury Bills. Bessembinder and Seguin's (1992) study on eight futures contracts support those of prior studies.

However, not all researchers support this positive relationship. Godfrey et al.'s (1964) results did not support a price-volume relation. Even for studies which show a positive correlation, some of the tests indicate that the correlation is weak (Crouch 1970). One point to note is that such findings are restricted to research performed on stock markets and not futures markets. As such, we would like to investigate whether this relationship holds for the Brent Crude Oil Futures contract and whether it has any implications for SGX in their contract design.

3.3.6. Mutual Offset Feature

In addition to testing the abovementioned hypotheses from a time-series perspective using the lifespan of the Brent Crude Oil futures contract, we also investigate the effect of the mutual offset feature on volume, number of trades, open interest, bid–ask spread, and volatility. The contract specifications of the SGX-listed Brent Crude Oil futures contract indicates the trading hours are separated into three time periods: 0925–1600 (electronic trading), 1600–1745 (mutual offset trading with ICE), and 1802–0413 (mutual offset trading with ICE) during the Fall.

McAleer and Sequeira (2004) found that models of futures pricing that incorporate price linkages between markets beyond market boundaries into the information set can be expected to be superior empirically Also, since the mutual offset feature allows the benefit of combined liquidity of both exchanges and trading opportunities across international time zones, we expect an increase in trading volume, open interest and number of trades during the time periods where mutual offset trading with ICE are present. This increased liquidity should result in a lower bid–ask spread. We therefore expect the following hypotheses to hold:

Hypothesis 4a. *Trading hours with a mutual offset feature increases trading volume.*

Hypothesis 4b. *Trading hours with a mutual offset feature increases number of trades.*

Hypothesis 4c. *Trading hours with a mutual offset feature increases open interest.*

Hypothesis 4d. *Trading hours with a mutual offset feature reduces bid–ask spreads.*

4. Data and Methodology

4.1. Data

The data used in the analysis are extracted from the SGX Tick Data & Daily Statistics database. For daily data, the sample period covers 2 January 1996 through 16 April 2002. For tick data, the sample period covers 21 May 1996 through 16 March 2002. Due to the shorter period covered by the tick data, we restrict our sample period from 21 May 1996 to 16 March 2002 to maintain data integrity. In total, there are 1493 daily observations and 69,679 tick-by-tick observations.

The contract with the nearest expiration is more closely monitored by traders hence volume and open interest tend to be higher with greater liquidity. Thus, for the purpose of this paper, only the data of the contract with the nearest expiration month is used on each trading date. Based on data observation, 15th of the trading month is generally the last trading day for the contract with the nearest expiration month. For example, the last trading day for the October 1999 contract is on 15 September 1999. However, we recognize the effect of contract rollover, whereby the next nearest monthly contract's volume is higher than the nearest monthly contract. Thus, it is necessary to collect data for the nearest contract until the crossover date, after which data from the next nearest monthly contract are collected. This method is used in similar types of studies in which prices are collected for a nearby contract until some days before its expiration, upon which prices from the next nearest monthly contract are collected (Laux and Senchack 1994; Christie-David and Koch 1997; Antoniou et al. 1998; Roope and Zurbruegg 2002; Ding and Charoenwong 2003).This is to ensure that prices are collected from the most liquid contract and that biases because of the effect of contract maturity are minimized. The crossover date is observed to be on average, two days before the last trading date.

The data are then compiled together to form a time series for analysis. Use of this method of linking data from different contracts to form one single time series of data is justified by Malliaris and Urrutia (1998) who reports that general conclusions would not be altered.

For the testing between time periods to determine the effects of mutual offset (Hypothesis 4a–4d), we must take into account the daylight savings time[3] in London. Clocks are advanced by an hour on the last Sunday of March and October every year during daylight saving time. As the trading time in the SGX Tick Data & Daily Statistics is based on Singapore's local timing (GMT +8), slight adjustments must be made, i.e., trading dates between March and October have the trading time periods advanced by an hour. This is to ensure that each period incorporates the relevant data to prevent distorting the results of the hypotheses being tested. The exact dates and the changes in the trading period can be found in Appendix C.

4.2. Methodology

Each trading day is defined as the time from 0800 to 0413 the next day, i.e., for trading day 1 January 2000, the trading hours starts at 0800 on 1 January 2000 and ends at 0413 on 2 January 2000. Period 1 refers to the trading hours 0900–1600, period 2 refers to the trading hours 1600–1745 and period 3 refers to the trading hours 1802–0413.

4.2.1. Trading Volume

Daily trading volume is calculated by summing up the volume generated for all contracts in a trading day for the period 21 May 1996–16 March 2002.

4.2.2. Number of Trades

The number of trades daily is calculated by using the intraday data and summing up the total number of transactions that went through in a trading day for the period 21 May 1996–16 March 2002.

4.2.3. Open Interest

Daily open interest is calculated by summing up the open interest outstanding for all contracts in a trading day for the period 21 May 1996–16 March 2002.

4.2.4. Bid–Ask Spread

As there are no official market makers in the futures market to simultaneously provide quotes on both sides, we match each ask quote with the most recent bid quote, and vice versa, to form a matched-pair quote. The difference of the bid and ask prices represent the tick (quoted) spread. Traded and settlement orders are ignored in forming the matched-pair quote.

The bid–ask spread percentage is then calculated as:

$$\%\,BAS = \frac{(ask - bid)}{(ask + bid)/2} \tag{1}$$

Bid–ask spread percentages that are zero are taken out of the data set. Subsequently, the daily time-weighted bid ask spread percentage is calculated using the same method as McInish and Wood (1992). In the interval (t_N, t_1), there are N quotation updates, occurring at times t_i, $i = 1, \ldots, N$, with bid–ask spread percentage BAS_i, $i = 1, \ldots, N$. Bid–ask quotes are not carried forward from the previous day, thus the daily time-weighted bid–ask spread percentage is calculated as:

$$\sum_{i=1}^{N} \frac{BAS_i(t_{i+1} - t_i)}{t_N - t_1} \tag{2}$$

Daily time-weighted BAS% which yields zero percent is excluded from the sample data.

4.2.5. Volatility

The daily return volatility of the futures contract is calculated as:

$$Var(ln\ P_{t+1} - ln\ P_t) \tag{3}$$

This is the same as the equation used by Cornell (1981) in his study on price variability in futures markets, where daily settlement prices are used to estimate the variance. However, instead of following the method used by Cornell (1981) of separating the data sample into two-month intervals, we used the time-series data used in BAS. This is to minimize distortion of results because of different time interval used.

The variance of the log price relative is used rather than the variance of the rate of return on investment because as Black (1986) states, the initial investment in a futures position is zero. Using the rate on return on initial margin is also misleading as not all investors face the same margin requirements.

Another potential source of bias is the maturity of the futures contract used to estimate the variance. Samuelson (1965) argues that commodity returns become riskier as a contract approaches maturity. While Cornell (1981) acknowledged the fact that having such bias means it is inappropriate to use the time-series returns from a given contract to estimate the variance, it is the only feasible way to measure the variance and the trading volume over the same interval.

4.2.6. Mutual Offset Feature

As mentioned earlier, during the fall, the trading hours are: 0925–1600 (electronic trading), 1600–1745 (mutual offset trading with ICE) and 1802–0413 (mutual offset trading with ICE). During the summer, the trading hours are advanced by an hour: 1025–1700 (electronic trading), 1700–1845 (mutual offset trading with ICE) and 1902–0513 (mutual offset trading with ICE). We separate the data into these three time periods accordingly to arrive at the trading volume, number of trades, open interest, BAS, and volatility for each period.

From the SGX Tick Data Statistics, we were unable to determine the trading volume attributed to each successful trade. As such, a pro-rata method was used to allocate the trading volume for each day. For example, a particular trading day has trading volume of 108 from three successful trades. Therefore, each successful trade is allocated a trading volume of 36 (108/3). Similarly, open interest was allocated using the pro-rata method.

The number of trades in each period is calculated by using the intraday data and summing the total number of transactions that went through in that period. Time-weighted bid–ask spread is calculated for the three time periods using the same method described above.

5. Empirical Results

5.1. Time-Series Analysis

5.1.1. Number of Trades, Volume and Open Interest

We look at the results generated for the number of trades, volume, and open interest collectively because of the high correlation between the three. The total number of trades for each year is observed to decrease from 1996 to 2002 as shown in Figure 1. One way ANOVA analysis is performed to compare the mean number of trades for each year. The decrease in mean number of trades is significant at the 1% level from 1996 to 2000. Comparing 1998 to 2000, 2001 and 2002, it shows that the contract's mean number of trades has decreased significantly from the year 1998 onwards. From 2000 to 2001 and 2001 to 2002, although the decrease is not statistically significant, observation shows that it is a 99% and 100% decrease from prior year's mean number of trades, respectively. The results confirm our hypothesis that the number of trades decreases when a contract nears its demise.

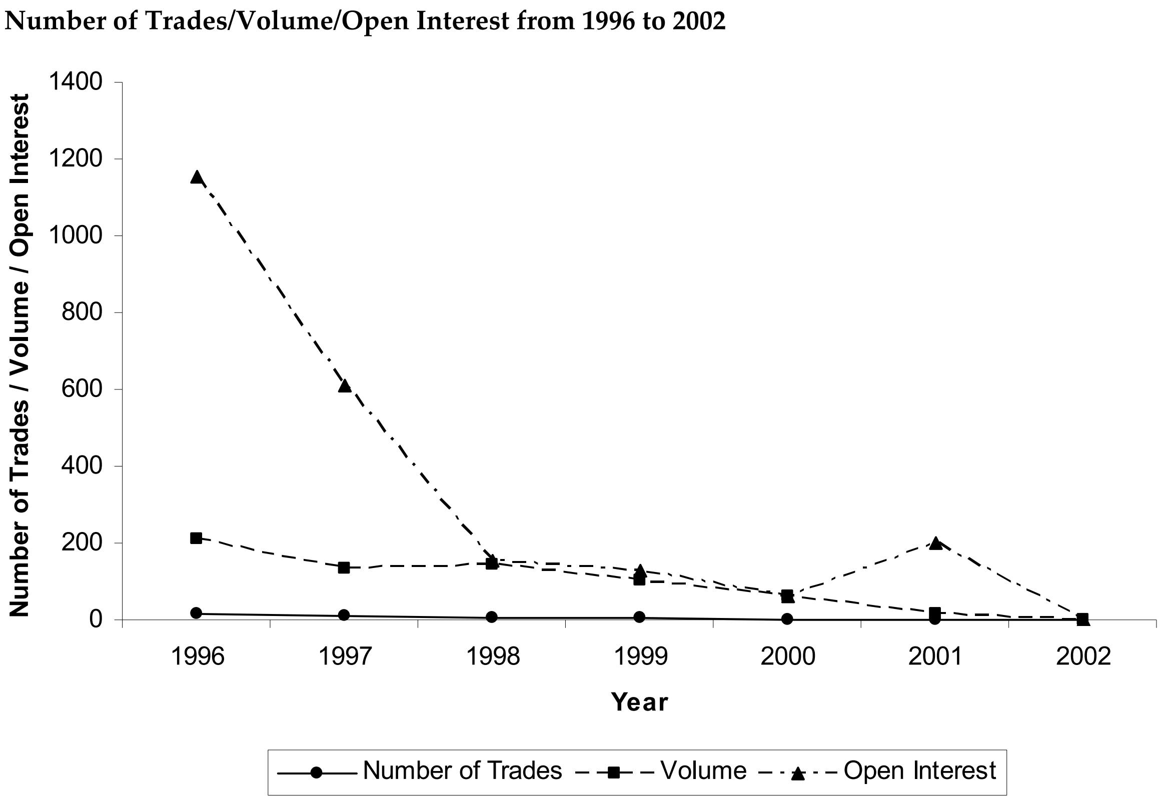

Figure 1. The figure illustrates the downward trend for number of trades, trading volume and open interest for the lifespan of the contract, up till the year 2002, when there was zero trades, volume and open interest.

Similarly, volume is expected to decrease from 1996 to 2002. From data observation, Figure 1 shows that volume decreases through the years except in 1998 when mean volume increased from 120.0157 to 124.4585 in 1998. This increase in mean volume is not statistically significant at 1% level. Interestingly, the volume increases from 1997 to 1998 while the number of trades decreases during the same period. This suggests that there are fewer trades, but trades are of a higher volume The mean volume decrease from 1996 to 1997, 1998 to 1999 and 1999 to 2000 is significant at 1% level. Like the results of number of trade analysis, the decrease from 2000 to 2001 and 2001 to 2002 is a 99% and 100% decrease, respectively, although the decrease is statistically not significant. However, the decrease from 1998 to 2000, 2001 and 2002 is significant at 1% level. This implies that the continuing decrease in mean trading volume from year 1998 is significant. The results also confirm the hypothesis that volume decreases as the contract nears its demise.

Open interest is also expected to decrease when the contract nears its demise. As shown in Figure 1, during the first 2 years from 1996 to 1998, there is a sharp drop in open interest from 1162.9809 to 158.9012. The decrease from 1996 to 1998 is statistically significant at 1% level. However, there is no statistically significant decrease from 1998 to 2002. Based on the results, it is not significant to conclude that open interest decreases near the contract's demise.

While some years do not show a statistical difference, in general, all three variables portray a downward trend through the lifespan of the contract. Figure 1 shows the time-series graph for number of trades, volume, and open interest. As can be seen from the graph, the number of trades, volume and open interest for the contract have declined by a large amount as compared to the start. As mentioned earlier, we infer that an exchange will delist a contract if it is not able to sustain a profitable level of trading volume. Clearly, interest in the Brent Crude Oil futures contract had diminished to such an extent that it was no longer profitable for the SGX to continue listing it. On hindsight, the impending demise of the contract seems to be evident starting from 1998. A summary of the results can be found in Table 1.

Table 1. Daily Volume, Open Interest, Number of Trades and Bid–Ask Spread.

Panel A: Descriptives

Year	N	Mean Volume	N	Mean Open Interest	N	Mean No. of Trades	N	Mean Bid–Ask Spread %
1996	157	201.89	157	1162.98	157	15.47	155	0.64%
1997	254	120.02	254	646.64	254	10.18	249	0.75%
1998	253	124.46	253	158.90	253	6.85	248	1.20%
1999	252	66.90	252	117.75	252	3.51	191	1.45%
2000	252	15.04	252	55.56	252	0.84	72	1.02%
2001	252	0.20	252	21.31	252	0.01	NA	NA
2002	73	0.00	73	0.00	73	0.00	NA	NA

Panel B: Year-on-Year Comparison

Year	Volume		Open Interest		Number of Trades		Bid–Ask Spread %	
Period	Mean Difference	Sig.	Mean Difference	Sig.	Mean Difference	Sig.	Mean Difference	Sig.
1996 : 1997	81.88 **	0.000	516.34 **	0.000	5.29 **	0.000	−0.11%	0.938
1997 : 1998	−4.44	1.000	487.74 **	0.000	3.33 **	0.000	−0.45% **	0.002
1998 : 1999	57.56 **	0.001	41.15	0.947	3.34 **	0.000	−0.25%	0.287
1999 : 2000	51.86 **	0.004	62.19	0.711	2.67 **	0.003	0.43%	0.133
2000 : 2001	14.84	0.939	34.25	0.979	0.83	0.900	NA	NA
2001 : 2002	0.20	1.000	21.31	1.000	0.01	1.000	NA	NA
1998 : 2000	109.42 **	0.000	103.34	0.131	6.00 **	0.000	−0.18%	0.852
1998 : 2001	124.26 **	0.000	137.59 *	0.011	6.83 **	0.000	NA	NA
1998 : 2002	124.46 **	0.000	158.9	0.108	6.85 **	0.000	NA	NA

* Significant at 5% level. ** Significant at 1% level.

Panel A reports the mean volume, open interest, number of trades and bid–ask spread across the lifespan of the contract. The mean of the various microstructure effects is compared to determine the trend when the contract nears its demise. Mean trading volume is calculated by taking the daily trading volume and dividing it by the number of observations for the year. Mean open interest is calculated by taking the daily open interest and dividing it by the number of observations for the year. Mean number of trades is calculated by taking the daily number of trades and dividing it by the number of observations for the year. Mean bid–ask spread is calculated by taking the daily time-weighted bid–ask spread (Equation (2)) and dividing it by the number of observations for the year. The number of observations for bid–ask spread is less than the rest because there are trading days with no bid, no ask or both. In general, the results show a downward trend in the mean volume, mean open interest and mean number of trades. In contrast, the mean bid–ask spread shows an upward trend except for the year 2000, when there is a decrease. Panel B reports the mean difference between yearly volume, open interest, number of trades and bid–ask spread across the lifespan of the contract. The mean difference is derived by taking the difference in trading volume, open interest, number of trades and bid–ask spread between two relevant years using information from Panel A.

5.1.2. Bid–Ask Spread

Observation shows that the mean bid–ask spread widens from 1996 to 1999 as expected. However, the bid–ask spread narrows from 0.0145 to 0.0102 in 2000, which contradicts our hypothesis. However, this can be attributed to the smaller sample size due to exclusions of trading days which yield zero BAS. Statistically, the only significant difference in mean bid–ask spread occurs in the period 1997–1998. The results are not statistically significant to conclude that bid–ask spread widens when the contract nears its demise. However, the time-weighted bid–ask spread widens from 1996 to 1999. This supports the literature that lower liquidity (lower trading volume and open interest) leads to widening of BAS.

A summary of the bid–ask spread analysis through the years can be found in Table 1.

5.1.3. Volatility

An analysis of the volatility of returns shows that there is no clear trend through the years. The F-statistic of 1.403 is not significant at the 5% level. The returns variances are statistically similar. This is contrary to previous literature which suggests a positive relationship between trading volume and price volatility. We suggest two possible reasons for this: (1) we define volatility as the variance of the difference between two trading days' settlement prices, whereas some studies use a different definition and (2) most of the previous studies were performed on contracts that generated a relatively high trading volume. As such, such a relation may not hold for the Brent Crude Oil contract as hypothesized. A summary of results can be found in Table 2.

Table 2. Results of Returns Volatility Tests from 1996 to 2002.

Panel A: Descriptives		
Year	**N**	**Variance of Returns**
1996	157	0.0346%
1997	254	0.0263%
1998	253	0.0632%
1999	252	0.0951%
2000	252	0.0632%
2001	252	0.0777%
2002	50	0.0782%

Panel B: F-test statistics	
F	**Sig.**
1.40	0.21

5.2. Mutual Offset Effect

To examine the mutual offset effect embedded in the contract, we compare the number of trades, trading volume, open interest and bid–ask spread of period 1 (0925–1600), period

2 (1600–1745), and period 3 (1802–0413) in a time series separately, as well as between the three periods.

5.2.1. Number of Trades, Volume and Open Interest

In period 1, there is no mutual offset with ICE. The number of trades is observed to decrease from 1996 to 2002 however the decrease is not statistically significant except from 1997 to 1998. The trading volume is observed to decrease generally except in years 1999 and 2001. However, the mean difference between the years is also not statistically significant except from 1999 to 2000. Open interest shows a similar decreasing trend from 1996 to 2000. A summary of results is shown in Table 3.

Table 3. Volume, Open Interest, Number of Trades and Bid–Ask Spread for 0925–1600.

Panel A: Descriptives								
Year	**N**	**Mean Volume**	**N**	**Mean Open Interest**	**N**	**Mean No. of Trades**	**N**	**Mean Bid–Ask Spread %**
1996	157	38.60	157	175.23	157	3.35	148	0.73%
1997	254	32.98	254	91.15	254	2.59	231	0.87%
1998	253	23.90	253	25.99	253	1.31	210	1.42%
1999	252	21.70	252	22.36	252	0.96	138	1.47%
2000	252	3.12	252	3.47	252	0.15	25	1.93%
2001	252	0.20	252	2.36	252	0.01	NA	NA
2002	73	0.00	73	0.00	73	0.00	NA	NA

Panel B: Year-on-Year Comparison								
Year	**Volume**		**Open Interest**		**Number of Trades**		**Bid–Ask Spread %**	
Period	**Mean Difference**	**Sig.**	**Mean Difference**	**Sig.**	**Mean Difference**	**Sig.**	**Mean Difference**	**Sig.**
1996 : 1997	5.62	0.971	84.08 **	0.000	0.76	0.497	−0.14%	0.761
1997 : 1998	9.07	0.632	65.16 **	0.000	1.27 *	0.007	−0.56% **	0.000
1998 : 1999	2.20	1.000	3.63	1.000	0.36	0.955	−5%%	0.994
1999 : 2000	18.57 *	0.011	18.89	0.801	0.81	0.267	−0.45%	0.310
2000 : 2001	2.93	0.998	1.11	1.000	0.14	1.000	NA	NA
2001 : 2002	0.20	1.000	3.47	1.000	0.01	1.000	NA	NA
1998 : 2000	20.87 **	0.003	22.52	0.633	1.16 *	0.020	−0.50%	0.189
1998 : 2001	23.70 **	0.000	23.63	0.578	1.30 **	0.005	NA	NA
1998 : 2002	23.90 *	5%0	25.99	0.855	1.31	0.174	NA	NA

* Significant at 5% level. ** Significant at 1% level.

Panel A reports the mean volume, open interest, number of trades and bid–ask spread across the lifespan of the contract for period 1 (0925–1600). The mean of the various microstructure effects in period 1 is compared to determine the trend when the contract nears its demise. In general, the results show a downward trend in the mean volume, mean open interest and mean number of trades for period 1. In contrast, the mean bid–ask spread shows an upward trend. Panel B reports the mean difference between yearly volume, open interest, number of trades and bid–ask spread across the lifespan of the contract for period 1. The mean difference is derived by taking the difference in trading volume, open interest, number of trades and bid–ask spread between two relevant years using information from Panel A.

In period 2, there is mutual offset with ICE. The number of trade decreases from 1996 to 2001, whereby the number of trades from 2001 onwards is zero. The decrease is significant at 1% level. Trading volume shows an overall decrease except in year 1998 where trading volume increases from 85.83 to 98.65. The increase is not significant at 5% level. Open interest shows a similar decreasing trend, with significant decreases from 1996 to 1998. The results in period 2 are closer to the results shown in the time-series analysis. A summary of results is shown in Table 4.

Table 4. Volume, Open Interest, Number of Trades and Bid–Ask Spread for 1600–1745.

Panel A: Descriptives								
Year	**N**	**Mean Volume**	**N**	**Mean Open Interest**	**N**	**Mean no. of Trades**	**N**	**Mean Bid–Ask Spread %**
1996	157	152.69	157	919.91	157	11.93	170	0.39%
1997	254	85.83	254	460.09	254	7.50	275	0.47%
1998	253	98.65	253	103.27	253	5.48	263	0.85%
1999	252	41.09	252	57.41	252	2.46	202	1.19%
2000	252	11.92	252	12.51	252	0.69	73	0.72%
2001	252	0.00	252	0.00	252	0.00	NA	NA
2002	73	0.00	73	0.00	73	0.00	NA	NA

Panel B: Year-on-Year Comparison								
Year	**Volume**		**Open Interest**		**Number of Trades**		**Bid–Ask Spread %**	
Period	**Mean Difference**	**Sig.**	**Mean Difference**	**Sig.**	**Mean Difference**	**Sig.**	**Mean Difference**	**Sig.**
1996 : 1997	66.86 **	0.000	459.82 **	0.000	4.43 **	0.000	−0.08%	0.958
1997 : 1998	−12.82	0.835	356.82 **	0.000	2.02 **	0.000	−0.37% **	0.003
1998 : 1999	57.56 **	0.000	45.85	0.833	3.02 **	0.000	−0.35% *	0.018
1999 : 2000	29.17 *	0.040	44.90	0.847	1.77 **	0.003	0.47% *	0.036
2000 : 2001	11.92	0.879	12.51	1.000	0.69	0.764	NA	NA
2001 : 2002	0.00	1.000	0.00	1.000	0.00	1.000	NA	NA
1998 : 2000	86.73 **	0.000	90.75	0.112	4.79 **	0.000	0.12%	0.940
1998 : 2001	98.65 **	0.000	103.27 *	0.041	5.48 **	0.000	NA	NA
1998 : 2002	98.65 **	0.000	103.27	0.402	5.48 **	0.000	NA	NA

* Significant at 5% level. ** Significant at 1% level.

Panel A reports the mean volume, open interest, number of trades and bid–ask spread across the lifespan of the contract for period 2 (1600–1745). The mean of the various microstructure effects in period 2 is compared to determine the trend when the contract nears its demise. In general, the results show a downward trend in the mean volume, mean open interest and mean number of trades for period 2. In contrast, the mean bid–ask spread shows an upward trend except for the year 2000, when there is a decrease. Panel B reports the mean difference between yearly volume, open interest, number of trades and bid–ask spread across the lifespan of the contract for period 2. The mean difference is derived by taking the difference in trading volume, open interest, number of trades and bid–ask spread between two relevant years using information from Panel A.

In period 3, there is a general decreasing trend for open interest and number of trades and trading volume. The mean difference is not statistically significant. The lack of trading volume, open interest, and number of trades from 1998 onwards shows that the contract is thinly traded for this period of time from 1998 onwards. A summary of results can be found in Table 5.

Panel A reports the mean volume, open interest and number of trades across the lifespan of the contract for period 3 (1802–0413). The mean of the various microstructure effects in period 3 is compared to determine the trend when the contract nears its demise. In general, the results show a downward trend in the mean volume, mean open interest and mean number of trades for period 3 except for the year 1999, when there is an increase in mean number of trades. Panel B reports the mean difference between yearly volume, open interest and number of trades across the lifespan of the contract for period 3. The mean difference is derived by taking the difference in trading volume, open interest and number of trades between two relevant years using information from Panel A.

Table 5. Volume, Open Interest and Number of Trades for 1802–0413.

Panel A: Descriptives						
Year	**N**	**Mean Volume**	**N**	**Mean Open Interest**	**N**	**Mean No. of Trades**
1996	157	9.53	157	8.85	157	0.19
1997	254	1.21	254	2.70	254	0.09
1998	253	1.67	253	1.38	253	0.06
1999	252	2.13	252	0.95	252	0.10
2000	252	0.00	252	0.00	252	0.00
2001	252	0.00	252	0.00	252	0.00
2002	73	0.00	73	0.00	73	0.00

Panel B: Year-on-Year Comparison						
Year	**Volume**		**Open Interest**		**Number of Trades**	
Period	**Mean Difference**	**Sig.**	**Mean Difference**	**Sig.**	**Mean Difference**	**Sig.**
1996 : 1997	8.32	0.217	6.14	0.136	0.10	0.504
1997 : 1998	−0.46	1.000	1.32	0.996	0.04	0.978
1998 : 1999	−0.46	1.000	0.43	1.000	−0.04	0.976
1999 : 2000	2.12	0.993	0.95	0.999	0.10	0.356
2000 : 2001	0.00	1.000	0.00	1.000	0.00	1.000
2001 : 2002	0.00	1.000	0.00	1.000	0.00	1.000
1998 : 2000	1.67	0.998	1.38	0.995	0.06	0.887
1998 : 2001	1.67	0.998	1.38	0.995	0.06	0.887
1998 : 2002	1.67	1.000	1.38	0.999	0.06	0.983

An analysis is also performed between the periods. Mean number of trades in period 2 is 3.9900, statistically higher than period 1 and 3. A similar observation is made for mean open interest and mean volume. Period 2's open interest and trading volume are statistically higher than period 1 and 3. It is noted that although period 2 lasted 1 h and 45 min as compared to 6 h and 35 min (period 1) and 11 h and 11 min (period 3), the open interest, trading volume and number of trades generated are statistically higher. This suggests that the contract is primarily used during the mutual offset period between 1600 and 1745. The contract is thinly traded in period 3 although mutual offset feature is available. The differences in trading volume, open interest and number of trades are significant at the 1% level between period 3 and the other 2 periods.

We identify two possible reasons for this phenomenon. First, people who trade this contract are mostly European traders.[4] The first mutual offset trading period coincides with the time the London market opens. Therefore, it is reasonable to expect higher trading volume during this period when traders have time to factor in new price-sensitive information from the previous day market close. The traders will thus trade on this information, leading to higher trading activity. Second, as a result of high trading activity during the start of London trading hours, some traders will use SGX as a platform to execute their trades. This accounts for the fact that number of trades, trading volume and open interest is significantly higher for the first mutual offset time period (1600–1745) as compared to the second mutual offset time period (1802–0413).

However, even though the results suggest that the contract is primarily used during the mutual offset period between 1600 and 1745, a look at Table 4 shows that even the mutual offset feature is not sufficient to sustain the initial trading volume, open interest and number of trades. A reason could be improvements in the trading platform of ICE made it no longer necessary for European traders to use SGX as a platform to execute their trades during start of European trading hours. A summary of results for analysis between periods can be found in Table 6, and the time-series graphs can be found in Figure 2.

Table 6. Volume, Open Interest, Number of Trades and Bid–Ask Spread Between Periods.

Panel A: Descriptives

Period	N	Mean Volume	N	Mean Open Interest	N	Mean No. of Trades	N	Mean Bid–Ask Spread %
1	1493	17.94	1493	43.10	1493	1.20	752	1.14%
2	1493	56.32	1493	204.31	1493	3.99	983	0.73%
3	1493	1.85	1493	1.79	1493	0.06	NA	NA

Panel B: Year-on-Year Comparison

Year	Volume		Open Interest		Number of Trades		Bid–Ask Spread %	
Period	**Mean Difference**	**Sig.**	**Mean Difference**	**Sig.**	**Mean Difference**	**Sig.**	**Mean Difference**	**Sig.**
Period 1 : 2	−38.38 **	0.000	−161.21 **	0.000	−2.79 **	0.000	−0.41% **	0.000
Period 2 : 3	54.47 **	0.000	202.53 **	0.000	3.93 **	0.000	NA	NA
Period 1 : 3	16.09 **	0.000	41.31 **	0.000	1.14 **	0.000	NA	NA

** Significant at 1% level.

Panel A reports the mean volume, open interest, number of trades and bid–ask spread across the lifespan of the contract between periods. The mean of the various microstructure effects between the three periods is compared to determine the impact of the mutual offset feature. The mean volume, mean open interest and mean number of trades reported the highest figures in period 2 and the lowest figures in period 3. The mean bid–ask spreads shows a downward trend between periods. Panel B reports the mean difference between yearly volume, open interest, number of trades and bid–ask spread across the lifespan of the contract between periods. The mean difference is derived by taking the difference in trading volume, open interest, number of trades and bid–ask spread between two periods using information from Panel A.

Panel A illustrates the variance of returns across the lifespan of the contract. Figures (rounded off to four decimal places) are calculated using the formula:

$$Var(ln\ P_{t+1} - ln\ P_t)$$

where P is the daily settlement price.

Panel B illustrates the F-test statistics that shows the variability in the returns through the years. It does not appear that there is a general trend statistically for the variance of returns.

5.2.2. Bid–Ask Spread

In period 1, the bid–ask spread widens through observation. The increase in spreads is only significant from 1997 to 1998. A summary of results can be found in Table 3. In period 2, there is mutual offset with ICE. The widening of BAS is significant at the 1% level from 1997 to 1998. From 1998 to 1999 and from 1999 to 2000, the widening is significant at 5% level. A summary of results can be found in Table 4. There are no BAS % in period 3 due to the lack of a pair of bid and ask orders daily in this period.

The bid–ask spreads are analyzed between the periods to examine the effects of mutual offset on the contract. Spreads are observed to be smaller in period 2 as compared to period 1. The narrowing of spreads in a mutual offset period is statistically significant at 1% level. Results can be found in Table 6. This finding supports our hypothesis that bid–ask spread narrows during the mutual offset period. Period 3 is ignored in this analysis as there is only one observation.

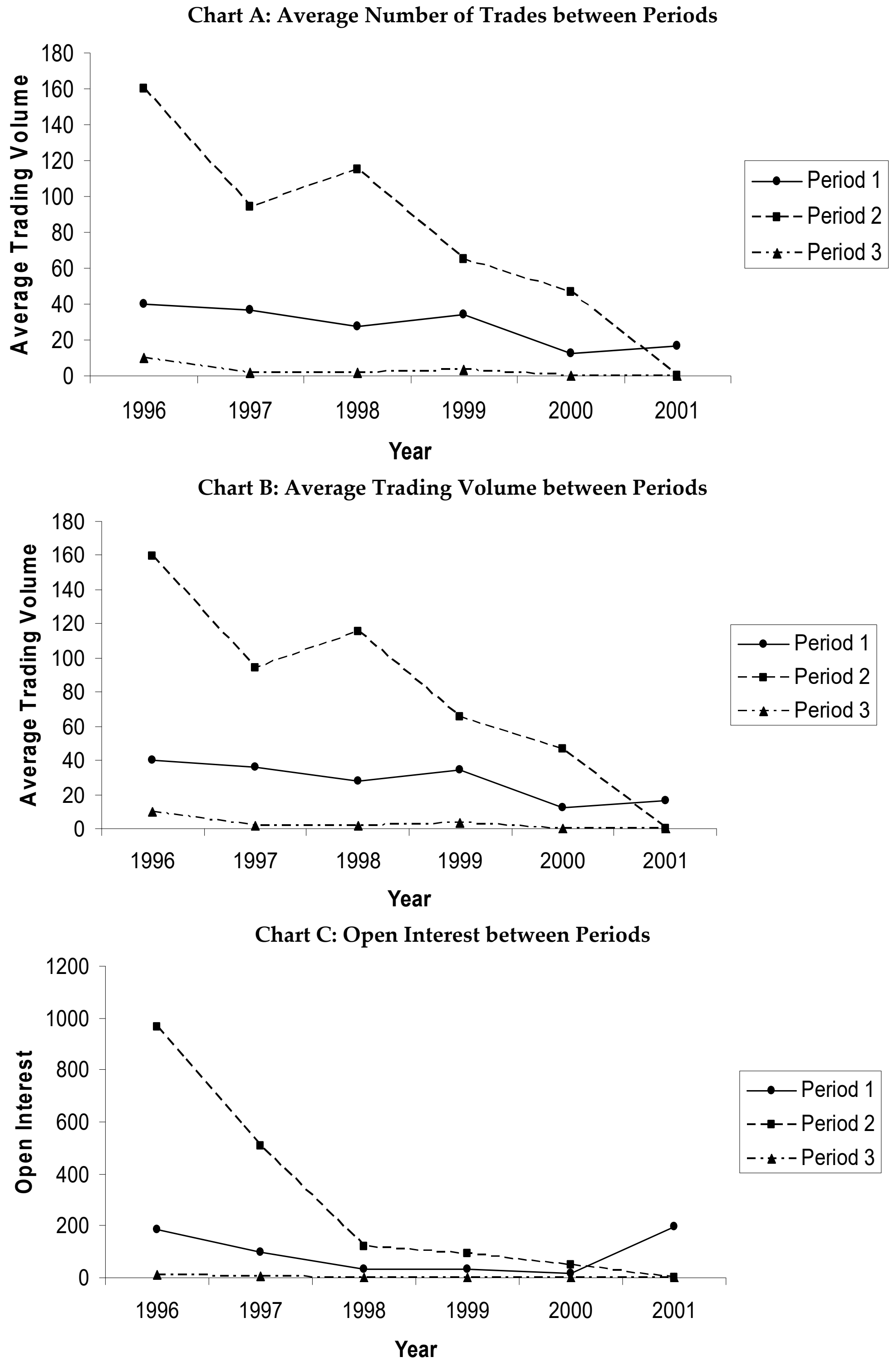

Figure 2. Charts A, B and C shows a graphical representation of the trend in average number of trades, average trading volume (in 1000 barrel) and trend open interest across the lifespan of the contract between time periods. Period 1 spans 0925–1600, period 2 spans 1600–1745 and period 3 spans 1802–0413, respectively. The time periods have been adjusted for the effects of daylight savings time. The three charts show a downward trend through the years. In addition, the average number of trades, average trading volume and open interest are generally highest in period 2, followed by period 1 followed by period 3.

6. Summary and Conclusions

Much valuable time and resources are wasted whenever a contract fails, i.e., delists from the exchange. The Brent Crude Oil futures contract serves as a typical example of a futures contract that started out with much promise but as time passed, interest in the contract dwindled and resulted in its failure, even with the presence of a mutual offset feature. Thus, it is of utmost importance to examine the factors that led to its demise.

We acknowledge that our study only identifies the microstructure aspects that explain its failure. There may be external factors that contributed to its demise. Macroeconomic factors, like the Asian Financial Crisis, can adversely impact the success of a contract. Moreover, the fact that the energy industry is often subjected to various political implications can also be a factor.

From our findings, we establish that trading volume and number of trades decrease near a contract's demise, aligned with our hypothesis. Open interest is observed to decrease as expected; however, the results do not confirm our hypothesis statistically. BAS increases when liquidity decreases, increasing the transaction costs of trading the contract.

Within the mutual offset feature, there is a significantly high level of volume, open interest, and number of trades in period 2 over period 1 even though its trading hours are much shorter. This suggests that the contract is primarily used during the mutual offset period between 1600 and 1745. We conclude that having a mutual offset feature in contracts with multi-market trading significantly increases trading activity, ultimately affecting the probability of a contract's success.

Futures exchanges can focus on the determinants studied in the paper and establish a set of criteria on when a contract should be deemed to be unprofitable. For example, after 2000, we can see that trading activity in the Brent Crude Oil futures contract was already very low. With an established set of criteria to follow, the waste of precious time and resources could have been avoided. Also, exchanges can introduce incentives during the launch of a contract to influence trading activity, e.g., marketing efforts and initial waiver of trading fees. By building up an initial critical mass of trading volume, contracts are more likely to have a higher chance of success.

We acknowledge that there are limitations in our paper. Future research can be performed to build on our microstructure studies on the drivers of successful contracts. This is especially important when exchanges introduce new contracts at an increasingly remarkable pace.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

The three tables show all the derivative contracts that have been listed on SGX-DT since its induction. As can be seen, out of the 38 contracts listed, 10 have been delisted and 7 are classified as dormant. This represents a success rate of only 55.26% (where success is defined as contracts still listed and traded on SGX-DT).

Listed SGX-DT Contracts	Symbol	Date
Eurodollar	ED	07/09/1984
Nikkei 225 Stock Index	NK	03/09/1986
Eurodollar Options	CE. PE	25/09/1987
Euro yen	EY	27/10/1989
Euro yen Options	CEY, PEY	19/06/1990
Nikkei 225 Stock Index Options	CNK, PNK	19/03/1992
Mini Japanese Government Bonds	JB	01/10/1993
Mini Japanese Government Bond Options	CJB, PJB	11/05/1994
MSCI Taiwan Index	TW	09/01/1997
MSCI Taiwan Index Options	CTW, PTW	09/01/1997
MSCI Singapore Stock Index	SG	07/09/1998
MSCI Hong Kong Stock Index	HK	23/11/1998
Euro yen Libor	EL	22/02/1999
Euro yen Libor Options	CEL, PEL	08/03/1999
Singapore Dollar Interest Rate	SD	10/09/1999
Straits Times Index	ST	28/06/2000
S&P CNX Nifty Index	IN	25/09/2000
5-Year Singapore Government Bond	SB	29/06/2001
Single Stock Futures	SSF	26/10/2001
MSCI Japan Index	JP	15/05/2002
Additional Single Stock Futures	SSF	15/08/2002
Delisted Contracts	**Launched Date**	**Delisted Date**
Treasury Bond Futures	08/10/1986	04/12/1987
Dubai Crude Oil Futures	21/06/1990	31/01/1992
Gasoil Futures	25/06/1991	19/11/1993
Deutschemark Options	27/11/1987	19/11/1993
Japanese Yen Futures	07/11/1984	23/06/1995
British Pound Futures	01/07/1986	23/06/1995
MSCI Hong Kong Futures	31/03/1993	28/08/1997
Brent Crude Futures	09/06/1995	14/03/2002
Euro mark Futures	20/09/1990	29/10/2004
Deferred Spot USD/DM	01/11/1993	29/10/2004
Dormant Contracts	**Launched Date**	**Effective Date**
Gold Futures	05/07/1984	15/05/1998
High Sulphur Fuel Oil	01/11/1993	08/06/1998
Deferred Spot USD/JY	01/11/1993	08/06/1998
DJ Thailand Stock Index	02/11/1998	01/11/2000
Nikkei 300 Stock Index	03/02/1995	19/09/2005
Nikkei 300 Stock Index Options	03/02/1995	19/09/2005
10-Year Japanese Government Bond Options	18/04/2002	19/09/2005

Appendix B

Contract Specifications of SGX Brent Crude Futures:

Contract size:	1000 barrels (42,000 US gallons)
Ticker symbol:	BC
Contract Months:	2 consecutive front months
Trading hours: (Singapore time)	Fall: 9.25 a.m.–4.00 p.m. (Electronic trading) 4.00 p.m.–5.45 p.m. (Mutual offset trading with IPE) 6.02 p.m.–04.03 a.m. (Mutual offset trading with IPE) Summer: 10.25 a.m.–5.00 p.m. (Electronic trading) 5.00 p.m.–6.45 p.m. (Mutual offset trading with IPE) 7.02 p.m.–05.03 a.m. (Mutual offset trading with IPE)
Minimum price fluctuation:	1 cent per barrel (USD 10)

Daily price limits:	+/- USD 15 from previous day's settlement price, trading at or within a price limit of USD 15 is allowed for the next 15 min. Thereafter, there shall be no price limit for the rest of the trading day. No price limit during the last 30 min before the close of trading on any trading day. There shall be no price limit on the last trading day of the expiring contract month.
Settlement basis:	Cash settlement with option for physical delivery under the Exchange for Physicals mechanisms.
Final settlement price:	Based on the cash settlement price which is used to settle the Brent Crude futures for the same contract month at IPE. This value will the price indicated by the Brent Index for the last day of trading for the futures contract.

Appendix C

Daylight savings time (DST), also known as summertime in British English, is the convention of advancing clocks so that evenings have more daylight and mornings have less. Typically, clocks are adjusted forward one hour in late winter or early spring and are adjusted backward in autumn. DST is used mostly in temperate and Polar Regions, where summer mornings are longer and have more hours to spare.

Fall Trading Hours (October–March)	Summer Trading Hours (March–October)
0925–1600	1025–1700
1600–1745	1700–1845
1802–0413	1902–0513

This occurs on the last Sunday of March and October every year, respectively. The exact dates when DST occurs are given below in the table.

Year	Exact Dates
1996	March 31–Oct 27
1997	March 30–Oct 26
1998	March 29–Oct 25
1999	March 28–Oct 24
2000	March 26–Oct 29
2001	March 25–Oct 28
2002	March 24–Oct 27

Notes

1 Refer to Appendix A.
2 Refer to Appendix B.
3 Refer to Appendix C.
4 This information is supplied by Mr. Calvin Teng of TFS Energy Singapore.

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