A Study of Pairs Trading in the Hong Kong Stock Market: 0005.HK & 0011.HK

BY

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On Why I Choose This Topic

My father once asked me: "As a finance student, why do you think most of the people investing in stocks[1] lose their money?" I hesitated to answer the question at that time. My father never plays stocks although he is very good at playing card games. After a while I replied, "Like playing cards, a good player should not merely bet on luck. More importantly, he should receive enough training to be experienced and skillful." I had no idea what the skills should be at that moment. But deep in my mind, I was determined to study the skill set in the investment playground.

Traditional long-only strategy works well in a bull market. The simple rule under this strategy is to "buy and hold". To me, "buy and hold" is more like a philosophy rather than a skill. But this philosophy hardly makes sense in today's highly volatile market[2]. From early 2007 to date, more than five years have passed but the Index level almost remains the same. And how many investors buy the index for dividends?

Then the concept of "hedge fund" draws my attention. This concept was first created by Alfred Winslow Jones in 1949. The original idea was using stock short positions to hedge long positions. Although the hedge fund industry has developed rapidly and includes many other styles today, equity long short (ELS) strategy is still the most popular one. Unfortunately, ELS relies much on one's judgment of the market direction. It will be subjective in reality and is sensitive to the market movement.

In comparison, pairs trading is a market-neutral strategy and can be conducted in a very scientific and objective way, which is even valuable for playing equities. People are risk-averse and they enjoy absolute return. Personally speaking, I don't mind how much a strategy earns in an up market, but I do care how much it loses when the whole market goes down. Thus it is highly attractive for me to devote my time and effort to study "pairs trading".

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[1] He was talking about A-share at that time.
[2] See Appendices Figure 1 Volatile Stock Market

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Abstract

Pairs trading is a common strategy used by institutional investors, especially certain types of hedge funds. In this paper, we will study the mechanism and profitability of pairs trading using a specific pair from the Hong Kong Stock Market. The two stocks being selected are 0005.HK and 0011.HK, both of which are included in the Hang Seng Index and are from the banking sector. Daily price data including bid/ask prices from January 2005 to December 2011 are collected. Dividend effects on return are adjusted trade by trade. The trading strategy, which merely takes advantage of historical price information, keeps losing money before the 2008 global financial crisis but generates a stable profit afterwards. Variations of the strategy change little about this "V" pattern of return but still provide us more understanding of pairs trading. The paper shows that the correlation of these two banking stocks changes after the financial crisis. In the case that there is a stable and predictable correlation between any two securities, we may apply similar strategy to bring abnormal returns.

I.   Introduction

Modern Portfolio Theory tells us the Holy Grail of investing is "diversification". It works well when the correlations of different assets are low. What if the correlations increase, for one reason or another?

Then we need another set of skills. Pairs trading is one of them. As the name suggests, pairs trading is about trading pairs. Although the concept can be extended to a basket of stocks, this paper will mainly focus on a pair of stocks, which is the original form of pairs trading. The idea behind pairs trading is straightforward: find two stocks with similar price movements historically, thus a high price correlation and construct an arbitrage portfolio when their prices diverge, expecting the prices to converge again in the near future. It is also known as statistical arbitrage or convergence trading.

Pairs trading is a short-term market-neutral arbitrage strategy, which has been widely used by major investment banks and some hedge funds. The strategy is based on relative pricing. To me, relative pricing is more meaningful than traditional absolute pricing, since there is nothing absolute in the world.

The investment horizon of pairs trading is short-term since pairs trading is essentially taking advantage of two relatively mispriced securities and this mispricing is only sustainable in a short period. But as John Maynard Keynes said, "the market can stay irrational longer than you can stay solvent." This is the risk of pairs trading.

The feature of market-neutral is a beauty of pairs trading. Pairs trading can be constructed in a way of dollar neutrality, beta neutrality, sector neutrality, etc. Although market-neutral is hard to achieve perfectly in reality, this feature still makes the idea of pairs trading attractive.
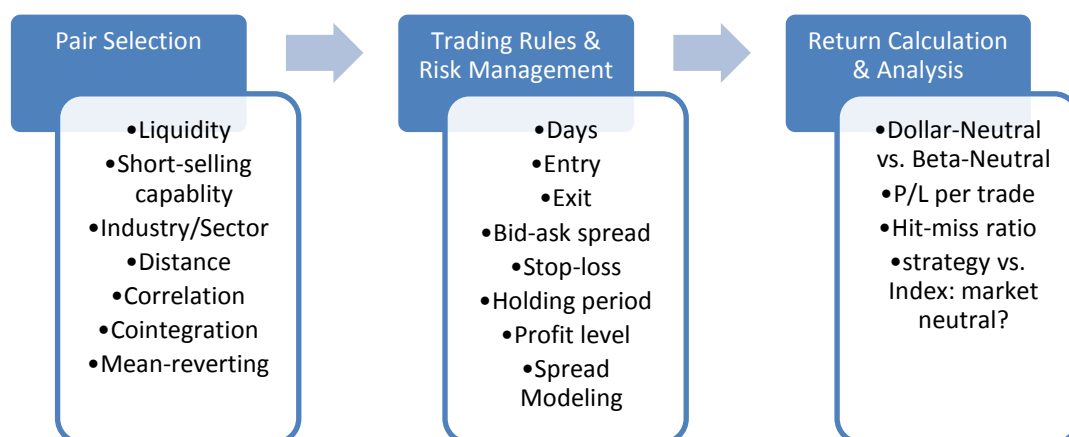
Arbitrage is the action taken to lock in the profit associated with this strategy. It is easily done with a long position of the relatively undervalued stock and a simultaneous short position of the overvalued one.

Pioneers of pairs trading include the fabulous US stock trader Jesse Livermore, Wall Street quants Nunzio Tartaglia and David Shaw.

It is common practice to take the following steps to apply pairs trading strategy:

- Identify trading pairs based on predetermined criterion;
- Set trading rules and risk management techniques;
- Calculate and analyze returns.

There is no consensus on these steps. A list of factors needs to be considered.

Pair Selection	Trading Rules & Risk Management	Return Calculation & Analysis
•Liquidity •Short-selling capablity •Industry/Sector •Distance •Correlation •Cointegration •Mean-reverting	•Days •Entry •Exit •Bid-ask spread •Stop-loss •Holding period •Profit level •Spread Modeling	•Dollar-Neutral vs. Beta-Neutral •P/L per trade •Hit-miss ratio •strategy vs. Index: market neutral?

On short selling

Short selling has been allowed[3] in the Hong Kong Stock Market since 1994. There is a list of securities eligible for short selling. Both 0005.HK and 0011.HK are among them. In practice, short selling is typically for institutional investors or professional investors such as hedge funds. Short sellers should firstly set up a stock borrowing and short selling account with their brokers. Under the tick rule, the short sale price should not be below the best current ask price. When a stock is sold short, they need to deposit a margin into the stock account. The margin requirement is negotiable. For individual investors, short selling will be possible in the near future. Currently Hong Kong Exchange is studying on "central stock borrowing" in which individual investors may borrow stocks from HKSCC[4] and participate in short selling activities. The rest of the paper is organized as follows: Section II discusses the objectives. Section III is the literature review. Section IV describes the data. Section V tells the methodology. Section VI presents the results and discussions. Section VII concludes.

II.   Objectives of the Study

This project will investigate the profitability of pairs trading in the Hong Kong stock market. Theoretically the methodology used in this paper can be applied to any pair. In this paper, I focus on 0005.HK and 0011.HK, both of which are in the banking sector. I will study the performance of this specific pair under different trading strategies. Factors affecting the profitability will be the emphasis, including:

- The length of days used to set up a stable historical relationship
- The entry point to open the position
- The exit point to close the position
- Ways to calculate returns or P/L

Through a comparison of different methods, we expect to develop a thorough understanding of the mechanism of pairs trading.

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[3] http://www.hkex.com.hk/eng/market/sec_tradinfo/regshortsell.htm
[4] Hong Kong Securities Clearing Company Limited (HKSCC)

III. Literature Review

Broadly speaking, there are four approaches to conduct pairs trading in academic and practice:

- Distance Approach

  Gatev et al (1999) match pairs with minimum sum of squared deviations between two normalized price series. The position will be opened when prices diverge by more than two historical standard deviations, as estimated during the pairs formation period, and unwound at the next crossing of the price or at the end of the trading interval. Most empirical studies follow the methodology of Gatev et al (1999), for example Perlin (2009).

- Co-integration

  Vidyamurthy (2004) explains the co-integration approach in details in his book pairs trading: quantitative methods and analysis. Trades are put on and unwound on either direction at least the spread is larger than the bid-ask spread and the value that maximizes the profit should be around 0.75σ. ADF test may be used to test whether the generated series is stationary or not.

- Spread Modeling

  Elliot et al (2005) use a spread model to describe the mean-reverting process. The spread is simply the price difference of two stocks. One step further, Do et al (2006) propose a stochastic residual spread model. Thomaidis et al (2006) proposed an intelligent statistical arbitrage trading system based on neural network-GARCH autoregressive models.

- Price ratio

  To the best of my knowledge, no existing academic studies use the methodology of price ratio to conduct pairs trading. But it is widely used in practice. Traders may prefer this method. If we expect $\dfrac{P_A}{P_B}$ to rise, we buy stock A and short stock B, vice versa. Technical analysis can be easily applied to price ratio.

IV. Data

Daily price data of 0005.HK and 0011.HK (including adjusted close price, bid and ask price at close of the market) from January 2005 to December 2011 will be collected from DataStream. Given that 0005.HK had a rights issue[5] on 2009/03/12, the price data obtained from DataStream has already adjusted this factor by itself. However, this price data doesn't take dividends into account. Given that both 0005.HK and 0011.HK pay dividends quarterly, we have to consider the effects to our trading strategy. A conventional way is to assume dividends are reinvested in the stocks and to adjust the closing price accordingly. In this paper, I will not follow this assumption. Instead, a separate account is open for dividends. The dividend amount and the ex-dividend date over the seven years will be collected from DataStream. Dividend effects on return are calculated at the end of each trade.

As a reference, daily index value of Hang Seng Index over the same period will also be collected from DataStream.

V. Methodology

Denote the daily adjusted closing price, bid price and ask price of a stock as follows:

Adjusted closing price of stock i on day j	$P_{i,j}$
Bid price of stock i on day j	$PB_{i,j}$
Ask price of stock i on day j	$PA_{i,j}$

Suppose that the prices of 0005.HK and 0011.HK are correlated over a past period of t days, we run a simple linear regression over that period.

The population regression model is: $P_{y,i} = \alpha + \beta * P_{x,i} + \varepsilon_i$ (i=1, 2, …, t)

Using OLS estimation, the regression line is estimated as: $\hat{P}_{y,i} = a + b * P_{x,i}$

We use a daily rolling t-day window to estimate the parameters. We will start with 60-day window and change the length of period to see its effects in later stage of the study. For example, parameters used on day 61 is estimated using price data from t=1 to t=60, parameters used on day 62 is estimated using price data from t=2 to t=61, etc.

The one-step-ahead forecasting of price y is: $\hat{P}_{y,t+1} = a + b * P_{x,t+1}$

The forecasting error is calculated as: $\varepsilon_{t+1} = P_{y,t+1} - \hat{P}_{y,t+1} = P_{y,t+1} - (a + b * P_{x,t+1})$

The error term ε_{t+1} is a representation of the mispricing between the two stocks. The mispricing will be observed on every subsequent trading day. We expect a mean-reverting behavior of this error term.

When $\varepsilon_{t+1} > 0$, which means stock y is temporary over-priced compared to stock x, thus we should long stock x and short stock y. When ε_{t+1} returns back to zero, we will close the position. Similarly, when $\varepsilon_{t+1} < 0$, which means stock y is temporary under-priced compared to stock x, we should long stock y and short stock x. When ε_{t+1} returns back to zero, we will close the position.

We can standardize ε_{t+1} as follows: $N = \dfrac{\varepsilon_{t+1}}{SER}$, where SER is the standard error of regression. In the first trading strategy, we will open the position when N is larger than 2 or smaller than -2, and close it when N returns back to zero. The effects of different entry and exit point will be studied at later stages.

Excel VBA will be used to process the data. Important formulas used are:

Correlation	CORREL(array 1, array 2)
Slope (a)	SLOPE(known_y's, known_x's)
Intercept (b)	INTERCEPT(known_y's, known_x's)
Standard Error of Regression (SER)	STEYX(known_y's, known_x's)

We will count the returns of both long and short positions at the end of each trade.

When $\varepsilon_{t+1}>0$, we long stock x and short stock y.

Return from stock x is calculated as: $\quad R_x = \dfrac{PB_{x,t} + Div_x}{PA_{x,1}} - 1$

Return from stock y is calculated as: $\quad R_y = \dfrac{PA_{y,1} - Div_y}{PA_{y,t}} - 1$

When $\varepsilon_{t+1}<0$, we short stock x and long stock y.

Return from stock x is calculated as: $\quad R_x = \dfrac{PA_{x,1} - Div_x}{PA_{x,t}} - 1$

Return from stock y is calculated as: $\quad R_y = \dfrac{PB_{y,t} + Div_y}{PA_{y,1}} - 1$

We correct the return for dividends at the end of every trade. If we buy a stock before the ex-dividend date, we are entitled the dividends and the return after dividends should be larger. If we short a stock before the ex-dividend date, we need to pay the dividends and the return after dividends should be smaller. In reality, we may wait until the payment date so as to receive or pay the dividends. The time lag is ignored in the calculation.

The return of the arbitrage portfolio depends on the weight of each position.

$$R_p = w_x R_x + (1 - w_x)R_y$$

To produce an index of the trading strategies, firstly dollar neutrality will be adopted. Notice that dollar neutrality is equal to the situation when $w_x = \dfrac{1}{2}$. Risk-free rate will be ignored in our calculation. This is a more conservative approach since we assume zero interest when we hold the capital out of the market. We will change the weight to see its effect later.

An alternative way is to calculate the cash flows by trade. When $\varepsilon_{t+1}>0$, we open the position and unwind it when $\varepsilon'_{t+1}\leq 0$, the cash flows will be as follows:

Transactions	CF_0	CF'
Short 1 share stock Y	$+P_y$	$-P'_y$
Deposit \$a	$-a$	a[6]
Buy b shares stock X	$-b*P_x$	$b*P'_x$

$CF_0 = P_y - a - b*P_x = \varepsilon_{t+1} > 0;$

$CF' = -P'_y + a + b*P'_x = -P'_y + a' + b'^*P'_x + (a-a') + (b-b')*P'_x = -\varepsilon'_{t+1} - (\Delta a + \Delta b*P'_x).$

As long as $\Delta a + \Delta b*P'_x < -\varepsilon'_{t+1}$, we can get a profit. With a stable pair or a short holding period[7], $\Delta a + \Delta b*P'_x \approx 0 < -\varepsilon'_{t+1}$.

Similar analysis can be applied when $\varepsilon_{t+1} < 0$.

In reality, which stock should be used as the independent variable is an aspect we need to study. To keep our discussion simple, we assign 0005.HK to be the independent variable (x) for the regression at first.

VI.   Results and Discussion

The first experiment is set up as follows:

- Rolling Days: 60
- Entry Point: 2
- Exit Point: 0

Bid-ask spread and dividends are considered.

Details of each trade are summarized in Table I.

In total, we have 36 trades over the seven years, with 16 trades losing money. It seems

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[6] Assume a zero deposit rate.

[7] Another way to think about it is that: $\Delta a + \Delta b*P'_x = \Delta\hat{P}_y - b*\Delta P_x \approx 0$.

that this strategy cannot bring abnormal return for investors. However, if we break down the seven years into pre-crisis period and post-crisis period, we can observe a desirable pattern.
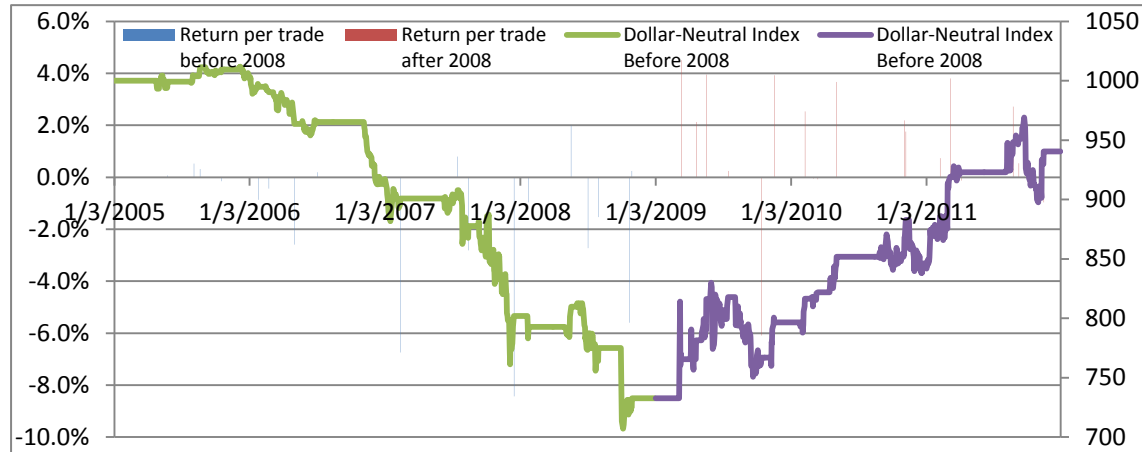
As we can see from the results, the trading strategy doesn't work well before the 2008 global financial crisis, but generates stable profits afterwards. This is explained by an increased price correlation between 0005.HK and 0011.HK after the crisis.

|	2005	2006	2007	2008	2009	2010	2011	Before 2008	After 2008
Correlation	0.6820	(0.0486)	(0.1843)	0.9052	0.8955	0.4532	0.9303	**0.0203**	**0.8120**
Dollar-Neutral	0.5%	-9.0%	-12.4%	-8.6%	8.7%	6.1%	11.7%	**-26.7%**	**28.3%**
Cumulative Return	0.8%	-3.7%	-17.2%	-8.6%	8.7%	10.0%	6.7%	**-28.7%**	**25.4%**

A closer look at the correlation and regression slope gives us more knowledge about the reasons of losses. We focus on returns less than -2%, including 6 trades before 2008 and 1 trade afterwards.


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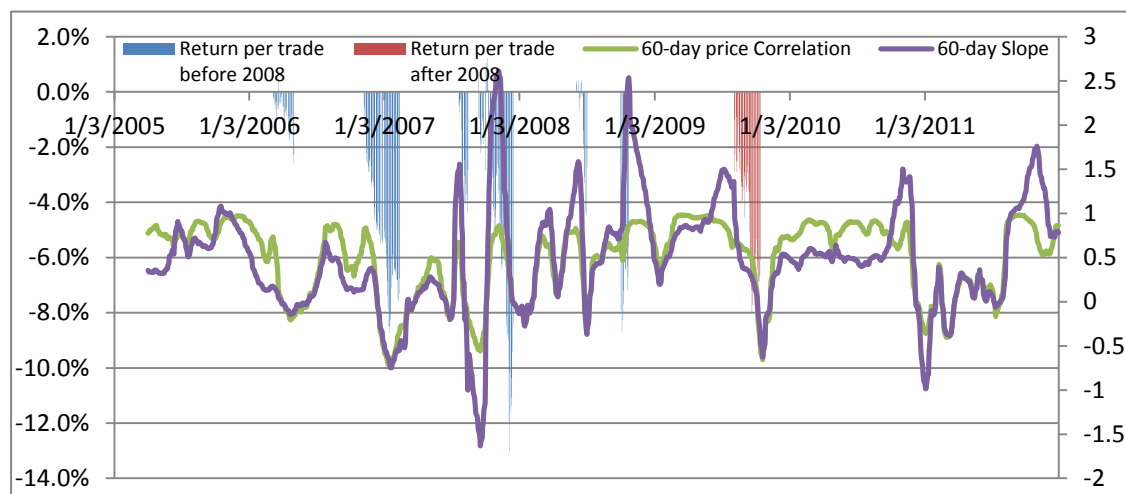
A common characteristic of these trades is that the price correlation or regression slope changes suddenly. Meanwhile, the holding period tends to be longer. A summary of these seven trades is as follows:

Date	Signal	Action	Return X	Return Y	Return Portfolio	Cashflows per trade	P/L per trade	Holding Period	Slope
3/7/2006	-2.122	SELL 0005.HK , BUY 0011.HK @ Last Min				0.82057			0.1763
5/3/2006	0.056	Close Positions @ Last Min	-5.2%	0.0%	-2.6%	-3.2827	-2.4621	57	-0.116
11/7/2006	2.691	BUY 0005.HK , SELL 0011.HK @ Last Min				1.29673			0.1481
2/13/2007	-0.520	Close Positions @ Last Min	-7.2%	-6.3%	-6.8%	-8.9321	-7.6354	98	-0.528
7/20/2007	2.086	BUY 0005.HK , SELL 0011.HK @ Last Min				3.49446			1.4697
8/16/2007	-0.910	Close Positions @ Last Min	-5.5%	-0.1%	-2.8%	-15.934	-12.44	27	-1.001
9/12/2007	2.048	BUY 0005.HK , SELL 0011.HK @ Last Min				11.034			-1.359
12/17/2007	-0.102	Close Positions @ Last Min	-5.1%	-11.8%	-8.4%	-17.508	-6.4744	96	-0.023
6/3/2008	2.776	BUY 0005.HK , SELL 0011.HK @ Last Min				12.8347			1.4326
7/3/2008	-0.720	Close Positions @ Last Min	-9.9%	4.4%	-2.7%	-23.005	-10.17	30	-0.371
9/30/2008	-2.216	SELL 0005.HK , BUY 0011.HK @ Last Min				7.03353			0.7654
10/23/2008	0.285	Close Positions @ Last Min	21.2%	-32.4%	-5.6%	-38.354	-31.32	23	2.5206
8/4/2009	-2.028	SELL 0005.HK , BUY 0011.HK @ Last Min				10.4761			1.3614
10/14/2009	0.177	Close Positions @ Last Min	-6.9%	-5.3%	-6.1%	-25.296	-14.82	71	-0.353

The effect of dividends is small. Even though we ignore the effect, the result should still be unbiased.
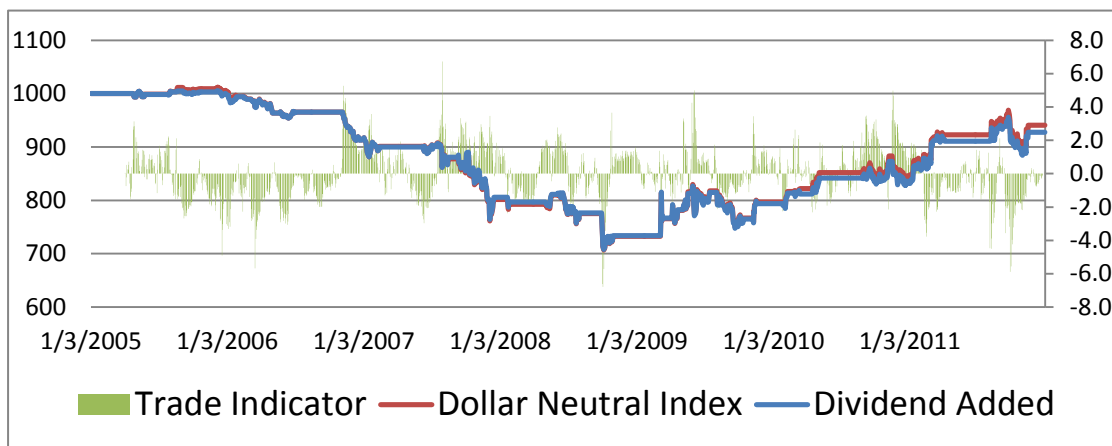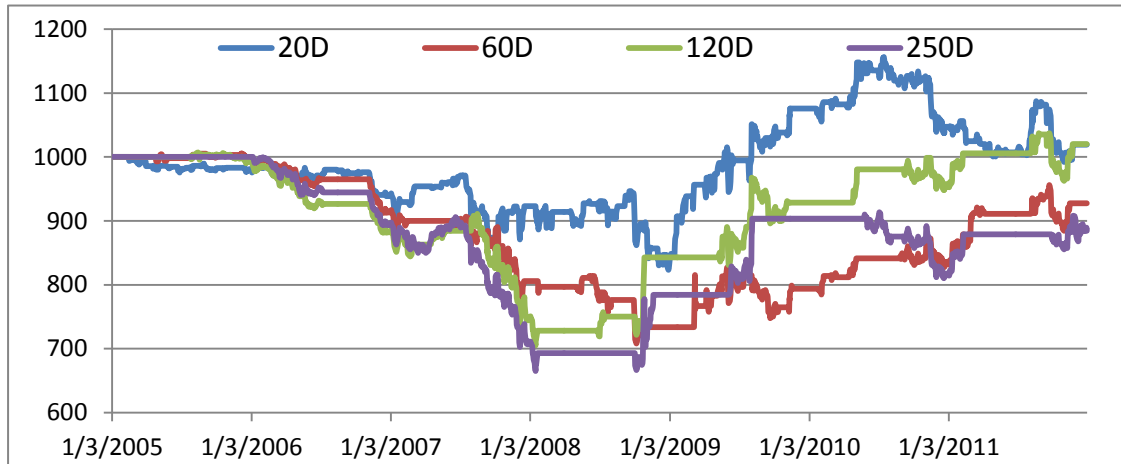

The plot of the dollar neutral index with Hang Seng Index is as follows:
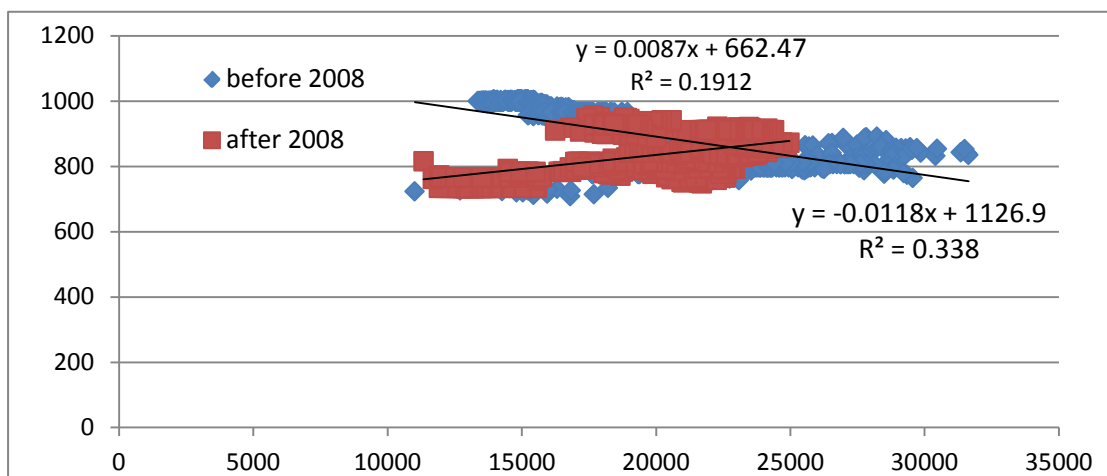
As we can see, the correlations are small. Thus this strategy is close to market-neutral.

- Comparison of different rolling days

We compare the rolling days of 20, 60, 120, and 250, keeping other factors constant.

As we can see from the chart, the shorter rolling days we use, the more frequent we trade. Surprisingly, 20 day regression generates a much less loss before the crisis. The explanation is that the positions of bad trades are closed faster so that we avoid some potential losses. Moreover, 20 day regression turns to produce profits faster in the rebounding period. Performance of 20 day regression is bad during late 2010 because the correlation decreases a lot.

- Comparison of different entry points

We compare the entry points of 3SER, 2SER, 1.5SER and 1SER, keeping other factors constant.
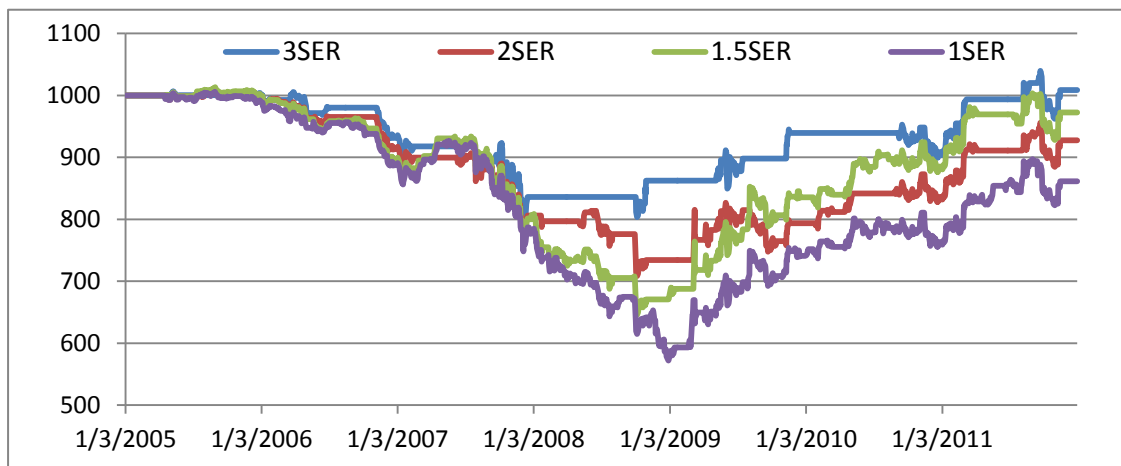
The patterns are relatively clearer. With more aggressive entry, we trade more frequently and our portfolio has a larger variation. Risk-averse people may prefer a more conservative entry method, i.e. larger deviation from long-run mean.

- Comparison of different exit points
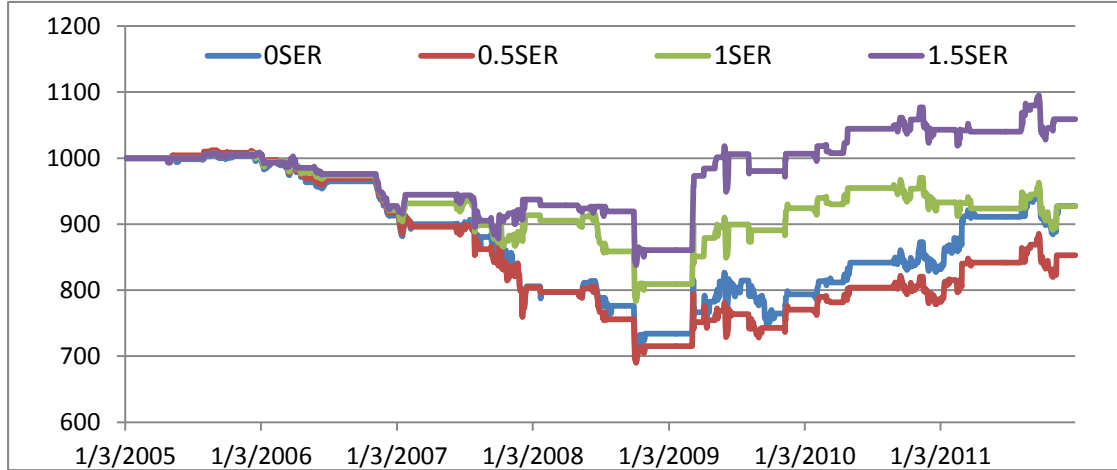
We compare the exit points of 0SER, 0.5SER, 1SER and 1.5SER, keeping other factors constant.

A large exit point (e.g. 1.5SER) will decrease the holding period of every trade. As a result, the loss will be less. Surprisingly, the profit is not affected that much.

- Comparison of different regression

What if we use the stock price of 0011.HK as the independent variable?
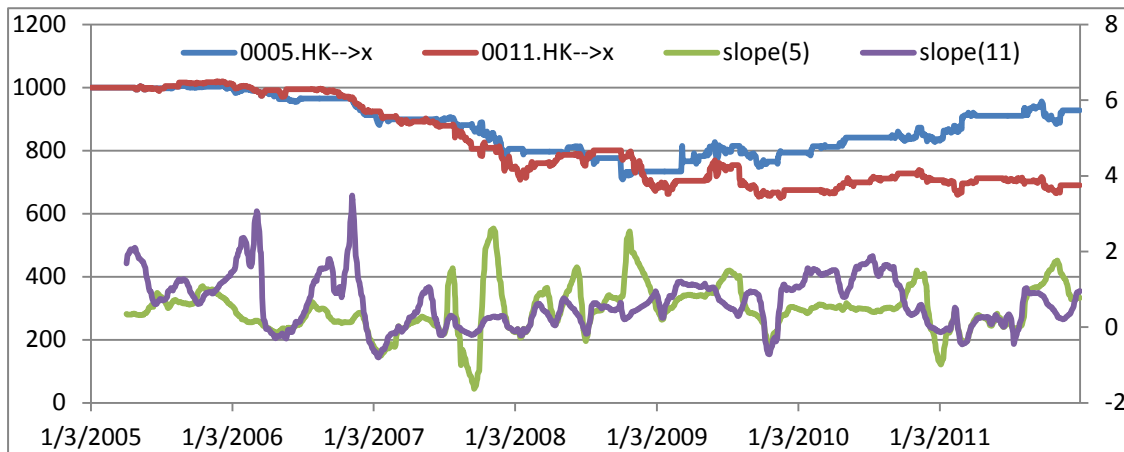
Obviously the result using 0011.HK as the independent variable is unsatisfactory. It doesn't rebound as much as the first method. The correlations under both methods are the same. The explanation is that the slope under the second method is more volatile.

	before 2008	after 2008	entire period
SD of slope(5)	0.68434384	0.519131	0.618863
SD of slope(11)	0.73656963	0.579921	0.672197

In practice, we may use more volatile stocks as the independent variable so that the slope will be more stable.

- Comparison of weight

Previously we assign the weight $w_x = w_y = \dfrac{1}{2}$.

According to $\hat{P}_{y,t+1} = a + b * P_{x,t+1}$, we should trade 1 share stock y and b shares stock x meanwhile. This is similar to the concept of beta neutrality. Instead, we are hedging the change of prices in absolute value instead of percentages.

If ε_{t+1} >0, we will buy b shares stock x and short 1 share stock y. If ε_{t+1} <0, we will short b shares stock x and long 1 share stock y. As long as we trade 1 share stock y and b shares stock x, we need an initial investment of $P_y + |b| * P_x$ (assume zero leverage). Thus $w_x = \dfrac{|b| * P_x}{P_y + |b| * P_x}$, $w_y = \dfrac{P_y}{P_y + |b| * P_x}$. What if b<0? Then we will trade stock x and y on the same direction. To conclude, we have $w_x = \dfrac{b * P_x}{P_y + |b| * P_x}$,

$w_y = \dfrac{P_y}{P_y + |b| * P_x}$. Table II compares the returns of each trade under both weighting.

There is an obvious improvement in overall returns but we should be cautious of this weighting strategy if we expect the slope to change suddenly.

VII. Conclusions

This project is an empirical study of pairs trading strategy in the Hong Kong Stock Market. Although focusing on one specific pair (0005.HK & 0011.HK), we develop an in-depth understanding of the mechanism of pairs trading and its profitability in the Hong Kong Stock Market. After considering bid-ask spread and adjusting for dividend effects on return trade by trade, we can observe a clear "V" pattern of the returns, regardless of the variations of trading strategies. The 2008 global financial crisis does change the correlation of the two stocks. Possible areas for further study are to forecast the correlation, to figure out the sources of pairs trading return, etc.

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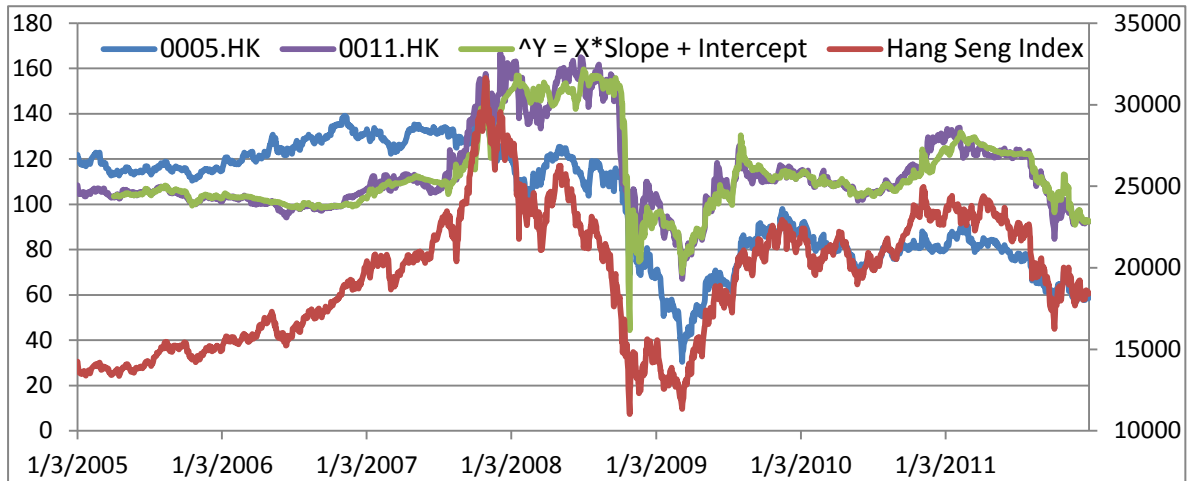
IX. Appendices

Figure 1 Volatile Stock Market

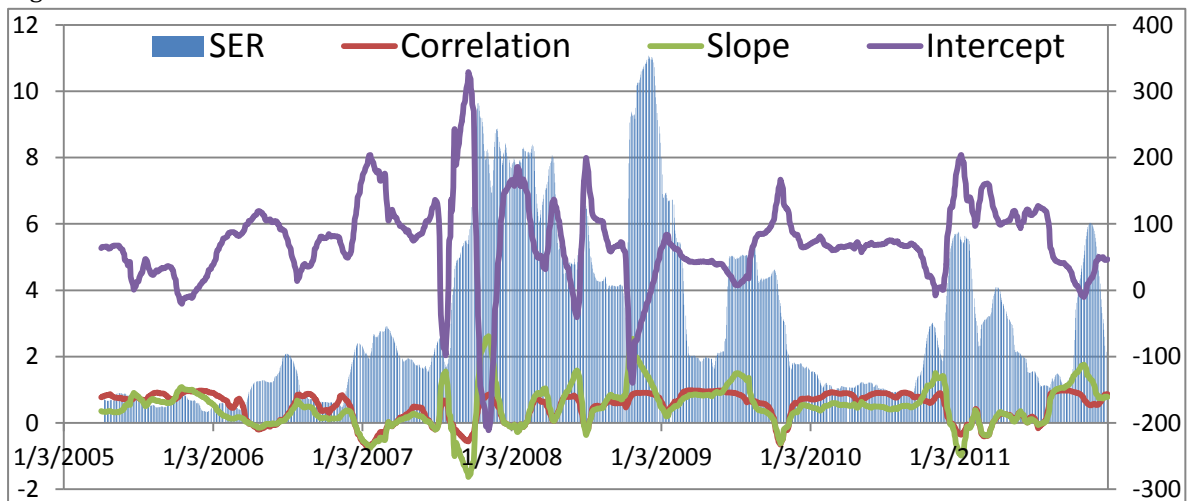Figure 2 Stock Prices and Index Level

Figure 3 Regression Parameters

Date	Signal	Action	Return X	Return Y	Return Portfolio	Cashflows per trade	P/L per trade	Holding Period	Slope
4/26/2005	2.825	BUY 0005.HK , SELL 0011.HK @ Last Min				1.87785			0.355
5/26/2005	-0.210	Close Positions @ Last Min	-0.7%	0.9%	0.1%	-0.3678	1.51006	30	0.3771
7/28/2005	2.163	BUY 0005.HK , SELL 0011.HK @ Last Min				1.09986			0.6068
8/5/2005	-0.064	Close Positions @ Last Min	1.0%	0.1%	0.5%	-0.2741	0.82578	8	0.7096
8/19/2005	2.110	BUY 0005.HK , SELL 0011.HK @ Last Min				1.00649			0.6758
8/22/2005	-1.257	Close Positions @ Last Min	0.6%	0.0%	0.3%	0.5909	1.59739	3	0.6675
9/5/2005	-2.066	SELL 0005.HK , BUY 0011.HK @ Last Min				1.00751			0.6298
10/18/2005	0.341	Close Positions @ Last Min	3.9%	-4.2%	-0.2%	-2.4841	-1.4765	43	1.0833
12/2/2005	-2.231	SELL 0005.HK , BUY 0011.HK @ Last Min				0.79684			0.8281
1/27/2006	0.208	Close Positions @ Last Min	-3.1%	1.4%	-0.9%	-3.5203	-2.7234	56	0.2111
2/13/2006	-2.276	SELL 0005.HK , BUY 0011.HK @ Last Min				1.0666			0.1382
2/23/2006	0.059	Close Positions @ Last Min	-2.1%	1.3%	-0.4%	-0.1099	0.95672	10	0.1321
3/7/2006	-2.122	SELL 0005.HK , BUY 0011.HK @ Last Min				0.82057			0.1763
5/3/2006	0.056	Close Positions @ Last Min	-5.2%	0.0%	-2.6%	-3.2827	-2.4621	57	-0.116
5/24/2006	-2.905	SELL 0005.HK , BUY 0011.HK @ Last Min				3.6818			-0.032
7/4/2006	0.016	Close Positions @ Last Min	-1.1%	1.5%	0.2%	-2.0936	1.58824	41	0.1909
11/7/2006	2.691	BUY 0005.HK , SELL 0011.HK @ Last Min				1.29673			0.1481
2/13/2007	-0.520	Close Positions @ Last Min	-7.2%	-6.3%	-6.8%	-8.9321	-7.6354	98	-0.528
6/8/2007	-2.526	SELL 0005.HK , BUY 0011.HK @ Last Min				4.05627			0.0447
7/18/2007	0.067	Close Positions @ Last Min	-1.8%	3.4%	0.8%	-0.4591	3.5972	40	1.3432
7/20/2007	2.086	BUY 0005.HK , SELL 0011.HK @ Last Min				3.49446			1.4697
8/16/2007	-0.910	Close Positions @ Last Min	-5.5%	-0.1%	-2.8%	-15.934	-12.44	27	-1.001
9/12/2007	2.048	BUY 0005.HK , SELL 0011.HK @ Last Min				11.034			-1.359
12/17/2007	-0.102	Close Positions @ Last Min	-5.1%	-11.8%	-8.4%	-17.508	-6.4744	96	-0.023
1/22/2008	-2.370	SELL 0005.HK , BUY 0011.HK @ Last Min				18.8531			-0.175
1/25/2008	0.242	Close Positions @ Last Min	-13.5%	11.5%	-1.0%	-0.1677	18.6854	3	-0.041
5/2/2008	2.007	BUY 0005.HK , SELL 0011.HK @ Last Min				9.49146			0.5313
5/19/2008	-0.463	Close Positions @ Last Min	-0.4%	4.4%	2.0%	-2.1847	7.30673	17	0.9532
6/3/2008	2.776	BUY 0005.HK , SELL 0011.HK @ Last Min				12.8347			1.4326
7/3/2008	-0.720	Close Positions @ Last Min	-9.9%	4.4%	-2.7%	-23.005	-10.17	30	-0.371
7/8/2008	-2.133	SELL 0005.HK , BUY 0011.HK @ Last Min				10.7015			-0.189
8/1/2008	0.432	Close Positions @ Last Min	-10.5%	7.5%	-1.5%	2.75933	13.4608	24	0.4341
9/30/2008	-2.216	SELL 0005.HK , BUY 0011.HK @ Last Min				7.03353			0.7654
10/23/2008	0.285	Close Positions @ Last Min	21.2%	-32.4%	-5.6%	-38.354	-31.32	23	2.5206
10/24/2008	2.575	BUY 0005.HK , SELL 0011.HK @ Last Min				23.6063			2.5379
10/30/2008	-0.049	Close Positions @ Last Min	7.7%	-7.2%	0.2%	-13.328	10.2779	6	1.9763
3/6/2009	-2.064	SELL 0005.HK , BUY 0011.HK @ Last Min				4.14724			0.7841
3/13/2009	1.149	Close Positions @ Last Min	4.5%	4.5%	4.5%	1.04295	5.19019	7	0.8391
4/6/2009	-2.018	SELL 0005.HK , BUY 0011.HK @ Last Min				3.77167			0.8371
4/21/2009	0.091	Close Positions @ Last Min	-0.2%	4.5%	2.1%	-0.0054	3.76629	15	0.8384
5/6/2009	3.180	BUY 0005.HK , SELL 0011.HK @ Last Min				5.18784			0.7974
5/19/2009	-0.686	Close Positions @ Last Min	10.7%	-2.8%	3.9%	-1.6557	3.53217	13	0.9325
5/29/2009	4.258	BUY 0005.HK , SELL 0011.HK @ Last Min				9.20595			0.905
7/16/2009	-0.057	Close Positions @ Last Min	-2.5%	3.0%	0.2%	-7.2991	1.9068	48	1.4425
8/4/2009	-2.028	SELL 0005.HK , BUY 0011.HK @ Last Min				10.4761			1.3614
10/14/2009	0.177	Close Positions @ Last Min	-6.9%	-5.3%	-6.1%	-25.296	-14.82	71	-0.353
11/9/2009	2.358	BUY 0005.HK , SELL 0011.HK @ Last Min				3.93374			-0.093
11/19/2009	-0.101	Close Positions @ Last Min	7.9%	-0.1%	3.9%	-3.1549	0.77887	10	0.2821
1/27/2010	-2.267	SELL 0005.HK , BUY 0011.HK @ Last Min				2.42627			0.3755
2/9/2010	0.847	Close Positions @ Last Min	6.0%	-0.9%	2.5%	-0.9426	1.48368	13	0.5124
2/25/2010	2.117	BUY 0005.HK , SELL 0011.HK @ Last Min				2.00213			0.6011
3/3/2010	-0.550	Close Positions @ Last Min	-4.5%	4.4%	-0.1%	0.38347	2.3856	6	0.5908
3/10/2010	2.077	BUY 0005.HK , SELL 0011.HK @ Last Min				2.16108			0.5675
3/15/2010	-0.106	Close Positions @ Last Min	-1.0%	0.8%	-0.1%	-0.0867	2.07438	5	0.5437
4/16/2010	-2.324	SELL 0005.HK , BUY 0011.HK @ Last Min				2.53395			0.5523
5/5/2010	0.014	Close Positions @ Last Min	9.1%	-1.7%	3.7%	-0.3678	2.16614	19	0.5732
8/27/2010	2.461	BUY 0005.HK , SELL 0011.HK @ Last Min				2.18038			0.5188
11/4/2010	-1.424	Close Positions @ Last Min	12.2%	-7.8%	2.2%	-6.33	-4.1496	69	1.5049
11/5/2010	-2.142	SELL 0005.HK , BUY 0011.HK @ Last Min				4.90005			1.4695
11/8/2010	0.034	Close Positions @ Last Min	1.7%	1.8%	1.8%	-0.5693	4.33073	3	1.3665
11/16/2010	3.196	BUY 0005.HK , SELL 0011.HK @ Last Min				5.94171			1.3557
2/8/2011	-0.017	Close Positions @ Last Min	6.9%	-5.4%	0.7%	-6.0922	-0.1505	84	0.3206
2/10/2011	-2.540	SELL 0005.HK , BUY 0011.HK @ Last Min				6.22217			0.3765
3/8/2011	0.056	Close Positions @ Last Min	5.1%	2.5%	3.8%	-1.503	4.71914	26	-0.374
3/15/2011	-2.282	SELL 0005.HK , BUY 0011.HK @ Last Min				7.60031			-0.359
4/6/2011	0.106	Close Positions @ Last Min	-3.8%	3.5%	-0.1%	-2.3829	5.21743	22	0.2437
8/5/2011	-4.461	SELL 0005.HK , BUY 0011.HK @ Last Min				4.73312			0.1618
8/24/2011	0.054	Close Positions @ Last Min	10.3%	-4.9%	2.7%	-10.144	-5.4105	19	0.9969
8/31/2011	2.109	BUY 0005.HK , SELL 0011.HK @ Last Min				2.77477			1.03
9/9/2011	-0.035	Close Positions @ Last Min	-3.6%	4.6%	0.5%	-0.0437	2.73108	9	1.0589
9/16/2011	-3.559	SELL 0005.HK , BUY 0011.HK @ Last Min				4.18782			1.0788
11/15/2011	0.018	Close Positions @ Last Min	4.3%	-6.3%	-1.0%	-7.6369	-3.4491	60	1.3829

Table I Trade Summary

	X	Y	$w_x = 1/2$	$w_x = \dfrac{b * P_x}{P_y + \lvert b \rvert * P_x}$
5/26/2005	-0.7%	0.9%	0.1%	0.4%
8/5/2005	1.0%	0.1%	0.5%	0.4%
8/22/2005	0.6%	0.0%	0.3%	0.3%
10/18/2005	3.9%	-4.2%	-0.2%	-0.9%
1/27/2006	-3.1%	1.4%	-0.9%	-0.8%
2/23/2006	-2.1%	1.3%	-0.4%	0.8%
5/3/2006	-5.2%	0.0%	-2.6%	-0.9%
7/4/2006	-1.1%	1.5%	0.2%	1.5%
2/13/2007	-7.2%	-6.3%	-6.8%	-6.4%
7/18/2007	-1.8%	3.4%	0.8%	3.1%
8/16/2007	-5.5%	-0.1%	-2.8%	-3.5%
12/17/2007	-5.1%	-11.8%	-8.4%	-2.9%
1/25/2008	-13.5%	11.5%	-1.0%	11.7%
5/19/2008	-0.4%	4.4%	2.0%	2.9%
7/3/2008	-9.9%	4.4%	-2.7%	-2.7%
8/1/2008	-10.5%	7.5%	-1.5%	7.8%
10/23/2008	21.2%	-32.4%	-5.6%	-9.9%
10/30/2008	7.7%	-7.2%	0.2%	3.2%
3/13/2009	4.5%	4.5%	4.5%	4.5%
4/21/2009	-0.2%	4.5%	2.1%	2.9%
5/19/2009	10.7%	-2.8%	3.9%	1.9%
7/16/2009	-2.5%	3.0%	0.2%	1.0%
10/14/2009	-6.9%	-5.3%	-6.1%	-6.1%
11/19/2009	7.9%	-0.1%	3.9%	-0.7%
2/9/2010	6.0%	-0.9%	2.5%	0.6%
3/3/2010	-4.5%	4.4%	-0.1%	1.6%
3/15/2010	-1.0%	0.8%	-0.1%	0.3%
5/5/2010	9.1%	-1.7%	3.7%	1.4%
11/4/2010	12.2%	-7.8%	2.2%	-2.3%
11/8/2010	1.7%	1.8%	1.8%	1.8%
2/8/2011	6.9%	-5.4%	0.7%	0.5%
3/8/2011	5.1%	2.5%	3.8%	3.0%
4/6/2011	-3.8%	3.5%	-0.1%	3.6%
8/24/2011	10.3%	-4.9%	2.7%	-3.5%
9/9/2011	-3.6%	4.6%	0.5%	1.5%
11/15/2011	4.3%	-6.3%	-1.0%	-2.0%
sum	24.5%	-31.1%	-3.3%	14.2%

Table II Return Comparison

Bin	Frequency
-8.44%	1
-6.28%	1
-4.12%	2
-1.96%	3
0.20%	11
2.35%	11
More	7
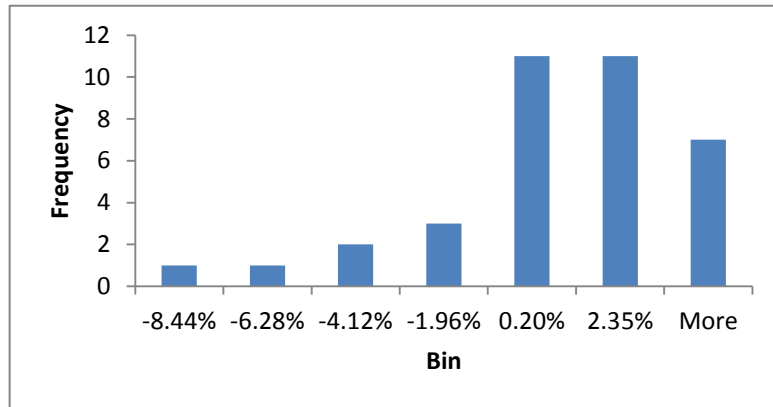
Figure 4 Return Distribution: $w_x = 1/2$

Bin	Frequency
-9.92%	1
-6.31%	1
-2.70%	5
0.91%	13
4.52%	14
8.13%	1
More	1
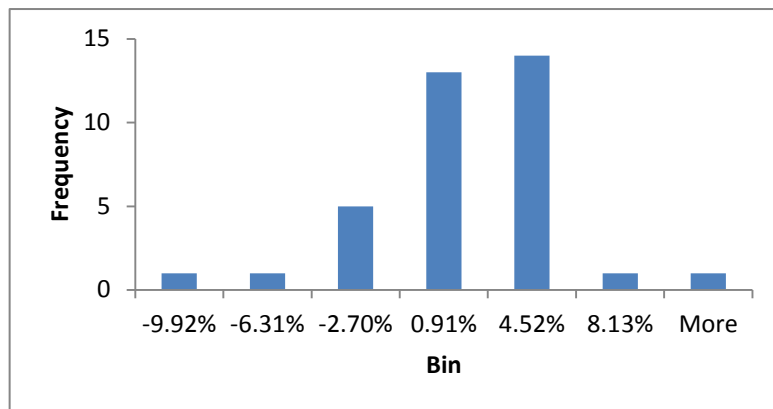
Figure 5 Return Distribution: $w_x = \dfrac{b * \mathrm{P}_x}{\mathrm{P}_y + |b| * \mathrm{P}_x}$