PRICE DISCREPANCY OF DUAL-LISTED COMPANIES IN AN ARBITRAGE-FREE MARKET PAIR

An Undergraduate Research Scholars Thesis

by

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Submitted to the Undergraduate Research Scholars program
Texas A&M University
in partial fulfillment of the requirements for the designation as an

UNDERGRADUATE RESEARCH SCHOLAR

Approved by
Research Advisor: Dr. Dennis W. Jansen

May 2016

Major: Economics

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ABSTRACT

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The topics of dual-listed companies (DLC, or Siamese twins) have been greatly intensified on arbitrage. Essentially, the implication from the effectiveness of arbitrage, which is theoretically assumed to function as the mechanism to realize the fundamental value of the underlying asset, is that the mispricing is not simply irrational in the real world, and the market is not as efficient as we expect it to be. Now the question is this- what can we expect from the prices of DLCs with the absence of arbitrage opportunities? Will the pair price merely show more randomness in the absence of arbitrage instead? One possible answer may hide in the performance of the DLCs listed on Chinas Shanghai/Shenzhen stock market (SSE/SZE) and Hong Kong (HSI) market. In this paper, we attempt to evaluate the mispricing phenomena from the arbitrage-free market pair by adapting VAR and error correction model. Our results show that even without arbitrage spaces, many of the pairs still present a long-term convergence. Also we find that the the price of the host market does not dominate its counterpart in the foreign market as expected, and after controlling the potential market noise, a more favorable result of most of the DLCs show cointegration turns out. This implies that there should be some significant but undefined factors hidden in the whole market driving the dynamics of the mispricing.

ACKNOWLEDGMENTS

I would like to thank Dr. Dennis W. Jansen for supporting me. His suggestions are paramount to this thesis, my improvement as a student, and as a person.
All mistakes that I have inevitably made are mine alone.

NOMENCLATURE

DLC Dual-listed Companies

SSE Shanghai Stock Exchange Index

SZE Shenzhen Stock Exchange Index

HSI Hang Seng Index

CHAPTER I

INTRODUCTION

The topics of dual-listed companies (DLC, or Siamese twins) have been greatly focused on arbitrage. Given the presence of transaction costs, holding costs and agent problems such as idiosyncratic risks constant, many researches have maintained that even with the availability of arbitrage opportunities, an increasing discrepancy in prices can still be observed. This discrepancy in prices can even be observed during the arbitraging process, and, under some extreme conditions, the deviation of parity can be up to an abnormal level (Pontiff, 2006) [3]. Thus, the implication from the effectiveness of arbitrage, which is theoretically assumed to function as the mechanism to realize the fundamental value of the underlying asset, is that the mispricing is not simply irrational in the real world, and the market is not as efficient as we expect (De Jong et al., 2009) [2]. Now the question is thiswhat can we expect from the prices of DLCs with the absence of arbitrage opportunities? Despite the fact that arbitrage may not help with the price convergence in the short run, the long-run mispricing is not significant (around 4%) for a DLC listed on the US and Europe. This demonstrates a rough lockstep of pair prices for DLCs (De Jong et al., 2009) [2]. So, will the pair price just show more randomness in the absence of arbitrage instead? One possible answer may hide in the performance of a DLC listed on China Shanghai/Shenzhen stock market (SSE/SZE) and Hong Kong HSI market.

Compared to other pairs of markets, SSH/SSZ and HSI (or, in abbrev, A+H markets) exhibit evident market separation, which prevents against the possibility of intense arbitrage. The primary reasons for the partition are that the DLC stocks are not convertible to each other, that there exists quite harsh short-selling constraints in SSE/SZE markets, and that the degree of market freedom are different. Based on such a separate design, it is not surprising to discern the fact that, in the past several months, the SSE/SZE Composite Index has experienced a rapid creation of big bubbles, sky-rocketing by almost 100% from the last quarter of last year to this June, while HSI markets remains stable through the period, twisting around other global major financial market such as NASDAQ and Dow Jones. However, the DLC prices in the A+H markets show quite a complicated intertwinement rather than expected irrelevance. Specifically, during the bubble period, the stock prices in both markets increases, and particularly, the DLC price in HSI has enjoyed a similar strong growth and rapid decline as the counterparts performed in SSE/SZE markets throughout the bubble period. From such observations, it is not a bold hypothesis that the host price can actually dominate the pair foreign price regardless whether the host price is informative or not. That is, the host price can blind the pair foreign price even when the price is not staying in rationality as suggested by some economists (Stein, 1987) [5]. Thus, in this paper, we try to investigate this major hypothesis, and evaluate mispricing phenomena from the arbitrage-free market pairs with a VAR and a VECM.

CHAPTER II

DATA AND METHODOLOGY

We gather daily price data on 48 companies that are dual-listed, meaning they are listed on the Hong Kong stock exchange (HSI) and simultaneously listed on either the Shanghai or Shenzhen stock exchange (SSE/SZE). Our data source is Yahoo Finance, and the data range varies by company. We also derive earnings per share data and assets information from Shanghai Stock Exchange official websites. This is quarterly data from 2007 through the second quarter of 2015.

We will investigate pricing dynamics between these markets and the implication for information transmission. For this intention, a Vector Autoregression model (VAR) is expected. However, there exists two major concerns arising from such setting. One of the of issue is model misspecification. For the very first step, we need to make sure that the both sides of the equation are unit-root stationary, or a spurious regression is very likely to be suspected (Sims, 1972) [4]. To avoid this problem, we will apply augmented Dickey-Fuller (ADF) test to examine whether the integration order of our target variables is one or not (maybe even more than one):

$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \Theta(\pounds) \cdot \Delta y_t$, where $\Theta(\pounds)$ is the lag operator polynomial matrix

Given the nature of our targeted variables, it is unlikely to have a trend and intecept terms for stock returns, therefore, we impose the restrictions such that $\alpha = 0, \beta = 0$ and apply t-value test over the other coefficients. Suppose, the result fails to grant strong statistic evdence to reject our null hypothesis that $\gamma = 0$, then there exists a unit-root, indicating the time series of the variable is non-stationary. And in such case, we should difference the variable, and repeat the ADF test over the differentiated variable. In particular, if, for our original variable, the ADF test does reject the null hypothesis upon γ, then we claim the time series is integrated of order zero, that is, $y_t \sim I(0)$. If we have repeated the ADF for once and the differenced time series is stationary, then we denote the original time series is integrated of order one, that is, $y_t \sim I(1)$.

Bivariate case 1: $y_t, x_t \sim I(0)$

We could simply use a simple VAR model in this case:

$$\begin{bmatrix} y_t \\ x_t \end{bmatrix} = c_0 + \Theta(\pounds^{\{m\}}) \cdot \begin{bmatrix} y_t \\ x_t \end{bmatrix} + \Phi \cdot \begin{bmatrix} p_t \\ q_t \end{bmatrix} + \begin{bmatrix} \varepsilon_{y_t} \\ \varepsilon_{x_t} \end{bmatrix},$$

where m are the highest order of lags of y_t, x_t chosen by Akaike information criterion, Θ, Φ is a linear combination of 2×2 vectors in this bivariate case, p_t, q_t are stationary exogenous variables, c_0 is a 2×1 vector and $\varepsilon_{y_t}, \varepsilon_{x_t}$ are white noice. We will further reduce the VAR and apply multivariate least square with stat package to estimate the coefficients.

Bivariate case 2: $y_t, x_t \sim I(1)$

Our second concern arises from this case, we can either choose difference the variables and make them stationary and then repeat the case 1 procedure, or we can introduce the concepts of cointegration model proposed by Engle and Granger in 1987 [1]. Given that $y_t, x_t \sim I(1)$, we have $\Delta y_t, \Delta x_t \sim I(0)$, we construct the VAR model as following:

$$\begin{bmatrix} \Delta y_t \\ \Delta x_t \end{bmatrix} = c_0 + \Theta(\pounds^{\{m\}}) \cdot \begin{bmatrix} \Delta y_t \\ \Delta x_t \end{bmatrix} + \Pi \begin{bmatrix} y_{t-1} \\ x_{t-1} \end{bmatrix} + \Phi \cdot \begin{bmatrix} p_t \\ q_t \end{bmatrix} + \begin{bmatrix} \varepsilon_{y_t} \\ \varepsilon_{x_t} \end{bmatrix} \text{ (1)},$$

$$\Pi \begin{bmatrix} y_{t-1} \\ x_{t-1} \end{bmatrix} = c_0 + \Theta(\pounds^{\{m\}}) \cdot \begin{bmatrix} \Delta y_t \\ \Delta x_t \end{bmatrix} - \begin{bmatrix} \Delta y_t \\ \Delta x_t \end{bmatrix} + \Phi \cdot \begin{bmatrix} p_t \\ q_t \end{bmatrix} + \begin{bmatrix} \varepsilon_{y_t} \\ \varepsilon_{x_t} \end{bmatrix} \text{ (2)}$$

We note that the right hand side of the equation (2) is stationary therefore the left-hand side should be stationary as well, implying a possibility such that two time-series with $I(1)$ can be co-integrated linearly to be $I(0)$. Actually, the concern can be resolved by this cointegration model through examining the rank of Π which in this case, is a 2×2 vector:

$$\begin{cases} rank(\Pi) = 0, \text{ there is no cointegration} \\ rank(\Pi) = 2, \ y_t, x_t \text{ are already stationary} \\ rank(\Pi) = 1, \text{ cointegration relationship exists} \end{cases}$$

That is, if $rank(\Pi) = 2$, we goes back to Case 1; if $rank(\Pi) = 0$, we difference the variables, and repeat the procedure of case 1. if if $rank(\Pi) = 1$, we can further explicate our model to have an Error-Correction representation (ECM) as following:

We rewrite Π explicitly as

$$\Pi := \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{12} & \alpha_{22} \end{bmatrix} \rightarrow \Pi \begin{bmatrix} y_{t-1} \\ x_{t-1} \end{bmatrix} = \begin{bmatrix} \alpha_{11} y_{t-1} + \alpha_{12} x_{t-1} \\ k \cdot (\alpha_{11} y_{t-1} + \alpha_{12} x_{t-1}) \end{bmatrix} = \begin{bmatrix} \alpha_{11} \\ k \cdot \alpha_{11} \end{bmatrix} (y_{t-1} + \frac{\alpha_{12}}{\alpha_{11}} x_{t-1}),$$

Denote: $\alpha_{11} = \theta_1, k \cdot \alpha_{11} = \theta_2, \frac{\alpha_{12}}{\alpha_{11}} = -\beta$, We have:

$$\begin{bmatrix} \Delta y_t \\ \Delta x_t \end{bmatrix} = c_0 + \Theta(\pounds^{\{m\}}) \cdot \begin{bmatrix} \Delta y_t \\ \Delta x_t \end{bmatrix} + \begin{bmatrix} \theta_1 \\ \theta_2 \end{bmatrix} (y_{t-1} - \beta x_{t-1}) + \Phi \cdot \begin{bmatrix} p_t \\ q_t \end{bmatrix} + \begin{bmatrix} \varepsilon_{y_t} \\ \varepsilon_{x_t} \end{bmatrix},$$

where we call θ_1, θ_2 as the speed of adjustment of y_t, x_t respectively, indicating their extent of response to the deviation from the long-run equilibrium, that is, $y_t = \beta x_t$.

Johansen cointegration test

To estimate the vector coefficients, we here apply *Johansen* procedure. Note that OLS is inappropriate since there exists cross-equation restictions problem. To test the significance of the rank of Π vector, we adapt $\lambda trace$ statistic test over Π with the following progressive hypothesis:

H_0 : the variables are not cointegrated, that is $rank(\Pi) = 0$.

$H_A : rank(\Pi) > 0$

To test the hypothesis, we compute $\lambda_{trace(0)} = -(T-p)\sum_{i=1}^{k} ln(1-\lambda_i)$, where T is the number of observations, p is the number of lags, k is the number of endogenous varibles in the cointegration relation. Then compare it with the critical value evaluated via simulation given the asymptotic distribution of the trace statistics is a function of standard Brownian motions (Tsay, 2005).

Next, suppose we reject the null hypothesis. In a bivariate case, we further establish the hypothesis test:

$H_0 : rank(\Pi) = 1$

$H_A : rank(\Pi) > 1$, which implying $rank(\Pi)$ is full in terms of a bivariate case.

$\lambda_{trace(1)} = -(T-p)\sum_{i=2}^{k} ln(1-\lambda_i)$, where $k = 2$ in a bivaraite case, thus further we have $\lambda_{trace(1)} = -(T-p) ln(1-\lambda_2)$.

CHAPTER III

MODEL SPECIFICATION & EMPIRICAL ANALYSIS

The ADF test over the log price traded in HK market adjusted and the log price traded in SS/SZ market shows that both of the variables in most of companies (41/48) in our sample do exhibit integration order of one.

Augmented Dickey-Fuller		
Company	Test Statistic ***(hkp)***	Test Statistic ***(ssp)***
Air China	-0.881	-0.703
Aluminum Corporation Of China Limited	-2.246**	-2.033**
Angang Steel	-2.023**	-1.752*
Anhui Conch Cement	-0.349	-0.511
Anhui Expressway	-0.040	0.025
Bank of China Limited	-0.522	-0.489
Bank of Communications	-0.908	-0.803
Beijing Jingcheng Machinery Electric	-0.620	-0.119
Beijing North Star Company	-2.098**	-1.415
China CITIC Bank Corporation	-0.522	-0.786
China Construction Bank Corporation	-0.488	-0.556
China COSCO Holdings Company	-2.100**	-1.877*
China Eastern Airlines	-1.658*	-1.032
China Life Insurance	-0.907	-1.088
China Merchants Bank	-0.548	-0.542
China Oilfield Services	-0.820	-1.149
China Petroleum and Chemical	-0.854	-1.671*
China Shenhua Energy	-1.220	-1.766*
China Shipping Development	-1.335	-1.370
China Southern Airlines	-0.925	-1.113
Chongqing Iron and Steel	-2.243**	-1.406

Augmented Dickey-Fuller		
Company	Test Statistic ***(hkp)***	Test Statistic ***(ssp)***
CSSC Offshore & Marine Engineering Group	-0.781	-0.723
Datang International Power Generation	-1.397	-1.700
Dongfang Electric	-1.292	-1.096
Guangshen Railway	-1.182	-1.334
Guangzhou Baiyunshan Pharmaceutical Holdings	0.232	0.114
Hisense Kelon Electrical Holdings	-0.391	-0.394
Huadian Power International	-0.137	-0.712
Industrial and Commerical Bank of China Limited	-0.612	-0.572
Jiangsu Expresswway	0.136	-0.125
Jiangxi Copper	-0.699	-1.348
Jingwei Textile Machinery	-0.062	-0.041
Luoyang Glass	-0.833	0.383
Maanshan Iron & Steel	-2.127**	-1.536
Nanjing Panda Electronics	-0.535	-0.022
Northeast Electric Development	-2.341	-0.582
Ping An Insurance Group Company of China	-0.515	-0.392
Shandong Xinhua Pharmaceutical	-0.355	0.275
Shanghai Electric Group Company Limited	-1.118	-1.775
Shenji Group Kunming Machine Tool	-0.943	-0.869
Shenzhen Expressway	-1.134	-0.730
Sinopec Oilfield Service Corp	-2.045**	-0.329
Sinopec Shanghai Petrochemical	-1.769*	-0.810
Tianjin Capital Environmental Protection Group	-0.924	-0.313
Tsingtao Brewery	0.035	0.041
Weichai Power	-0.443	-0.315
Yanzhou Coal Mining	-1.127	-0.171
ZTE	-0.503	0.052

Note: ** indicates 5% significant level; * indicates 10% significant level. ***hkp*** denotes log price traded in HK market and ***ssp*** denotes log price traded in SS/SZ market.

Model Specification

Case 1: $hkp, ssp \sim I(0)$

As in this case, we build up a simple bivariate VAR:

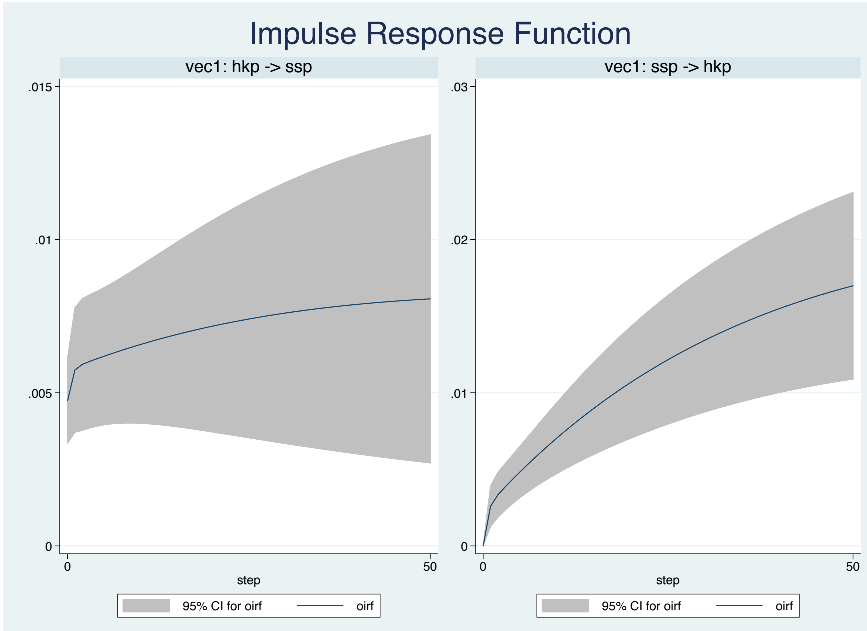
$\begin{bmatrix} hkp_t \\ ssp_t \end{bmatrix} = \Theta(\pounds^{\{m\}}) \cdot \begin{bmatrix} hkp_t \\ ssp_t \end{bmatrix} + \begin{bmatrix} \varepsilon_{hkp_t} \\ \varepsilon_{ssp_t} \end{bmatrix}$, where ε_{hkp_t} and ε_{ssp_t} are white noice. The order of lag m is chosen based on Lutkepohl versions of the information criteria.

Aluminum Corporation Of China Limited:

	hkp	ssp
L.hkp	1.025**	0.0237
	(45.72)	(1.00)
L2.hkp	-0.0424*	-0.0193
	(-1.91)	(-0.82)
L.ssp	0.0817**	1.059**
	(3.85)	(47.19)
L2.ssp	-0.0651**	-0.0665**
	(-3.05)	(-2.95)
Constant	0.0112**	0.000620
	(4.12)	(0.21)
Observations	2026	2026

t statistics in parentheses, ** indicates 5% siginifcant level, * indicates 10% siginificant level

The empirical results above are calculated from the representative example Aluminum Corporation Of China Limited (SEHK: 2600, SSE: 601600). Based on Lutkepohl version of AIC, we choose the order of lag m to be 2. It is evident that the logarithm HK price of the company presents a high exposure under its pair logarithm Shanghai price while the reverse relation does not occur. This seemingly signals the possibility that the price in the host market dominates the



foreign market, which coincides with our conjecture that even with a relatively low level of market efficiency, the host market price may ”blind” and guide the foreign market price. The above impulse response function plots also presents the fact that host market price shocks impose a much stronger effect on the foreign market price. However, due to the limited sample size in such case, it is quite insufficient to infer the confirmation over our hypothesis.

Case 2: $hkp, ssp \sim I(1)$

We have three choices in terms of perspective Error-Correction model.

$$(1)\begin{bmatrix}\Delta hkp_t\\ \Delta ssp_t\end{bmatrix} = \Theta(\pounds^{\{m\}})\cdot\begin{bmatrix}\Delta hkp_t\\ \Delta ssp_t\end{bmatrix} + \Pi\begin{bmatrix}hkp_{t-1}\\ ssp_{t-1}\end{bmatrix} + \begin{bmatrix}\varepsilon_{hkp_t}\\ \varepsilon_{ssp_t}\end{bmatrix},$$

$$(2)\begin{bmatrix}\Delta hkp_t\\ \Delta ssp_t\end{bmatrix} = \Theta(\pounds^{\{m\}})\cdot\begin{bmatrix}\Delta hkp_t\\ \Delta ssp_t\end{bmatrix} + \Pi\begin{bmatrix}hkp_{t-1}\\ ssp_{t-1}\end{bmatrix} + \Phi\cdot\begin{bmatrix}loghkm_t\\ loga_t\end{bmatrix} + \begin{bmatrix}\varepsilon_{hkp_t}\\ \varepsilon_{ssp_t}\end{bmatrix},$$

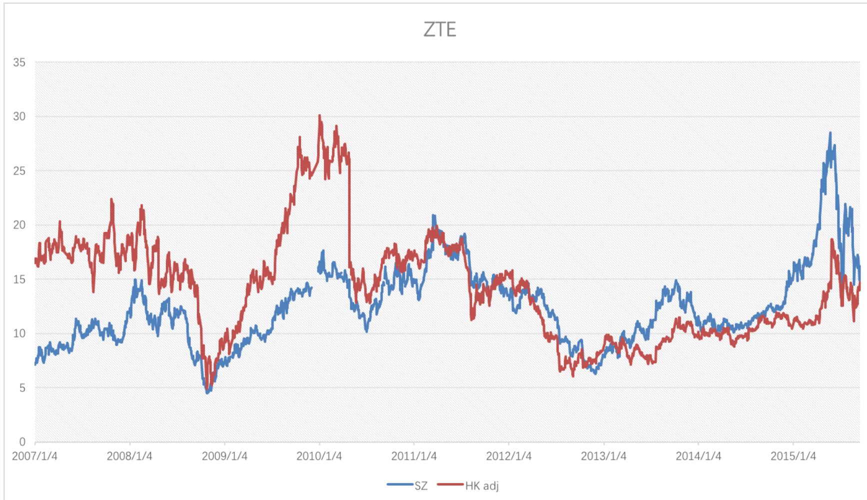
where *loghkm* denotes the logarithm of HSI after exchange rate adjustment and *loga* denotes the logarithm of SS/SZ index

Johansen cointegration test results

For model (1)

Johansen cointegration test

$rank(\Pi)$=1	$rank(\Pi)$=0
Air China	Bank of China
Anhui Conch Cement	Beijing Jingcheng Machinery Electric
Anhui Expressway	China Eastern Airlines
Bank of Communications	China Petroleum and Chemical
Beijing North Star Company	China Southern Airlines
China CITIC Bank Corporation	Chongqing Iron and Steel
China Construction Bank Corporation	Guangzhou Baiyunshan Pharmaceutical Holdings
China Life Insurance	Hisense Kelon Electrical Holdings
China Merchants Bank	Huadian Power International
China Oilfield Services	Jingwei Textile Machinery
China Shenhua Energy	Luoyang Glass
China Shipping Development	Nanjing Panda Electronics
CSSC Offshore & Marine Engineering Group	Northeast Electric Development
Datang International Power Generation	Shandong Xinhua Pharmaceutical
Dongfang Electric	Shenji Group Kunming Machine Tool
Guangshen Railway	Sinopec Oilfield Service
Industrial and Commerical Bank of China	Sinopec Shanghai Petrochemical
Jiangsu Expresswway	Tianjin Capital Environmental Protection Group
Jiangxi Copper	Yanzhou Coal Mining
Ping An Insurance Group Company of China	ZTE
Shanghai Electric Group Company	Maanshan Iron & Steel
Shenzhen Expressway	Tsingtao Brewery
Weichai Power	



Surprisingly, in these model specifications, nearly half of the companies with $I(1)$ variables fail to reject the first null hypothesis that $rank(\Pi) = 0$. Take ZTE, a Chinese multinational telecommunications equipment and systems company as our typical example, the HK stock price illustrates a different pattern of co-movement corresponding to the SSH/SSZ stock price. In particular, it raises more rapidly when the host stock price increases while it also declines in a faster manner than the host stock price does before 2010. The co-movement of the pair switch their character after 2010. For some other companies with no strong evidence of cointegration, their price paths exhibit similar mannerisms in which the behavior of the relation between the pair switches at some point.

On the other side, in the result of Model (1), for those DLCs presenting cointegration feature, most of results illustrate a long-term convergence between the pair prices in the same currency given that the result shows $\beta = 1$. And furthermore, in some of them, we find $\begin{bmatrix} \theta_1 \\ \theta_2 \end{bmatrix}$, namely the alpha matrix fails to have both entries significant, implying that there exists a weakly exogenous term in our variables. Specifically, within the pool exhibiting cointegration, we have the results of more than half of the companies suggesting that the HK price is a weakly exogenous, indicating that there is no significant evidence to reject that hypothesis that the HK price does not adjust its price with respect to the long term equilibrium with its pair SSH/SSZ price.

VECM β results with no constant, maximum lag order is 2, Model (1)

$\beta \neq 1$	$\beta \approx 1$
Datang International Power Generation	Others with cointegration shown in the Johansen test table
Shanghai Electric Group Company	
Shenzhen Expressway	

VECM α results with no constant, maximum lag order is 2, Model (1)

No weakly exogenous	$\theta_1 = 0(hkp)$	$\theta_2 = 0(ssp)$
Air China	Anhui Conch Cement	CSSC Offshore
Anhui Expressway	Bank of Communications	
China Shipping Development	China CITIC Bank	
Datang International Power Generation	China Construction Bank	
Dongfang Electric	China Life Insurance	
Jiangsu Expresswway	China Merchants Bank	
Jiangxi Copper	China Oilfield Services	
Shenzhen Expressway	China Shenhua Energy	
	Guangshen Railway	
	Industrial and Commerical Bank of China	
	Ping An Insurance Group Company of China	
	Shanghai Electric Group	
	Weichai Power	

VAR Regression Model based on VECM (1) for $rank(\Pi) = 0$

for rhk, coef of rss is significant	for rss, coef of rhk is significant	both are significant
Bank of China	China Eastern Airlines	Beijing Jingcheng Machinery
Shenji Group Kunming Machine Tool	Guangzhou Baiyunshan	Jingwei Textile Machinery
	Hisense Kelon Electrical	Maanshan Iron & Steel

for rhk, coef of rss is significant	for rss, coef of rhk is significant	both are significant
	Huadian Power International	Nanjing Panda Electronics
	Luoyang Glass	Northeast Electric Development
	Sinopec Shanghai Petrochemical	Shandong Xinhua Pharmaceutical
		Sinopec Oilfield Service
		Tianjin Capital
		Tsingtao Brewery
		Yanzhou Coal Mining

at 5% siginifcant level

We here further run a VAR model for those samples after differencing them firstly to control for non-stationarity. Our results show that 6 of the 22 companies' host market prices do not disclose effective information to the counterpart market while the left does. Though the result does not suggest uniformly that the HK price behaves exogenously in this case, we are still surprised that the price market fails to influence the counterpart at this percentage of our samples.

The empirical results from Model (1) suggest it is not always true that the price pairs are cointegrated. It arises in our further guess that given the difference of market efficiency of the two markets, the noise contained in the host price may not be able to cast significant influence on the counterpart. Thus, we adapt the logarithm of both market indexes (adjusted by exchange rates) as our control variables to capture the noise which is exogenous to information reflected by the true portion of prices in our VECM (2).

Johansen cointegration test results

For model (2)

Johansen cointegration test

$rank(\Pi)$=1	$rank(\Pi)$=0
Air China	Bank of China
Anhui Expressway	Huadian Power International
Bank of Communications	Maanshan Iron & Steel

rank(Π)=1	*rank*(Π)=0
Beijing Jingcheng Machinery Electric	
Beijing North Star Company	
China Eastern Airlines	
China CITIC Bank Corporation	
China Construction Bank Corporation	
China Life Insurance	
China Merchants Bank	
China Oilfield Services	
China Petroleum and Chemical	
China Shenhua Energy	
China Shipping Development	
China Southern Airlines	
Chongqing Iron and Steel	
CSSC Offshore & Marine Engineering Group	
Datang International Power Generation	
Dongfang Electric	
Guangshen Railway	
Hisense Kelon Electrical Holdings	
Industrial and Commerical Bank of China	
Jiangsu Expresswway	
Jiangxi Copper	
Jingwei Textile Machinery	
Luoyang Glass	
Nanjing Panda Electronics	
Northeast Electric Development	
Ping An Insurance Group Company of China	
Weichai Power	

$rank(\Pi)$=1	$rank(\Pi)$=0
Shanghai Electric Group Company	
Shandong Xinhua Pharmaceutical	
Shenji Group Kunming Machine Tool	
Shenzhen Expressway	
Tianjin Capital Environmental Protection Group	
ZTE	

VECM β results with no constant, maximum lag order is 2, Model (2)

$\beta \neq 1$	$\beta \approx 1$
Datang International Power Generation	Others with cointegration shown in the above table
Beijing Jingcheng Machinery Electric	
China Petroleum and Chemical	
Hisense Kelon Electrical Holdings	
Nanjing Panda Electronics	
Shanghai Electric Group Company	
Shenzhen Expressway	
Tianjin Capital Environmental Protection Group	

VECM α results with no constant, maximum lag order is 2, Model (2) (the pool is the companies showing cointegration from model (2)

$\theta_2 = 0(ssp)$	$\theta_1 = 0(hkp)$	No weakly exogenous
China Eastern Airlines	China CITIC Bank Corporation	Other 24 companies
China Petroleum and Chemical	Hisense Kelon Electrical Holdings	
China Southern Airlines	Jingwei Textile Machinery	
Luoyang Glass	Weichai Power	
Shenji Group Kunming Machine Tool	ZTE	
Shenzhen Expressway		
Sinopec Oilfield Service		

The empirical results from VECM (2) are surprising, but also expected. After controlling for noise (market sentiment) by including market index terms, all but three companies show cointegration in Model (1), with the fact that more than half of the pool converges. And more importantly, the results now exhibit that the foreign price does actively respond to the deviation from the equilibrium, if holding up the market noise. Though admittedly the model specification has not been calibrated sufficiently, it is still appropriate to derive the implication from the comparison between Model (1) and Model (2) that some local noise such as market sentiment can have impact on the mispricing phenomenon, creating more randomness between the pairs.

CHAPTER IV

CONCLUSION

For most of the companies, the log price variables in both markets present unit root after ADF test and surprisingly, nearly half of those companies fail to present cointegration. Under VECM (1), without controlling the market noise for those cointegrated, we find a long-term convergence based on the results of the VECM. And furthermore, the price variable in the foreign market does not always respond to the long-term equilibrium while host price adjusts itself toward the equilibrium. For those without evidence of cointegration, the VAR results also show in many cases that the host price plays less important roles in the foreign market compared to the counterpart.

Though the result from model (1) does not imply evidence of market segmentation, and many of the companies price-pairs do show cointegration, still it illustrates the imbalance between the two markets. It is surprising to learn that, in this case, we fail to suggest that the host market dominates the foreign market price. Besides the argument that some have already posted that the price in foreign markets disclose less information if the host market is relatively immature, one of other possible reasons of this fact may lie in less liquidity and less shares available in the foreign market, which may explain the relatively indifferent or passive response to the host price. Another possible reason may lie in market efficiency. Though the liquidity is much higher in SSH/SSZ market, the major participants in the market are individuals. These individuals probably have less information than in the company they are, thus the host price fails to lead the foreign price in a more positive manner. Under VECM (2), after controlling the potential noise, a more favorable result of most of the DLCs show cointegration turns out. This implies that there should be some significant but undefined factors hidden in the whole market driving the dynamics of the mispricing. Our results call for further research on the relationship between certain specific industry and market level capitalization variables and mispricing of DLCs.

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