5-2016

Single Stock Futures and Stock Options: Complement or Substitutes

Cuyler Strong
Utah State University

SINGLE STOCK FUTURES AND STOCK OPTIONS:

COMPLEMENT OR SUBSITITUTES

by

Cuyler Strong

A thesis submitted in partial fulfillment

of the requirements for the degree

of

MASTER OF SCIENCE

in

Financial Economics

Approved:

_____	_____
Tyler Brough	Ben Blau
Major Professor	Committee Member

_____

Ryan Whitby

Committee Member

UTAH STATE UNIVERSITY

Logan, Utah

2016

ABSTRACT

Single Stock Futures and Stock Options:

Complement or Substitutes

by

Cuyler Strong, Master of Science

Utah State University, 2016

Major Professor: Tyler Brough
Department: Finance and Economics

Are single stock futures and stock options complement or substitute goods? In this study, I test this research question by examining option trading activity (option volume and open interest) surrounding an arguably exogenous introduction of single stock futures. This event study provides a natural experiment that allows us to make causal inferences about how the presence of single stock futures affects the options market. While it is commonly thought that single stock futures and options are substitute goods, my evidence instead suggests that they are complements. While I observe very little change in option volume surrounding the introduction of single stock futures, I find that total open interest increases by 9%, on average, after the introduction of single stock futures. The most plausible explanation is that the introduction of single stock futures makes it easier to hedge the risk of writing on option.

(15 pages)

ACKNOWLEDGMENTS

I would like to thank Dr. Ryan Whitby and Dr. Benjamin Blau for inspiring me to do research, and having the patience to work with me throughout the whole process. I would also like to thank Tyler Brough for helping me work through the details of my thesis.

Special thanks to my wonderful wife, Courtney, for her patience and pushing me to do the best I can. Thanks to all the professors in the Finance and Economics Department for teaching me, and the other students who went through it all with me.

Cuyler

LIST OF TABLES

Table Page

1. Variables 4
2. Summary Statistics 5
3. Before and After T-Values for Stocks with Futures and Options 7
4. Before and After T-Values for Stocks with Options and no Futures 8
5. Difference in Differences Between stocks with Futures and those without Futures 9
6. OLS Regressions on Option Volume 10
7. White Test on Option Volume 11
8. OLS Regression on Option Open Interest 12
9. White Test on Option Open Interest 12

CONTENTS

Page

ABSTRACT iii

ACKNOWLEDGMENTS iv

LIST OF TABLES v

INTRODUTION 1

DATA 3

RESULTS 6

CONCLUSION 13

REFERENCES 14

Introduction

Liquidity in options markets is affected by the ability to hedge both bearish and bullish positions (Evans et.al 2009). For instance, the cost of providing liquidity in the options market is decreasing in the ability of the option market maker to hedge various positions. In 2008, the U.S. Securities and Exchange Commission (SEC) restricted short selling on all financial stocks in the United States. Battalio and Schultz (2011) show that this ban led to a decrease in option market liquidity as bid-ask spreads in the options market increased, suggesting that the ability to sell short complements liquidity in options markets. However, it is commonly thought that options and futures are substitutes (Lapan et al 1991, and Frechette 2001), Danielsen, Van Ness, and Warr (2009) find that single stock futures are a substitute for short sales, in the case that single stock futures are available to be substituted for short selling, It could follow that option liquidity will increase as the availability of single stock futures increase as well.

If single stock futures can be used to hedge positions in option markets, the availability of these futures would be very important. The idea of single stock futures traded on the value of stock prices was first introduced by Ross (1979), although Australia was the first to offer single stock futures in 1994. In 2002, the United State started offering a few single stock futures and the number of offerings has increased dramatically since. The effect that single stock futures have on the underlying stock has been studied extensively by Lee and Tong (1998), Dennis and Sim (1999), McKenzie et al. (2001), Lien and Yang (2003), and Chau et al. (2007). Other research has performed event studies to show the effect that introducing other derivatives into the market has on the underlying stock; Detemple and Jorion (1990) studied the impact of Option listings on the underlying stock price, while Blau and Brough (2011) show that the introduction of options decrease market frictions.

Moriarty et. al. (1981) argue that while in theory, futures and options would be substitutes, they will not likely be perfect substitutes because of the differences between futures and options. In this paper, I examine what happens to option volume when futures are introduced into the market. If futures and options are substitutes, as suggested by Lapan et al (1991) and Frechette (2001), then option volume will decrease after the introduction of single stock futures. However if single stock futures and stock options are complements, option volume will increase after the instruction of futures leading to better information in the market. While it is often assumed that futures and options are substitutes, there has been little empirical research to show one way or the other.

Because the introduction of a single stock future happened at different times for different stocks, and time of each introduction was decided by the futures exchange and not by the corporation, it is an (arguably) exogenous event, and provides a natural experiment to test whether futures and options are complements or substitutes. Using panel data for 660 stocks I perform a difference-in-difference type test to compare what happens to options for stocks with single stock futures to a matched sample of options on stocks that do not have single stock futures. I compare the volume and open interest of options for the six months before to the introduction of single stock futures to the six months after the introduction.

I run a series of univariate tests as well as multivariate tests with controls for underlying share prices, volatility, bid-ask spreads, and trading volume. Further, my multivariate tests control for conditional heteroskedasticity. In general, my tests show that single stock futures and options are complements as opposed to substitutes. While option volume changes marginally in response to the introduction of single stock futures, results show that there is a 9% increase in option open interest after the introduction. These results are significant at 0.01 level and suggest that single stock futures and stock options are complement goods, and that futures

may improve the liquidity of option markets. While these results are contrary to conventional wisdom, if the costs associated with liquidity provision in the options market is decreasing in the ability of market makers to hedge positions. Single stock futures could allow for this type of hedging. Therefore, the presence of futures might increase liquidity in options markets.

Data

I pulled data from wrds for this project. I also collected the dates that single stock futures were introduced for certain stocks from the press releases by ChicagoOne. I started with 1700 stocks that introduced futures from 2002 through 2012. I then merged these two data sets and added a dummy variable for before and after the introduction of single stock futures. I then matched the stocks with options that had single stock futures with stocks with options that did not have single stock futures, I matched the samples by industry and market cap on the day of the introduction. After creating at matched sample this left me with 660 stocks with single stock futures and 660 matches.

Table 1: Variables	
cvol	Call OptionVolume
pvol	Put Option Volume
tvol	Total Option Volume
coi	Call Option Open Interest
poi	Put Option Open Interest
toi	Total Option Open Interest
PRC	Price
VOL	Volume
RET	Return
BID	Bid Price
ASK	Ask Price
SHROUT	Shares Outstanding
mv	Market Cap
pricevol	Price Volitility
spread	Bid Ask Spread
StDev ret	Standard Deviation of Return
StDev Vol	Standard Deviation of Volume
StDev cvol	Standard Deviation of Call Option Volume
StDev pvol	Standard Deviation of Put Option Volume
StDev tvol	Standard Deviation of Total Option Volume

For the stocks with single stock futures the average price was $31.01, the average daily return was .0767%, and the average daily volume was 2,346,932.83. As for the options on those stocks the average total option volume in a day was 2945.06 and the average total open interest was 72444.31.

For the stocks without single stock futures the average price was $26.21, the average daily return was .0864%, and the average daily volume was 2,719,052.7. As for the options on

those stock the average total option volume in a day was 4397.37 and the average total open interest was 89421.71.

As you can see in Table 2 the control sample has higher returns and volume and in fact is higher in every category except for price, shares outstanding and market cap.

Table 2: Summary Statistics

Single Stock Future

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
cvol		24,014	1,703.20	4,942.00	0.00	172,962.38
pvol		24,014	1,241.85	4,235.73	0.00	224,514.62
tvol		24,014	2,945.06	8,727.93	0.00	397,477.00
coi		24,014	40,448.37	123,356.60	0.00	3,223,080.95
poi		24,014	31,995.88	97,888.62	0.00	2,688,664.76
toi		24,014	72,444.31	215,367.81	0.00	4,889,855.19
PRC	Price or Bid/Ask Average	24,012	31.0384	28.5922	0.2353	508.9933
VOL	Volume	24,012	2,346,932.83	6,343,096.28	3,150.00	331,352,485.00
RET	Returns	24,011	0.0008	0.0091	-0.0972	0.3506
BID	Bid	24,006	31.0121	28.5741	0.2285	508.8981
ASK	Ask	24,006	31.0578	28.6073	0.2440	509.8819
SHROUT	Shares Outstanding	24,014	229,946.19	706,560.28	115.38	11,144,681.00
mv		24,012	7,925,089.88	26,019,555.89	2,361.99	402,231,531.00
pricevol		24,006	0.0021	0.0029	-0.0018	0.0863
spread		24,006	0.0021	0.0032	-0.0018	0.1135
StDev ret	Returns	23,994	0.0336	0.0266	0.0001	1.3927
StDev Vol	Volume	23,994	972,573.71	2,484,391.65	70.71	90,215,521.38
StDev cvol		23,996	1,637.75	5,688.63	0.00	196,745.71
StDev pvol		23,996	1,128.44	3,379.47	0.00	117,736.30
StDev tvol		23,996	2,474.62	7,259.10	0.00	196,673.36

Controls

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
cvol_opt		21,608	2,286.18	12,216.48	0.00	426,134.59
pvol_opt		21,608	2,111.19	16,602.20	0.00	995,752.50
tvol_opt		21,608	4,397.37	27,581.08	0.00	1,334,401.17
coi_opt		21,608	47,201.91	172,632.75	0.00	4,405,262.91
poi_opt		21,608	42,219.77	208,838.04	0.00	6,992,366.00
toi_opt		21,608	89,421.71	372,551.51	0.00	10,324,403.84
prc_opt	Price or Bid/Ask Average	24,014	26.2143	25.0686	0.0255	359.7205
vol_opt	Volume	24,014	2,719,052.70	8,251,770.75	481.82	289,575,359.00
ret_opt	Returns	24,012	0.0009	0.0118	-0.8696	0.5910
bid_opt	Bid	24,014	26.1909	25.0547	0.0248	359.5652
ask_opt	Ask	24,014	26.2323	25.0846	0.0264	359.8590
shrout_opt	Shares Outstanding	24,014	179,244.15	346,958.06	100.00	4,704,921.00
mv_opt		24,014	5,191,349.74	11,319,900.23	479.01	166,856,346.00
pricevol_opt		24,014	0.0032	0.0068	-0.0152	0.1840
spread_opt		24,014	0.0033	0.0074	-0.0151	0.2115
StDev ret_opt	Returns	23,996	0.0360	0.0337	0.0000	2.3168
StDev vol_opt	Volume	23,996	1,223,533.78	4,072,206.01	832.26	117,878,037.00
StDev cvol_opt		21,591	2,100.09	13,940.23	0.00	781,024.96
StDevpvol_opt		21,591	1,572.75	8,273.13	0.00	359,477.61
Stdev tvol_opt		21,591	3,309.86	17,807.80	0.00	782,802.63

Results

In this section, I report the results from running a series of univariate and multivariate test to determine what effect the introduction of single stock futures has on the options of the same stock. Table 3 shows the underlying stock and option data for 6 months before and 6 months after the introduction of single stock futures on the stock. As seen in the table, the price for these stocks decreases by 1.05%. This decrease is statistically significant. I also find a statistically significant decrease to price volatility and the bid-ask spread. While looking at the option data there is a slight increase in put and call volume after the single stock futures are introduce, however this change is not statistically significant. The most interesting results is that there is an 8.9% increase in total open interest, and it is significant. The call and put open interest increase by 8.5% and 9.8% respectively.

Table 3: Stocks with SSF and Options								
	Before			After				
Variables	Mean	Std Dev	Std Err	Mean	Std Dev	Std Err	Difference	T Value
Call Open Interest	39,405.0	115,023.0	331.4	42,748.4	122,132.0	349.8	3,343.4	6.94
Put Open Interest	31,215.4	88,389.8	254.7	34,252.2	98,684.4	282.7	3,036.8	7.98
Total Open Interest	70,624.0	197,736.0	569.7	77,002.0	214,170.0	613.5	6,378.0	7.61
Call Volume	1,742.3000	8,110.5000	23.3660	1,801.8000	7,683.7000	22.0094	59.5000	1.86
Std Dev Call Volume	1,658.9000	6,320.6000	18.2092	1,743.5000	5,896.9000	16.8912	84.6000	3.41
Put Volume	1,331.0000	5,386.5000	15.5190	1,337.4000	5,691.3000	16.3025	6.4000	0.29
Std Dev Put Volume	1,166.4000	3,276.4000	9.4391	1,248.9000	3,691.2000	10.5733	82.5000	5.81
Total Volume	3,073.4000	11,800.0000	33.9966	3,139.4000	11,624.5000	33.2982	66.0000	1.39
Std Dev Total Volume	2,530.9000	7,753.5000	22.3374	2,685.6000	7,638.4000	21.8798	154.7000	4.95
Price	31.8044	30.2879	0.0873	31.4694	31.5780	0.0905	-0.3350	-2.67
Volume	2,404,069.0	6,819,403.0	19,646.3	2,391,262.0	7,807,356.0	22,363.7	-12,807.0	-0.43
Std Dev Volume	987,047.0	2,391,597.0	6,890.1	998,131.0	2,702,626.0	7,741.5	11,084.0	1.07
Returns	0.0014	0.0388	0.0001	-0.0001	0.0426	0.0001	-0.0016	-9.37
Std Dev Returns	0.0322	0.0221	0.0001	0.0332	0.0269	0.0001	0.0010	10.45
Bid	31.7745	30.2639	0.0872	31.4461	31.5575	0.0904	-0.3284	-2.61
Ask	31.8233	30.3016	0.0873	31.4857	31.5897	0.0905	-0.3376	-2.68
Shares Outstanding	226,493.0	680,475.0	1,960.4	228,170.0	698,653.0	2,001.2	1,677.0	0.60
MV	7,774,078.0	24,685,088.0	71,116.1	7,556,406.0	23,578,935.0	67,540.4	-217,672.0	-2.22
Pricevol	0.00199	0.00488	0.00001	0.00187	0.00488	0.00001	-0.00012	-6.28
Spread	0.00201	0.00624	0.00002	0.00189	0.00698	0.00002	-0.00012	-4.58

Table 4 shows the effect that the introduction of single stock futures has on the control group of stocks that have options but no single stock futures. Again, the table used data for 6 months before and after each stocks matched stock introduced single stock futures. With these stocks, the price decreased by 1.5% and this decrease is statistically significant, while there is not a statically significant change to the price volatility or the bid-ask spread. Options, however, move in the opposite direction as compared to those with single stock futures. Option volume have a statistically insignificant decrease, while total option open interest decreased by 4.4%. Call and put open interest decrease by 3.9% and 4.8% respectively.

Table 4: Stocks with Options and No SSF								
	Before			After				
Variables	Mean	Std Dev	Std Err	Mean	Std Dev	Std Err	Difference	T Value
Call Open Interest	49,684.6	188,226.0	577.5	47,739.2	122,132.0	349.8	-1,945.4	-2.52
Put Open Interest	44,638.1	214,302.0	657.5	42,474.4	195,677.0	589.8	-2,163.7	-2.45
Total Open Interest	94,329.3	394,762.0	1,211.2	90,221.3	360,095.0	1,085.3	-4,108.0	-2.53
Call Volume	2,384.4000	20,085.6000	61.6250	2,349.6000	17,754.6000	53.5095	-34.8000	-0.43
Std Dev Call Volume	2,399.3000	15,392.4000	47.1196	2,137.8000	13,798.7000	41.5107	-261.5000	-4.17
Put Volume	2,268.9000	18,316.8000	56.2005	2,184.8000	16,999.7000	51.2377	-84.1000	-1.11
Std Dev Put Volume	1,748.7000	8,519.5000	26.0801	1,667.8000	8,589.5000	25.8400	-80.9000	-2.20
Total Volume	4,653.7000	34,066.4000	104.5000	4,534.8000	30,880.0000	93.0742	-118.9000	-0.85
Std Dev Total Volume	3,762.1000	19,466.4000	59.5912	3,416.8000	17,838.7000	53.6644	-345.3000	-4.31
Price	26.7100	25.3323	0.0730	26.2808	26.2847	0.0753	-0.4292	-4.09
Volume	2,672,242.0	9,472,817.0	27,290.6	2,825,940.0	9,002,359.0	25,786.6	153,698.0	4.09
Std Dev Volume	1,254,918.0	4,752,392.0	13,691.4	1,275,211.0	3,833,501.0	10,980.8	20,293.0	1.16
Returns	0.0015	0.0489	0.0001	0.0002	0.0465	0.0001	-0.0013	-6.91
Std Dev Returns	0.0341	0.0283	0.0001	0.0358	0.0306	0.0001	0.0017	13.80
Bid	26.6856	25.3184	0.0729	26.2607	26.2767	0.0753	-0.4249	-4.05
Ask	26.7275	25.3462	0.0730	26.2987	26.3036	0.0753	-0.4288	-4.09
Shares Outstanding	180,604.0	361,362.0	1,041.1	176,800.0	327,284.0	937.5	-3,804.0	-2.72
MV	5,486,652.0	12,040,107.0	34,686.8	5,013,880.0	11,031,777.0	31,599.7	-472,772.0	-10.08
Pricevol	0.00298	0.00831	0.00002	0.00302	0.00837	0.00002	0.00004	1.14
Spread	0.00303	0.01060	0.00003	0.00306	0.00895	0.00003	0.00003	0.85

Table 5 shows the difference in differences between the stocks with single stock futures and the matched sample of stocks without single stock futures, six months before and six months after the introduction of single stock futures. Very few of the variables in this table are statistically significant. Although the change in price was statistically significant in the first two tables, the differences balance out and the t-statistic is only .77. In table 3, the price volatility and the bid-ask spread significantly decrease, but in table 5 it is shown that this is due to market fluctuations. Where I do see statistically significant results is in the option open interest where the stocks with introductions observe an increase to open interest and the stocks without single stock futures had a decrease to open interest. The difference in the difference of total open

interest was 15,910.8 with at t-statistic of 3.15. The difference in call open interest was 8182.5 with a t-statistic of 3.06, and the difference in the put open interest was 7729.3 with a t-statistic of 2.56. When I control for market fluctuations by using a difference in difference test, the only major statistically significant change is that option open interest increases as single stock futures are introduced.

Table 5: Difference in Differences

	Treatment			Control				
Variables	Mean	Std Dev	Std Err	Mean	Std Dev	Std Err	Difference	T Value
Call Open Interest	7,992.4	53,566.3	1,701.6	-190.1	62,430.7	2,091.5	8,182.5	3.06
Put Open Interest	7,224.1	4,420.4	1,506.4	-505.2	80,820.0	2,707.6	7,729.3	2.56
Total Open Interest	15,215.3	95,760.5	3,041.9	-695.5	122,744.0	4,112.1	15,910.8	3.15
Call Volume	252.8000	2,478.7000	78.7374	-8.2305	5,877.5000	196.9000	261.0305	1.28
Std Dev Call Volume	311.8000	-29.0230	70.7209	-29.0230	5,505.6000	184.0000	340.8230	1.79
Put Volume	138.5000	2,389.6000	75.9090	-168.6000	8,061.5000	270.1000	307.1000	1.14
Std Dev Put Volume	128.2000	1,923.7000	61.1096	-169.6000	4,018.2000	4,018.2000	134.3000	2.08
Total Volume	391.2000	4,579.3000	145.5000	-176.8000	12,317.8000	412.7000	568.0000	1.35
Std Dev Total Volume	395.5000	3,163.2000	100.5000	-201.8000	6,906.4000	230.9000	597.3000	2.45
Price	-0.7561	13.3194	0.4231	-1.2113	13.1390	0.4174	0.4552	0.77
Volume	251,793.0	3,525,591.0	111,994.0	300,698.0	3,708,732.0	117,812.0	-48,905.0	-0.30
Std Dev Volume	75,269.9	1,245,811.0	39,574.5	122,993.0	1,407,891.0	44,723.1	-47,723.1	-0.80
Returns	-0.0004	0.0039	0.0001	-0.0002	0.0044	0.0001	-0.0003	-1.36
Std Dev Returns	-0.0027	0.0222	0.0007	-0.0026	0.0253	0.0008	0.0000	-0.01
Bid	-0.7451	13.3134	0.4229	-1.2026	13.1348	0.4172	0.4575	0.77
Ask	-0.7649	13.3210	0.4232	-1.2165	13.1435	0.4175	0.4516	0.76
Shares Outstanding	12,336.1	137,853.0	4,379.1	822.1	127,704.0	4,056.6	11,514.0	1.93
MV	-376,286.0	4,380,277.0	139,144.0	-615,783.0	4,028,287.0	127,963.0	239,497.0	1.27
Pricevol	-0.00056	0.00255	0.00008	-0.00078	0.00565	0.00018	0.00022	1.13
Spread	-0.00056	0.00266	0.00009	-0.00081	0.00600	0.00019	0.00025	1.16

Next, I run a multivariate regression using the following equations:

$$\text{Abnormal Option Volume}_i = B/A\text{intro}_i + \text{Log}(\text{Price}_i) + \text{Log}(\text{MarketCap}_i) + \text{Log}(\text{Return}_i) + \text{BidAskSpread}_i + \text{PriceVolatility}_i + \text{Log}(\text{Volume}_i)\ (1) + u$$

In Table 6, it is shown that the introduction of single stock futures leads to an increase of 292.298 in abnormal call volume, an increase of 143.09 in abnormal put volume, and an increase of 438.764 in total option volume. It is also seen that there is a slight decrease to the adjusted R-Squared when I leave the Before/After dummy variable out of the equation.

Table 6: Option Volume

Dependant Variable	Before/After	LogPrice	LogMarketValue	LogReturn	BidAskSpread	Price Vol	LogVolume	Intercept	R Squared	F Value
Abnormal Call Volume	292.298	311.587	330.748	82.081	-88,877	141,253	1,872.549	-30,925	0.131	5,183.440
(T-Value)	(9.15)	(12.64)	(20.59)	(5.83)	(-6.82)	(8.81)	(122.09)	(-168.8)		
Abnormal Call Volume		293.622	335.517	76.224	-83,478	132,441	1,870.356	-30,776	0.131	6,031.330
		(11.95)	(20.89)	(5.42)	(-6.41)	(8.27)	(121.94)	(-168.62)		
Abnormal Put Volume	143.097	657.206	22.115	-42.487	-185,093	242,469	1,333.736	-21,209	0.151	6,118.350
	(7.31)	(43.39)	(2.25)	(-4.92)	(-9.77)	(11.71)	(141.92)	(188.45)		
Abnormal Put Volume		648.197	24.450	-45.308	-178,918	234,411	1,332.628	-21,135	0.151	7,127.630
		(42.94)	(2.49)	(-5.25)	(-9.45)	(11.34)	(141.81)	(-188.55)		
Abnormal Total Option Volume	438.764	975.131	352.886	38.311	-374,143	489,959	3,207.360	-52,187	0.177	7,371.120
	(9.85)	(28.32)	(15.77)	(1.95)	(-8.69)	(10.41)	(150.13)	(-203.98)		
Abnormal Total Option Volume		947.507	360.045	29.662	-355,208	465,251	3,203.637	-51,959	0.176	8,580.030
		(27.61)	(16.10)	(1.51)	(-8.25)	(9.90)	(149.96)	(-203.88)		

I then ran the same regression with a white test to control for heteroskedasticity. When using the white test, I find that, with the exception of the Before/After dummy variable, the t-statistics decrease but are still statistically

significant for most variables. However, I find that for the Before/After dummy variable the t-statistics remain relatively constant.

Table 7: Heteroscedasticity Consistent

Dependant Variable	Before/After	LogPrice	LogMarketValue	LogReturn	BidAskSpread	Price Vol	LogVolume	Intercept	R Squared	F Value
Abnormal Call Volume	292.298	311.587	330.748	82.081	-88,877	141,253	1,872.549	-30,925	0.131	5,183.440
(T-Value)	(9.26)	(10.05)	(13.89)	(5.36)	(-5.45)	(7.72)	(64.16)	(-91.83)		
Abnormal Call Volume		293.622	335.517	76.224	-83,478	132,441	1,870.356	-30,776	0.131	6,031.330
		(9.49)	(14.10)	(4.96)	(-5.48)	(7.69)	(64.11)	(-91.88)		
Abnormal Put Volume	143.097	657.206	22.115	-42.487	-185,093	242,469	1,333.736	-21,209	0.151	6,118.350
	(7.23)	(29.47)	(1.37)	(-4.73)	(-4.09)	(5.13)	(59.54)	(-89.98)		
Abnormal Put Volume		648.197	24.450	-45.308	-178,918	234,411	1,332.628	-21,135	0.151	7,127.630
		(29.34)	(1.52)	(-5.06)	(-4.10)	(5.14)	(59.60)	(-90.82)		
Abnormal Total Option Volume	438.764	975.131	352.886	38.311	-374,143	489,959	3,207.360	-52,187	0.177	7,371.120
	(9.89)	(21.45)	(10.34)	(1.81)	(-4.12)	(5.16)	(73.14)	(-102.01)		
Abnormal Total Option Volume		947.507	360.045	29.662	-355,208	465,251	3,203.637	-51,959	0.176	8,580.030
		(20.98)	(10.57)	(1.40)	(-4.13)	(5.16)	(73.14)	(-102.37)		

Next, I replicate my previous multivariate analysis but instead of examining option volume, I examine open interest.

$$\text{Abnormal Option Open Interest}_i = \text{B/Aintro}_i + \text{Log}(\text{Price}_i) + \text{Log}(\text{MarketCap}_i) + \text{Log}(\text{Return}_i) + \text{BidAskSpread}_i + \text{PriceVolatility}_i + \text{Log}(\text{Volume}_i) \quad (2)$$

In Table 8, it is shown that the introduction of single stock futures leads to an increase of 7095.825 in abnormal call open interest, an increase of 5632.29 in abnormal put open interest and an increase of 12,818 in abnormal total open interest. While all other variables are statistically significant. The adjusted R-Square also decreases when I drop the Before/After dummy variable.

Table 8: Open Interest											
Dependant Variable		Before/After	LogPrice	LogMarketValue	LogReturn	BidAskSpread	Price Vol	LogVolume	Intercept	R Squared	F Value
Abnormal Call Open Interest		7,095.825	-18,218.000	24,063.000	-3,881.465	-2,276,025	3,657,845	28,140.000	-684,011	0.266	12,465.500
		(16.07)	(-53.47)	(108.37)	(-19.94)	(-12.63)	(16.51)	(132.75)	(-270.15)		
Abnormal Call Open Interest			-18,654.000	24,178.000	-4,023.677	-2,144,934	3,443,901	28,087.000	-680,404	0.265	14,484.600
			(-54.90)	(108.9)	(-20.68)	(-11.91)	(15.56)	(132.45)	(269.64)		
Abnormal Put Open Interest		5,632.291	-989.111	12,084.000	-3,795.392	-4,534,561	5,978,089	25,856.000	-539,233	0.242	10,980.400
		(15.67)	(-3.56	(66.91)	(-23.96)	(-13.04)	(15.74)	(149.94)	(-261.12)		
Abnormal Put Open Interest			-1,343.713	12,176.000	-3,906.421	-4,291,500	5,660,917	25,812.000	-536,302	0.241	12,756.500
			(-4.85)	(67.42)	(-24.67)	(-12.35)	(14.92)	(149.63)	(-260.64)		
Abnormal Total Open Interest		12,818.000	-19,045.000	36,148.000	-7,709.923	-9,389,526	12,370,873	54,022.000	-1,224,608	0.268	12,561.800
		(16.57)	(-31.85)	(93)	(-22.61)	(-12.55)	(15.14)	(145.57)	(-275.55)		
Abnormal Total Open Interest			-19,852.000	36,357.000	-7,962.600	-8,836,371	11,649,056	53,923.000	-1,217,938	0.267	14,593.100
			(-33.29)	(93.54)	(-23.36)	(-11.82)	(14.26)	(145.24)	(-275.03)		

When I applied the white test to the regression again the t-statistics for all the variables markedly decreases, except for the Before/After dummy where the level of statistical significance increases slightly.

Table 9: Open Interest Heteroscedasticity Consistent											
Dependant Variable		Before/After	LogPrice	LogMarketValue	LogReturn	BidAskSpread	Price Vol	LogVolume	Intercept	R Squared	F Value
Abnormal Call Open Interest		7,095.825	-18,218.000	24,063.000	-3,881.465	-2,276,025	3,657,845	28,140.000	-684,011	0.266	12,465.500
		(16.65)	(-40.36)	(59.60)	(-18.73)	(-5.6)	(8.26)	(102.75)	(-105.05)		
Abnormal Call Open Interest			-18,654.000	24,178.000	-4,023.677	-2,144,934	3,443,901	28,087.000	-680,404	0.265	14,484.600
			(-40.97)	(59.75)	(-19.32)	(-5.66)	(8.30)	(102.70)	(-105.32)		
Abnormal Put Open Interest		5,632.291	-989.111	12,084.000	-3,795.392	-4,534,561	5,978,089	25,856.000	-539,233	0.242	10,980.400
		(15.86)	(-2.69)	(39.37)	(-22.77)	(-4.07)	(5.15)	(82.46)	(-115.11)		
Abnormal Put Open Interest			-1,343.713	12,176.000	-3,906.421	-4,291,500	5,660,917	25,812.000	-536,302	0.241	12,756.500
			(-3.66)	(39.7)	(-23.34)	(-4.07)	(5.16)	(82.51)	(-115.95)		
Abnormal Total Open Interest		12,818.000	-19,045.000	36,148.000	-7,709.923	-9,389,526	12,370,873	54,022.000	-1,224,608	0.268	12,561.800
		(17.01)	(-24.30)	(52.76)	(-21.41)	(-3.93)	(4.97)	(96.89)	(-111.97)		
Abnormal Total Open Interest			-19,852.000	36,357.000	-7,962.600	-8,836,371	11,649,056	53,923.000	-1,217,938	0.267	14,593.100
			(-25.23)	(53.01)	(-22.01)	(-3.93)	(4.97)	(96.90)	(-112.42)		

These results suggest that there is a statistically significant relationship between the introduction of a single stock future and both option volume and option open interest.

Conclusion

Options and futures are often thought of as substitute goods. Because this is thought of as conventional wisdom, there is very little empirical research that tests this contention. The lack of tests create a problem because researchers have just assumed that options and futures are substitutes, this assumption can bias the researchers results. Using a variety of empirical tests, this paper shows that, instead of substitutes, futures and options are complement goods. In the analysis, I examine both option volume and open interest six months before and after the introduction of single stock futures, which is an (arguably) exogenous event and provides a natural experiment. Option volume and open interest both increase after the introduction of single stock future. While option volume does not initially appear to increase in a significant way, when I control for underlying share prices, volatility, bid-ask spreads, and trading volume, I observe that the increase in option volume is both statistically significant and economically meaningful. I also observe a 9% increase in option open interest, on average, after the introduction of single stock futures. These results suggest that, as single stock futures become available, more options are traded, thus indicating that single stock futures and stock options are complement goods, and that futures may improve the liquidity of option markets. While these results are contrary to conventional wisdom, if the costs associated with liquidity provision in the options market is decreasing in the ability of market makers to hedge positions. Single stock futures could allow for this type of hedging. Therefore, the presence of futures might increase liquidity in options markets. Having a better understanding of how stock options and single stock futures will help researchers perform more accurate research.

REFERENCES

Battalio, Robert, and Paul Schultz. "Regulatory uncertainty and market liquidity: The 2008 short sale ban's impact on equity option markets." *The Journal of Finance* 66.6 (2011): 2013-2053.

Blau, Benjamin M., and Tyler Brough. "Options and Market Friction." *Available at SSRN 1777184* (2011).

Chau, F., P. Holmes and K. Paudyal (2008), 'The Impact of Universal Stock Futures on Feedback Trading and Volatility Dynamics', Journal of Business Finance & Accounting, Vol. 35, pp. 227–
49.

Danielsen, Bartley R., Robert A. Van Ness, and Richard S. Warr. "Single stock futures as a substitute for short sales: Evidence from microstructure data." *Journal of Business Finance & Accounting* 36.9-10 (2009): 1273-1293.

Dennis, S. and A. Sim (1999), 'Share Price Volatility with the Introduction of Individual Share Futures on the Sydney Futures Exchange', International Review of Financial Analysis, Vol. 8,
pp. 153–63.

Detemple, J. and P. Jorion (1985), 'Option Listing and Stock Returns', Journal of Banking and Finance, Vol. 14, pp. 781–801.

Evans, Richard B., et al. "Failure is an option: Impediments to short selling and options prices." *Review of Financial Studies* 22.5 (2009): 1955-1980.

Frechette, Darren L. "The demand for hedging with futures and options." *Journal of Futures Markets* 21.8 (2001): 693-712.

Lapan, Harvey, Giancarlo Moschini, and Steven D. Hanson. "Production, hedging, and speculative decisions with options and futures markets." *American Journal of Agricultural Economics* 73.1 (1991): 66-74.

McKenzie, M. D., T.J. Brailsford and R.W. Faff (2001), 'New Insights into the Impact of the Introduction of Futures Trading on Stock Price Volatility', Journal of Futures Markets, Vol. 21, pp. 237–55.

Moriarty, Eugene, Susan Phillips, and Paula Tosini. "A comparison of options and futures in the Management of Portfolio risk." *Financial Analysts Journal* 37.1 (1981): 61-67.

Lien D. and L. Yang (2003), 'Options Expiration Effects and the Role of Individual Share Futures Contracts', Journal of Futures Markets, Vol. 23, pp. 1107–18.

Ross, S. A. (1976), 'Options and Efficiency', *Quarterly Journal of Economics*, Vol. 90, pp. 75–89.