**Co-movements of Shanghai and New York Stock prices by time-varying regressions**

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Abstract

We use time-varying regression to model the relationship between returns in the Shanghai and New York stock markets, with possible inclusion of lagged returns. The parameters of the regressions reveal that the effect of current stock return of New York on Shanghai steadily increases after the 1997 Asian financial crisis and turns significantly and persistently positive after 2002 when China entered WTO. The effect of current return of Shanghai on New York also becomes significantly positive and increasing after 2002. The upward trend has been interrupted during the recent global financial crisis, but reaches the level of about 0.4-0.5 in 2010 for both markets. Our results show that China’s stock market has become more and more integrated to the world market in the past twenty years with interruptions occurring during the recent global economic downturn.

Highlights

>Using time-varying parameter regression we study co-movement of Shanghai and New York stock prices. > The coefficients of the two regressions of the rates of return for these two markets increased from 1999 to 2010. > The increases are interrupted by the world economic downturn in 2008-9. > Effect of the rate in NY on the rate in Shanghai was larger than the effect of Shanghai on NY. > Useful measures of globalization China and the US are provided.

Jel classification: C29; C58; G14; P43

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**1. Introduction**

The purpose of this paper is to study the co-movement of the price indices of stocks traded in the Shanghai and New York Stock Exchanges by time-varying regressions. The parameters of the regressions will show the extent to which these two markets are integrated in the course of time. The estimates of the parameters are also measures of China's economic globalization,i.e., to what extent China's financial markets are affected by the US markets and to what extent the US markets are affected by the Chinese markets.

Globalization consists of flows of goods, capital, people and the accompanying information and technology among nations. After China opened up to the outside world in 1978, its economy has been gradually integrated to the rest of the world through international trade and foreign direct investment. This process has accelerated since China joined the WTO at the end of 2001. The flow of financial capital is an important component of globalization. China’s capital market has experienced rapid development for twenty years since the Shanghai Stock Exchange was established in December 1990 and the Shenzhen Stock Exchange was founded one year later. As of the end of 2009, China's A-share market has become the world's second-largest after the United States, with a market value of 24.27 trillion RMB yuan ($3.57 trillion). However, the extent to which China’s financial market is internationally integrated into the world still remains a question and has not been adequately measured. For China, the flows of both physical capital, in the form of direct foreign investment, and financial capital are regulated by the government. There was a distinction between stocks traded in China which only the Chinese citizens can purchase (the A shares) and those which are reserved for foreigners (B shares).

Various papers have investigated the linkages among stock markets in the great China area such as Zhu et al. (2004), Groenewold et al. (2004) and Zhang et al.(2009), or the relationship between China’s and foreign stock markets such as Ghosh et al. (1999), Chow and Lawler (2003), Cheng and Glascock (2005) and Li (2007). Among the first group, Zhu et al. (2004) reject causal relationship and cointegration between market returns in Shanghai, Shenzhen and Hong Kong; Groenewold et al. (2004) support cointegration between Shanghai and Shenzhen, but reject it between mainland markets and Hong Kong and Taiwan. Zhang et al. (2009) find weak return linkage and no volatility spillover between Shanghai and Hong Kong, but volatility linkage on both tails. Among the second group of papers where international linkages are studied, Chow and Lawler (2003) find no correlation between Shanghai and New York stock returns and negative correlation between their volatilities, using weekly data from 1992 to 2002. They ascribe the negative correlation in volatility as spurious, driven by macroeconomic fundamentals in the United States and China as indicated by a negative correlation between the rates of change in their GDP while their capital markets were not integrated. Li (2007) finds evidence of spillover between Hong Kong and China’s stock market with multivariate GARCH using daily data from January 2000 to August 2005, but no spillover between China and US markets; other papers in general also reject cointegration relationship or spillover effect between China and the US market.

In this paper we use time-varying regression to model the relationship between returns in the Shanghai and New York stock markets, with possible inclusion of lagged returns. The parameters of the regressions reveal the extent to which these two markets are integrated through time. Our econometric model implies a nonstationary relationship between the variables for China and for the outside world. Under such circumstances, a cointegration test assuming long run equilibrium is inappropriate to find the trend of integration. Likewise, by assuming the existence of an unconditional covariance matrix of returns, multivariate GARCH models or stochastic volatility models assume stationarity and tend to emphasize high frequency changes in volatility and covolatility but ignore the underlying smooth structural change model in this paper. In spite of the institutional restrictions in China’s financial market, we find robust evidence of a steady increase of integration between the Shanghai and New York stock markets, with the integration becoming particularly stronger after China joined the WTO. The process was disturbed during the recent financial crisis, but the trend was restored in 2010.

The rest of this paper is organized as follows. We first present in section 2 a comparison of the regressions of the rate of return and of volatility of stocks traded in the Shanghai Stock Exchange on the corresponding variables for the New York Stock exchange in two periods 1992-2002 and 2002-2010. In section 3 we present three specifications of models of regressions with time-varying parameters to study the co-movement between the rates of return of stocks traded in the Shanghai and New York stock markets. The results of estimating these models are given in section 4. Our results show that the method of regression with time-varying parameters depicts the co-movements of the stock prices in the two markets extremely well. These results agree with the history of China's globalization and of the recent world economic downturn during the period studied. Section 5 concludes.

**2. Co-movement of prices of stocks traded in the Shanghai and New York Stock Exchanges in two sample periods**

Stocks are first traded in the Shanghai stock market in December 1990, at a time when the Chinese economy was not integrated with the world economy. Chow and Lawler (2003) studied the co-movements of the prices of stocks traded in the Shanghai Stock Market and the New York Stock Market, using weekly data from the beginning of 1992 to February 2002. Daily movements were not used because of the time difference between Shanghai and New York, with trades in Shanghai taking place before New York. Monthly intervals are too long and miss the co-variation in the prices of stocks traded in the two markets. Chow and Lawler (2003) used two variables to measure the weekly movement of prices of stocks in the two markets. The first is the rate of return , which is the rate of change in weekly prices, calculated as log difference of price: . The second is volatility, which is measured by the absolute value of the rate of return . The study showed no co-movement in the prices in these two markets and predicted that co-movement would increase in the course of time following the integration of the Chinese economy into the world economy.

In this section we examine weekly returns of Shanghai and New York stocks for two subsamples. The first is from 1992-01-27 to 2002-02-25 as in Chow and Lawler (2003), and the second is from 2002-03-04 to 2010-12-27, with 511 and 455 observations respectively, after excluding holidays on either market with missing data. For the entire sample the beginning of 2002 is a reasonable break point. The two stock price indices used in Chow and Lawler (2003) and in this paper are the Shanghai Composite Index and the NYSE Composite Index, as reported in Datastream International. The two subsamples divide the sample roughly into halves. China joined WTO at the end of 2001 which promotes the economic and financial integration of China’s financial market into the world financial market.

For the whole sample and each subsample, Table 1 presents summary statistics of returns and volatilities (measured by absolute return) in Table 1. Table 2 compares correlations of the two measures between the two markets.

**Table 1. Rate of Return and Volatility in the Full Sample and Two Sub-samples**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Shanghai Rate of Return | | | New York Rate of Return | | |
|  | Full Sample | Before Feb.2002 | After Feb. 2002 | Full Sample | Before Feb.2002 | After Feb. 2002 |
| Mean | 0.002308 | 0.003095 | 0.001405 | 0.001245 | 0.001846 | 0.000554 |
| Variance | 0.0037 | 0.075292 | 0.038073 | 0.000630 | 0.019708 | 0.030129 |
|  | Shanghai Volatility | | | New York Volatility | | |
|  | Full Sample | Before Feb.2002 | After Feb. 2002 | Full Sample | Before Feb.2002 | After Feb. 2002 |
| Mean | 0.035455 | 0.041297 | 0.028748 | 0.016823 | 0.014644 | 0.019326 |
| Variance | 0.002449 | 0.063005 | 0.024964 | 0.000348 | 0.013303 | 0.023103 |

**Table 2. Correlation of Rate of Return and Volatility**

Rate of Return

|  |  |  |  |
| --- | --- | --- | --- |
|  | Full sample | Before Feb. 2002 | After Feb. 2002 |
| Correlation | 0.041632 | -0.022727 | 0.151953 |

Volatility

|  |  |  |  |
| --- | --- | --- | --- |
|  | Full sample | Before Feb. 2002 | After Feb. 2002 |
| Correlation | 0.000598 | -0.120583 | 0.257922 |

From the above two tables, three observations are in order.

1. Overall, the mean and variance of the Shanghai Stock return are higher.
2. During the first subsample before Feb. 2002, Shanghai stock return experienced a highly volatile period due to its early development stage and the 1997 Asian crisis. During the recent financial crisis in 2007-2008, the New York stock return experienced a surge in volatility; while the Shanghai stock volatility was affected to some extent, the change in volatility is not as drastic as the New York counterpart.
3. The correlation of returns between the two markets turns from negative before 2002 to positive after. This happens both in terms of return and its absolute value, a proxy for volatility. The negative correlation before 2002 was explained in Chow and Lawler (2003) as driven by macro fundamentals which were different in the two countries. The positive correlation after 2002 reflects economic and financial integration through time.

In what follows, we regress return of one market on its own lag term and on the current and lagged returns of the other market. For Shanghai the lag terms are selected first by AIC for the first subsample in order to be comparable to the Chow and Lawler (2003) subsample. Then we do the same regression for the full sample and the other subsample in order to see the difference between different periods. In Table 3, the first column displays variable names, where “S” stands for Shanghai and “N” stands for New York, the number 0 and 1 denote lag orders. For each coefficient, we report the t-statistics behind it.

**Table 3. Regressions of Rate of Return of Shanghai and New York Stock Indices**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Shanghai** | | | | **New York** | | | |
|  | All Data  ( obs. 955) | Before 02.2002  ( obs. 510) | | After 02.2002  ( obs. 444) | All Data  ( obs. 955) | | Before 02.2002  ( obs. 510) | After 02.2002  ( obs. 444) |
| **Lag** | Coef./ t | Coef./ t | Coef./ t | | Coef./ t | Coef. / t | | Coef. / t |
| **S0** |  |  |  | | .0225 1.68 | -.0057 -0.49 | | .1368 3.63\* |
| **S1** | .1090 3.38 | .1235 2.80 | .0337 0.72 | | -.0260 -1.94 | -.0036 -0.31 | | -.1172 -3.16\* |
| **N0** | .1318 1.68 | -.0828 -0.49 | .2131 3.63\* | |  |  | |  |
| **N1** | .1675 2.14 | -.0259 -0.15 | .2614 4.46\* | | -.0880 -2.73 | -.1240 -2.80 | | -.0845 -1.77 |
| **Cons.** | .0017 0.85 | .0029 0.86 | .0009 0.52 | | .0014 1.70 | .0021 2.43 | | .0006 0.40 |
| **R2** | .0189 | .0158 | .0684 | | .0138 | .0159 | | .0546 |
| **RMSE** | .0604 | .0750 | .0367 | | .0250 | .0196 | | .0294 |

From the multivariate regressions in Table 3 for returns, it is evident that after 2002, the interaction between markets is stronger. A star indicates that the return of the foreign market has a significant effect. It can be seen that not only the lagged and current values of returns from the New York market affect the corresponding variables in Shanghai, but the effects also go from the Shanghai to the New York market.

**3. Specification of time-varying coefficient regressions for the co-movement between stock returns in Shanghai and New York**

As revealed by the statistics and linear regressions presented in the last section, there have been significant structural changes in the co-movement of returns in the Shanghai and New York stock market. In this section we specify three time-varying coefficient regressions of the rate of return of one market on the return of the other market. In a bivariate distribution there are two regressions. Movements in the New York Stock Exchange represent a larger part of the global financial activities than movements in the Shanghai Stock Exchange. To reflect possible asymmetric effects between these two markets, we run the regressions in both directions. In each specification, the time-varying coefficient of the current foreign market return is modeled as a random walk process. The model of random walk is appropriate because an autoregression coefficient of less than unity would imply a stationary process with the parameter converging to a constant.

For robustness, we consider three specifications of the regressions for co-movement between the Shanghai and New York stock returns. The first specification is the simplest one where return in domestic market is regressed only on the foreign return with a constant intercept and a time-varying coefficient.

Model I:

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The second specification adds one lagged domestic return with constant coefficient to the first specification. The third specification adds to the second specification one lagged foreign return as an additional regressor with time-varying coefficient. This choice of a time-varying coefficient reflects the subsample comparison in Table 3 of Section 2 for those coefficients which change signs and are significant for the second subsample.

Model II:

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Model III:

These time-varying coefficient models fit naturally into the state-space framework. The states here are the time-varying parameters. Standard maximum likelihood estimation (MLE) with the Kalman filter can be used to estimate the models.

**4. Estimation results**

In this section, we present the parameter estimates of each model for both market returns. For the constant coefficients, we report the estimates in the equation and denote the t-statistics in parentheses; for time-varying coefficients, we plot the estimated process in a figure.

Model I:

Figure 1. Plot of

|  |  |  |
| --- | --- | --- |
| Shanghai | New York | |
|  | |  |

From the first equation and the first plot we observe how the New York market influences the Shanghai market. In this simplest specification, the effect of the current stock return of New York on Shanghai, measured by , steadily increases after the 1997 Asian crisis. The impact turns to significantly and persistently positive after 2002 when China entered WTO. The upward trend has been interrupted during the recent financial crisis, but in 2010 it resumes the level before crisis as the markets gradually recover from the financial and economic turmoil.

From the second equation and the second plot we observe how the Shanghai market influences the New York market. The effect of Shanghai on New York is weaker as expected and is close to zero before 2002. The impact becomes positive and increases since 2002, but it reverses direction during the financial crisis, and then increases rapidly in 2009 and 2010.

Overall, it is clear that the co-movement between Shanghai and New York stock returns become positively related and stronger in the past decade, with interruptions associated with the global financial market turmoil.

Model II:

Figure 2. Plot of

|  |  |  |
| --- | --- | --- |
| Shanghai | New York | |
|  | |  |

From the results of the second model where an autoregressive part is added to explain the domestic return, the paths of the time-varying coefficients for the two markets are fairly similar to the paths of the first model. The effect of the New York market on the Shanghai market has been stronger than the effect in the opposite direction. Both coefficients turn persistently positive after 2002. After the financial crisis, the coefficient resumes a high value of about 0.4-0.5.

Model III:

Figure 3. Plot of

|  |  |  |
| --- | --- | --- |
| Shanghai | New York | |
|  | |  |

Figure 4. Plot of

|  |  |
| --- | --- |
| Shanghai | New York |
|  |  |

To further check the robustness for the time-varying coefficients of the current returns of the foreign market, we add one lagged foreign market return also with a time-varying coefficient. This specification is motivated by the results of estimation presented in Section 2, where we have found the coefficient of the lagged foreign return becoming statistically insignificant in the latter subsample.

The results show that:

1. The coefficients of the current foreign returns are still robust with the presence of the lag variable, showing paths similar in shape to those based on Models I and II .
2. Conditional on the impact of the current foreign returns, the effects of the lagged foreign returns are less important. For Shanghai, lagged New York return seems to have positive effects around 1994 while the effect of current return is zero or negative, indicating that the information in New York return may affect Shanghai stock price with some time lag. But with turning significantly positive after 2002, becomes closer to zero while remaining positive most of the time.
3. For New York, conditional on the presence of , is not significantly different from zero, showing the weak lagged effect of the Shanghai market.

**5. Conclusions**

By the use of time-varying regressions, this paper has provided estimates of the degrees of dependence of the Shanghai stock market on the New York market and the dependence in the opposite direction. Weekly estimates are provided from January 1992 to December 2010. The time-varying coefficients obtained by regressing current returns of Shanghai (New York) on New York (Shanghai) are fairly robust among alternative specifications.

As Figure 1 shows, the effect of current stock return of New York on Shanghai steadily increases after the 1997 Asian crisis and turns significantly and persistently positive after 2002 when China entered WTO. For New York, it is also the case that the effect of current return of Shanghai becomes significantly positive and increasing after 2002. The upward trend has been disturbed during the recent financial crisis, but reaches the level of about 0.4-0.5 in 2010 for both markets. China’s stock market has become more and more integrated to the world market in the past twenty years. Our results provide measures of this integration.

It remains the task of future research to build models to explain the process of economic globalization itself with China and the US playing important roles.

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