The lead-lag relationship of Block Trade Single Stock Futures and the underlying stocks: Evidence from Thailand

Miss Pimnapa Wongvisavakorn

An Independent Study Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science in Finance
Department of Banking and Finance
FACULTY OF COMMERCE AND ACCOUNTANCY
Chulalongkorn University
Academic Year 2020

ความสัมพันธ์แบบนำ-ตาม ระหว่างตลาดสัญญาซื้อขายล่วงหน้าที่อ้างอิงราคาหุ้นแบบรายใหญ่และตลาดทุน-หลักฐานจากประเทศไทย

น.ส.พิมพ์นภา วงศ์วิศวะกร

สารนิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
สาขาวิชาการเงิน ภาควิชาการธนาคารและการเงิน
คณะพาณิชยศาสตร์และการบัญชี จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2563

Independent Study Title	The lead-lag relationship of Block Trade Single Stock Futures and the underlying stocks: Evidence from Thailand
By	Miss Pimnapa Wongvisavakorn
Field of Study	Finance
Thesis Advisor	Assistant Professor Dr. TANAKORN LIKITAPIWAT, Ph.D.

Accepted by the FACULTY OF COMMERCE AND ACCOUNTANCY, Chulalongkorn University in Partial Fulfillment of the Requirement for the Master of Science

INDEPENDENT STUDY COMMITTEE

.... Chairman
()

.... Advisor
(Assistant Professor Dr. TANAKORN LIKITAPIWAT, Ph.D.)

.... Examiner
(Associate Professor Dr. VIMUT VANITCHAREARNTHUM, Ph.D.)

.... Examiner
(Assistant Professor Dr. RUTTACHAI SEELAJAROEN, Ph.D.)

พิมพ์นภา วงศ์วิศวะกร : ความสัมพันธ์แบบนำ-ตาม ระหว่างตลาดสัญญาซื้อขายล่วงหน้าที่อ้างอิงราคาหุ้นแบบรายใหญ่และตลาดทุน-หลักฐานจากประเทศไทย. (The lead-lag relationship of Block Trade Single Stock Futures and the underlying stocks: Evidence from Thailand) อ.ที่ปรึกษาหลัก : ผศ. ดร.ธนากร ลิขิตาภิวัฒน์

-

สาขาวิชา	การเงิน	ลายมือชื่อนิสิต ....
ปีการศึกษา	2563	ลายมือชื่อ อ.ที่ปรึกษาหลัก ....

6284046526 : MAJOR FINANCE
KEYWORD: VECM, Granger causality, Block trade single stock futures, futures, Lead-lag relationship

Pimnapa Wongvisavakorn : The lead-lag relationship of Block Trade Single Stock Futures and the underlying stocks: Evidence from Thailand. Advisor: Asst. Prof. Dr. TANAKORN LIKITAPIWAT, Ph.D.

According to the efficient market hypothesis, there should not be any lead-lag relationship of the spot and futures price of the financial assets; however, many empirical studies have suggested otherwise. This study uses the Vector Error Correction Model (VECM) and Granger causality test with the daily trading data of Thailand's block trade single stock futures and its underlying securities of 42 companies from 2016 to 2020. It reveals both unidirectional and bidirectional relationships of spot and futures markets with a less dominant role of the futures market in the price discovery function. None of the sample companies have both long-run and short-run causality from futures to spot market, and only 5% of the 42 companies show the leading role of the futures market in the long-run with bilateral interaction in the short-run. The results contradict our hypothesis that block trade single stock futures lead the counterpart underlying stocks in the short-run and long-run despite the higher leverage, lower transaction cost, and no short sale restriction of the futures market. The lead-lag relationship between block trade single stock futures and the underlying stocks in Thailand can provide insightful information for regulators and policymakers in promoting efficiency and improving the information asymmetry that would help create a better trading environment for investors.

Field of Study:	Finance	Student's Signature	....
Academic Year:	2020	Advisor's Signature	....

ACKNOWLEDGEMENTS

Writing this special project is much more difficult than I thought and more rewarding than ever imagined. Being a full-time employee in a securities firm and a part-time student in the MSF program is very much challenging especially during the COVID-19 pandemic. This special project would not be completed without the help and guidance from the following persons. Firstly, I would like to express my deepest appreciation to Asst. Prof. Tanakorn Likitapiwat. Being his advisee is very fortunate not only from an academic point of view but also his devotion and understanding allowing for flexibility in communication and working conditions. I'm also deeply indebted to my committee, Asst. Prof. Ruttachai Seelajaroen and Assoc. Prof. Vimut Vanitcharearnthum for their valuable comments and constructive suggestions. Their questions have triggered me to think allowing me to fill in the missing aspects in my work. I cannot begin to express my thanks to Mr. Natapong Teekaput who is my MSF classmate. He has helped me a lot in the data collection process, his outstanding coding skill made it much easier for me to gather all the big data used in my analysis. Without him, this study would have taken a much longer time, or even impossible to start. I must also thank Mr. Paripon Sriboon who is also my MSF classmate. He has sent me books and answered most of my questions in econometrics, I am glad that we can share opinions to improve our work together. Completion of this project would not have been possible without the support from my colleague, Mr. Thanakorn Chongsuksirichoke who covered my work whenever I need to spend extra time on this project. He always cheers me up when things are out of the plan and willing to give a fresh eye opinion on my work. Most importantly, I am extremely grateful for being the only daughter in our family. My parents are unbelievably opened to whatever path I choose; they have always given unwavering supports and inspired me to fearlessly overcome any obstacles.

Pimnapa Wongvisavakorn

TABLE OF CONTENTS

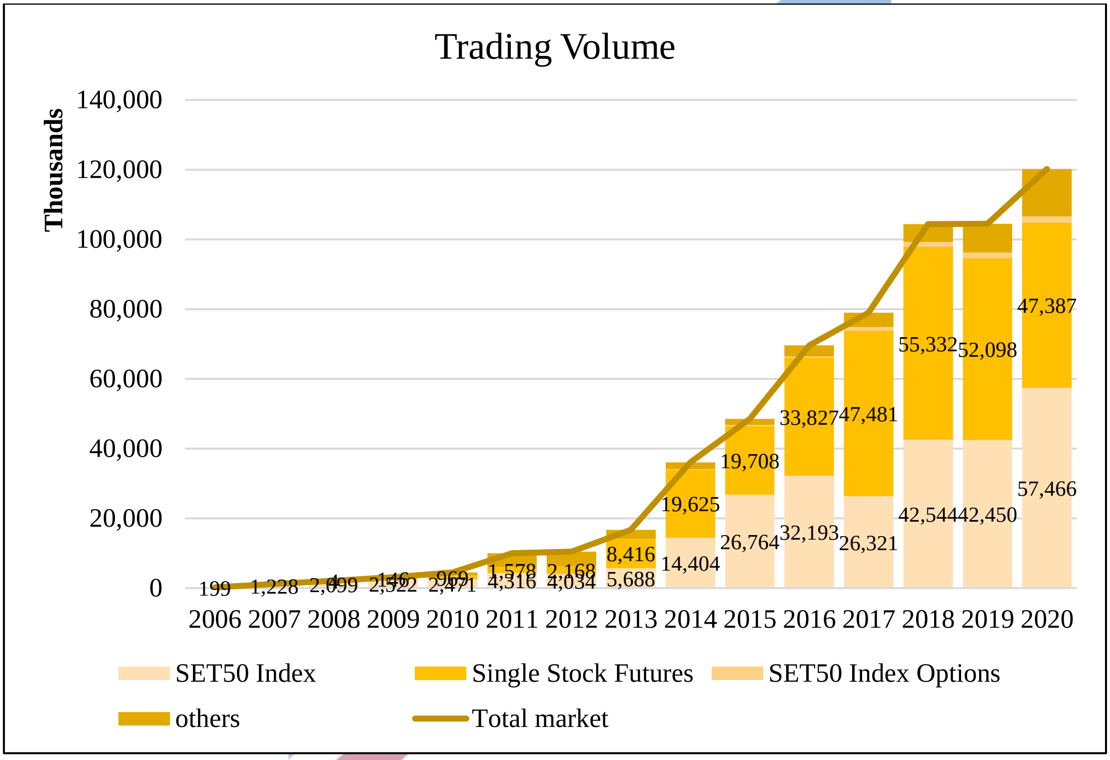
Page

1. INTRODUCTION

There are currently more than 2,600 listed equity-related securities that can be exchanged in the SET market while there are 138 futures and 1 index option being traded in the TFEX market. Thailand Futures Exchange (TFEX), a subsidiary of the Stock Exchange of Thailand (SET), was later established in May 2004 with continued development over time. SET50 Index futures were the first product launched in 2006 followed by the SET50 Index Options in October 2007. Single Stock Futures (SSF) was then launched in November 2008 having three well-established stocks namely PTT, PTTEP, and ADVANC as the underlying assets in the first batch, followed by an additional 11 SSF in June 2009. However, these stock futures did not get enough attention from investors having low trading activities. Therefore, on November 8, 2010, a “Block Trade” transaction was allowed on SSF when the transaction started to increase substantially with the support from more continuous launches reaching 121 stock futures in 2021. SET50 Index and Single Stock Futures are the two major products driving trading volume in the Thailand futures market as shown in Figure 1.

The studies of the interaction between spot and futures markets mainly concentrated on stock indices and commodities due to their prevalence and relatively higher trading activities in most of the developed markets. However, the rapid development of SSF has recently received more attention in developing markets; Thailand’s success story of Single Stock Futures has interested many regulators, policymakers, and practitioners. Like other high leverage products, lower trading costs, and unrestricted short-sale property, many investors relate Block trade on SSF to create higher volatility of the counterpart underlying assets. Vichitcholchai (2018)studied the relationship and concluded that Block Trade on SSF in Thailand provides liquidity and stabilized the spot market for the underlying assets, not the other way around. Jain et al. (2019) studies the Indian market, where the stock futures and options markets are very liquid, and found a significant increase in volume before the earnings announcements. Luerchathorn (2017) showed the abnormally increase in short-selling activities before the earning announcements in the Thai market and find the evidence against Efficient Market Hypothesis in that there was a negative relationship between short-selling trading in the pre-earnings announcements and earnings surprise, and short-sellers can predict the extreme negative earnings surprise. The lead-lag relationship has been studied by Judge and Reancharoen (2014), suggesting the leading role of the spot market using the TDEX as a proxy for SET50 index and SET50 index futures. This has raised the interesting question of how the information has been transmitted between the two markets, Block Trade on SSF and underlying securities in Thailand.

Figure 1: Annual Trading Volume in TFEX by product (numbers of contract)



Source: SETSMART

There are two types of trading transactions for SSF which are Automatic Order Matching (AOM) and Block Trade. AOM is the automatic process to match the order sent to the trading platform in which investors will have no information of the counterparty; on the contrary, Block Trade is the over-the-counter transaction that occurred from the negotiated party at the agreed volume and price. Specifically, Block trade for SSF in Thailand requires a minimum number of contracts for each transaction.

One contract is accounted for one thousand shares of the underlying stock and it differs in groups of stocks according to the announcement from TFEX as shown in Table 1

Table 1: Block Trade minimum contract size by TFEX

Underlying	Block Size	Underlying	Block Size	Underlying	Block Size	Underlying	Block Size
ADVANC	20	BCP	100	PSH	100	ITD	500
AEONTS	20	BCPG	100	PTG	100	JAS	500
AOT	20	BDMS	100	PTT	100	LH	500
BBL	20	BGRIM	100	RS	100	LPN	500
BH	20	BJC	100	SPALI	100	ORI	500
CBG	20	BLA	100	SPCG	100	PLANB	500
CPALL	20	BPP	100	STA	100	PRM	500
CPN	20	BTS	100	STEC	100	PSL	500
DELTA	20	CENTEL	100	TASCO	100	QH	500
EGCO	20	CK	100	THG	100	S	500
GPSC	20	COM7	100	TOA	100	SAMART	500
INTUCH	20	CPF	100	TTW	100	SGP	500
KBANK	20	DTAC	100	TU	100	SPRC	500
KKP	20	EA	100	TVO	100	STPI	500
M	20	EASTW	100	VNT	100	THAI	500
MTC	20	GFPT	100	AAV	500	THANI	500
PTTEP	20	GLOBAL	100	AP	500	THCOM	500
PTTGC	20	GULF	100	BA	500	TKN	500
RATCH	20	HANA	100	BANPU	500	TMB	500
ROBINS	20	HMPRO	100	BEAUTY	500	TPIPL	500
SAWAD	20	IVL	100	BEC	500	TPIPP	500
SCB	20	JMT	100	BEM	500	TTA	500
SCC	20	KCE	100	BLAND	500	TTCL	500
TCAP	20	KTB	100	CHG	500	UNIQ	500
TISCO	20	KTC	100	CKP	500	VGI	500
TOP	20	MAJOR	100	EPG	500	VNG	500
TQM	20	MBK	100	ERW	500	WHA	500
AMATA	100	MEGA	100	ESSO	500	WHAUP	500
BAY	100	MINT	100	GUNKUL	500	TRUE	500
BCH	100	OSP	100	ICHI	500	SIRI	1,000
				IRPC	500	SUPER	1,000

Table 2: Trading Volume of Single stock futures by transaction type (numbers of contract)

Volume	Total	Numbers of contract		% of Total trading Volume	
		AOM	BLOCK TRADE	AOM	BLOCK TRADE
Avg/Day	**97,811**	**10,237**	**87,574**	**10.47%**	**89.53%**
2020	47,386,674	2,183,139	45,203,535	4.61%	95.39%
2019	52,098,173	1,986,155	50,112,018	3.81%	96.19%
2018	55,332,444	2,256,852	53,075,592	4.08%	95.92%
2017	47,480,762	2,611,685	44,869,077	5.50%	94.50%
2016	33,826,624	2,698,441	31,128,183	7.98%	92.02%
2015	19,708,113	4,063,242	15,644,871	20.62%	79.38%
2014	19,624,561	6,980,815	12,643,746	35.57%	64.43%
2013	8,415,967	3,746,999	4,668,968	44.52%	55.48%
2012	2,168,037	1,179,615	988,422	54.41%	45.59%
2011	1,578,092	1,393,582	184,510	88.31%	11.69%
2010	969,353	968,353	1,000	99.90%	0.10%

Source: SETSMART

More than 90% of the recent trading volume of single stock futures in Thailand has come from Block Trade, which significantly dominates the futures market as shown in Table 2. Block trade on SSF was mainly traded by local investors having similar functions to put-through transactions in the spot market. Table 3 shows the investor participation in Single Stock Futures since 2011; the SSF market has been dominated by the local players. This supports the recent meaning of Block trade on SSF, it is the big lot trade on SSF where a minimum number of contracts is exchanged over the counter having the broker members as a counterparty for any investors. Individuals can participate easily by placing collateral not less than the initial margin and sending an order to buy or sell an underlying asset not less than a minimum number of the contract specified by Thailand Clearing House Co., Ltd. (TCH). The counterparty broker members usually hedge the position through the spot market; therefore, we can assume some relationship between the two markets. Empirical studies in Thailand by

Muntanaveerakul et al. (2020) have suggested that Single Stock Futures trading reduces volatilities in their counterpart's spot market.

Table 3: Trading Volume of Single Stock futures by investor type

Date	**SSF Trading Volume (contracts)**				**SSF Trading Volume (% share)**			
	Foreign Investors	Local Institutions	Local Individuals	**Total**	Foreign Investors	Local Institutions	Local Individuals	**Total**
2020	7,886,725	42,166,966	44,719,657	**94,773,348**	8.32%	44.49%	47.19%	**100.00%**
2019	9,065,599	46,682,057	48,448,690	**104,196,346**	8.70%	44.80%	46.50%	**100.00%**
2018	7,932,635	51,461,465	51,270,788	**110,664,888**	7.17%	46.50%	46.33%	**100.00%**
2017	3,540,039	46,237,505	45,183,980	**94,961,524**	3.73%	48.69%	47.58%	**100.00%**
2016	453,338	34,743,064	32,456,846	**67,653,248**	0.67%	51.35%	47.98%	**100.00%**
2015	395,138	18,944,086	20,077,002	**39,416,226**	1.00%	48.06%	50.94%	**100.00%**
2014	404,088	16,121,280	22,723,754	**39,249,122**	1.03%	41.07%	57.90%	**100.00%**
2013	287,065	5,922,269	10,622,600	**16,831,934**	1.71%	35.18%	63.11%	**100.00%**
2012	114,785	1,361,725	2,859,564	**4,336,074**	2.65%	31.40%	65.95%	**100.00%**
2011	7,776	289,444	1,333,134	**1,630,354**	0.48%	17.75%	81.77%	**100.00%**

Source: SETSMART

In an efficient market, all publicly available information will be reflected in the security price. Assuming risk neutrality and rationality, any new information will be reflected in the two markets simultaneously. Any speculative activities would generate zero abnormal return; in other words, there is no existence of predictability. Thus, the lead-lag relationship between the futures and spot market doesn't exist. Empirically, despite the advanced development of the cointegration technique, it is difficult to conclude the relationship between the spot and futures prices. Various studies have revealed the conflicting relationship between the two markets. The studies of S&P 500 & FTSE 100 (Wahab & Lashgari, 1993), Malaysian stock market (Zakaria & Shamsuddin, 2012), and Turkish stock market (Kasman & Kasman, 2008) suggested the long-run dominant role of spot returns while some researchers have shown that futures price movement leads the index movement in short-run such as Nasdaq 100 (Hasbrouck, 2003), S&P 500 (Chu et al., 1999; Kawaller et al., 1987; Niederhoffer &

Zeckhauser, 1980; Pizzi et al., 1998), DAX (Booth et al., 1999), FTSE 100 (Abhyankar, 1995; Booth et al., 1999), and S&P CNX Nifty (Pati & Rajib, 2011). Moreover, some also found the bidirectional relationship between index and futures such as S&P 500 (Pizzi et al., 1998), Turkish market (Özen et al., 2009), and Hang Seng (Rajaguru & Pattnayak, 2007).

The development of block trade on single stock futures and comparable trading volume to stock index futures have made Thailand a unique case study to unfold the interaction between single stock futures and their pairs in the spot market, focusing on how the new information being processed by both markets. In other words, the study is aimed to reveal the existence of the lead-lag relationship between the market for block trade SSF and underlying securities.

The vibrant market for SSF in Thailand might be due to the lack of stock options products, and the absence of an active or efficient stock-lending together with the advantages of futures products that have low transaction costs, unrestricted short-sale activities, and high leverage nature. Therefore, the hypothesis of this empirical study in Thailand is the block trade single stock futures leads the counterpart underlying stocks.

The results from the study will shed light on how information is absorbed by different markets which could explain the investors' trading behavior and reveal the better-informed investor. Regulators, policymakers, and investors can use the results to better promote market efficiency. The Framework is drawn upon the daily data of single stock futures in TFEX and their underlying stocks in SET. The period starts from the first trading day of 2016 to a few days before the muted market at the end of the year (4^{th} January 2016 to 22^{nd} December 2020). All data for 121 pairs will be collected from SETSMART and the pairs that have inadequate daily trading data will be filtered out.

2. LITERATURE REVIEW

2.1 Efficient Market Hypothesis

According to Fama (1970), in an efficient market, stocks and their associated derivatives such as futures and options will fully respond to the arrival of new publicly available information instantaneously and simultaneously. Many recent empirical studies found counteract pieces of evidence and many emphasized the unrealistic and strong assumptions of EMH and have shown that the real market is far from fully efficient.

Grossman and Stiglitz (1980) found that the price cannot fully reflect all available information because the information is costly. The action to find and gather information must receive the compensation, thus the market is far from perfectly informationally efficient. Similarly, Cutler et al. (1988) and Black (1986) found that information arrival cannot fully explain the movement in the market; Black (1986) has also shown that "noise traders", who trade using everything else other than the information, contribute to the market liquidity. French and Roll (1986) suggested that the higher price volatility during trading hours can be explained using private information. Moreover, trading strategies such as buying past winners and selling past losers proposed by Jegadeesh and Titman (1993), and value strategies proposed by Lakonishok et al. (1994) can earn abnormal returns.

2.2 Price discovery and Spot-Futures market interaction

2.2.1 Stock Index and Stock Index futures

The long-run dominant role of the spot market is supported by many studies; for example, Wahab and Lashgari (1993) have shown that there is a unidirectional relationship of the index market leading the futures market in S&P 500 & FTSE 100. Similarly, Zakaria and Shamsuddin (2012), and Kasman and Kasman (2008) also found the leading role of the spot market in the Malaysian stock market, and the Turkish stock market respectively. On the contrary, some researchers have proposed the other end of the direction which shows the short-run dominant role of the futures market; Nasdaq 100 (Hasbrouck, 2003), S&P 500 (Chu et al., 1999; Kawaller et al., 1987; Niederhoffer & Zeckhauser, 1980; Pizzi et al., 1998), DAX (Booth et al., 1999), FTSE 100 (Abhyankar, 1995; Booth et al., 1999), and S&P CNX Nifty (Pati & Rajib, 2011). However, a study by Pizzi et al. (1998) has suggested a bidirectional relationship between S&P 500 index and S&P 500 index futures. This relationship also found in the Turkish market (Özen et al., 2009), and Hang Seng market (Rajaguru & Pattnayak, 2007). Using intraday quoted price for SET50 Index and traded prices of SET50 Index Futures and TDEX, CHIYACHANTANA et al. (2012) found the existence of long-run relationship among the three markets and concluded the market efficiency can be improved through the multi-market trading of the derivatives market and its underlying. SET50 Index futures contributes the most in price discovery, followed by SET50 Index, and the least in TDEX.

2.2.2 Commodities

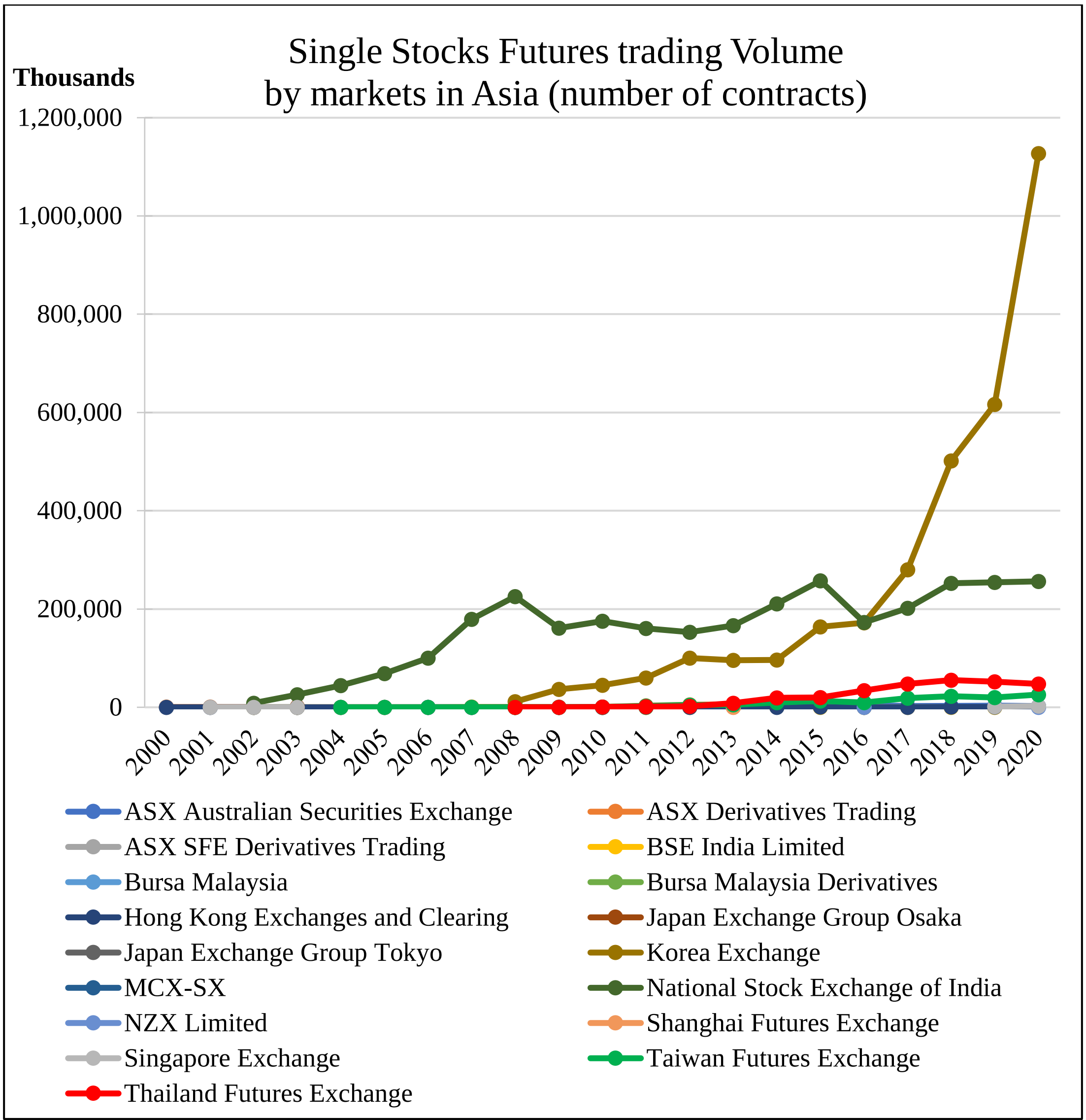
Markets for Commodities are also active and liquid in derivatives trading, Mahalik et al. (2009) studied price discovery and volatility spillovers of the commodity market and futures market in India and found that futures market (MCX) for Agricultures, Energy, and Aggregate commodity has price discovery function in the spot market while metal has no price discovery function. Liu and Zhang (2006) have shown the dominant role of price discovery in Chinese commodity futures markets for Copper, Aluminium, Soybean, Rubber, and wheat.

Attentions have been given to the relationship between the stock index and stock index futures, and commodities market, yet the results are mixed and unique to the market condition. Much of the studies also focus on the developed markets due to the longer establishment and higher liquidity; however, a different setting to the younger markets where there are many recent developments on derivatives products might also help reveal the unanswered questions.

2.2.3 Single Stock Futures

Single Stock Futures are one of the growing products in many Asian countries. While Korea, India, and Thailand are so vibrant in SSF trading as shown in Figure 2, SSF trading activities in most developed countries are relatively low; Jones and Brooks (2005) found that the lack of liquidity and transaction may lead to poor execution and fulfillment for hedging and speculating purposes in the US market. However, Shastri et al. (2008) used the data from OneChicago and found the decreasing share in the price discovery process when the volatility in the spot market and the relative spread of the futures market to the spot market rise. Fung and Tse (2008) suggested that SSF has accounted for 33% of price discovery despite the low trading volume using intraday data from Hong Kong Exchange. Bilateral interaction also observed from the papers from Kumar and Tse (2009) while Srinivasan (2009) found 43% of the SSF samples in India that the futures market has the leading role, 28.5% of the sample that the spot market has the leading role, and 28.5% has bilateral interaction. There is also a study in Taiwan by Songyoo (2012); it shows a bilateral interaction in the long run, and the futures market leads the spot market in the short run. Moreover, some studies involve the determinant of the SSF trading volume; for example, Bialkowski and Jakubowski (2012) have shown that institutional holdings, volatility, and trading volume of the underlying stocks in the spot market are the significant factor to the trading activities on SSF using the data from the Eurex Exchange.

Figure 2:Single Stock Futures trading volume in Asian markets (number of contracts)



Source: The World Federation of Exchanges (WFE)

3. DATA

The Framework is drawn upon the daily data of single stock futures in TFEX and their underlying stocks in SET. The period starts from the first trading day of 2016 to a few days before the muted market at the end of the year (4th January 2016 to 22nd December 2020). All data for 121 pairs will be collected from SETSMART, and the pairs that have insufficient daily trading data will be filtered out.

Daily traded prices for block trade single stock futures and underlying stocks will be collected as shown in the example in Figure 3 and Figure 4. For the SSF, there are four contracts available at any time, H series for ending in March, M series for ending in June, U series for ending in September, and Z series for ending in December. The nearest maturity will be used since it is the most active contract with the highest trading volume to avoid the illiquidity problem. The data from the next series will be used 4 days before the last trading day of the current series, following the real data patterns and method employed by Judge and Reancharoen (2014).

Figure 3: Example of the data obtained from SETSMART (Block trade SSF, Airports of Thailand PCL, AOTM20)

SETSMART Trading Company News Tools Fund TFEX Data for Indu

Historical Trading

Series : look up AOTM20
Display : Trading Adjusted Price
Trading Method : BlockTrade
Period : All Trading Period
Daily 31/03/2020 To 29/06/2020
Go

AOTM20

Date	Average Price	Volume (Contracts)
29/06/2020	62.88	460
26/06/2020	59.11	20
25/06/2020	56.11	1,190
24/06/2020	58.34	870
23/06/2020	55.61	740
22/06/2020	61.18	340
19/06/2020	59.76	230
18/06/2020	61.78	440
17/06/2020	67.67	75
16/06/2020	61.05	30
15/06/2020	63.56	80
12/06/2020	62.91	1,230
11/06/2020	64.61	1,891
10/06/2020	66.42	90
09/06/2020	66.03	880
08/06/2020	66.79	120
05/06/2020	66.52	1,030
04/06/2020	66.89	420
02/06/2020	63.69	1,055
01/06/2020	62.54	160
29/05/2020	61.39	419
28/05/2020	61.70	900
27/05/2020	60.96	820
26/05/2020	59.43	280
25/05/2020	57.64	180
22/05/2020	57.51	470
21/05/2020	58.88	140
20/05/2020	59.90	180
19/05/2020	60.45	1,200
18/05/2020	58.87	780

Page : 1, 2

Figure 4: Example of the data obtained from SETSMART (underlying stock, Airports of Thailand PCL, AOT)

Date	Prior	Open	High	Low	Close	Change	%Change	Average	Bid	Offer
29/06/20	59.00	58.50	59.25	58.00	59.25	+0.25	+0.42%	58.64	59.00	59.25
26/06/20	59.00	59.25	59.75	58.50	59.00	0.00	0.00%	59.08	58.75	59.00
25/06/20	59.75	59.50	60.00	58.75	59.00	-0.75	-1.26%	59.20	59.00	59.25
24/06/20	60.25	60.25	61.00	59.50	59.75	-0.50	-0.83%	60.18	59.50	59.75
23/06/20	60.00	60.50	60.75	59.50	60.25	+0.25	+0.42%	60.14	60.00	60.25
22/06/20	61.50	61.25	61.75	60.00	60.00	-1.50	-2.44%	60.65	60.00	60.25
19/06/20	61.75	61.75	62.50	61.50	61.50	-0.25	-0.40%	61.78	61.25	61.50
18/06/20	63.25	61.50	62.50	61.00	61.75	-1.50	-2.37%	61.81	61.75	62.00
17/06/20	63.25	63.25	64.25	62.75	63.25	0.00	0.00%	63.42	63.25	63.50
16/06/20	62.50	64.50	64.75	63.25	63.25	+0.75	+1.20%	63.95	63.25	63.50
15/06/20	65.00	64.50	64.50	62.00	62.50	-2.50	-3.85%	63.04	62.50	62.75
12/06/20	64.00	62.00	65.00	62.00	65.00	+1.00	+1.56%	63.88	64.75	65.00
11/06/20	66.50	66.00	66.25	63.75	64.00	-2.50	-3.76%	64.75	64.00	64.25
10/06/20	65.75	66.00	67.00	65.50	66.50	+0.75	+1.14%	66.36	66.25	66.50
09/06/20	67.00	66.75	67.75	65.00	65.75	-1.25	-1.87%	66.46	65.50	65.75
08/06/20	67.00	67.00	67.50	66.25	67.00	0.00	0.00%	66.81	66.75	67.00
05/06/20	67.50	67.00	67.25	65.75	67.00	-0.50	-0.74%	66.61	66.75	67.00
04/06/20	63.50	66.50	67.50	66.00	67.50	+4.00	+6.30%	66.86	67.25	67.50
02/06/20	61.75	62.25	64.75	62.00	63.50	+1.75	+2.83%	63.59	63.25	63.50
01/06/20	62.00	62.50	63.00	61.75	61.75	-0.25	-0.40%	62.34	61.75	62.00
29/05/20	61.25	60.75	62.00	60.50	62.00	+0.75	+1.22%	61.50	61.75	62.00
28/05/20	61.50	62.00	62.50	61.25	61.25	-0.25	-0.41%	61.85	61.25	61.50
27/05/20	59.25	59.25	61.75	59.25	61.50	+2.25	+3.80%	60.50	61.50	61.75
26/05/20	58.00	59.00	60.00	58.50	59.25	+1.25	+2.16%	59.51	59.25	59.50
25/05/20	57.25	57.00	58.25	57.00	58.00	+0.75	+1.31%	57.77	58.00	58.25
22/05/20	58.75	58.25	58.50	57.00	57.25	-1.50	-2.55%	57.45	57.25	57.50
21/05/20	59.50	59.25	59.50	58.25	58.75	-0.75	-1.26%	58.80	58.75	59.00
20/05/20	60.00	60.00	60.25	59.00	59.50	-0.50	-0.83%	59.61	59.50	59.75
19/05/20	58.50	60.50	60.75	59.75	60.00	+1.50	+2.56%	60.26	60.00	60.25

4. METHODOLOGY

4.1 Stationary Test

For time-series data, it is crucial to test for stationarity of the variables first, non-stationary data in a regression model can give us spurious regression results that are misleading and wrongly interpreted. Variables that are random and have no relationship among them can generate significant results with a high degree of R^2. To prevent this misrepresentation, it is a common econometric practice to do the stationary test first. Augmented Dickey-Fuller test will be employed here in this study, expecting the price series of spot and futures to be non-stationary, integrated of order one.

4.2 Cointegration Test

Granger (1981) brought in the concept of cointegration in that two non-stationary variables may move together if there are cointegrated. If such cointegration exists, there is a long-run relationship between them meaning that the two variables cannot be far apart, and any deviation in the short-run will reverse back to the equilibrium. In our study, if the spot and futures price are cointegrated, there exists a long-run relationship and the error correction representation.

Following Judge and Reancharoen (2014), Spot and futures price have earned their theoretical relationship through the cost-of-carry model:

$$F_t^* = S_t e^{(r-d)(T-t)} \qquad (1)$$

where F_t^* is the fair price of block trade single stock futures at day t, S_t is the spot price at day t, r is the risk free-rate, d is the dividend yield until maturity, and $T - t$ is the number of days to maturity of the futures contract. Stoll and Whaley (1990) and Brooks et al. (2001) have suggested that the market force which drives the cost-of-carry model is the never-ending search for free lunch. Arbitrageurs will act and close any deviation from the relation.

Therefore, relying on the cost-of-carry model, the integration between the spot and futures price is therefore strengthened by the arbitrage activity (Chan et al., 1991). Taking natural logarithms of both side of the equation (1) to transform into the linear form:

$$f_t^* = s_t + (r - d)(T - t) \qquad (2)$$

where f_t^* is the natural logarithm of the fair price of block trade single stock futures, s_t is the natural logarithm of the spot price. Equation (2) suggests the one-to-one long-run relationship between the natural logarithm of spot and futures price. Therefore, f_t^* and s_t are expected to be non-stationary, integrated of order 1 while the first difference of f_t^* and s_t are expected to be stationary, integrated of order zero.

However, the cointegration test will be performed using Engle and Granger's two-step method to test for cointegration according to Engle and Granger (1987). Following the relationship in the cost-of-carry model in (1) and (2) focusing on the long-run equilibrium relationship between single stock futures and the underlying stock, the cointegration error is defined as $\hat{\lambda}_t$ where

$$\hat{\lambda}_t = f_t^* - \hat{\beta}_1 s_t - \hat{\beta}_0 \qquad (3)$$

The second step is to test for stationarity of the estimated residual in the first step, the estimated cointegration error ($\hat{\lambda}_t$), using the ADF test. In the case of stationary cointegration error, we can conclude that the natural logarithm of spot and block trade single stock futures prices are cointegrated. Thus, the return of stock and block trade single stock futures are expected to be used instead.

$$R_{f,t} = ln\left(\frac{F_t}{F_{t-1}}\right) = f_t - f_{t-1} = \Delta f_t \qquad (4)$$

$$R_{s,t} = ln\left(\frac{S_t}{S_{t-1}}\right) = s_t - s_{t-1} = \Delta s_t \qquad (5)$$

4.3 Vector Error Correction Model (VECM)

The optimal number of lags will be obtained using the VAR lag selection. Various information criterions such as AIC (Akaike Information Criterion), and BIC (Bayesian Information Criterion) will be considered in optimal lag selection to be used in the Vector error correction model. According to Judge and Reancharoen (2014) who studied the relationship between SET50 index futures and SET50 index, they obtained 2 lags from VAR lag selection while CHIYACHANTANA et al. (2012) used nine lags.

Referring to Engle and Granger (1987), the cointegration price series can be shown as:

$$\Delta p_t = \gamma z_{t-1} + \sum_{j=1}^{k} A_j \Delta p_{t-j} + e_t \qquad (6)$$

where $\Delta p_t = \begin{bmatrix} p_{1,t} - p_{1,t-1} \\ p_{2,t} - p_{2,t-1} \end{bmatrix}$, the error correction term is $z_{t-1} = p_{1,t-1} - \beta_t p_{2,t-1}$, and e_t is a vector of serially uncorrelated residuals that have covariance matrix Ω,

$$\Omega = \begin{bmatrix} \sigma_1^2 & \rho\sigma_1\sigma_2 \\ \rho\sigma_1\sigma_2 & \sigma_2^2 \end{bmatrix}$$

while $\beta = [1, -1]$ is the cointegration vectors and γ is a non-zero error correction vector to tell the correction of the short-run error to the long-run equilibrium. In our case, the dynamic interaction between the cointegrated spot and block trade single stock futures prices using VECM is given as (7) and (8):

$$\Delta f_t = \delta_f + \gamma_f(f_{t-1} - \beta_1 s_{t-1} - \beta_0) + \sum_{i=1}^{l} a_{f1t-i}\Delta s_{t-i} + \sum_{i=1}^{l} a_{f2t-i}\Delta f_{t-i} + \varepsilon_{f,t} \quad (7)$$

$$\Delta s_t = \delta_s + \gamma_s(f_{t-1} - \beta_1 s_{t-1} - \beta_0) + \sum_{i=1}^{l} a_{s1t-i}\Delta s_{t-i} + \sum_{i=1}^{l} a_{s2t-i}\Delta f_{t-i} + \varepsilon_{s,t} \quad (8)$$

Δf_t is the natural logarithm of return on the block trade single stock futures while Δs_t is the natural logarithm of return on the counterpart stock at day t as presented in equations (4) and (5) respectively. l is the optimal lagged period. δ is (2×1) constant vector. $\beta_1 = [1 \quad -1]$ is the cointegrating vector and $\gamma = [\gamma_s \quad \gamma_f]$

is the coefficient matrix for the error correction term. The absolute value of them explains the speed of adjustment of the short-run deviation to the long-run equilibrium. The summation of the error correction coefficient (γ) must be greater than zero where $-1 < \gamma_f \leq 0$ and $0 \leq \gamma_s < 1$. At least one of the coefficients must be significantly different from zero if the variables are cointegrated or having a long-run relationship. The high absolute value of error correction coefficient (γ) means the strong adjustment to the long-run equilibrium; on the contrary, the low absolute value implies that the market will slowly adjust from the deviation.

Although cointegration can explain the long-run relationship of the two variables, it does not specify the direction, the coefficient of the error correction term will help explain the relationship in the long run as shown in Table 4**Error! Reference source not found.**.

Table 4: Summary of long-run relationship from error correction coefficients

Coefficient	Significance		
$-1 < \gamma_f \leq 0$	significant	significant	insignificant
$0 \leq \gamma_s < 1$	significant	insignificant	significance
Relationship	Bidirectional relationship	Unidirectional, Spot leads futures	Unidirectional, Futures leads spot

However, to be able to explain the relationship in the short run, an F-test on the coefficients of lagged independent variables will be performed. The F-test will be performed twice for each company by setting the first null hypothesis that all a_{f1t-i} for $i = 1,2,3, \dots, i$ are zero in the equation (7), and the second null hypothesis that all a_{s2t-i} for $i = 1,2,3, \dots, i$ are zero in the equation (8). In other words, if all coefficients of Δs_{t-i} in equation (7) is statistically different from zero (we reject the null hypothesis) and all coefficients of Δf_{t-i} in equation (8) is not statistically different from zero (we cannot reject the null hypothesis), we can conclude that spot leading futures price. However, if all coefficients of Δf_{t-i} in equation (8) is statistically different from zero (we reject the null hypothesis) and all coefficients of Δs_{t-i} in equation (7) is not statistically different from zero (we cannot reject the null hypothesis), we can conclude that futures leading spot price.

Unidirectional causality from spot market (S) to futures market (F) can be verified if the set of estimated coefficients of the lagged S are significant and the estimated coefficients of error correction term are significant, but the estimated coefficients of lagged F are not significantly different from zero. In our case, a one-way relationship of futures leading spot market would require a_{s2} to be significant, a_{f1} to be insignificant, and γ_s to be significant. On the contrary, spot leads futures market would require a_{f1} to be significant, a_{s2} to be insignificant, and γ_f to be significant. Bidirectional causality requires the set of estimated coefficients of lagged S and F to be significant and the two error correction terms to be significant.

Our hypothesis is to observe the block trade single stocks futures lead the counterpart underlying stocks in the short-run and long run. Thus, we expect to observe a strong Unidirectional causality from the futures to spot market.

5. EMPIRICAL RESULTS

5.1 Introduction

Block trade single stock futures have a limitation on data in that trading activities might not occur every day; therefore, the trading prices of these futures are not fully available for the whole period of study even for stocks that are very high in liquidity and popular among traders. In our scope of 121 stocks and their counterparts, 42 pairs are suitable for testing. 76 pairs are excluded based on the missing information of more than 30% of the overall data in the period of study from 4th January 2016 to 22nd December 2020. Three pairs namely WHA, MTC, and PTG are also excluded because the block trade single stock futures of these securities have been put to market after 2016. Therefore, they have large contiguous missing data of 252, 544, and 252 points respectively. The summary table of data inclusion and inclusion is shown in Table 5.

Table 5: Summary of data availability in the period of study

	Name	%data available in the period	remark
1	PTTEP	97.53%	included
2	KBANK	96.54%	included
3	ADVANC	95.39%	included
4	PTTGC	95.14%	included
5	IVL	94.40%	included
6	PTT	93.99%	included
7	SCB	93.41%	included
8	BANPU	93.08%	included
9	CPALL	92.67%	included
10	IRPC	92.50%	included
11	BBL	91.35%	included
12	TRUE	91.10%	included
13	JAS	88.14%	included
14	AOT	87.31%	included
15	SCC	87.23%	included
16	INTUCH	86.74%	included
17	TOP	86.74%	included
18	KTB	85.01%	included

19	BDMS	84.60%	included
20	CBG	84.10%	included
21	TMB	83.77%	included
22	CPF	83.11%	included
23	CPN	83.11%	included
24	BEM	82.78%	included
25	SAWAD	82.37%	included
26	STEC	82.29%	included
27	MINT	82.21%	included
28	HMPRO	80.56%	included
29	TU	80.07%	included
30	DTAC	79.90%	included
31	CKP	79.57%	included
32	BJC	79.00%	included
33	AMATA	77.84%	included
34	BLAND	77.76%	included
35	CK	77.68%	included
36	BCH	77.02%	included
37	SIRI	75.12%	included
38	WHA*	75.04%	excluded
39	BH	74.22%	included
40	AAV	73.81%	included
41	MTC*	73.81%	excluded
42	BTS	73.06%	included
43	STA	72.65%	included
44	LH	72.41%	included
45	PTG*	70.43%	excluded
46	KKP	69.60%	excluded
47	ITD	69.19%	excluded
48	KCE	66.89%	excluded
49	VGI	66.23%	excluded
50	TPIPL	66.06%	excluded
51	TPIPP	66.06%	excluded
52	TASCO	65.57%	excluded
53	BEAUTY	64.91%	excluded
54	QH	64.91%	excluded
55	TISCO	63.76%	excluded
56	THAI	63.67%	excluded
57	GPSC	59.47%	excluded
58	CHG	58.15%	excluded
59	GLOBAL	55.93%	excluded
60	GUNKUL	55.77%	excluded

61	LPN	55.35%	excluded
62	RATCH	54.20%	excluded
63	SPALI	52.97%	excluded
64	AP	51.40%	excluded
65	KTC	51.40%	excluded
66	ROBINS	49.84%	excluded
67	PLANB	49.09%	excluded
68	CENTEL	48.27%	excluded
69	TTA	47.94%	excluded
70	TCAP	44.98%	excluded
71	BCP	44.81%	excluded
72	UNIQ	43.16%	excluded
73	BEC	43.00%	excluded
74	HANA	42.92%	excluded
75	EGCO	42.34%	excluded
76	THCOM	40.20%	excluded
77	BA	39.13%	excluded
78	S	38.22%	excluded
79	TTCL	37.97%	excluded
80	DELTA	37.73%	excluded
81	BLA	37.40%	excluded
82	EPG	35.75%	excluded
83	SAMART	35.58%	excluded
84	ICHI	30.40%	excluded
85	GULF	29.32%	excluded
86	PSH	28.01%	excluded
87	BGRIM	26.69%	excluded
88	SPCG	26.44%	excluded
89	TVO	26.28%	excluded
90	MAJOR	25.70%	excluded
91	EA	25.45%	excluded
92	STPI	24.30%	excluded
93	ESSO	22.90%	excluded
94	COM7	22.82%	excluded
95	RS	22.57%	excluded
96	TTW	22.16%	excluded
97	SUPER	22.08%	excluded
98	BCPG	21.83%	excluded
99	PRM	16.06%	excluded
100	TKN	14.58%	excluded
101	SPRC	13.84%	excluded
102	AEONTS	12.69%	excluded

103	GFPT	12.60%	excluded
104	THANI	12.60%	excluded
105	BAY	12.27%	excluded
106	PSL	12.19%	excluded
107	VNG	11.45%	excluded
108	ERW	11.04%	excluded
109	ORI	9.14%	excluded
110	OSP	7.25%	excluded
111	JMT	6.75%	excluded
112	TQM	4.78%	excluded
113	SGP	4.20%	excluded
114	MEGA	3.87%	excluded
115	MBK	3.13%	excluded
116	BPP	2.97%	excluded
117	VNT	2.88%	excluded
118	M	1.98%	excluded
119	TOA	1.57%	excluded
120	EASTW	0.74%	excluded
121	WHAUP	0.74%	excluded

Imperfect data is very common in reality, linear interpolation and extrapolation are utilized to fill the data gap in the mentioned period before proceeding with other steps to test the hypothesis. Logarithm transformation on both price series is implemented for more convenience to work with the hypothetical cost-of-carry model. We then proceed with the logarithmic form of the price level and the return form.

Each pair of stock and block trade single stock futures will be tested separately following the process i) Stationary test ii) Cointegration test iii) Vector Error Correction model, then the conclusion will be drawn upon these 42 pairs which will help us understand more of the interaction between the two markets in both long run and short run.

5.2 Descriptive Statistics

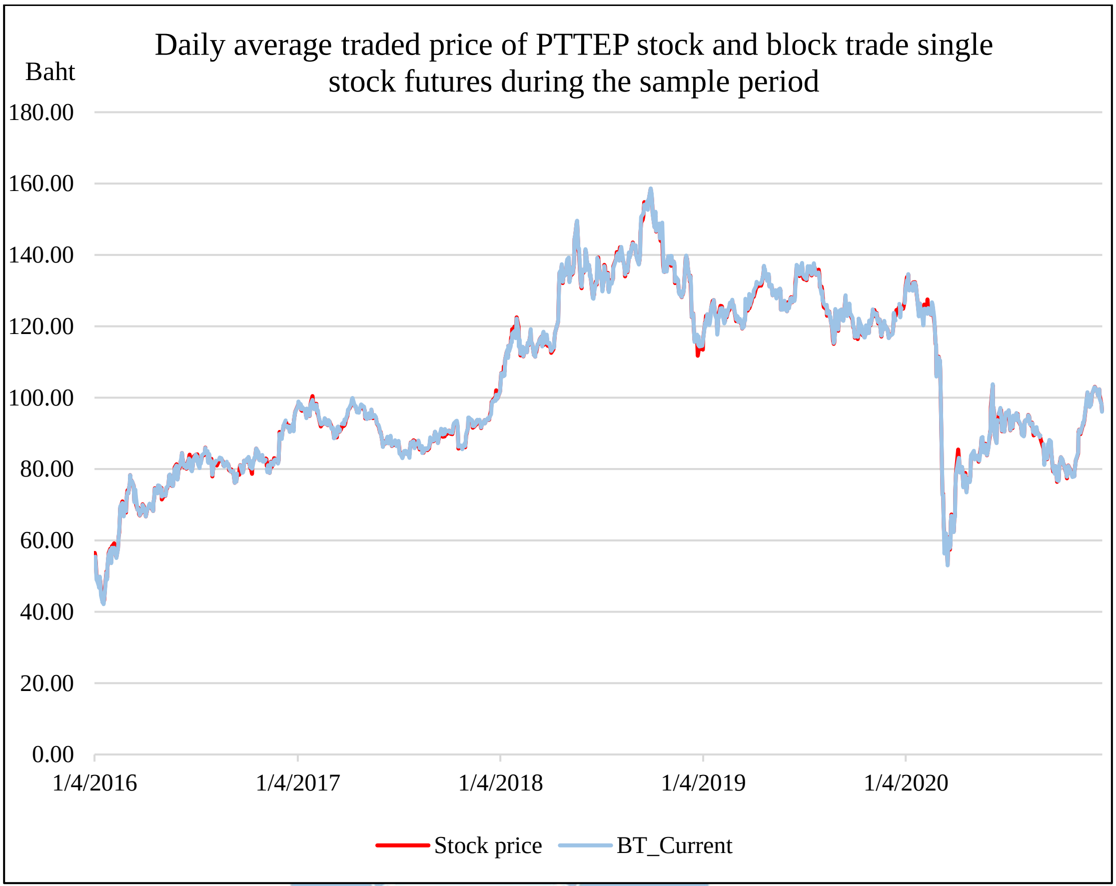
We examined the total 42 pairs; PTTEP has the most data points in our period of study, so it is selected as an example pair represented in Table 6 where S is the spot price and F is the corresponding current futures price (see Appendix A for all descriptive statistics). The two means are very similar while the standard deviation, and minimum and maximum values are also very close to each other. Normally distributed data requires zero skewness, 0.0622833 for spot price and 0.0413249 for block trade single stock futures price, which is slightly more than zero meaning that these two prices are skewed right. These prices also have a thinner tail than the case of normality as they are less than 3 on kurtosis.

Table 6: PTTEP Descriptive Statistics

PTTEP	stats	F	S
	min	42.1200	42.6603
	max	158.6400	158.5421
	mean	103.5224	103.4817
	sd	24.0283	23.9852
	skewness	0.0577	0.0623
	kurtosis	2.0779	2.0579

In Figure 5, line plotting of average traded stock price and block trade single stock futures of PTTEP shows a closely tracking behavior between the two price series as expected.

Figure 5: The daily average traded price of PTTEP stock and block trade single stock futures during the sample period



5.3 Stationary Test

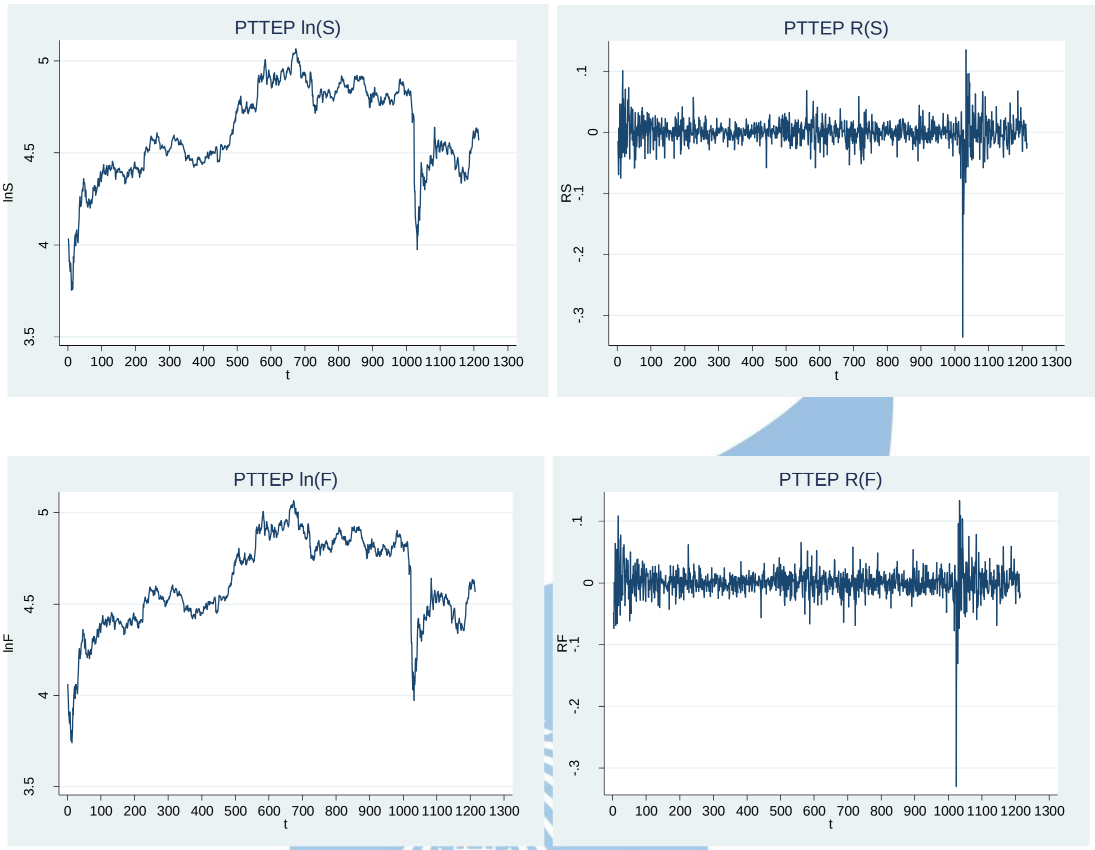
To begin the testing of time series data, the Augmented Dickey-Fuller test will be performed to check the stationarity. A model selection in this process involves a combination of theory and visual inspection of data; a Random walk with no drift and no trend model is chosen as the most appropriate model in this study. Because it is more appropriate to use the Augmented Dickey-Fuller test, lagged variables have to be included in the model. The optimal number of lags using in the ADF test has no distinctive formula; however, the guidance from Schwert (1989) will be followed here. In his work, he suggested including a maximum of $12(\frac{T}{100})^{1/4}$ lags where T is the number of observations, T is 1214 in this study; thus, 22 is used here for the ADF test. The decision to include too few lags can cause autocorrelation problems while too many lags can lower the power of the test. However, 1 lag and 22 lags are tested to see if there is any change in the conclusion of stationary. From the result in Table 7, altering the lags included does change the test statistic, but it does not change the conclusion. For all 42 companies, we cannot reject the null hypothesis of having unit root at the price level (lnF and lnS), but we can reject the null hypothesis at the return level (R_S and R_F) or non-stationary I(1). For example, the Augmented Dickey-Fuller test statistic for PTTEP is -7.462 in the case of R_F and -7.221 for R_S, which are statistically significant at 1% level.

Likewise, it can be observed from the data plot illustrated in Figure 6 that there is a strong potential for non-stationary in price level and stationary after the first difference.

Table 7: Summary of results from Augmented Dickey-Fuller test for stationary

	lnF		lnS		R_f		R_s	
Company	1 lags	22 lags	1 lags	22 lags	1 lags	22 lags	1 lags	22 lags
AAV	-0.592	-0.610	-0.956	-1.048	-21.736 ***	-5.608 ***	-20.511 ***	-6.597 ***
ADVANC	0.497	0.202	0.481	0.107	-26.166 ***	-7.740 ***	-23.173 ***	17.703 ***
AMATA	0.155	0.087	0.153	0.164	-23.626 ***	-6.544 ***	-22.945 ***	-6.670 ***
AOT	0.913	0.826	0.902	0.817	-25.738 ***	-6.952 ***	-24.090 ***	-6.865 ***
BANPU	-0.515	-0.566	-0.275	-0.263	-24.731 ***	-6.886 ***	-23.371 ***	-6.180 ***
BBL	-0.554	-0.501	-0.466	-0.440	-24.875 ***	-8.699 ***	-23.143 ***	-8.707 ***
BCH	0.302	0.545	0.361	0.505	-26.613 ***	-7.566 ***	-25.690 ***	-7.081 ***
BDMS	-0.212	-0.159	-0.212	-0.155	-24.660 ***	-7.596 ***	-23.937 ***	-7.600 ***
BEM	0.534	0.530	0.565	0.562	-24.365 ***	-6.859 ***	-23.576 ***	-6.608 ***
BH	-1.092	-1.368	-1.069	-1.375	-27.364 ***	-7.846 ***	-24.664 ***	-7.227 ***
BJC	-0.014	0.042	0.073	0.219	-29.227 ***	-8.158 ***	-25.567 ***	-7.918 ***
BLAND	-0.766	-0.755	-0.772	-0.719	-24.456 ***	-7.878 ***	-20.007 ***	-7.449 ***
BTS	0.005	0.241	0.028	0.256	-25.570 ***	-7.352 ***	-23.634 ***	-7.222 ***
CBG	1.084	0.857	0.967	0.858	-29.845 ***	-7.224 ***	-24.056 ***	-6.678 ***
CK	-0.764	-0.739	-0.848	-0.756	-27.236 ***	-8.020 ***	-22.455 ***	-7.892 ***
CKP	0.645	0.480	0.512	0.401	-25.996 ***	-6.622 ***	-24.055 ***	-6.867 ***
CPALL	0.707	0.635	0.725	0.648	-26.732 ***	-7.105 ***	-23.985 ***	-6.725 ***
CPF	0.443	0.468	0.451	0.474	-28.036 ***	-7.832 ***	-24.852 ***	-7.592 ***
CPN	-0.003	0.146	0.043	0.159	-25.772 ***	-7.513 ***	-24.148 ***	-7.569 ***
DTAC	0.059	-0.127	0.017	-0.115	-23.592 ***	-7.519 ***	-23.947 ***	-7.409 ***
HMPRO	0.731	1.026	0.934	1.094	-27.156 ***	-6.917 ***	-25.246 ***	-6.713 ***
INTUCH	0.231	-0.105	0.289	-0.086	-29.191 ***	-7.412 ***	-22.409 ***	-7.186 ***
IRPC	-0.463	-0.346	-0.440	-0.367	-25.342 ***	-5.652 ***	-22.976 ***	-5.183 ***
IVL	0.425	0.387	0.406	0.408	-24.683 ***	-6.396 ***	-22.609 ***	-6.566 ***
JAS	-0.314	-0.178	-0.285	-0.158	-28.898 ***	-8.396 ***	-23.371 ***	-8.408 ***
KBANK	-0.411	-0.557	-0.401	-0.561	-25.976 ***	-7.916 ***	-23.535 ***	-7.628 ***
KTB	-1.053	-1.220	-0.758	-0.840	-20.133 ***	-6.937 ***	-23.110 ***	-6.917 ***
LH	-0.310	-0.293	-0.322	-0.251	-27.186 ***	-7.990 ***	-24.631 ***	-7.858 ***
MINT	-0.504	-0.521	-0.455	-0.450	-26.401 ***	-8.371 ***	-22.643 ***	-8.209 ***
PTT	0.673	0.853	0.673	0.839	-24.782 ***	-7.630 ***	-23.459 ***	-7.410 ***
PTTEP	0.483	0.564	0.479	0.553	-23.636 ***	-7.462 ***	-22.876 ***	-7.221 ***
PTTGC	0.057	0.109	0.052	0.072	-24.613 ***	-7.307 ***	-23.008 ***	-7.237 ***
SAWAD	0.138	0.133	0.394	0.403	-23.982 ***	-6.609 ***	-23.516 ***	-6.495 ***
SCB	-0.588	-0.666	-0.539	-0.632	-23.856 ***	-7.465 ***	-23.381 ***	-7.291 ***
SCC	-0.372	-0.285	-0.406	-0.299	-25.336 ***	-7.502 ***	-23.464 ***	-7.353 ***
SIRI	-0.955	-0.943	-0.911	-0.873	-28.554 ***	-7.245 ***	-21.660 ***	-7.058 ***
STA	0.626	0.463	0.723	0.544	-24.300 ***	-6.245 ***	-23.512 ***	-6.243 ***
STEC	-0.792	-0.776	-0.850	-0.785	-22.527 ***	-7.542 ***	-21.445 ***	-7.370 ***
TMB	-1.136	-1.231	-1.138	-1.236	-24.919 ***	-7.290 ***	-22.981 ***	-7.121 ***
TOP	-0.369	-0.344	-0.339	-0.313	-26.370 ***	-6.953 ***	-22.894 ***	-6.274 ***
TU	-0.432	-0.650	-0.475	-0.763	-27.259 ***	-8.115 ***	-25.183 ***	-7.886 ***
TRUE	-0.901	-1.072	-0.831	-0.997	-27.567 ***	-8.508 ***	-22.486 ***	-8.015 ***

Figure 6: Comparison of the price level and return format of PTTEP



5.4 Cointegration Test

To be able to specify the long-run relationship between spot and futures prices, we need to test whether these series are cointegrated. In common practice, the Johansen Cointegration test will be performed to identify how many relationships exist in the system; however, with just two series in the scope, we can employ Engle and Granger’s two-step cointegration test. The results for all 42 companies are presented in Table 8. For example, PTTEP has the test statistic of -28.455, we can reject the null hypothesis of no cointegration at a 1% significant level. In other words, there exists a cointegration between spot and futures price, or they have a long-run relationship. According to the results in Table 8, all 42 companies can be concluded to have cointegration between spot and futures prices (lnS and lnF). It is worth noting that for Engle and Granger's two-step cointegration test has its unique critical value. In this case, they are -3.905, -3.341, and -3.048 for 1%, 5%, and 10%

Table 8: Summary of test statistics of Engle and Granger's two-step Cointegration test

Name	Test Statistic	Name	Test Statistic
AAV	-6.362 ***	INTUCH	-30.520 ***
ADVANC	-27.034 ***	IRPC	-22.808 ***
AMATA	-19.508 ***	IVL	-32.169 ***
AOT	-24.734 ***	JAS	-10.467 ***
BANPU	-6.891 ***	KBANK	-31.050 ***
BBL	-24.066 ***	KTB	-8.474 ***
BCH	-22.158 ***	LH	-20.777 ***
BDMS	-26.059 ***	MINT	-24.352 ***
BEM	-21.931 ***	PTT	-26.487 ***
BH	-21.118 ***	PTTEP	-28.455 ***
BJC	-15.019 ***	PTTGC	-28.057 ***
BLAND	-20.475 ***	SAWAD	-5.319 ***
BTS	-23.773 ***	SCB	-24.662 ***
CBG	-22.411 ***	SCC	-18.477 ***
CK	-17.851 ***	SIRI	-19.410 ***
CKP	-11.938 ***	STA	-12.837 ***
CPALL	-26.033 ***	STEC	-24.178 ***
CPF	-26.824 ***	TMB	-13.542 ***
CPN	-21.833 ***	TOP	-25.685 ***
DTAC	-25.455 ***	TU	-23.874 ***
HMPRO	-22.930 ***	TRUE	-26.991 ***

5.5 Vector Error Correction Model (VECM)

The Stationary test and the Cointegration test are the basic requirements for the Vector Error Correction Model. This model is used to reveal the dynamic correction of the cointegrating data series that could help build the understanding of the deviation and the correction to the long-run relationship. Because our price series are non-stationary I(1), and cointegrated, VECM is the most suitable model to be applied in this study. Following equations (7) and (8), it is first to define the optimal lag length to be included in the model using the function embedded in the statistical software which is based on the Akaike Information Criterion (AIC). For example, the optimal lag length for PTTEP is 6 lags which are mainly based on Akaike Information Criterion (AIC). In this process, repetitions of testing using different lags are required to find the appropriate number of lags to be used in VECM.

$$\Delta f_t = \delta_f + \gamma_f(f_{t-1} - \beta_1 s_{t-1} - \beta_0) + \sum_{i=1}^{l} a_{f1t-i}\,\Delta s_{t-i} + \sum_{i=1}^{l} a_{f2t-i}\,\Delta f_{t-i} + \varepsilon_{f,t} \quad (7)$$

$$\Delta s_t = \delta_s + \gamma_s(f_{t-1} - \beta_1 s_{t-1} - \beta_0) + \sum_{i=1}^{l} a_{s1t-i}\,\Delta s_{t-i} + \sum_{i=1}^{l} a_{s2t-i}\,\Delta f_{t-i} + \varepsilon_{s,t} \quad (8)$$

For different pairs of securities, lag length could differ in each system depending on how many lag lengths could best fit the model. After defining the optimal lags (p), VECM will be specified with p-1 lags. The optimal lag length to be used in VECM, and the estimated coefficients of error correction terms, γ_f and γ_s for each company are summarized in Table 9 for all 42 companies. The coefficient of error correction term tells the correction of the deviation to a long-run equilibrium where the absolute value explains the speed of adjustment.

Using PTTEP as an example, 6 lags is appropriate based on AIC in VECM specification, the coefficient of error correction term (γ_f) in equation (7) is -0.424 which is statistically significant at a 1% level, suggesting that the deviation from the long-run equilibrium on the previous day will be corrected at a convergence speed of 42.4% within today. The negative sign of the error correction term, γ_f is as expected; this means that when there is a positive (negative) error in this period, the futures price will adjust downward (upward) in the next period to restore the equilibrium. On the other hand, the coefficient of error correction term (γ_s) in equation (8) is positive, 0.415, or a correction speed of 41.5% on the next day, but it is statistically insignificant. For BCH, the coefficient of error correction term in equation (7), γ_f is -0.298 while γ_s is 0.292 in equation (8); both are significant at 1% level. It can be interpreted that when there is a positive (negative) error in this period, the futures price will adjust downward (upward) in the next period at a convergence speed of 29.8% while the spot price will upward (downward) at a convergence speed of 29.2% to restore the long-run equilibrium.

According to Granger (1988) there are two types of causality; (i) the long-run granger temporal causality which can be discovered from the error correction term in VECM, and (ii) the short-run temporal causality which can be determined from the lagged independent variables using the F-test for joint significance.

(i) Long-run dynamic

For long-run causality, it can be discovered using the result of the coefficient of error correction term in VECM. From Table 9, we found a long-run spot leading futures market relationship in 16 companies which are AAV, ADVANC, BTS, CBG, CPALL, HMPRO, IVL, KBANK, LH, PTT, SAWAD, SCB, SCC, and TRUE. The two companies; AMATA and PTTGC are observed to have futures leading the spot market while the rest of the 24 companies which are BANPU, BBL, BCH, BDMS, BEM, BH, BJC, BLAND, CK, CKP, CPF, CPN, DTAC, INTUCH, IRPC, JAS, KTB, MINT, SIRI, STA, STEC, TMB, TOP, and TU have a bilateral relationship in the long-run.

Table 9: Summary of lags and VECM's error correction coefficients to reveal long-run dynamic

		lag length		γ_f		γ_s	
		VAR	VECM				
	Name	p	p-1	coefficient	$p > \|z\|$	coefficient	$p > \|z\|$
1	AAV	15	14	-0.1105509	0.000***	0.0290002	0.230
2	ADVANC	6	5	-0.4996060	0.000***	0.0448489	0.567
3	AMATA	11	10	-0.0882424	0.287	0.2502811	0.001***
4	AOT	7	6	-0.4759643	0.000***	0.0351708	0.712
5	BANPU	5	4	-0.0313554	0.023***	0.0199879	0.055*
6	BBL	9	8	-0.2193380	0.009***	0.1207521	0.073*
7	BCH	3	2	-0.2983406	0.000***	0.2924338	0.000***
8	BDMS	2	1	-0.5651366	0.000***	0.1257786	0.059*
9	BEM	7	6	-0.3841430	0.000***	0.2926508	0.000***
10	BH	3	2	-0.2626670	0.000***	0.1877513	0.000***
11	BJC	8	7	-0.0743647	0.017***	0.0488311	0.062*
12	BLAND	12	11	-0.1065876	0.028***	0.1588343	0.000***
13	BTS	2	1	-0.4719547	0.000***	0.0250559	0.748
14	CBG	9	8	-0.3257017	0.000***	-0.0099395	0.751
15	CK	11	10	-0.2690493	0.000***	0.0751596	0.041**
16	CKP	5	4	-0.0674242	0.012***	0.0966854	0.000***
17	CPALL	2	1	-0.6790992	0.000***	0.0094144	0.845
18	CPF	6	5	-0.2650648	0.001***	0.2753138	0.000***
19	CPN	3	2	-0.2706356	0.000***	0.2013301	0.001***
20	DTAC	7	6	-0.2062969	0.018***	0.3033718	0.000***
21	HMPRO	4	3	-0.4883872	0.000***	0.0739559	0.118
22	INTUCH	10	9	-0.4197318	0.000***	0.1114813	0.038**
23	IRPC	2	1	-0.4874144	0.000***	0.0705015	0.063*
24	IVL	5	4	-0.8284484	0.000***	0.0134506	0.865
25	JAS	10	9	-0.0972155	0.000***	0.0334076	0.017**
26	KBANK	7	6	-0.5566689	0.000***	0.0359829	0.728
27	KTB	9	8	-0.1780248	0.024***	0.1378650	0.018**
28	LH	5	4	-0.3298641	0.000***	0.0608757	0.136
29	MINT	8	7	-0.2040770	0.025***	0.2495798	0.001***
30	PTT	8	7	-0.4508730	0.001***	0.1435291	0.246
31	PTTEP	6	5	-0.4240306	0.010***	0.1119923	0.492
32	PTTGC	11	10	-0.2150490	0.101	0.7891682	0.010***
33	SAWAD	8	7	-0.3135020	0.003***	-0.0216846	0.190
34	SCB	10	9	-0.3573184	0.002***	0.0462503	0.677
35	SCC	7	6	-0.4120810	0.000***	0.0336119	0.479
36	SIRI	8	7	-0.2855787	0.000***	0.0917613	0.006***
37	STA	5	4	-0.0964290	0.005***	0.0512778	0.086*
38	STEC	2	1	-0.4269113	0.000***	0.1637561	0.000***
39	TMB	10	9	-0.0559030	0.063**	0.5648654	0.065*
40	TOP	11	10	-0.6698821	0.000***	0.2179827	0.005***
41	TU	4	3	-0.4105073	0.000***	0.1216458	0.014**
42	TRUE	5	4	-0.5466576	0.000***	-0.0177421	0.726

Note: (*) testifies that values are significant at 10% level, (**) testifies that values are significant at 5% level, (***) testifies that values are significant at 1% level

(ii) Short-run dynamic

To reveal the short-run relationship between spot and futures market, we need to test for all coefficients of lagged explanatory variables in equation (7) and (8), which denoted as a_{f1t-i} and a_{s2t-i} respectively. If all coefficients of Δs_{t-i} in equation (7) is statistically different from zero (we reject the null hypothesis) and all coefficients of Δf_{t-i} in equation (8) is not statistically different from zero (we cannot reject the null hypothesis), we can conclude that spot leading futures price. However, if all coefficients of Δf_{t-i} in equation (8) is statistically different from zero (we reject the null hypothesis) and all coefficients of Δs_{t-i} in equation (7) is not statistically different from zero (we cannot reject the null hypothesis), we can conclude that futures leading spot price. The F-test result is presented in Table 10.

We found short-run spot leading futures market in 18 companies which are AAV, ADVANC, BBL, BH, BTS, CK, CKP, CPALL, CPN, DTAC, INTUCH, IRPC, IVL, SIRI, STA, STEC, TU and TRUE while 23 companies, AMATA, AOT, BANPU, BCH, BEM, BJC, BLAND, CBG, CPF, HMPRO, JAS, KBANK, KTB, LH, MINT, PTT, PTTEP, PTTGC, SAWAD, SCB, SCC, TMB, and TOP have a bidirectional relationship between spot and futures market in the short run. Only BDMS that its futures lead the spot market in short run.

Table 10: Summary of F-test of coefficients of lagged independent variables in equation (7) and (8)

Name	lag length		Independent / Dependent	F-stat	
	VAR (p)	VECM (p-1)		Futures	Spot
AAV	15	14	Futures		0.000***
			Spot	0.8298	
ADVANC	6	5	Futures		0.000***
			Spot	0.3460	
AMATA	11	10	Futures		0.000***
			Spot	0.014**	
AOT	7	6	Futures		0.000***
			Spot	0.067*	
BANPU	5	4	Futures		0.000***
			Spot	0.000***	
BBL	9	8	Futures		0.000***
			Spot	0.1644	
BCH	3	2	Futures		0.021**
			Spot	0.065*	
BDMS	2	1	Futures		0.840
			Spot	0.003***	
BEM	7	6	Futures		0.003***
			Spot	0.081*	
BH	3	2	Futures		0.028**
			Spot	0.9239	
BJC	8	7	Futures		0.000***
			Spot	0.084*	
BLAND	12	11	Futures		0.003***
			Spot	0.000***	
BTS	2	1	Futures		0.000***
			Spot	0.7488	
CBG	9	8	Futures		0.000***
			Spot	0.004***	
CK	11	10	Futures		0.000***
			Spot	0.9007	
CKP	5	4	Futures		0.000***
			Spot	0.1454	
CPALL	2	1	Futures		0.007***
			Spot	0.5297	
CPF	6	5	Futures		0.000***
			Spot	0.007***	
CPN	3	2	Futures		0.000***
			Spot	0.4787	
DTAC	7	6	Futures		0.000***
			Spot	0.9479	

Name	lag length		Independent / Dependent	F-stat	
	VAR (p)	VECM (p-1)		Futures	Spot
HMPRO	4	3	Futures		0.032**
			Spot	0.016**	
INTUCH	10	9	Futures		0.000***
			Spot	0.4175	
IRPC	2	1	Futures		0.000***
			Spot	0.3516	
IVL	5	4	Futures		0.000***
			Spot	0.2053	
JAS	10	9	Futures		0.000***
			Spot	0.001***	
KBANK	7	6	Futures		0.000***
			Spot	0.073*	
KTB	9	8	Futures		0.018**
			Spot	0.032**	
LH	5	4	Futures		0.001***
			Spot	0.010***	
MINT	8	7	Futures		0.000***
			Spot	0.010***	
PTT	8	7	Futures		0.003***
			Spot	0.059*	
PTTEP	6	5	Futures		0.000***
			Spot	0.000***	
PTTGC	11	10	Futures		0.000***
			Spot	0.080*	
SAWAD	8	7	Futures		0.000***
			Spot	0.000***	
SCB	10	9	Futures		0.001***
			Spot	0.04**	
SCC	7	6	Futures		0.000***
			Spot	0.004***	
SIRI	8	7	Futures		0.000***
			Spot	0.5416	
STA	5	4	Futures		0.000***
			Spot	0.1057	
STEC	2	1	Futures		0.000***
			Spot	0.6051	
TMB	10	9	Futures		0.000***
			Spot	0.000***	
TOP	11	10	Futures		0.000***
			Spot	0.000***	
TU	4	3	Futures		0.006***
			Spot	0.1029	
TRUE	5	4	Futures		0.000***
			Spot	0.4278	

Note: (*) testifies that values are significant at 10% level, (**) testifies that values are significant at 5% level, (***) testifies that values are significant at 1% level

However, from the study of 42 pairs of securities in Thailand in both long-run and short-run relationship, 26% of the sample has a strong bidirectional relationship between spot and futures markets (BANPU, BCH, BEM, BJC, BLAND, CPF, JAS, KTB, MINT, TMB, and TOP), 14% of the sample show a strong unidirectional relationship of spot leads futures market (AAV, ADVANC, BTS, CPALL, IVL, and TRUE), 0% of the sample shows a unidirectional relationship of futures leads spot market.

For different relationships across time, we found 24% of the sample to have spot leading futures market in the long-run, but both markets interact with each other in the short-run while 5% of the sample have futures leading spot market in the long-run but bidirectional in the short run. There are 29% of the sample that has a bidirectional relationship in long run, but spot leads the futures market in the short run; however, there is only 2 percent of the sample shows a bidirectional relationship in the long run, but futures leads spot in the short run.

6. SUMMARY AND CONCLUSION

According to the efficient market hypothesis, there should not be any lead-lag relationship of the spot and futures price of the financial assets. For the case of stock futures and their underlying asset, it should follow the Cost-of-carry model, and arbitrage futures model; therefore, the change in spot prices and changes in futures prices are expected to happen simultaneously. However, many empirical pieces of evidence do not support these theories; Luerchathorn (2017) found that the short-sellers can predict the extreme negative earnings surprise in Thai market settings while Judge and Reancharoen (2014) found the lagged changes in spot price lead to changes in futures price using TDEX and SET50 index futures.

With the vibrant market of block trade single stock futures in Thailand, this study finds evidence against the Efficient market hypothesis. Vector Error Correction Model (VECM) has revealed both unidirectional and bidirectional relationship of spot and futures market. However, none of the companies have both long-run and short-run causality from futures to spot market, and only 5% of 42 companies show the leader role of the futures market in the long-run with bilateral interaction in the short-run. Likewise, only 2% of the companies show a bilateral relationship in the long run having futures lead spot market in the short run. The results are contradicting to our hypothesis which is to observe the block trade single stocks futures lead the counterpart underlying stocks in the short-run and long run.

Despite the advantage of futures market, we observe a less dominant role in the price discovery function. According to Jong and Donders (1998), they studied the Netherlands stock and futures market and found that options and cash markets are led by the futures market because of its higher leverage and lower transaction cost. Floros and Vougas (2007) found the leading role of a futures market in Greece due to lower transaction costs and more liquidity in the futures market. However, in this study using 42 companies listed in the Thai market, we have weak leadership of the futures market using block trade single stock futures. The possible explanation of this outcome could be the minimum contracts per transaction and its limited order execution. For block trade single stock futures, there is a minimum requirement of buying and selling the product which is determined by Thailand Futures Exchange PCL. For example, it requires investors to open a position at least 20 contracts for a block of ADVANC which is equivalent to 20,000 shares or expose an investor to a size of 3.5-million-baht worth of money, calculated at 175 baht per share. In addition, to send an order to buy or sell these products, investors must make a call to their brokers to execute the order. Unlike stocks and other futures products, investors cannot trade block trade single stock futures through the internet on their own. These examples of unique features might be the reason why block trade single stock futures are being led by the spot market. In addition, the Thai market is considered to be far from a mature state, traders and investors might also have a limited understanding of futures products due to their higher complexity compared to the products in the spot market. Therefore, we can conclude at the top level that the spot market has a leading role in the Thai market.

REFERENCES

Abhyankar, A. N. (1995). Return and volatility dynamics in the FT-SE 100 stock index and stock index futures markets. The Journal of Futures Markets (1986-1998), 15(4), 457.

Bialkowski, J., & Jakubowski, J. (2012). Determinants of Trading Activity on the Single-Stock Futures Market: Evidence from the Eurex Exchange. Journal of Derivatives, 19(3), 29-47,24.

Black, F. (1986). Noise. The Journal of Finance, 41(3), 528-543.

Booth, G. G., So, R. W., & Tse, Y. (1999). Price discovery in the German equity index derivatives markets. Journal of Futures Markets: Futures, Options, and Other Derivative Products, 19(6), 619-643.

Brooks, C., Rew, A. G., & Ritson, S. (2001). A trading strategy based on the lead–lag relationship between the spot index and futures contract for the FTSE 100. International Journal of Forecasting, 17(1), 31-44.

Chan, K., Chan, K. C., & Karolyi, G. A. (1991). Intraday volatility in the stock index and stock index futures markets. The Review of Financial Studies, 4(4), 657-684.

CHIYACHANTANA, C. N., Choochuay, J., & Likitapiwat, T. (2012). Intraday Price Discovery in Emerging Equity Market: Analysis of SET50 Index, SET 50 Index Futures and THAIDEX SET50 (TDEX). Journal of Applied Economics Sciences, 7(4), 380.

Chu, Q. C., Hsieh, W.-l. G., & Tse, Y. (1999). Price discovery on the S&P 500 index markets: An analysis of spot index, index futures, and SPDRs. International Review of Financial Analysis, 8(1), 21-34.

Cutler, D. M., Poterba, J. M., & Summers, L. H. (1988). What moves stock prices? In: National Bureau of Economic Research Cambridge, Mass., USA.

Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: representation, estimation, and testing. Econometrica: journal of the Econometric Society, 251-276.

Fama, E. F. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. The Journal of Finance, 25(2), 383-417.

Floros, C., & Vougas, D. (2007). Lead-lag relationship between futures and spot markets in Greece: 1999-2001. International Research Journal of Finance and Economics(7), 168-174.

French, K. R., & Roll, R. (1986). Stock return variances: The arrival of information and the reaction of traders. Journal of financial economics, 17(1), 5-26.

Fung, J. K., & Tse, Y. (2008). Efficiency of single-stock futures: An intraday analysis. Journal of Futures Markets: Futures, Options, and Other Derivative Products, 28(6), 518-536.

Granger, C. W. (1981). Some properties of time series data and their use in econometric model specification. Journal of econometrics, 16(1), 121-130.

Granger, C. W. (1988). Some recent development in a concept of causality. Journal of econometrics, 39(1-2), 199-211.

Grossman, S. J., & Stiglitz, J. E. (1980). On the impossibility of informationally efficient markets. The American economic review, 70(3), 393-408.

Hasbrouck, J. (2003). Intraday price formation in US equity index markets. The Journal of Finance, 58(6), 2375-2400.

Jain, S., Agarwalla, S. K., Varma, J. R., & Pandey, A. (2019). Informed trading around earnings announcements—Spot, futures, or options? Journal of Futures Markets, 39(5), 579-589.

Jegadeesh, N., & Titman, S. (1993). Returns to buying winners and selling losers: Implications for stock market efficiency. The Journal of Finance, 48(1), 65-91.

Jones, T., & Brooks, R. (2005). An analysis of single-stock futures trading in the US. Financial Services Review, 14(2), 85-95.

Jong, F. D., & Donders, M. W. (1998). Intraday lead-lag relationships between the futures-, options and stock market. Review of Finance, 1(3), 337-359.

Judge, A., & Reancharoen, T. (2014). An empirical examination of the lead–lag relationship between spot and futures markets: Evidence from Thailand. Pacific-Basin Finance Journal, 29, 335-358.

Kasman, A., & Kasman, S. (2008). The impact of futures trading on volatility of the underlying asset in the Turkish stock market. Physica A: Statistical Mechanics and its Applications, 387(12), 2837-2845.

Kawaller, I. G., Koch, P. D., & Koch, T. W. (1987). The temporal price relationship between S&P 500 futures and the S&P 500 index. The Journal of Finance, 42(5), 1309-1329.

Kumar, U., & Tse, Y. (2009). Single-stock futures: Evidence from the Indian securities market. Global Finance Journal, 20(3), 220-234.

Lakonishok, J., Shleifer, A., & Vishny, R. W. (1994). Contrarian investment, extrapolation, and risk. The Journal of Finance, 49(5), 1541-1578.

Liu, Q., & Zhang, J. (2006). Price discovery and volatility spillovers: Evidence from Chinese spot-futures markets. China & World Economy, 14(2), 79-92.

Luerchathorn, N. (2017). Short selling prior to Earnings Announcements: Case in Thailand [Independent Study, Thammasat University].

Mahalik, M. K., Acharya, D., & Babu, M. S. (2009). Price discovery and volatility spillovers in futures and spot commodity markets: Some empirical evidence from India. IGIDR Proceedings/Project Reports Series(062-10).

Muntanaveerakul, A., Tangjitprom, N., & Siwamogsatham, T. (2020). The impact of single stock futures on spot price volatility of underlying stock in the stock exchange of Thailand during 2006-2012. AU-GSB e-JOURNAL, 13(2), 16-23.

Niederhoffer, V., & Zeckhauser, R. (1980). Market index futures contracts. Financial Analysts Journal, 36(1), 49-55.

Özen, E., Bozdoğan, T., & Zügül, M. (2009). The relationship of causality between the price of futures transactions underlying stock exchange and price of cash market: the case of Turkey. Middle Eastern Finance and Economics, 4, 28-37.

Pati, P. C., & Rajib, P. (2011). Intraday return dynamics and volatility spillovers between NSE S&P CNX Nifty stock index and stock index futures. Applied Economics Letters, 18(6), 567-574.

Pizzi, M. A., Economopoulos, A. J., & O'Neill, H. M. (1998). An examination of the relationship between stock index cash and futures markets: A cointegration approach.

Rajaguru, G., & Pattnayak, S. S. (2007). Investigation of a lead-lag relationship between spot and futures indices of the Hang Seng stock average. International Journal of Business Studies: A Publication of the Faculty of Business Administration, Edith Cowan University, 15(1), 69-82.

Schwert, G. W. (1989). Tests for Unit Roots: A Monte Carlo Investigation. Journal of Business & Economic Statistics, 7(2), 147-159.

Shastri, K., Thirumalai, R. S., & Zutter, C. J. (2008). Information revelation in the futures market: Evidence from single stock futures. Journal of Futures Markets: Futures, Options, and Other Derivative Products, 28(4), 335-353.

Songyoo, K. (2012). Optimal Positioning in Thailand's Spot and Future Market. Procedia-Social and Behavioral Sciences, 40, 741-745.

Srinivasan, P. (2009). Price Discovery in NSE Spot and Futures Markets of Selected Oil and Gas Industries in India: What Causes What? IUP Journal of Financial Risk Management, 6.

Stoll, H. R., & Whaley, R. E. (1990). The Dynamics of Stock Index and Stock Index Futures Returns. Journal of Financial and Quantitative Analysis, 25(4), 441-468.

Vichitcholchai, C. (2018). The Impact of Block Trade on Volatility and Liquidity of Underlying Securities: Evidence from Stock Exchange of Thailand Chulalongkorn University].

Wahab, M., & Lashgari, M. (1993). Price Dynamics and Error Correction in Stock Index and Stock Index Futures Markets: A Cointegration Approach: INTRODUCTION. The Journal of Futures Markets (1986-1998), 13(7), 711.

Zakaria, Z., & Shamsuddin, S. (2012). Empirical Evidence on the Relationship between Stock Market Volatility and Macroeconomics Volatility in Malaysia. Journal of Business Studies Quarterly, 4(2), 61-71.

APPENDICES

Appendix A

PTTEP

stats	F	S
min	42.1200	42.6603
max	158.6400	158.5421
mean	103.5224	103.4817
sd	24.0283	23.9852
skewness	0.0577	0.0623
kurtosis	2.0779	2.0579

AAV

stats	F	S
min	1.0900	1.0277
max	7.6800	7.6361
mean	4.6209	4.5899
sd	1.7821	1.7855
skewness	-0.4451	-0.4297
kurtosis	1.8963	1.8596

ADVANC

stats	F	S
min	134.0000	134.6549
max	237.4900	236.7745
mean	185.6181	185.5936
sd	20.1119	20.0421
skewness	0.1064	0.1269
kurtosis	2.8801	2.8818

AMATA

stats	F	S
min	9.4400	9.2643
max	28.8200	28.3677
mean	18.0998	17.9492
sd	4.9123	4.8566
skewness	0.0797	0.0770
kurtosis	1.6732	1.6767

AOT

stats	F	S
min	32.6160	33.1014
max	81.0200	80.9082
mean	57.3048	57.2607
sd	13.1039	13.1087
skewness	-0.3125	-0.3121
kurtosis	1.6642	1.6607

BANPU

stats	F	S
min	4.6300	4.8347
max	23.6700	23.5855
mean	15.0687	14.8827
sd	4.7772	4.7821
skewness	-0.6657	-0.5731
kurtosis	2.4072	2.3070

BBL

stats	F	S
min	88.3000	89.1273
max	216.1800	215.7902
mean	171.1841	171.0363
sd	33.9221	33.8425
skewness	-0.8886	-0.8773
kurtosis	2.8460	2.8227

BCH

stats	F	S
min	8.3100	8.1333
max	20.7800	20.5975
mean	14.8061	14.7916
sd	2.3787	2.3876
skewness	-0.3999	-0.3946
kurtosis	2.9394	2.9437

BDMS

stats	F	S
min	17.5400	17.4856
max	27.5200	27.4992
mean	22.7717	22.7542
sd	2.1321	2.1429
skewness	-0.0880	-0.0983
kurtosis	2.2914	2.2870

BEM

stats	F	S
min	5.0400	5.0617
max	11.9000	11.9404
mean	8.4579	8.4371
sd	1.6199	1.6172
skewness	0.1972	0.1894
kurtosis	2.3065	2.3073

BH

stats	F	S
min	91.2700	91.3064
max	230.4300	229.8660
mean	170.5662	170.2021
sd	33.7292	33.3432
skewness	-0.6163	-0.6198
kurtosis	2.3546	2.3597

BJC

stats	F	S
min	29.0000	28.9201
max	65.7200	65.3288
mean	47.0622	46.7616
sd	7.8183	8.1707
skewness	-0.1749	-0.2693
kurtosis	2.0882	2.1883

BLAND

stats	F	S
min	0.7500	0.7189
max	2.0100	2.0046
mean	1.5689	1.5638
sd	0.2903	0.2927
skewness	-0.8864	-0.8400
kurtosis	2.7758	2.7103

BTS

stats	F	S
min	7.8300	7.7899
max	14.2600	14.2572
mean	9.8443	9.8271
sd	1.6772	1.6733
skewness	1.0813	1.0689
kurtosis	2.9452	2.9187

CBG

stats	F	S
min	29.9900	30.1863
max	131.8900	131.8826
mean	70.4381	70.0770
sd	22.3247	22.4900
skewness	0.6226	0.5973
kurtosis	2.9349	2.9254

CK

stats	F	S
min	14.2300	13.1962
max	33.8100	33.7765
mean	24.9262	24.8266
sd	4.1796	4.2047
skewness	-0.6872	-0.6917
kurtosis	2.7417	2.7701

CKP

stats	F	S
min	1.9000	1.8793
max	7.2100	7.2040
mean	4.1867	4.1694
sd	1.1592	1.1648
skewness	0.3245	0.3080
kurtosis	2.6438	2.6088

CPALL

stats	F	S
min	39.8500	39.3522
max	89.2300	89.2262
mean	67.6230	67.5719
sd	11.3859	11.4340
skewness	-0.3039	-0.3009
kurtosis	2.6291	2.6447

CPF

stats	F	S
min	17.6000	17.4131
max	34.7900	34.7280
mean	26.7985	26.7532
sd	2.9604	2.9293
skewness	-0.1723	-0.1812
kurtosis	3.7941	3.8609

CPN

stats	F	S
min	33.8300	33.5308
max	86.2700	85.6536
mean	64.3480	64.2805
sd	12.5778	12.5172
skewness	-0.1137	-0.1205
kurtosis	1.8375	1.8456

DTAC

stats	F	S
min	27.8300	28.4266
max	64.1400	63.9935
mean	44.0903	44.0538
sd	8.4087	8.4431
skewness	0.2034	0.2072
kurtosis	2.1505	2.1490

JAS

stats	F	S
min	2.5400	2.5753
max	9.7600	9.7422
mean	5.8567	5.8364
sd	1.7845	1.7701
skewness	-0.0158	0.0233
kurtosis	2.0793	2.0760

HMPRO

stats	F	S
min	6.4900	6.4663
max	18.5300	18.6228
mean	12.9856	12.9743
sd	2.9873	2.9762
skewness	-0.3439	-0.3547
kurtosis	1.9436	1.9438

KBANK

stats	F	S
min	70.6500	70.9159
max	243.3500	243.1975
mean	171.8666	171.7961
sd	41.7285	41.6589
skewness	-0.9510	-0.9475
kurtosis	3.0037	2.9950

INTUCH

stats	F	S
min	43.1600	43.4503
max	76.2200	68.2823
mean	55.9975	55.9039
sd	4.2317	4.1578
skewness	0.6206	0.4012
kurtosis	4.6577	3.7462

KTB

stats	F	S
min	7.5767	8.4879
max	21.0400	20.9591
mean	17.0979	17.0905
sd	3.2529	3.2353
skewness	-1.4212	-1.4166
kurtosis	3.7995	3.7867

IRPC

stats	F	S
min	1.9500	1.9340
max	8.2500	8.1469
mean	4.9207	4.9061
sd	1.4760	1.4711
skewness	-0.2799	-0.2743
kurtosis	2.3274	2.3374

LH

stats	F	S
min	5.8700	6.0859
max	12.2200	12.2715
mean	9.6603	9.6541
sd	1.3056	1.3058
skewness	-0.6643	-0.6711
kurtosis	2.7999	2.7911

IVL

stats	F	S
min	16.7500	16.9325
max	62.3500	62.3259
mean	38.8105	38.7527
sd	11.9805	11.9627
skewness	0.3180	0.3268
kurtosis	1.8876	1.8887

MINT

stats	F	S
min	14.0600	13.8233
max	45.0400	44.2243
mean	35.1230	34.5768
sd	6.9396	6.7091
skewness	-1.4028	-1.3935
kurtosis	3.9754	3.9866

PTT

stats	F	S
min	19.3780	19.9005
max	58.5900	58.3921
mean	41.2831	41.2588
sd	7.9330	7.8872
skewness	-0.2134	-0.2095
kurtosis	2.5356	2.5368

PTTEP

stats	F	S
min	42.1200	42.6603
max	158.6400	158.5421
mean	103.5224	103.4817
sd	24.0283	23.9852
skewness	0.0577	0.0623
kurtosis	2.0779	2.0579

PTTGC

stats	F	S
min	24.3800	23.9975
max	103.0400	102.6773
mean	65.1749	65.1234
sd	15.3938	15.4076
skewness	0.1201	0.1162
kurtosis	2.7282	2.7303

SAWAD

stats	F	S
min	28.5200	26.2217
max	79.0100	79.3245
mean	50.0902	45.8760
sd	9.7145	11.0122
skewness	0.4361	0.4209
kurtosis	2.6892	2.5783

SCB

stats	F	S
min	58.1000	59.5976
max	164.8200	164.7945
mean	128.3040	128.2816
sd	27.9353	27.8606
skewness	-1.1449	-1.1405
kurtosis	3.1401	3.1377

SCC

stats	F	S
min	259.8800	269.2589
max	550.1800	548.1123
mean	446.9640	446.0791
sd	60.3140	60.2903
skewness	-0.6073	-0.5998
kurtosis	2.4453	2.4118

SIRI

stats	F	S
min	0.5300	0.5450
max	2.4700	2.4618
mean	1.5182	1.5149
sd	0.4785	0.4765
skewness	-0.2580	-0.2510
kurtosis	2.2859	2.2827

STA

stats	F	S
min	9.5700	9.6292
max	35.3800	35.2328
mean	15.1306	14.9257
sd	5.5918	5.5462
skewness	1.5366	1.5799
kurtosis	4.3026	4.4834

STEC

stats	F	S
min	9.8200	9.8786
max	28.9400	28.6332
mean	21.3705	21.3381
sd	4.6586	4.6490
skewness	-0.7423	-0.7495
kurtosis	2.4271	2.4248

TMB

stats	F	S
min	0.7100	0.7101
max	3.1400	3.1121
mean	2.0206	2.0236
sd	0.5841	0.5773
skewness	-0.6388	-0.6879
kurtosis	2.4853	2.5900

TOP

stats	F	S
min	26.3400	26.4820
max	106.5300	107.1292
mean	70.1231	70.1434
sd	17.1832	17.2591
skewness	-0.2389	-0.2254
kurtosis	2.8147	2.7999

TU

stats	F	S
min	12.1500	12.0340
max	22.5100	22.7151
mean	18.0687	18.0509
sd	2.7678	2.7759
skewness	-0.3970	-0.4146
kurtosis	2.0123	2.0392

TRUE

stats	F	S
min	2.0900	2.4693
max	9.2200	9.1761
mean	5.7265	5.7097
sd	1.4385	1.4259
skewness	-0.3731	-0.3574
kurtosis	2.5401	2.5235

Appendix B: VECM Results

BDMS

VARIABLES	(7) D_lnF	(8) D_lnS
D_lnF		
L._ce1	-0.565***	0.126*
	(-7.714)	(-1.889)
LD.lnF	0.127**	0.168***
	(-2.064)	(-3.003)
LD.lnS	-0.0131	-0.0169
	(-0.203)	(-0.287)
D_lnS		
Constant	-1.20E-05	-5.41E-05
	(-0.0304)	(-0.150)
Observations	1,212	1,212
R-sq	0.0637	0.0426
chi2	82.14859	53.72549
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

BTS

VARIABLES	(7) D_lnF	(8) (D_lnS)
D_lnF		
L._ce1	-0.542***	0.0311
	(-11.68)	(-0.788)
LD.lnF	-0.0814**	0.0112
	(-1.982)	(-0.32)
LD.lnS	0.252***	0.151***
	(-4.922)	(-3.454)
D_lnS		
Constant	2.86E-06	4.97E-05
	(-0.00703)	(-0.144)
Observations	1,212	1,212
R-sq	0.1981	0.0255
chi2	298.3601	31.55987
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

CPALL

VARIABLES	(7) D_lnF	(8) D_lnS
D_lnF		
L._ce1	-0.679***	0.00941
	(-11.80)	(-0.195)
LD.lnF	-0.0173	0.0253
	(-0.361)	(-0.628)
LD.lnS	0.156***	0.142***
	(-2.693)	(-2.943)
D_lnS		
Constant	3.81E-06	0.000275
	(-0.00989)	(-0.852)
Observations	1,212	1,212
R-sq	0.171	0.0291
chi2	249.181	36.16232
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

IRPC

VARIABLES	(7) D_lnF	(8) D_lnS
D_lnF		
L._ce1	-0.487***	0.0705*
	(-10.37)	(-1.857)
LD.lnF	-0.0315	0.0343
	(-0.691)	(-0.931)
LD.lnS	0.234***	0.131***
	(-4.305)	(-2.98)
D_lnS		
Constant	-1.87E-05	-0.00013
	(-0.0294)	(-0.252)
Observations	1,212	1,212
R-sq	0.1552	0.0322
chi2	221.9884	40.23613
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

STEC

VARIABLES	(7) D_lnF	(8) D_lnS
D_lnF		
L._ce1	-0.427***	0.164***
	(-8.230)	(-3.513)
LD.lnF	-0.0727	0.0215
	(-1.569)	(-0.517)
LD.lnS	0.330***	0.235***
	(-6.367)	(-5.05)
D_lnS		
Constant	-0.000182	-0.000474
	(-0.296)	(-0.858)
Observations	1,212	1,212
R-sq	0.1525	0.0745
chi2	217.3858	97.22248
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

BCH

VARIABLES	(7) D_lnF	(8) D_lnS
D_lnF		
L._ce1	-0.298***	0.292***
	(-5.412)	(-6.138)
LD.lnF	0.082	0.0752
	(-1.527)	(-1.622)
L2D.lnF	0.0181	-0.0272
	(-0.387)	(-0.672)
LD.lnS	0.023	0.0193
	(-0.409)	(-0.397)
L2D.lnS	-0.117**	-0.0651
	(-2.403)	(-1.546)
D_lnS		
Constant	0.000273	0.000278
	(-0.49)	(-0.579)
Observations	1,211	1,211
R-sq	0.0456	0.0822
chi2	57.56899	107.9752
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

BH

VARIABLES	(7) D_lnF	(8) D_lnS
D_lnF		
L._ce1	-0.263***	0.188***
	(-5.232)	(-4.412)
LD.lnF	-0.146***	-0.0155
	(-2.776)	(-0.349)
L2D.lnF	-0.122***	0.000554
	(-2.579)	(-0.0138)
LD.lnS	0.145**	0.116**
	(-2.553)	(-2.397)
L2D.lnS	0.0811	-0.0278
	(-1.555)	(-0.629)
D_lnS		
Constant	-0.000429	-0.0006
	(-0.806)	(-1.331)
Observations	1,211	1,211
R-sq	0.0807	0.0365
chi2	105.8217	45.71231
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

CPN

VARIABLES	(7) D_lnF	(8) D_lnS
D_lnF		
L._ce1	-0.271***	0.201***
	(-4.271)	(-3.26)
LD.lnF	-0.169***	-0.072
	(-2.694)	(-1.180)
L2D.lnF	-0.152***	-0.0161
	(-2.820)	(-0.307)
LD.lnS	0.333***	0.214***
	(-5.171)	(-3.413)
L2D.lnS	0.0861	-0.0299
	(-1.487)	(-0.530)
D_lnS		
Constant	4.57E-05	6.14E-05
	(-0.0905)	(-0.125)
Observations	1,211	1,211
R-sq	0.0977	0.029
chi2	130.5208	36.01769
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

HMPRO

VARIABLES	(7) D_lnF	(8) D_lnS
D_lnF		
L._ce1	-0.488***	0.074
	(-8.656)	(-1.565)
LD.lnF	0.0789	0.130***
	(-1.421)	(-2.79)
L2D.lnF	0.013	0.0505
	(-0.261)	(-1.213)
L3D.lnF	0.0361	-0.0048
	(-0.844)	(-0.134)
LD.lnS	0.0708	-0.044
	(-1.13)	(-0.839)
L2D.lnS	-0.083	-0.120**
	(-1.457)	(-2.510)
L3D.lnS	-0.0725	0.0262
	(-1.448)	(-0.625)
D_lnS		
Constant	9.71E-05	0.000641
	(-0.174)	(-1.374)
Observations	1,210	1,210
R-sq	0.1227	0.0369
chi2	168.1103	46.06839
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

TU

VARIABLES	(7) D_lnF	(8) D_lnS
D_lnF		
L._ce1	-0.411***	0.122**
	(-7.046)	(-2.441)
LD.lnF	-0.0767	0.0591
	(-1.344)	(-1.21)
L2D.lnF	-0.0157	0.105**
	(-0.309)	(-2.409)
L3D.lnF	-0.0207	0.0328
	(-0.485)	(-0.9)
LD.lnS	0.142**	0.021
	(-2.297)	(-0.395)
L2D.lnS	-0.037	-0.145***
	(-0.666)	(-3.056)
L3D.lnS	-0.0485	-0.0366
	(-0.987)	(-0.872)
D_lnS		
Constant	-6.60E-05	-0.000223
	(-0.135)	(-0.532)
Observations	1,210	1,210
R-sq	0.1174	0.0362
chi2	159.9051	45.12938
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

BANPU

VARIABLES	(7) D_lnF	(8) D_lnS
D_lnF		
L._ce1	-0.0314**	0.0200*
	(-2.278)	(-1.916)
LD.lnF	-0.0844**	0.160***
	(-2.153)	(-5.368)
L2D.lnF	-0.0668*	0.0471
	(-1.658)	(-1.544)
L3D.lnF	-0.0784*	0.0343
	(-1.952)	(-1.126)
L4D.lnF	-0.0476	0.0294
	(-1.220)	(-0.993)
LD.lnS	0.243***	0.0748*
	(-4.746)	(-1.929)
L2D.lnS	0.0111	-0.0988**
	(-0.217)	(-2.537)
L3D.lnS	0.0441	-0.0563
	(-0.858)	(-1.446)
L4D.lnS	0.106**	0.0174
	(-2.166)	(-0.471)
D_lnS		
Constant	-6.49E-05	-0.000102
	(-0.0788)	(-0.163)
Observations	1,209	1,209
R-sq	0.0319	0.078
chi2	39.46058	101.4653
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

CKP

VARIABLES	(7) D_lnF	(8) D_lnS
D_lnF		
L._ce1	-0.0674**	0.0967***
	(-2.520)	(-3.99)
LD.lnF	-0.238***	-0.000899
	(-5.452)	(-0.0228)
L2D.lnF	-0.116***	-0.0327
	(-2.650)	(-0.824)
L3D.lnF	-0.0976**	-0.0398
	(-2.269)	(-1.023)
L4D.lnF	-0.042	-0.0918**
	(-1.042)	(-2.514)
LD.lnS	0.313***	0.193***
	(-6.711)	(-4.564)
L2D.lnS	0.0252	-0.0464
	(-0.536)	(-1.093)
L3D.lnS	0.127***	0.114***
	(-2.764)	(-2.724)
L4D.lnS	-0.0107	0.054
	(-0.244)	(-1.354)
D_lnS		
Constant	0.000763	0.000532
	(-1.256)	(-0.968)
Observations	1,209	1,209
R-sq	0.0674	0.0559
chi2	86.6723	71.05695
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

IVL

VARIABLES	D_lnF	D_lnS
D_lnF		
L._ce1	-0.828***	0.0135
	(-8.939)	(-0.17)
LD.lnF	-0.0275	0.0625
	(-0.327)	(-0.868)
L2D.lnF	0.166**	0.0959
	(-2.192)	(-1.478)
L3D.lnF	0.105	0.0114
	(-1.581)	(-0.201)
L4D.lnF	0.045	0.0321
	(-0.93)	(-0.776)
LD.lnS	0.218**	0.114
	(-2.425)	(-1.485)
L2D.lnS	-0.183**	-0.103
	(-2.212)	(-1.459)
L3D.lnS	-0.113	-0.0345
	(-1.557)	(-0.554)
L4D.lnS	-0.0902	-0.00892
	(-1.548)	(-0.179)
D_lnS		
Constant	6.57E-06	0.000405
	(-0.00904)	(-0.651)
Observations	1,209	1,209
R-sq	0.248	0.0366
chi2	395.4445	45.58171
P>chi2	0.0000	0.0000

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

LH

VARIABLES	D_lnF	D_lnS
D_lnF		
L._ce1	-0.330***	0.0609
	(-6.648)	(-1.491)
LD.lnF	-0.0313	0.126***
	(-0.608)	(-2.961)
L2D.lnF	-0.0411	0.0818**
	(-0.837)	(-2.022)
L3D.lnF	-0.0283	0.0167
	(-0.624)	(-0.449)
L4D.lnF	-0.0709*	0.0673**
	(-1.799)	(-2.072)
LD.lnS	0.175***	-0.054
	(-2.995)	(-1.126)
L2D.lnS	-0.0423	-0.116**
	(-0.749)	(-2.492)
L3D.lnS	0.0515	0.00401
	(-0.979)	(-0.0924)
L4D.lnS	0.102**	-0.00468
	(-2.151)	(-0.120)
D_lnS		
Constant	-1.49E-05	-8.06E-05
	(-0.0295)	(-0.194)
Observations	1,209	1,209
R-sq	0.1144	0.0983
chi2	154.9537	47.76507
P>chi2	0.0000	0.0000

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

STA

VARIABLES	D_lnF	D_lnS
D_lnF		
L._ce1	-0.0964***	0.0513*
	(-2.826)	(-1.718)
LD.lnF	-0.192***	0.111**
	(-3.629)	(-2.404)
L2D.lnF	-0.152***	0.0515
	(-2.837)	(-1.1)
L3D.lnF	-0.146***	-0.0183
	(-2.801)	(-0.401)
L4D.lnF	-0.0678	0.0205
	(-1.404)	(-0.486)
LD.lnS	0.396***	0.125**
	(-6.731)	(-2.423)
L2D.lnS	0.083	-0.134**
	(-1.396)	(-2.568)
L3D.lnS	0.193***	0.0912*
	(-3.332)	(-1.798)
L4D.lnS	0.0505	-0.0428
	(-0.933)	(-0.906)
D_lnS		
Constant	0.000388	0.00073
	(-0.469)	(-1.008)
Observations	1,209	1,209
R-sq	0.0714	0.0662
chi2	92.18535	84.97159
P>chi2	0.0000	0.0000

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

TRUE

VARIABLES	(7) D_lnF	(8) D_lnS
D_lnF		
L._ce1	-0.547***	-0.0177
	(-7.699)	(-0.351)
LD.lnF	-0.232***	0.0462
	(-3.374)	(-0.944)
L2D.lnF	-0.152**	0.0642
	(-2.405)	(-1.421)
L3D.lnF	-0.0684	0.0747*
	(-1.238)	(-1.897)
L4D.lnF	-0.0509	0.0446
	(-1.186)	(-1.459)
LD.lnS	0.539***	0.180***
	(-6.715)	(-3.144)
L2D.lnS	0.106	-0.110**
	(-1.394)	(-2.039)
L3D.lnS	0.0764	-0.0563
	(-1.102)	(-1.139)
L4D.lnS	0.0417	-0.0710*
	(-0.706)	(-1.685)
D_lnS		
Constant	1.24E-05	-0.000382
	(-0.0161)	(-0.698)
Observations	1,209	1,209
R-sq	0.2443	0.0544
chi2	387.6967	68.98993
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

ADVANC

VARIABLES	(7) D_lnF	(8) D_lnS
D_lnF		
L._ce1	-0.500***	0.0448
	(-5.725)	(-0.572)
LD.lnF	-0.257***	-0.0168
	(-3.020)	(-0.219)
L2D.lnF	-0.189**	0.0288
	(-2.354)	(-0.399)
L3D.lnF	-0.206***	-0.0503
	(-2.806)	(-0.764)
L4D.lnF	-0.113*	-0.042
	(-1.769)	(-0.735)
L5D.lnF	-0.131***	-0.068
	(-2.618)	(-1.517)
LD.lnS	0.494***	0.243***
	(-5.479)	(-2.999)
L2D.lnS	0.0584	-0.0918
	(-0.679)	(-1.189)
L3D.lnS	0.229***	0.0773
	(-2.887)	(-1.083)
L4D.lnS	0.0514	-0.0261
	(-0.737)	(-0.417)
L5D.lnS	0.0597	0.0276
	(-1.017)	(-0.523)
D_lnS		
Constant	1.79E-05	0.000199
	(-0.0469)	(-0.581)
Observations	1,208	1,208
R-sq	0.2209	0.0604
chi2	339.0816	76.92728
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

CPF

VARIABLES	(7) D_lnF	(8) D_lnS
D_lnF		
L._ce1	-0.265***	0.275***
	(-3.359)	(-4.119)
LD.lnF	-0.398***	-0.158**
	(-5.071)	(-2.372)
L2D.lnF	-0.303***	-0.0866
	(-4.071)	(-1.374)
L3D.lnF	-0.171**	-0.0614
	(-2.496)	(-1.056)
L4D.lnF	-0.0893	-0.0243
	(-1.509)	(-0.485)
L5D.lnF	-0.0961**	-0.111***
	(-2.053)	(-2.802)
LD.lnS	0.568***	0.354***
	(-6.916)	(-5.092)
L2D.lnS	0.163**	-0.0192
	(-2.088)	(-0.290)
L3D.lnS	0.244***	0.130**
	(-3.335)	(-2.103)
L4D.lnS	0.140**	0.069
	(-2.166)	(-1.264)
L5D.lnS	-0.000324	0.0327
	(-0.00591)	(-0.705)
D_lnS		
Constant	0.000284	0.000273
	(-0.556)	(-0.632)
Observations	1,208	1,208
R-sq	0.1894	0.0745
chi2	279.4029	96.23719
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

PTTEP

VARIABLES	(7) D_lnF	(8) D_lnS
D_lnF		
L._ce1	-0.424**	0.112
	(-2.563)	(-0.687)
LD.lnF	-0.231	0.0625
	(-1.419)	(-0.39)
L2D.lnF	-0.0846	0.127
	(-0.546)	(-0.833)
L3D.lnF	-0.21	-0.0518
	(-1.478)	(-0.370)
L4D.lnF	0.165	0.234*
	(-1.338)	(-1.927)
L5D.lnF	-0.286***	-0.266***
	(-3.010)	(-2.841)
LD.lnS	0.416**	0.106
	(-2.518)	(-0.649)
L2D.lnS	0.0316	-0.158
	(-0.202)	(-1.025)
L3D.lnS	0.322**	0.168
	(-2.23)	(-1.179)
L4D.lnS	-0.104	-0.213*
	(-0.830)	(-1.726)
L5D.lnS	0.155	0.170*
	(-1.562)	(-1.746)
D_lnS		
Constant	0.000146	0.000553
	(-0.23)	(-0.885)
Observations	1,208	1,208
R-sq	0.1275	0.0706
chi2	174.7277	90.80071
P>chi2	0.0000	0.0001

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

AOT

VARIABLES	(7) D_lnF	(8) D_lnS
D_lnF		
L._ce1	-0.476***	0.0352
	(-4.665)	(-0.369)
LD.lnF	-0.152	0.0355
	(-1.495)	(-0.375)
L2D.lnF	-0.00605	0.116
	(-0.0622)	(-1.275)
L3D.lnF	0.00413	0.041
	(-0.0459)	(-0.487)
L4D.lnF	0.0506	0.176**
	(-0.607)	(-2.258)
L5D.lnF	0.0723	0.0924
	(-0.974)	(-1.331)
L6D.lnF	0.0788	0.115**
	(-1.307)	(-2.037)
LD.lnS	0.271***	0.0679
	(-2.607)	(-0.699)
L2D.lnS	-0.0504	-0.151
	(-0.502)	(-1.612)
L3D.lnS	0.0209	-0.0207
	(-0.225)	(-0.238)
L4D.lnS	-0.0565	-0.180**
	(-0.649)	(-2.213)
L5D.lnS	-0.0394	-0.055
	(-0.504)	(-0.754)
L6D.lnS	-0.187***	-0.211***
	(-2.834)	(-3.426)
D_lnS		
Constant	3.90E-05	0.000528
	(-0.0814)	(-1.178)
Observations	1,207	1,207
R-sq	0.116	0.0345
chi2	156.558	42.57022
P>chi2	0.0000	0.0001

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

BEM

VARIABLES	(7) D_lnF	(8) D_lnS
D_lnF		
L._ce1	-0.384***	0.293***
	(-4.345)	(-3.668)
LD.lnF	0.150*	0.0177
	(-1.768)	(-0.232)
L2D.lnF	0.0487	-0.0803
	(-0.62)	(-1.132)
L3D.lnF	-0.0301	-0.127**
	(-0.420)	(-1.963)
L4D.lnF	-0.018	-0.0448
	(-0.276)	(-0.759)
L5D.lnF	-0.0259	-0.0890*
	(-0.437)	(-1.667)
L6D.lnF	0.0454	-0.0168
	(-0.879)	(-0.361)
LD.lnS	0.0748	0.171**
	(-0.867)	(-2.202)
L2D.lnS	-0.115	0.0305
	(-1.420)	(-0.418)
L3D.lnS	-0.011	0.108
	(-0.148)	(-1.614)
L4D.lnS	0.105	0.149**
	(-1.533)	(-2.406)
L5D.lnS	-0.0201	0.0619
	(-0.321)	(-1.097)
L6D.lnS	-0.112**	-0.0605
	(-2.038)	(-1.220)
D_lnS		
Constant	0.000241	0.000316
	(-0.538)	(-0.782)
Observations	1,206	1,206
R-sq	0.0895	0.0833
chi2	117.1463	108.3124
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

DTAC		
	(7)	(8)
VARIABLES	D_lnF	D_lnS
D_lnF		
L._ce1	-0.206**	0.303***
	(-2.363)	(-3.643)
LD.lnF	-0.184**	0.0262
	(-2.129)	(-0.317)
L2D.lnF	-0.124	0.0488
	(-1.507)	(-0.62)
L3D.lnF	-0.119	0.00363
	(-1.551)	(-0.0494)
L4D.lnF	-0.113	-0.00383
	(-1.604)	(-0.0570)
L5D.lnF	-0.063	0.0029
	(-1.018)	(-0.0492)
L6D.lnF	-0.0599	0.0344
	(-1.191)	(-0.717)
LD.lnS	0.352***	0.152*
	(-4.085)	(-1.851)
L2D.lnS	0.119	-0.0909
	(-1.435)	(-1.154)
L3D.lnS	0.0955	-0.000382
	(-1.231)	(-0.00516)
L4D.lnS	0.0854	-0.00515
	(-1.201)	(-0.0758)
L5D.lnS	-0.0104	-0.0317
	(-0.167)	(-0.533)
L6D.lnS	0.0377	-0.0930*
	(-0.721)	(-1.861)
D_lnS		
Constant	7.99E-05	5.43E-05
	(-0.118)	(-0.0845)
Observations	1,207	1,207
R-sq	0.0954	0.0763
chi2	125.8817	98.60959
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

KBANK		
	(7)	(8)
VARIABLES	D_lnF	D_lnS
D_lnF		
L._ce1	-0.557***	0.036
	(-4.854)	(-0.348)
LD.lnF	-0.169	0.153
	(-1.509)	(-1.517)
L2D.lnF	-0.129	0.134
	(-1.204)	(-1.398)
L3D.lnF	0.122	0.213**
	(-1.216)	(-2.358)
L4D.lnF	0.00831	0.103
	(-0.0897)	(-1.239)
L5D.lnF	0.028	0.0966
	(-0.358)	(-1.37)
L6D.lnF	0.0768	0.0976*
	(-1.327)	(-1.87)
LD.lnS	0.373***	0.0572
	(-3.243)	(-0.552)
L2D.lnS	0.0425	-0.212**
	(-0.385)	(-2.124)
L3D.lnS	-0.0577	-0.164*
	(-0.554)	(-1.751)
L4D.lnS	-0.0145	-0.0935
	(-0.151)	(-1.083)
L5D.lnS	0.0657	0.012
	(-0.793)	(-0.161)
L6D.lnS	-0.102	-0.153***
	(-1.604)	(-2.659)
D_lnS		
Constant	-1.28E-05	-0.000197
	(-0.0242)	(-0.416)
Observations	1,207	1,207
R-sq	0.1795	0.07
chi2	260.9114	89.79454
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

SCC		
	(7)	(8)
VARIABLES	D_lnF	D_lnS
D_lnF		
L._ce1	-0.412***	0.0336
	(-7.234)	(-0.708)
LD.lnF	0.0134	0.0295
	(-0.223)	(-0.587)
L2D.lnF	0.0434	0.0212
	(-0.761)	(-0.446)
L3D.lnF	0.0327	0.0088
	(-0.604)	(-0.195)
L4D.lnF	0.0353	-0.00394
	(-0.69)	(-0.0925)
L5D.lnF	-0.0907*	-0.0999**
	(-1.897)	(-2.507)
L6D.lnF	0.172***	0.0727**
	(-3.943)	(-1.999)
LD.lnS	0.184***	0.165***
	(-2.762)	(-2.975)
L2D.lnS	-0.0978	-0.0715
	(-1.500)	(-1.316)
L3D.lnS	0.00713	0.049
	(-0.114)	(-0.941)
L4D.lnS	0.00805	0.0415
	(-0.135)	(-0.834)
L5D.lnS	0.0212	0.0449
	(-0.374)	(-0.954)
L6D.lnS	-0.234***	-0.135***
	(-4.425)	(-3.064)
D_lnS		
Constant	-6.57E-06	-8.06E-05
	(-0.0177)	(-0.261)
Observations	1,207	1,207
R-sq	0.1465	0.0629
chi2	207.7332	80.087
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

BJC

	(7)	(8)
VARIABLES	D_lnF	D_lnS
D_lnF		
L._ce1	-0.0744**	0.0488*
	(-2.397)	(-1.864)
LD.lnF	-0.414***	0.041
	(-9.020)	(-1.056)
L2D.lnF	-0.319***	0.0965**
	(-6.593)	(-2.362)
L3D.lnF	-0.217***	0.0990**
	(-4.329)	(-2.335)
L4D.lnF	-0.167***	0.111***
	(-3.371)	(-2.639)
L5D.lnF	0.00517	0.115***
	(-0.107)	(-2.826)
L6D.lnF	-0.0385	0.0423
	(-0.878)	(-1.143)
L7D.lnF	-0.0313	0.00199
	(-0.822)	(-0.062)
LD.lnS	0.522***	0.105**
	(-10.24)	(-2.436)
L2D.lnS	0.202***	-0.195***
	(-3.789)	(-4.345)
L3D.lnS	0.0994*	-0.121***
	(-1.828)	(-2.631)
L4D.lnS	0.0988*	-0.159***
	(-1.849)	(-3.526)
L5D.lnS	0.0829	-0.141***
	(-1.583)	(-3.195)
L6D.lnS	-0.0256	-0.0218
	(-0.517)	(-0.522)
L7D.lnS	-0.0285	0.0297
	(-0.619)	(-0.763)
D_lnS		
Constant	7.49E-05	0.000114
	(-0.124)	(-0.223)
Observations	1,206	1,206
R-sq	0.1781	0.0639
chi2	257.802	81.23362
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

MINT

	(7)	(8)
VARIABLES	D_lnF	D_lnS
D_lnF		
L._ce1	-0.204**	0.250***
	(-2.242)	(-3.276)
LD.lnF	-0.330***	-0.101
	(-3.552)	(-1.300)
L2D.lnF	-0.288***	-0.0327
	(-3.212)	(-0.436)
L3D.lnF	-0.153*	0.0746
	(-1.790)	(-1.04)
L4D.lnF	-0.112	0.0931
	(-1.403)	(-1.388)
L5D.lnF	-0.139*	-0.00511
	(-1.892)	(-0.0829)
L6D.lnF	0.092	0.0816
	(-1.423)	(-1.508)
L7D.lnF	-0.0316	0.0275
	(-0.575)	(-0.598)
LD.lnS	0.512***	0.283***
	(-5.243)	(-3.457)
L2D.lnS	0.260***	0.0286
	(-2.775)	(-0.364)
L3D.lnS	0.132	-0.0384
	(-1.46)	(-0.508)
L4D.lnS	0.232***	0.0183
	(-2.763)	(-0.261)
L5D.lnS	0.147*	0.0418
	(-1.896)	(-0.645)
L6D.lnS	-0.238***	-0.210***
	(-3.397)	(-3.585)
L7D.lnS	0.128**	0.116**
	(-2.052)	(-2.217)
D_lnS		
Constant	-0.000235	-0.000192
	(-0.348)	(-0.340)
Observations	1,206	1,206
R-sq	0.1648	0.1051
chi2	234.873	139.815
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

PTT

	(7)	(8)
VARIABLES	D_lnF	D_lnS
D_lnF		
L._ce1	-0.451***	0.144
	(-3.448)	(-1.161)
LD.lnF	-0.207	-0.0674
	(-1.625)	(-0.560)
L2D.lnF	-0.245**	-0.0443
	(-2.046)	(-0.391)
L3D.lnF	-0.354***	-0.184*
	(-3.118)	(-1.712)
L4D.lnF	-0.148	-0.0441
	(-1.403)	(-0.443)
L5D.lnF	-0.14	-0.0772
	(-1.493)	(-0.870)
L6D.lnF	-0.107	-0.0114
	(-1.346)	(-0.152)
L7D.lnF	0.0585	0.0972
	(-0.909)	(-1.597)
LD.lnS	0.350***	0.216*
	(-2.698)	(-1.763)
L2D.lnS	0.209*	0.0176
	(-1.697)	(-0.152)
L3D.lnS	0.363***	0.224**
	(-3.103)	(-2.028)
L4D.lnS	0.182*	0.0763
	(-1.669)	(-0.741)
L5D.lnS	0.0325	-0.0204
	(-0.33)	(-0.219)
L6D.lnS	0.141*	0.0567
	(-1.685)	(-0.717)
L7D.lnS	-0.0115	-0.0317
	(-0.164)	(-0.480)
D_lnS		
Constant	0.000157	0.000494
	(-0.301)	(-1.001)
Observations	1,206	1,206
R-sq	0.1329	0.0489
chi2	182.4664	61.24701
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

SAWAD

	(7)	(8)
VARIABLES	D_lnF	D_lnS
D_lnF		
L._ce1	-0.0314***	-0.0217
	(-2.946)	(-1.311)
LD.lnF	-0.390***	0.166***
	(-7.753)	(-3.792)
L2D.lnF	-0.244***	0.111**
	(-4.228)	(-2.211)
L3D.lnF	-0.132**	0.139***
	(-2.142)	(-2.586)
L4D.lnF	-0.300***	0.0106
	(-4.898)	(-0.199)
L5D.lnF	-0.107*	0.131**
	(-1.726)	(-2.44)
L6D.lnF	-0.0663	0.0473
	(-1.095)	(-0.898)
L7D.lnF	0.0605	0.116**
	(-1.106)	(-2.438)
LD.lnS	0.607***	0.0768
	(-10.61)	(-1.543)
L2D.lnS	0.229***	-0.182***
	(-3.599)	(-3.284)
L3D.lnS	0.0932	-0.144**
	(-1.375)	(-2.450)
L4D.lnS	0.270***	-0.00937
	(-3.982)	(-0.159)
L5D.lnS	0.169**	-0.0845
	(-2.516)	(-1.443)
L6D.lnS	-0.0215	-0.118**
	(-0.324)	(-2.050)
L7D.lnS	0.000326	-0.0346
	(-0.00534)	(-0.651)
D_lnS		
Constant	-0.000266	0.000385
	(-0.360)	(-0.598)
Observations	1,206	1,206
R-sq	0.1248	0.0787
chi2	169.6898	101.6508
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

SIRI

	(7)	(8)
VARIABLES	D_lnF	D_lnS
D_lnF		
L._ce1	-0.286***	0.0918***
	(-5.763)	(-2.743)
LD.lnF	-0.187***	-0.038
	(-3.556)	(-1.071)
L2D.lnF	-0.122**	-0.00971
	(-2.390)	(-0.281)
L3D.lnF	-0.0721	0.00576
	(-1.454)	(-0.172)
L4D.lnF	0.0116	0.0161
	(-0.245)	(-0.503)
L5D.lnF	0.0079	-0.0103
	(-0.177)	(-0.344)
L6D.lnF	0.0491	0.0169
	(-1.206)	(-0.616)
L7D.lnF	0.00573	0.0311
	(-0.159)	(-1.279)
LD.lnS	0.292***	0.270***
	(-4.576)	(-6.263)
L2D.lnS	0.107*	0.0148
	(-1.681)	(-0.346)
L3D.lnS	0.0291	-0.0525
	(-0.466)	(-1.244)
L4D.lnS	0.110*	0.0615
	(-1.802)	(-1.498)
L5D.lnS	-0.0467	-0.00186
	(-0.792)	(-0.0468)
L6D.lnS	-0.100*	-0.0713*
	(-1.774)	(-1.869)
L7D.lnS	0.184***	0.022
	(-3.455)	(-0.615)
D_lnS		
Constant	-0.00015	-0.000466
	(-0.201)	(-0.928)
Observations	1,206	1,206
R-sq	0.1655	0.078
chi2	235.9888	100.7105
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

BBL

	(7)	(8)
VARIABLES	D_lnF	D_lnS
D_lnF		
L._ce1	-0.219***	0.121*
	(-2.606)	(-1.793)
LD.lnF	-0.507***	-0.0957
	(-5.742)	(-1.354)
L2D.lnF	-0.151*	-0.017
	(-1.693)	(-0.238)
L3D.lnF	-0.220**	-0.0815
	(-2.542)	(-1.178)
L4D.lnF	-0.0945	0.00433
	(-1.143)	(-0.0655)
L5D.lnF	-0.154**	-0.0848
	(-1.980)	(-1.366)
L6D.lnF	-0.132*	-0.0409
	(-1.770)	(-0.685)
L7D.lnF	-0.239***	-0.081
	(-3.404)	(-1.443)
L8D.lnF	-0.144**	0.0022
	(-2.415)	(-0.046)
LD.lnS	0.659***	0.302***
	(-7.019)	(-4.019)
L2D.lnS	0.0961	-0.036
	(-1.017)	(-0.476)
L3D.lnS	0.188**	0.127*
	(-2.058)	(-1.74)
L4D.lnS	0.249***	0.0917
	(-2.814)	(-1.294)
L5D.lnS	0.258***	0.128*
	(-3.071)	(-1.906)
L6D.lnS	0.0547	-0.0143
	(-0.672)	(-0.219)
L7D.lnS	0.243***	0.131**
	(-3.169)	(-2.128)
L8D.lnS	0.124*	0.0139
	(-1.806)	(-0.253)
D_lnS		
Constant	-0.000132	-0.000239
	(-0.266)	(-0.603)
Observations	1,205	1,205
R-sq	0.2232	0.0702
chi2	341.0464	89.55212
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

CBG

	(7)	(8)
VARIABLES	D_lnF	D_lnS
D_lnF		
L._ce1	-0.326***	-0.00994
	(-7.125)	(-0.318)
LD.lnF	-0.411***	0.0683*
	(-8.051)	(-1.954)
L2D.lnF	-0.172***	0.0586
	(-3.251)	(-1.617)
L3D.lnF	-0.119**	0.0198
	(-2.282)	(-0.554)
L4D.lnF	-0.0108	0.0965***
	(-0.212)	(-2.766)
L5D.lnF	0.0513	0.109***
	(-1.043)	(-3.226)
L6D.lnF	0.0454	0.102***
	(-0.97)	(-3.179)
L7D.lnF	0.0595	0.0439
	(-1.365)	(-1.471)
L8D.lnF	0.113***	0.00844
	(-3.284)	(-0.358)
LD.lnS	0.591***	0.176***
	(-9.223)	(-4.02)
L2D.lnS	-0.0818	-0.174***
	(-1.249)	(-3.877)
L3D.lnS	0.187***	0.0593
	(-2.902)	(-1.348)
L4D.lnS	0.0162	-0.0669
	(-0.256)	(-1.546)
L5D.lnS	-0.0184	-0.0943**
	(-0.299)	(-2.233)
L6D.lnS	-0.138**	-0.110***
	(-2.261)	(-2.637)
L7D.lnS	-0.0598	-0.0295
	(-1.039)	(-0.750)
L8D.lnS	-0.110**	0.0201
	(-2.120)	(-0.564)
D_lnS		
Constant	-1.63E-05	0.000533
	(-0.0165)	(-0.79)
Observations	1,205	1,205
R-sq	0.3296	0.844
chi2	583.5193	109.4772
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

KTB

	(7)	(8)
VARIABLES	D_lnF	D_lnS
D_lnF		
L._ce1	-0.178**	0.138**
	(-2.254)	(-2.366)
LD.lnF	0.0823	-0.0259
	(-1.014)	(-0.433)
L2D.lnF	-0.108	-0.0990*
	(-1.342)	(-1.674)
L3D.lnF	-0.0523	-0.132**
	(-0.675)	(-2.306)
L4D.lnF	-0.11	-0.133**
	(-1.465)	(-2.400)
L5D.lnF	-0.0115	-0.0428
	(-0.162)	(-0.814)
L6D.lnF	-0.0356	-0.0755
	(-0.534)	(-1.538)
L7D.lnF	-0.0044	-0.024
	(-0.0735)	(-0.544)
L8D.lnF	0.155***	0.0451
	(-3.059)	(-1.205)
LD.lnS	0.225***	0.176***
	(-2.597)	(-2.765)
L2D.lnS	0.0757	0.074
	(-0.897)	(-1.189)
L3D.lnS	0.135	0.221***
	(-1.639)	(-3.646)
L4D.lnS	0.144*	0.199***
	(-1.798)	(-3.378)
L5D.lnS	0.00527	0.0692
	(-0.0678)	(-1.206)
L6D.lnS	-0.0438	0.0238
	(-0.595)	(-0.439)
L7D.lnS	0.0096	-0.0155
	(-0.143)	(-0.313)
L8D.lnS	-0.0898	0.0608
	(-1.528)	(-1.402)
D_lnS		
Constant	-0.00032	-0.000413
	(-0.637)	(-1.114)
Observations	1,205	1,205
R-sq	0.091	0.0723
chi2	118.7687	92.52323
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

INTUCH

	(7)	(8)
VARIABLES	D_lnF	D_lnS
D_lnF		
L._ce1	-0.420***	0.111**
	(-5.478)	(-2.07)
LD.lnF	-0.442***	-0.0643
	(-5.775)	(-1.195)
L2D.lnF	-0.218***	-0.0201
	(-2.906)	(-0.381)
L3D.lnF	-0.171**	-0.00577
	(-2.344)	(-0.112)
L4D.lnF	-0.0974	0.021
	(-1.391)	(-0.427)
L5D.lnF	-0.120*	0.0334
	(-1.812)	(-0.721)
L6D.lnF	-0.0446	0.0425
	(-0.722)	(-0.979)
L7D.lnF	0.0133	0.00673
	(-0.235)	(-0.169)
L8D.lnF	-0.0483	0.00477
	(-0.960)	(-0.135)
L9D.lnF	0.0344	0.0228
	(-0.924)	(-0.871)
LD.lnS	0.511***	0.223***
	(-6.111)	(-3.796)
L2D.lnS	0.243***	0.0388
	(-2.931)	(-0.666)
L3D.lnS	0.132	0.0361
	(-1.628)	(-0.634)
L4D.lnS	0.161**	-0.052
	(-2.081)	(-0.954)
L5D.lnS	-0.0226	-0.0854
	(-0.304)	(-1.635)
L6D.lnS	0.0586	-0.0445
	(-0.833)	(-0.900)
L7D.lnS	0.0308	0.03
	(-0.462)	(-0.64)
L8D.lnS	-0.0111	0.0656
	(-0.180)	(-1.522)
L9D.lnS	-0.134**	-0.107***
	(-2.517)	(-2.842)
D_lnS		
Constant	2.35E-05	8.84E-05
	(-0.0471)	(-0.252)
Observations	1,204	1,204
R-sq	0.3698	0.0558
chi2	694.6321	69.91894
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

JAS

	(7)	(8)
VARIABLES	D_lnF	D_lnS
D_lnF		
L._ce1	-0.0972***	0.0334**
	(-4.527)	(-2.392)
LD.lnF	-0.277***	0.0104
	(-7.547)	(-0.434)
L2D.lnF	-0.0818**	-0.0219
	(-2.166)	(-0.893)
L3D.lnF	-0.102***	-0.0612**
	(-2.727)	(-2.507)
L4D.lnF	0.036	-0.0557**
	(-0.969)	(-2.306)
L5D.lnF	-0.0217	-0.0849***
	(-0.582)	(-3.506)
L6D.lnF	-0.0776**	-0.0268
	(-2.076)	(-1.103)
L7D.lnF	0.0128	0.001
	(-0.346)	(-0.0418)
L8D.lnF	0.0740**	-0.0595**
	(-2.033)	(-2.512)
L9D.lnF	0.00201	-0.0613***
	(-0.0591)	(-2.768)
LD.lnS	0.367***	0.184***
	(-6.831)	(-5.27)
L2D.lnS	-0.127**	-0.0364
	(-2.321)	(-1.023)
L3D.lnS	0.130**	0.129***
	(-2.398)	(-3.653)
L4D.lnS	0.00875	0.0452
	(-0.161)	(-1.276)
L5D.lnS	-0.00248	0.0548
	(-0.0456)	(-1.547)
L6D.lnS	0.0215	0.0216
	(-0.394)	(-0.61)
L7D.lnS	-0.0373	-0.0193
	(-0.687)	(-0.545)
L8D.lnS	-0.00822	0.0396
	(-0.153)	(-1.133)
L9D.lnS	0.0603	0.0655*
	(-1.163)	(-1.943)
D_lnS		
Constant	4.60E-06	1.34E-05
	(-0.00445)	(-0.0199)
Observations	1,204	1,204
R-sq	0.1458	0.0643
chi2	202.037	81.36949
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

SCB

	(7)	(8)
VARIABLES	D_lnF	D_lnS
D_lnF		
L._ce1	-0.357***	0.0463
	(-3.041)	(-0.417)
LD.lnF	-0.197	0.145
	(-1.621)	(-1.264)
L2D.lnF	-0.19	0.0438
	(-1.573)	(-0.385)
L3D.lnF	0.0284	0.157
	(-0.242)	(-1.417)
L4D.lnF	-0.0278	0.0567
	(-0.245)	(-0.53)
L5D.lnF	-0.126	-0.0596
	(-1.163)	(-0.584)
L6D.lnF	-0.0568	0.0165
	(-0.553)	(-0.17)
L7D.lnF	0.0424	0.0762
	(-0.441)	(-0.84)
L8D.lnF	0.184**	0.184**
	(-2.158)	(-2.295)
L9D.lnF	0.0549	0.0629
	(-0.802)	(-0.973)
LD.lnS	0.360***	0.0256
	(-2.901)	(-0.219)
L2D.lnS	0.195	-0.0734
	(-1.585)	(-0.632)
L3D.lnS	0.00413	-0.14
	(-0.0343)	(-1.226)
L4D.lnS	0.0875	0.000217
	(-0.751)	(-0.00198)
L5D.lnS	0.184*	0.135
	(-1.647)	(-1.284)
L6D.lnS	0.0221	-0.07
	(-0.209)	(-0.700)
L7D.lnS	0.0108	-0.0167
	(-0.109)	(-0.179)
L8D.lnS	-0.129	-0.134
	(-1.446)	(-1.590)
L9D.lnS	-0.154**	-0.152**
	(-2.115)	(-2.206)
D_lnS		
Constant	-2.82E-05	-0.000218
	(-0.0595)	(-0.487)
Observations	1,204	1,204
R-sq	0.1095	0.0693
chi2	145.6105	88.1812
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

TMB

	(7)	(8)
VARIABLES	D_lnF	D_lnS
D_lnF		
L._ce1	-0.0556*	0.0451*
	(-1.863)	(-1.844)
LD.lnF	-0.338***	0.103***
	(-7.243)	(-2.691)
L2D.lnF	-0.273***	0.021
	(-5.502)	(-0.517)
L3D.lnF	-0.243***	0.022
	(-4.810)	(-0.53)
L4D.lnF	-0.232***	-0.0191
	(-4.566)	(-0.460)
L5D.lnF	-0.176***	-0.0357
	(-3.474)	(-0.861)
L6D.lnF	-0.223***	-0.106***
	(-4.489)	(-2.611)
L7D.lnF	-0.162***	-0.0918**
	(-3.377)	(-2.335)
L8D.lnF	-0.0922**	-0.0353
	(-2.019)	(-0.945)
L9D.lnF	-0.110***	-0.106***
	(-2.745)	(-3.218)
LD.lnS	0.565***	0.102**
	(-10.54)	(-2.328)
L2D.lnS	0.233***	-0.0654
	(-4.113)	(-1.411)
L3D.lnS	0.263***	-0.0207
	(-4.556)	(-0.438)
L4D.lnS	0.237***	0.0625
	(-4.086)	(-1.314)
L5D.lnS	0.253***	0.0821*
	(-4.383)	(-1.735)
L6D.lnS	0.210***	0.0509
	(-3.671)	(-1.086)
L7D.lnS	0.191***	0.142***
	(-3.443)	(-3.113)
L8D.lnS	0.0843	0.0536
	(-1.577)	(-1.223)
L9D.lnS	0.178***	0.110***
	(-3.622)	(-2.725)
D_lnS		
Constant	-0.000411	-0.000507
	(-0.658)	(-0.989)
Observations	1,204	1,204
R-sq	0.1486	0.0735
chi2	206.6882	93.96068
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

AMATA		
	(7)	(8)
VARIABLES	D_lnF	D_lnS
D_lnF		
L._ce1	-0.0882	0.250***
	(-1.065)	(-3.247)
LD.lnF	-0.131	0.0282
	(-1.473)	(-0.34)
L2D.lnF	-0.182**	0.00242
	(-2.120)	(-0.0303)
L3D.lnF	-0.128	-0.0464
	(-1.515)	(-0.593)
L4D.lnF	-0.167**	-0.091
	(-2.075)	(-1.213)
L5D.lnF	-0.0728	0.00703
	(-0.942)	(-0.0977)
L6D.lnF	-0.0163	0.0773
	(-0.223)	(-1.132)
L7D.lnF	-0.0467	0.0718
	(-0.666)	(-1.1)
L8D.lnF	0.111*	0.164***
	(-1.677)	(-2.662)
L9D.lnF	-0.0303	0.0666
	(-0.502)	(-1.185)
L10D.lnF	0.101*	0.139***
	(-1.866)	(-2.764)
LD.lnS	0.375***	0.230***
	(-4.193)	(-2.765)
L2D.lnS	0.0818	-0.0594
	(-0.936)	(-0.731)
L3D.lnS	0.212**	0.0799
	(-2.507)	(-1.013)
L4D.lnS	0.107	0.0897
	(-1.313)	(-1.178)
L5D.lnS	0.189**	0.0749
	(-2.427)	(-1.032)
L6D.lnS	-0.0773	-0.206***
	(-1.027)	(-2.934)
L7D.lnS	0.0736	-0.015
	(-1.013)	(-0.222)
L8D.lnS	-0.0649	-0.094
	(-0.940)	(-1.462)
L9D.lnS	0.0305	-0.0668
	(-0.487)	(-1.144)
L10D.lnS	-0.0745	-0.102*
	(-1.305)	(-1.918)
D_lnS		
Constant	0.000187	6.61E-05
	(-0.308)	(-0.117)
Observations	1,203	1,203
R-sq	0.1095	0.1235
chi2	145.2839	166.394
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

CK		
	(7)	(8)
VARIABLES	D_lnF	D_lnS
D_lnF		
L._ce1	-0.269***	0.0752**
	(-5.088)	(-2.046)
LD.lnF	-0.177***	-0.0209
	(-3.161)	(-0.539)
L2D.lnF	-0.0909*	-0.00753
	(-1.699)	(-0.203)
L3D.lnF	-0.0858*	-0.0333
	(-1.688)	(-0.943)
L4D.lnF	0.00181	-0.0178
	(-0.0375)	(-0.530)
L5D.lnF	-0.0183	-0.0112
	(-0.386)	(-0.342)
L6D.lnF	0.0613	-0.00993
	(-1.34)	(-0.313)
L7D.lnF	-0.111**	-0.00716
	(-2.500)	(-0.232)
L8D.lnF	-0.148***	-0.0415
	(-3.490)	(-1.407)
L9D.lnF	-0.122***	0.00297
	(-3.049)	(-0.107)
L10D.lnF	-0.131***	-0.0262
	(-3.624)	(-1.043)
LD.lnS	0.395***	0.220***
	(-5.936)	(-4.746)
L2D.lnS	0.0234	-0.0168
	(-0.357)	(-0.370)
L3D.lnS	0.0312	0.062
	(-0.488)	(-1.397)
L4D.lnS	-0.0436	0.0421
	(-0.706)	(-0.98)
L5D.lnS	-0.107*	-0.0289
	(-1.757)	(-0.682)
L6D.lnS	-0.0749	-0.035
	(-1.249)	(-0.839)
L7D.lnS	-0.00187	0.0319
	(-0.0316)	(-0.775)
L8D.lnS	0.135**	0.0381
	(-2.335)	(-0.948)
L9D.lnS	0.123**	-0.0171
	(-2.205)	(-0.442)
L10D.lnS	0.179***	0.0647*
	(-3.384)	(-1.758)
D_lnS		
Constant	-0.000121	-0.000435
	(-0.175)	(-0.904)
Observations	1,203	1,203
R-sq	0.184	0.0573
chi2	266.2836	71.72692
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

PTTGC		
	(7)	(8)
VARIABLES	D_lnF	D_lnS
D_lnF		
L._ce1	-0.215	0.303**
	(-1.638)	(-2.572)
LD.lnF	-0.605***	-0.297**
	(-4.625)	(-2.529)
L2D.lnF	-0.447***	-0.256**
	(-3.484)	(-2.226)
L3D.lnF	-0.377***	-0.207*
	(-3.030)	(-1.851)
L4D.lnF	-0.410***	-0.213**
	(-3.408)	(-1.969)
L5D.lnF	-0.349***	-0.202**
	(-3.049)	(-1.960)
L6D.lnF	-0.236**	-0.116
	(-2.183)	(-1.192)
L7D.lnF	-0.202**	-0.158*
	(-2.034)	(-1.762)
L8D.lnF	-0.146	-0.103
	(-1.604)	(-1.257)
L9D.lnF	-0.141*	-0.11
	(-1.775)	(-1.541)
L10D.lnF	0.0184	0.0562
	(-0.299)	(-1.02)
LD.lnS	0.789***	0.507***
	(-5.969)	(-4.267)
L2D.lnS	0.400***	0.200*
	(-3.064)	(-1.703)
L3D.lnS	0.414***	0.262**
	(-3.261)	(-2.3)
L4D.lnS	0.417***	0.257**
	(-3.385)	(-2.322)
L5D.lnS	0.304***	0.141
	(-2.589)	(-1.341)
L6D.lnS	0.252**	0.148
	(-2.265)	(-1.48)
L7D.lnS	0.193*	0.166*
	(-1.87)	(-1.788)
L8D.lnS	0.239**	0.192**
	(-2.521)	(-2.257)
L9D.lnS	0.0537	0.0317
	(-0.634)	(-0.416)
L10D.lnS	0.0336	0.0428
	(-0.491)	(-0.697)
D_lnS		
Constant	0.000153	0.000108
	(-0.247)	(-0.195)
Observations	1,203	1,203
R-sq	0.1721	0.0806
chi2	245.5574	103.5798
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

TOP

VARIABLES	(7) D_lnF	(8) D_lnS
D_lnF		
L._ce1	-0.670***	0.218***
	(-6.855)	(-2.787)
LD.lnF	-0.0606	0.247***
	(-0.616)	(-3.143)
L2D.lnF	-0.0133	0.222***
	(-0.138)	(-2.864)
L3D.lnF	0.000261	0.202***
	(-0.00277)	(-2.672)
L4D.lnF	0.0151	0.115
	(-0.165)	(-1.57)
L5D.lnF	0.0942	0.0412
	(-1.057)	(-0.577)
L6D.lnF	0.174**	0.092
	(-2.01)	(-1.328)
L7D.lnF	0.076	0.112*
	(-0.926)	(-1.712)
L8D.lnF	0.194***	0.233***
	(-2.582)	(-3.875)
L9D.lnF	0.193***	0.218***
	(-2.913)	(-4.119)
L10D.lnF	0.049	0.142***
	(-0.909)	(-3.294)
LD.lnS	0.189*	-0.127
	(-1.783)	(-1.497)
L2D.lnS	0.0265	-0.218***
	(-0.257)	(-2.638)
L3D.lnS	-0.0452	-0.214***
	(-0.448)	(-2.650)
L4D.lnS	-0.0823	-0.149*
	(-0.834)	(-1.889)
L5D.lnS	-0.0383	-0.00438
	(-0.396)	(-0.0566)
L6D.lnS	-0.214**	-0.134*
	(-2.267)	(-1.766)
L7D.lnS	-0.0358	-0.0386
	(-0.398)	(-0.537)
L8D.lnS	-0.157*	-0.181***
	(-1.899)	(-2.729)
L9D.lnS	-0.266***	-0.270***
	(-3.575)	(-4.537)
L10D.lnS	0.0463	-0.069
	(-0.72)	(-1.341)
D_lnS		
Constant	1.24E-05	-3.81E-05
	(-0.017)	(-0.0653)
Observations	1,203	1,203
R-sq	0.2172	0.0661
chi2	327.5995	83.55069
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

BLAND

VARIABLES	(7) D_lnF	(8) D_lnS
D_lnF		
L._ce1	-0.107**	0.159***
	(-2.195)	(-5.481)
LD.lnF	-0.180***	0.204***
	(-3.314)	(-6.285)
L2D.lnF	-0.0252	0.137***
	(-0.454)	(-4.132)
L3D.lnF	-0.124**	0.0252
	(-2.262)	(-0.772)
L4D.lnF	-0.086	0.0327
	(-1.597)	(-1.016)
L5D.lnF	-0.105**	-0.0196
	(-2.014)	(-0.630)
L6D.lnF	-0.0985*	0.0427
	(-1.958)	(-1.421)
L7D.lnF	-0.126***	0.0411
	(-2.581)	(-1.416)
L8D.lnF	-0.046	0.00563
	(-0.974)	(-0.2)
L9D.lnF	-0.0251	0.02
	(-0.557)	(-0.744)
L10D.lnF	0.016	0.0092
	(-0.374)	(-0.36)
L11D.lnF	0.0219	-0.000909
	(-0.598)	(-0.0417)
LD.lnS	0.232***	0.0615
	(-3.584)	(-1.593)
L2D.lnS	0.198***	0.0087
	(-3.081)	(-0.227)
L3D.lnS	0.0209	-0.0699*
	(-0.328)	(-1.834)
L4D.lnS	0.165***	0.0921**
	(-2.618)	(-2.447)
L5D.lnS	0.0133	-0.0910**
	(-0.218)	(-2.486)
L6D.lnS	0.0857	-0.0743**
	(-1.432)	(-2.081)
L7D.lnS	0.0221	0.0498
	(-0.375)	(-1.414)
L8D.lnS	-0.0182	-0.0672*
	(-0.317)	(-1.955)
L9D.lnS	0.106*	0.0493
	(-1.901)	(-1.475)
L10D.lnS	0.00946	-0.0113
	(-0.182)	(-0.365)
L11D.lnS	0.0247	0.126***
	(-0.553)	(-4.719)
D_lnS		
Constant	-9.14E-05	-6.14E-05
	(-0.162)	(-0.183)
Observations	1,202	1,202
R-sq	0.1149	0.3278
chi2	152.946	574.4908
P>chi2	0.0000	0.0000

z-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

AAV

VARIABLES	(7) D_lnF	(8) D_lnS
D_lnF		
L._ce1	-0.111***	0.029
	(-3.879)	(-1.201)
LD.lnF	0.0324	0.0496
	(-0.772)	(-1.397)
L2D.lnF	0.0831**	-0.0112
	(-1.963)	(-0.311)
L3D.lnF	0.0815*	-0.0322
	(-1.915)	(-0.893)
L4D.lnF	0.119***	-0.00695
	(-2.792)	(-0.193)
L5D.lnF	-0.0217	0.0103
	(-0.517)	(-0.289)
L6D.lnF	0.0828**	0.0253
	(-1.989)	(-0.719)
L7D.lnF	-0.00126	0.00453
	(-0.0305)	(-0.129)
L8D.lnF	0.0491	0.0348
	(-1.199)	(-1.005)
L9D.lnF	0.0656	0.046
	(-1.62)	(-1.342)
L10D.lnF	-0.0175	0.0254
	(-0.443)	(-0.761)
L11D.lnF	0.0867**	0.0119
	(-2.201)	(-0.357)
L12D.lnF	0.146***	0.0211
	(-3.701)	(-0.634)
L13D.lnF	0.112***	0.039
	(-2.845)	(-1.169)
L14D.lnF	-0.00849	0.03
	(-0.222)	(-0.925)

AAV (continue)

VARIABLES	(7) D_lnF	(8) D_lnS
LD.lnS	0.181***	0.188***
	(-3.787)	(-4.638)
L2D.lnS	-0.0171	0.0441
	(-0.352)	(-1.074)
L3D.lnS	-0.0970**	-0.002
	(-1.994)	(-0.0486)
L4D.lnS	-0.102**	0.0161
	(-2.094)	(-0.392)
L5D.lnS	0.0348	-0.059
	(-0.725)	(-1.451)
L6D.lnS	0.00172	-0.0791*
	(-0.036)	(-1.959)
L7D.lnS	-0.0594	-0.000744
	(-1.252)	(-0.0185)
L8D.lnS	0.0588	-0.0283
	(-1.246)	(-0.707)
L9D.lnS	-0.041	-0.0473
	(-0.877)	(-1.196)
L10D.lnS	-0.00115	-0.0391
	(-0.0250)	(-1.002)
L11D.lnS	-0.000739	0.0913**
	(-0.0161)	(-2.344)
L12D.lnS	-0.0831*	-0.000505
	(-1.803)	(-0.0129)
L13D.lnS	-0.0622	0.0416
	(-1.353)	(-1.07)
L14D.lnS	-0.065	-0.102***
	(-1.448)	(-2.681)
D_lnS		
Constant	-0.000124	-0.000474
	(-0.165)	(-0.743)
Observations	1,199	1,199
R-sq	0.0979	0.0977
chi2	126.8402	126.5923
P>chi2	0.0000	0.0000

z-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

VITA

NAME	Pimnapa Wongvisavakorn
DATE OF BIRTH	11 July 1990
PLACE OF BIRTH	Bangkok
INSTITUTIONS ATTENDED	Chulalongkorn University
HOME ADDRESS	1088/83 Q Chidlom-Petchaburi, New Petchaburi road., Makkasan, Ratchathevi, Bangkok 10400