“Is China’s equity market a systematic risk for international asset pricing models?”

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Is China's equity market a systematic risk for international asset pricing models?

Abstract

The world market portfolio or the US market portfolio is regarded as a systematic risk factor in international asset pricing models given the integrated international financial markets. In light of the rapid growth of China's economy and financial markets, this paper examines if China's equity market is becoming an important systematic risk for international asset pricing models for the developed countries and the Asian emerging economies. The findings indicate that, from the perspective of international investors, China's equity market has become an important pricing factor only in the short term, but not in the long term. Asian markets are much more influenced by China's market than G7 countries. The results have rich implications for asset pricing and international portfolio management.

Keywords: China's stock market, systematic risk, ICAPM, SUR.
JEL Classification: G12, G15.

Introduction

According to finance theory, the capital asset pricing model (CAPM) of Sharpe (1964) and Lintner (1965) is used to estimate costs of capital for firms or required rate of return for investors in terms of the level of risk. Extending the CAPM to an international setting, the international CAPM (ICAPM) states that if an equity market is part of a global market, then each market's expected returns should be proportional to that market's covariance with the world market portfolio. Several international asset pricing models under different structures have been developed, notably by such scholars as Solnik (1974), Grauer, Litzenberger and Stehle (1976), Stulz (1981), and Adler and Dumas (1983). These models suggest that the world market portfolio is the only systematic risk factor in international financial markets.

These theories suggest completely integrated world financial markets. When world markets are integrated, the world market portfolio should be mean-variance efficient. As a result, the only priced risk should be the systematic risk, i.e. the world market risk. Given the relaxed controls over international capital flows in the developed and developing countries in the 1980s and 1990s, and precipitated development of financial derivatives for pricing and hedging purposes, the world markets have become more integrated. Whether the world financial markets are integrated or segmented is an empirical issue. Market segmentation can be due to transaction costs, barriers such as restrictions on foreign ownerships, informational asymmetries, etc. However, it is evident that the international financial markets are at least partly segmented. Papers regarding market integration and segmentation are presented by Errunza and Losq (1985), Eun and Janakiramanan (1986), Wheatley (1988), Hietala (1989), Bekaert and Harvey (1995), Foerster and Karolyi (1999), Errunza and Miller (2000) and the references therein.

If the world markets are not perfectly integrated, factors other than the world portfolio may also play an important role in the ICAPM. From the empirical perspective, some studies use the world index as a proxy for world market portfolio in the ICAPM to estimate costs of capital. Because the US index is highly related to world index due to the size and importance of the US equity market, the US equity index is often used for market portfolio to estimate costs of capital.

In addition to the US equity index, Japan's equity index also plays an important role in the world financial markets. Since Japan is a major investor and trade partner in the world economy, it is likely that Japan's equity market also serves as a key determinant of world market risks. For example, Ghosh, Saidi and Johnson (1999) attempt to investigate whether the US or Japan moves the Asian-Pacific markets. Their findings indicate that Hong Kong, India, Malaysia, and South Korea are closely linked with the US market while Indonesia, the Philippines, and Singapore have stronger ties with Japan. Ng (2000) uses the Japan's stock market as an important factor to examine the magnitude and changing nature of volatility spillovers from Japan and the US to the six Pacific-Basin equity markets.

Along with the US and Japan, China's equity market has attracted increased interests from investors since their inception in the early 1990s. The Shanghai Stock Exchange (SSE) and Shenzhen Stock Exchange (SZSE) were inaugurated in December 1990 and April 1991 with eight and six listed companies, respectively. However, the Chinese government imposed some capital restrictions on equity investment in early stages. Recently, China government has gradually eased controls on foreign capital flows, so China's equity market has attracted foreign capital from international investors. Given the influx of inter-

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national hot money and the waves of investments in China, China's equity market had kept growing rapidly until the devastating subprime mortgage crisis in 2007. After several years' operation, the *Shanghai* and *Shenzhen* stock exchanges list more than 1,500 companies with a combined *market capitalization* of US$2,658.2 billion (2008), surpassing the *Hong Kong Stock Exchange* (US$2,121.8 billion) as Asia's second-largest stock market only behind the *Tokyo Stock Exchange* (US$3,925.6 billion).

Furthermore, China has been one of the world's fastest growing economies over the past decades. For example, the so called "G2" refers to the two largest economies in the world: the US and China. At the same time, China's equity market has become more and more influential. For example, on February 27, 2007, black Tuesday, China's equity market plunged by nearly 9%, and spilled over to the stock markets of the rest of the world. *The Shanghai Stock Exchange* (SSE) lost 9% of its value and uncertainty caused the *Dow Jones Industrial Average* (DJIA) to dip 416 points. On a percentage basis, the Dow lost about 3.3 percent. The S&P 500 index (down 50.33 to 1,399.04) fell 3.5 percent, the NASDAQ composite (down 96.66 to 2,407.86) tumbled about 3.9 percent, and the Russell 2000 small-cap index (down 31.03 to 792.66) lost almost 4 percent. Given the rapidly growing size of the China's equity markets, the increasing presence of China in the world economy, and the acceleration of the influence of the China's markets, it is necessary to recognize the role the Chinese equity market is playing in international finance.

Literature concerning China's stock market has been documented. Among others, Chang, Chou and Wu (2000) conduct VAR tests on stock market daily returns of the five Chinese regions: Taiwan, Hong Kong, Singapore, Shanghai and Shenzhen, as well as on the US and Japan. Empirical findings indicate that among the seven stock markets, the US and Japan are most influential, while Hong Kong's stock market is most vulnerable to the changes of international stock markets. Johnson and Soenen (2002) examine the return co-movements for 12 Asian stock markets and find that markets in Australia, China, Hong Kong, Malaysia, New Zealand, and Singapore are highly integrated with the Japanese market between 1988 and 1998. There is also evidence that the degree of integration among these Asian markets is increasing over time. Darrat and Zhong (2002) use trivariate models to test cointegration between 11 Asian-Pacific, Japanese, and the US markets. They conclude that the US market is the main driving force for the equilibrium relations among these markets. Dunis and Shannon (2005) check if emerging market still offer international investors with a valuable diversification benefit. The study covers emerging markets in South-East Asia (Indonesia, the Philippines and Malaysia) and Central Asia (Korea, Taiwan, China and India) over the period from 31st August, 1999 to 29th August, 2003, with the US, the United Kingdom and Japan as the referential 'established' markets. They find that all emerging markets have become more closely integrated with the Japanese market.

From the perspective of international diversification, earlier literature suggests China's stock market is closely related to the US market and Japan's market. However, a more recent paper by Shih, Hsiao and Chen (2007), which explores the relations between stock indexes of China, the US, and Japan, find no cointegration relationship for the six stock indexes of these countries. Huang, Yang and Hu (2000) conducting cointegration tests which allows for structural breaks also find no cointegration relations between the stock markets of the US, Japan and China.

Is China's stock market redundant from the perspective of international diversification? Or can it serve as a systematic pricing factor? Given the aforementioned economic growth in China and the increasingly important role it is playing in the world's financial markets, the purpose of this study is to investigate if China's stock market has become an increasingly important systematic risk factor for the past decade.

We investigate this issue for G7 countries and Asian emerging countries. Because Asian emerging countries are often important trade partners with China due to their geographical proximity, their equity markets can be more closely tied to China than developed countries. We attempt to figure out if China's stock market has become another important world systematic risk. The remainder of this paper is organized as follows. Section 1 discusses the theoretical models for international asset pricing models. Section 2 describes the data and empirical analysis. We conclude in the final section with a summary of our findings.

1. International asset pricing model

The standard version of capital asset pricing model (CAPM) of Sharpe (1964) and Lintner (1965) postulates that the market portfolio is on the mean-variance efficient frontier, which implies that the expected return on each asset is linearly related to its systematic risk, the market portfolio. To extend the domestic CAPM to an international setting, several models such as Solnik (1974), Grauer, Litzenberger and Stehle (1976), Stulz (1981), and Adler and Dumas (1983) have been proposed. In particular, Adler and Dumas propose that an asset's expected return is specified as

$$E[r_{jt} \mid \Omega_{t-1}] = \sum_{i=1}^{L} \lambda_{i,t-1} \operatorname{cov}[r_{jt}, r_{n+i,t} \mid \Omega_{t-1}] + \\ + \lambda_{w,t-1} \operatorname{cov}[r_{jt}, r_{wt} \mid \Omega_{t-1}], \tag{1}$$

where r_{jt} is the nominal excess return on asset or portfolio j, $j = 1,\ldots, N$, from time $t - 1$ to t, in excess of the rate of interest of the currency in which returns are measured, r_{wt} is the excess return on the world market portfolio, and Ω_{t-1} is the information set available at time $t - 1$. The time-varying coefficients $\lambda_{i,t-1}$, $i = 1,\ldots L$, are the world prices of exchange rate risk. The time-varying coefficients $\lambda_{w,t-1}$, is the world price of market risk.

Suppose purchasing power parity holds, additional terms to reward exchange-rate risk should not be contained and there is only one risk premium based on the covariance of the asset return with the world market portfolio:

$$E(R_{j,t} \mid \Omega_{t-1}) - r_f = \beta_{j,W} [E(R_{w,t} \mid \Omega_{t-1}) - r_f] \quad j = 1,2...N, \tag{2}$$

where $R_{j,t}$ is the realized returns for equity market j at time t, $R_{w,t}$ is the realized return on the world market portfolio at time t, r_f is the return on a risk-free asset, $\beta_{j,W}$ is the coefficient with respect to world market risk premium and Ω_{t-1} is the information set available at time $t - 1$.

Given that the US stock market is the most dominant one in the world financial markets and given that the world financial markets are partly integrated, the US market portfolio is sometimes used to represent the world market risk. In this case, Equation (2) can be revised as:

$$E(R_{j,t} \mid \Omega_{t-1}) - r_f = \beta_{j,US} [E(R_{US,t} \mid \Omega_{t-1}) - r_f], \quad j = 1,2...N \tag{3}$$

where $R_{US,t}$ is the return on the US market portfolio and $\beta_{j,US}$ is the coefficient with respect to the US market risk premium. If China's stock market is also an incremental systematic risk other than the US market risk, equation (3) can be extended in the spirit of arbitrage pricing theory (APT) of Ross (1976):

$$\begin{aligned} &E(R_{j,t} \mid \Omega_{t-1}) - r_f = \beta_{j,US} [E(R_{US,t} \mid \Omega_{t-1}) - r_f] + \\ &+ \beta_{j,CH} [E(R_{China,t} \mid \Omega_{t-1}) - r_f], \\ &j = 1,2..N \end{aligned} \tag{4}$$

where $R_{China,t}$ is the return on China's market portfolio, and $\beta_{j,China}$ is the coefficient with respect to China's stock market risk premium.

Equation (4) is appropriate for identifying China's equity market as another possible risk factor for G7 countries. However, literature such as Ng (2000) document that Japan's equity market is another risk factor for Asian equity markets. As a result, we can also augment equation (4) with Japan's risk premium as an additional pricing factor for Asian equity markets in a similar fashion.

2. Empirical analysis

2.1. Data. Our dataset includes monthly and weekly stock indexes of the G7 countries (Canada, France, Germany, Italy, Japan, the UK and the US), China and nine Asian emerging countries (Hong Kong, India, Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan, and Thailand). All these indexes are measured in the US dollar. The indexes for these markets are given in Appendix A. To compute excess stock index return, we use 3-month US T-bill rate as the risk-free rate.

The sample period starts from January 1998 to December 2012. To compare the differences, we divided the period into two sub-periods, from January 1998 to July 2002 and from August 2007 to December 2012. All the data are sampled from *Thomson Reuters Datastream*.

2.2. Ex-post regression analysis. Because we speculate if China's and Japan's equity markets are aditional risk factors relative to the US equity market for G7 countries and Asian emerging countries. We first estimate correlation coefficients of excess returns between these three markets to see if they are highly correlated. The excess return correlation coefficients between the US, Japan and China are reported in Table 1.

First, with monthly excess returns, we can see the correlation coefficient between Japan and the US is the largest, which is about 0.63. For weekly data, this correlation coefficient is smaller, 0.49. The correlation coefficients between China and the other markets are not high, ranging from 0.08 to 0.24 for both monthly and weekly data. These suggest that these three markets are not highly correlated and it is appropriate to use these excess returns in a single regression equation.

Table 1. Excess return correlation coefficient matrix-full sample

Markets	US	Japan	China
Panel A. Monthly			
US	1		
Japan	0.6331	1	
China	0.2157	0.2379	1
Panel B. Weekly			
US	1		
Japan	0.4917	1	
China	0.0816	0.1542	1

The international capital asset pricing model (ICAPM) such as [equation (3)] or [equation (4)] postulates that an financial asset's risk premium is a linear combination of the risk premiums of the world systematic risk factors. Though ICAPM is *ex ante*, we first report the results of regressions of assets' excess returns on systematic risk factors as a preliminary analysis. We estimate the regression equation for G7 countries as follows:

$$r_{j,t} = \alpha_j + \beta_{j,US}\, r_{US,t} + \beta_{j,CH}\, r_{China,t} + \varepsilon_{j,t},\quad j = 1,2...N, \tag{5}$$

where $r_{j,t}$ is the excess return of the target equity market j at time t, $r_{US,t}$ is the excess return of the S&P 500 price index at time t, $r_{China,t}$ is the excess return of the Shanghai Composite stock index at time t, α_j is a constant, β_{US} and β_{CH} are coefficients and $\varepsilon_{j,t}$ denotes the residual of the equation for target equity market j at time t.

The regression estimations with monthly data for G7 countries are reported in Table 2. Panel A reports the results of monthly data for the first sub-period from January 1998 to July 2007, and Panel B for the second sub-period from August 2007 to December 2012. We use the end of July in 2007 as a break point of our data for two reasons: firstly, the date is the day when Bear Sterns announced that it liquidated two of its mortgage-related hedge funds, marketed an important event of the subprime mortgage crisis[1]. Secondly, the break point approximately divides our sample period evenly. In Panel A, only the UK's excess return is related to China's excess return in the first sub-period, but the coefficient is negative. In Panel B, none of the G7 country's excess return is significantly related to China's excess return. Overall, the excess returns of these developed countries are much more closely related to the excess return of the US index. Furthermore, of the G7 countries, we can see the constant term is negative and significant for France and Italy, but only after the subprime mortgage crisis. This finding can be possibly due the economic downturn in the euro area after the Lehman's bankruptcy in 2008. Among others, European countries were experiencing the sovereign debt crisis in the second sub-period. Besides, looking at the adjusted R-squares we can see that the values become much larger in the second sub-period than in the first sub-period universally, indicating the global equity markets are getting more integrated over time.

Table 2. Regressions for G7 countries − monthly data

Market	Panel A. 1998:1 to 2007:7				Panel B. 2007:8 to 2012:12			
	α	β_{US}	β_{CH}	$\bar{R}^2$ (%)	α	β_{US}	β_{CH}	$\bar{R}^2$ (%)
Canada	0.0023 (0.70)	0.8740*** (8.05)	0.0691 (1.39)	57.30	-0.0009 (-0.25)	0.7635*** (9.77)	0.0424 (1.20)	76.04
France	0.0016 (0.51)	1.1139*** (9.26)	0.0009 (0.02)	61.29	-0.0065** (-2.09)	0.8738*** (14.67)	0.0138 (0.38)	78.69
Germany	0.0005 (0.11)	1.2877*** (8.21)	0.0581 (1.37)	60.50	0.0011 (0.32)	0.9284*** (14.75)	0.0424 (1.25)	77.81
Italy	-0.0006 (-0.18)	0.9461** (6.14)	0.0402 (0.77)	41.27	-0.0132*** (-2.78)	0.9834*** (11.59)	0.0291 (0.59)	69.98
Japan	-0.0033 (-0.70)	0.6735*** (8.33)	0.0177 (0.28)	25.71	-0.0072 (-1.47)	0.7613*** (9.34)	0.1027 (1.38)	55.99
UK	-0.0019 (-1.08)	0.6679*** (11.73)	-0.0509* (-1.83)	69.22	-0.0003 (-0.16)	0.7572*** (18.07)	0.0222 (0.71)	85.90

Notes: This table presents estimates for the following regression: $r_{j,t} = \alpha_j + \beta_{US} r_{US,t} + \beta_{CH} r_{China,t} + \varepsilon_{j,t}$, where $r_{j,t}$ is the excess return of the target equity market j at time t, $r_{US,t}$ is the excess return of the S&P 500 price index at time t, $r_{China,t}$ is the excess return of the Shanghai Composite stock index at time t, α_j is a constant, β_{US} and β_{CH} are coefficients and $\varepsilon_{j,t}$ denotes the residual of the equation for target equity market j at time t. The t-statistics are in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

Results of weekly data are given in Table 3. The coefficients of China's return become positive and significant for Canada and Germany in the first sub-period, and positive and significant for all but Canada in the second sub-period. Furthermore, by looking at the sizes of the coefficients of China's excess returns, the sizes are much larger in the second sub-period than in the first sub-period. Like the case for monthly data, the adjusted R-squares are also larger in the second sub-period.

Table 3. Regressions for G7 countries – weekly data

Market	Panel A. 1998:1 to 2007:7				Panel B. 2007:8 to 2012:12			
	α	β_{US}	β_{CH}	$\bar{R}^2$ (%)	α	β_{US}	β_{CH}	$\bar{R}^2$ (%)
Canada	0.0006 (0.82)	0.7822*** (21.62)	0.0452** (2.14)	57.46	-0.0004 (-0.36)	0.7975*** (16.70)	0.0014 (0.04)	70.66
France	0.0004 (0.49)	0.9582*** (17.58)	0.0097 (0.37)	56.59	-0.0013 (-1.04)	0.7965*** (12.50)	0.1309*** (3.12)	63.84
Germany	0.0001 (0.14)	1.1088*** (19.16)	0.0700** (2.36)	56.57	0.0003 (0.27)	0.8087*** (13.88)	0.1069*** (2.62)	65.82
Italy	0.0001 (0.07)	0.8791*** (14.68)	0.0400 (1.29)	46.90	-0.0027* (-1.75)	0.8270*** (8.53)	0.1526*** (3.06)	53.35

[1] See crisis timeline on the website of Federal Reserve at St. Louis: http://timeline.stlouisfed.org/index.cfm?p=timeline.

Table 3 (cont.). Regressions for G7 countries – weekly data

Market	Panel A. 1998:1 to 2007:7				Panel B. 2007:8 to 2012:12			
	α	β_{US}	β_{CH}	$\bar{R}^2$ (%)	α	β_{US}	β_{CH}	$\bar{R}^2$ (%)
Japan	-0.0006 (-0.46)	0.4932*** (7.50)	0.0490 (1.28)	14.85	-0.0015 (-0.93)	0.6200*** (8.59)	0.1494*** (2.91)	38.81
UK	-0.0004 (-0.62)	0.7139*** (18.23)	0.0117 (0.54)	52.37	0.0001 (0.05)	0.6771*** (11.90)	0.1204*** (2.92)	62.25

Notes: This table presents estimates for the following regression: $r_{i,t} = \alpha_i + \beta_{US} r_{US,t} + \beta_{CH} r_{China,t} + \varepsilon_{i,t}$, where $r_{i,t}$ is the excess return of the target equity market i at time t, $r_{US,t}$ is the excess return of the S&P 500 price index at time t, $r_{China,t}$ is the excess return of the Shanghai Composite stock index at time t, α_i is a constant, β_{US} and β_{CH} are coefficients and $\varepsilon_{i,t}$ denotes the residual of the equation for target equity market i at time t. The t-statistics are in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

Given that previous literature such as Ng (2000) suggest that Japan's market has an impact on other Asian emerging markets, it is necessary to incorporate Japan's market into our regression equations for Asian emerging markets from the econometric point of view. That is, we speculate that Asian emerging markets are simultaneously affected by the US market, Japan's market and China's market. For Asian emerging markets, the regression equation is revised as:

$$r_{j,t} = \alpha_j + \beta_{j,US}\, r_{US,t} + \beta_{j,JP}\, r_{j,JAP,t} + \\ + \beta_{j,CH}\, r_{China,t} + \varepsilon_{j,t}, \quad (5a) \\ j = 1,2...N,$$

where $\beta_{j,JP}$ and $r_{j,JAP,t}$ correspond to the coefficient and excess return of Japan's market.

Estimates of regressions of excess returns of Asian emerging markets [equation (5a)] with monthly data are reported in Table 4. The US market is still the most dominant factor in explaining excess returns of the Asian emerging countries for monthly data in both sub-periods. The coefficients of Japan's excess returns are positive and significant for India, South Korea and Taiwan in the first sub-period, and positive and significant for Hong Kong, Indonesia, South Korea, Singapore, Taiwan and Thailand. China's market is universally significant, but only for weekly data in the second sub-period. Overall, these results indicate that the excess return of China has become an important factor in explaining the variation of monthly excess returns for all Asian emerging markets in the second sub-period. Besides, India had been experiencing a positive and significant return after adjusting the effects of equity market excess returns of the US, Japan and China in the first sub-period. In the second sub-period, Indonesia, Philippines and Thailand have positive and significant constant terms. These indicate that these markets have better performance after adjusting the effects of excess returns of the US, Japan and China. Similar to the case for G7 countries, the adjusted R-squares are much larger in the second sub-period than in the first sub-period, indicating the Asian markets are getting more integrated with the global financial markets over time.

Table 4. Regressions for Asian countries – monthly data

Market	Panel A. 1998:1 to 2007:7					Panel B. 2007:8 to 2012:12				
	α	β_{US}	β_{JP}	β_{CH}	$\bar{R}^2$ (%)	α	β_{US}	β_{JP}	β_{CH}	$\bar{R}^2$ (%)
Hong Kong	0.0036 (0.77)	0.9364*** (6.49)	0.1547 (1.40)	-0.0257 (-0.25)	41.80	0.0056 (1.00)	0.8210** (2.66)	0.2029* (1.98)	0.3170*** (7.75)	65.67
India	0.0128** (2.03)	0.2604 (0.90)	0.5224** (2.23)	0.1987 (1.31)	15.09	0.0096 (1.21)	0.8518*** (2.70)	0.1748 (1.65)	0.2445*** (3.02)	54.36
Indonesia	0.0100 (1.52)	0.7257*** (3.36)	0.2782 (1.45)	-0.0563 (-0.17)	20.31	0.0143** (2.06)	1.1747*** (3.42)	0.2669** (2.16)	0.1172** (2.11)	59.20
South Korea	0.0093 (1.18)	1.0378*** (4.62)	0.4102** (2.30)	-0.1522 (-1.03)	39.53	0.0053 (1.48)	1.0973*** (2.83)	0.2474* (1.77)	0.1759*** (2.73)	62.41
Malaysia	0.0025 (0.32)	0.8615*** (2.84)	-0.1181 (-0.71)	0.1846 (0.69)	14.77	0.0043 (1.18)	0.4768* (1.80)	0.0105 (0.18)	0.1163*** (2.72)	50.50
Philippines	0.0016 (0.24)	0.8629*** (3.11)	0.1031 (0.85)	-0.1040 (-0.61)	23.95	0.0111* (1.82)	0.7670*** (2.83)	0.0933 (0.61)	0.1886*** (2.99)	42.79
Singapore	0.0043 (0.77)	0.9684*** (5.54)	0.0998 (0.88)	-0.0700 (-0.51)	37.02	0.0013 (0.28)	0.6821*** (4.30)	0.2509*** (3.18)	0.1299*** (2.73)	73.17
Taiwan	-0.0030 (-0.49)	0.5627*** (3.03)	0.3690*** (3.09)	0.2442 (1.62)	25.14	0.0024 (0.41)	0.6587** (2.00)	0.3083*** (2.92)	0.1478*** (2.98)	62.03
Thailand	0.0016 (0.17)	0.8770*** (3.47)	0.1426 (0.79)	-0.0690 (-0.38)	18.54	0.0107* (1.80)	0.4635 (1.51)	0.1927* (1.84)	0.1041** (2.59)	51.88

Notes: This table presents estimates for the following regression: $r_{j,t} = \alpha_j + \beta_{US} r_{US,t} + \beta_{JP} r_{JAP,t} + \beta_{CH} r_{China,t} + \varepsilon_{j,t}$, where $r_{j,t}$ is the excess return of the target equity market j at time t, $r_{US,t}$ is the excess return of the S&P 500 price index at time t, $\beta_{j,JP}$ and $r_{j,JAP,t}$ correspond to the coefficient and excess return of Japan's market, $r_{China,t}$ is the excess return of the Shanghai Composite stock index at time t, α_j is a constant, β_{US} and β_{CH} are coefficients and $\varepsilon_{j,t}$ denotes the residual of the equation for target equity market j at time t. The t-statistics are in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

The estimates of regressions of Asian markets with weekly data are reported in Table 5. Surprisingly, the effect of US market disappears for Indonesia in the first sub-period when the effects of Japan and China are accounted for, and for Malaysia and Thailand in the second sub-period. The effect of Japan are all positive and significant for both sub-periods. In the first sub-period, the effect of China is positive and significant for Hong Kong, India, Singapore and Taiwan. The effect of China is positive and significant for all Asian countries in the second sub-period. Similarly, the adjusted R-squares are much larger in the second sub-period.

Table 5. Regressions for Asian countries – weekly data

Market	Panel A. 1998:1 to 2007:7					Panel B. 2007:8 to 2012:12				
	α	β_{US}	β_{JP}	β_{CH}	$\bar{R}^2$ (%)	α	β_{US}	β_{JP}	β_{CH}	$\bar{R}^2$ (%)
Hong Kong	0.0007 (0.56)	0.5982*** (8.65)	0.3574*** (7.33)	0.1134*** (2.83)	35.65	0.0016 (1.14)	0.3582*** (5.82)	0.4812*** (7.49)	0.2884*** (6.96)	62.01
India	0.0024 (1.57)	0.2569*** (2.75)	0.2677*** (4.11)	0.1021** (2.05)	10.01	0.0021 (1.11)	0.2926*** (3.47)	0.3594*** (4.37)	0.2076*** (3.75)	35.00
Indonesia	0.0029* (1.77)	0.1511 (1.46)	0.3132*** (4.35)	0.0230 (0.46)	7.42	0.0033* (1.80)	0.2587*** (2.99)	0.3458*** (4.05)	0.1841*** (3.24)	32.36
South Korea	0.0026 (1.56)	0.4764*** (4.60)	0.5276*** (7.37)	0.0751 (1.40)	25.29	0.0013 (0.93)	0.3626*** (4.30)	0.4009*** (5.26)	0.1428*** (4.12)	53.66
Malaysia	0.0010 (0.72)	0.1934*** (2.84)	0.2574*** (4.73)	0.0482 (1.04)	9.08	0.0013 (1.37)	0.0264 (0.59)	0.2280*** (4.75)	0.1350*** (4.23)	30.19
Philippines	0.0006 (0.42)	0.3369*** (4.17)	0.2438*** (3.78)	0.0485 (0.89)	11.66	0.0026 (1.55)	0.1779*** (3.02)	0.3240*** (4.45)	0.1614*** (3.34)	29.91
Singapore	0.0007 (0.61)	0.5013*** (6.64)	0.3076*** (5.88)	0.0849** (2.41)	28.30	0.0005 (0.37)	0.2937*** (5.11)	0.4635*** (7.61)	0.0982*** (2.87)	57.95
Taiwan	-0.0005 (-0.34)	0.2624*** (3.16)	0.4391*** (7.51)	0.1292*** (2.68)	20.38	0.0004 (0.27)	0.2782*** (4.69)	0.3876*** (6.41)	0.1528*** (3.47)	45.77
Thailand	0.0010 (0.62)	0.3636*** (4.22)	0.3100*** (4.36)	0.0510 (0.98)	13.09	0.0028 (1.63)	0.1057 (1.14)	0.3907*** (5.03)	0.1362** (2.44)	27.67

Notes: This table presents estimates for the following regression: $r_{j,t} = \alpha_j + \beta_{US}r_{US,t} + \beta_{JP}r_{JAP,t} + \beta_{CH}r_{China,t} + \varepsilon_{j,t}$, where $r_{j,t}$ is the excess return of the target equity market j at time t, $r_{US,t}$ is the excess return of the S&P 500 price index at time t, $\beta_{j,JP}$ and $r_{j,JAP,t}$ correspond to the coefficient and excess return of Japan's market, $r_{China,t}$ is the excess return of the Shanghai Composite stock index at time t, α_j is a constant, β_{US} and β_{CH} are coefficients and $\varepsilon_{j,t}$ denotes the residual of the equation for target equity market j at time t. The t-statistics are in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

2.3. Robustness: system of regression analysis. seemly unrelated regressions (SUR). If the US market and China's market are considered systematic risk factors, they should affect the excess returns of the other markets jointly. It is known that single equation OLS estimation is less efficient than SUR estimation of the system of regression equations if we allow for contemporaneously correlated error terms across equations. It is very likely that international stock markets are jointly affected by some other factors not incorporated in our models. In the last part of this study, we apply SUR of Zellner (1962) to re-estimate equation (5) to investigate if the markets of the developed and the Asian emerging markets in our sample are jointly affected by the US and China's markets. For Asian emerging markets, Japan's market is also incorporated in the models.

In the SUR model, the errors are independent over time but correlated across cross-section units. This type of correlation would arise if there are omitted variables that are common to all equations. That is, SUR model can take into account the contemporaneous correlations among different markets. SUR for G7 countries and Asian emerging markets are given as following respectively:

$$\begin{aligned} & r_{j,t} = \alpha_j + \beta_{j,US}\, r_{US,t} + \beta_{j,CH}\, r_{China,t} + \varepsilon_{j,t} \\ & j = 1,\ldots,n, \end{aligned} \quad (6)$$

$$\begin{aligned} & r_{j,t} = \alpha_j + \beta_{j,US}\, r_{US,t} + \beta_{j,JP}\, r_{JAP,t} + \\ & + \beta_{j,CH}\, r_{China,t} + \varepsilon_{j,t}, \\ & j = 1,\ldots,n \end{aligned} \quad (7)$$

and

$$\begin{aligned} & \operatorname{cov}(\varepsilon_{it}, \varepsilon_{js}) = \sigma_{ij}, \quad if\ t = s \\ & \operatorname{cov}(\varepsilon_{it}, \varepsilon_{js}) = 0, \quad if\ t \neq s \end{aligned},$$

where the variables are defined in equation (5) and equation (5a).

The results of SUR estimations for G7 are reported in Table 6 and Table 7. Table 6 shows that the monthly excess returns of G7 countries are not affected by China's excess return jointly, before and after the event of Bear Sterns. None of the coefficients

coefficients of China's excess returns is significant individually. Wald test for the restrictions that all coefficients of China's excess returns are all zero also indicates insignificant. However, for weekly data in Table 7, some of the coefficients of China's excess returns are positive and significant, especially in the second sub-period. The Wald test that the null hypothesis that all the coefficients of China's excess return are zero is rejected in both sub-periods at 5% significance level.

Table 6. Seemly unrelated regressions (SUR) for G7 countries − monthly data

Market	Panel A. 1998:1 to 2007:7			Panel B. 2007:8 to 2012:12		
	α	β_{US}	β_{CH}	α	β_{US}	β_{CH}
Canada	0.0023 (0.77)	0.8740*** (12.30)	0.0691 (1.60)	-0.0009 (-0.26)	0.7646*** (13.36)	0.0414 (1.18)
France	0.0016 (0.47)	1.1139*** (13.39)	0.0009 (0.02)	-0.0065 (-1.78)*	0.8665*** (14.67)	0.0200 (0.55)
Germany	0.0005 (0.12)	1.2877*** (13.26)	0.0581 (0.99)	0.0011 (0.27)	0.9139*** (14.03)	0.0502 (1.25)
Italy	-0.0006 (-0.13)	0.9461*** (9.05)	0.0402 (0.63)	-0.0132** (-2.52)	0.9787*** (11.53)	0.0331 (0.64)
Japan	-0.0033 (-0.75)	0.6735*** (6.45)	0.0177 (0.28)	-0.0073 (-1.25)	0.7483*** (7.95)	0.1138 (1.98)
UK	-0.0019 (-0.88)	0.8310*** (16.21)	-0.0509 (-1.64)	-0.0003 (-0.12)	0.7497*** (18.64)	0.0286 (1.16)
H_o : all $\beta'_{CH}s = 0, \chi(6)$			10.56			6.29

Notes: This table presents estimates for the following system:

$$r_{i,t} = \alpha_i + \beta_{i,US}\, r_{US,t} + \beta_{i,CH}\, r_{China,t} + u_{i,t} \quad i = 1,...,n, \text{ where } \operatorname{cov}(u_{it}, u_{js}) = \sigma_{ij}, \ if\ t = s,\ \operatorname{cov}(u_{it}, u_{js}) = 0,\ if\ t \neq s.$$

The *t*-statistics are in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

Table 7. Seemly unrelated regressions (SUR) for G7 countries – weekly data

	Panel A. 1998:1 to 2007:7			Panel B. 2007:8 to 2012:12		
	α	β_{US}	β_{CH}	α	β_{US}	β_{CH}
Canada	0.0006 (0.82)	0.7822*** (25.96)	0.0452** (2.10)	-0.0004 (-0.36)	0.7975*** (26.01)	0.0014 (0.06)
France	0.0004 (0.50)	0.9582*** (25.59)	0.0097 (0.36)	-0.0013 (-1.04)	0.7965*** (21.26)	0.1309*** (4.37)
Germany	0.0001 (0.14)	1.1088*** (25.48)	0.0700** (2.25)	0.0003 (0.27)	0.8087*** (22.47)	0.1069*** (3.71)
Italy	0.0001 (0.07)	0.8791*** (21.03)	0.0400 (1.34)	-0.0027* (-1.75)	0.8270*** (16.99)	0.1526*** (3.92)
Japan	-0.0006 (-0.47)	0.4932*** (9.36)	0.0490 (1.30)	-0.0015 (-0.93)	0.6200*** (12.37)	0.1494 (3.73)
UK	-0.0004 (-0.62)	0.7139*** (23.50)	0.0117 (0.54)	0.0001 (0.05)	0.6771*** (20.44)	0.1204*** (4.55)
H_o : all $\beta'_{CH}s = 0, \chi(6)$			14.63**			30.61***

Notes: This table presents estimates for the following system:

$$r_{i,t} = \alpha_i + \beta_{i,US}\, r_{US,t} + \beta_{i,CH}\, r_{China,t} + u_{i,t}, i = 1,...,n, \text{ where } \operatorname{cov}(u_{it}, u_{js}) = \sigma_{ij}, \ if\ t = s,\ \operatorname{cov}(u_{it}, u_{js}) = 0,\ if\ t \neq s.$$

The *t*-statistics are in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

Estimates of SUR for Asian countries with monthly data are reported in Table 8. The effect of Japan's excess return is positive and significant for four out of nine countries in the first sub-period, and five countries in the second sub-period. The effect of China's excess return is only marginally significant for Taiwan in the first sub-period, and significant for all but Indonesia and Thailand in the second sub-period. The joint hypothesis that all the coefficients of China's excess return are zero is rejected in the second sub-period, but not in the first sub-period.

Finally, the corresponding results for weekly data are reported in Table 9. The joint hypothesis that all the coefficients of China's excess return are zero is only marginally rejected in the first sub-period, and strongly rejected in the second sub-period.

Table 8. Seemly unrelated regressions (SUR) for Asian countries − monthly data

	Panel A. 1998:1 to 2007:7				Panel B. 2007:8 to 2012:12			
	α	β_{US}	β_{JP}	β_{CH}	α	β_{US}	β_{JP}	β_{CH}
Hong Kong	0.0036 (0.75)	0.9364*** (7.04)	0.1574 (1.54)	0.0192 (0.28)	0.0056 (0.94)	0.5592*** (4.13)	0.2122* (1.66)	0.3106*** (5.13)
India	0.0128 (1.74)*	0.2604 (1.28)	0.5224*** (3.34)	0.0330 (0.31)	0.0096 (1.21)	0.7341*** (4.12)	0.1781 (1.06)	0.2422*** (3.04)
Indonesia	0.0100 (0.41)	0.7257*** (3.69)	0.2781* (1.84)	-0.0121 (-0.12)	0.0143** (2.3)	0.6176*** (4.38)	0.2874** (2.16)	0.1029 (1.63)
South Korea	0.0093 (1.41)	1.0378*** (5.70)	0.4102*** (2.93)	-0.0849 (-0.90)	0.2422*** (3.04)	0.4840*** (4.04)	0.2689** (2.38)	0.1609*** (3.00)
Malaysia	0.0025 (0.33)	0.8615*** (4.13)	-0.1181 (-0.74)	0.1723 (1.59)	0.0043 (1.18)	0.3619*** (4.40)	0.0014 (0.02)	0.1227*** (3.34)
Philippines	0.0016 (0.26)	0.8629*** (4.97)	0.1031 (0.77)	-0.0629 (-0.70)	0.0111* (1.77)	0.4519*** (3.17)	0.0619 (0.46)	0.2104*** (3.30)
Singapore	0.0043 (0.84)	0.9684*** (6.75)	0.0998 (0.91)	-0.0443 (-0.59)	0.0013 (0.27)	0.6600*** (6.18)	0.2485** (2.47)	0.1316*** (2.76)
Taiwan	-0.0030 (-0.48)	0.5627*** (3.20)	0.3690*** (2.73)	0.1768* (1.94)	0.0024 (0.44)	0.4829*** (3.88)	0.3140*** (2.68)	0.1438*** (2.59)
Thailand	0.0016 (0.20)	0.8770*** (4.13)	0.1426 (0.87)	-0.1093 (-0.99)	0.1074 (1.59)	0.6427*** (4.20)	0.2172 (1.50)	0.0871 (1.27)
H_o : all β'_{CH} $s = 0$, $\chi(9)$				11.91				44.80***

Notes: This table presents estimates for the following system:

$$r_{j,t} = \alpha_j + \beta_{j,US}\, r_{US,t} + \beta_{j,JP}\, r_{JAP,t} + \beta_{j,CH}\, r_{China,t} + u_{j,t},\ j = 1,...,m,$$

where $\mathrm{cov}(u_{it}, u_{js}) = \sigma_{ij},\ if\ t = s,\ \mathrm{cov}(u_{it}, u_{js}) = 0,\ if\ t \neq s.$

The *t*-statistics are in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

Table 9. Seemly unrelated regressions (SUR) for Asian countries – weekly data

	Panel A. 1998:1 to 2007:7				Panel B. 2007:8 to 2012:12			
	α	β_{US}	β_{JP}	β_{CH}	α	β_{US}	β_{JP}	β_{CH}
Hong Kong	0.0007 (0.56)	0.5982*** (10.27)	0.3574*** (7.83)	0.1134*** (2.95)	0.0016 (1.14)	0.3582*** (6.62)	0.4812*** (9.32)	0.2884*** (8.08)
India	0.0024 (1.58)	0.2569*** (3.45)	0.2677*** (4.60)	0.1021** (2.08)	0.0020 (1.11)	0.2926*** (4.11)	0.3594*** (5.28)	0.2076*** (4.41)
Indonesia	0.0029* (1.78)	0.1511* (1.90)	0.3132*** (5.03)	0.0230 (0.44)	0.0032* (1.79)	0.2587*** (3.72)	0.3458*** (5.20)	0.1841*** (4.01)
South Korea	0.0026 (1.56)	0.4764*** (5.93)	0.5276*** (8.39)	0.0751 (1.42)	0.0013 (0.93)	0.3626*** (6.88)	0.4009*** (7.97)	0.1428*** (4.11)
Malaysia	0.0010 (0.71)	0.1934*** (2.89)	0.2574*** (4.92)	0.0482 (1.09)	0.0013 (1.35)	0.0264 (0.69)	0.2280*** (6.23)	0.1350*** (5.34)
Philippines	0.0006 (0.42)	0.3369*** (4.73)	0.2438*** (4.37)	0.0485 (1.03)	0.0026 (1.57)	0.1779*** (2.84)	0.3240*** (5.42)	0.1614*** (3.91)
Singapore	0.0007 (0.61)	0.5013*** (8.63)	0.3076*** (6.76)	0.0849** (2.21)	0.0005 (0.37)	0.2937*** (6.22)	0.4635*** (10.29)	0.0982*** (3.15)
Taiwan	-0.0005 (-0.34)	0.2624*** (3.77)	0.4391*** (8.06)	0.1292*** (2.81)	0.0004 (0.27)	0.2782*** (5.01)	0.3876*** (7.31)	0.1528*** (4.17)
Thailand	0.0010 (0.62)	0.3636*** (4.65)	0.3100*** (5.06)	0.0510 (0.99)	0.0028 (1.34)	0.1057 (1.61)	0.3907*** (6.23)	0.1362*** (3.14)
H_o : all β'_{CH} $s = 0$, $\chi(9)$				15.22*				82.73***

Notes: This table presents estimates for the following system:

$$r_{j,t} = \alpha_j + \beta_{j,US}\, r_{US,t} + \beta_{j,JP}\, r_{JAP,t} + \beta_{j,CH}\, r_{China,t} + u_{j,t},\ j = 1,...,m,$$

where $\mathrm{cov}(u_{it}, u_{js}) = \sigma_{ij},\ if\ t = s,\ \mathrm{cov}(u_{it}, u_{js}) = 0,\ if\ t \neq s.$

The *t*-statistics are in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

We summarize the results of SUR estimations as follows. First, for monthly data, China is not a significant pricing factor for G7 countries for both sub-periods, but significant for Asian countries only in the second sub-period. However, with weekly data, China is a significant pricing factor for G7 as well as Asian countries, before and after the subprime mortgage crisis. The effect of China's excess return is stronger in the second sub-period.

Conclusions

In this paper, we show that China's equity market has become an important pricing factor for weekly data for G7 and Asian emerging markets, when controlled for the effects of the equity markets of the US and Japan. However, we still can't jump to the conclusion that China's equity market is a systematic market risk factor. For example, with monthly data, the effect of China's excess return on G7 countries are not significant before and after the subprime mortgage crisis.

We divide the sample into two parts: before and after subprime mortgage crisis in the summer of 2007. Our findings can be summarized as follows. Firstly, the US market is still the most important pricing factor for all the countries especially with monthly data. Secondly, the effect of China's weekly excess return is jointly significant for the sectors of G7 and Asian countries, and the effect has become stronger in the post-Bear Sterns period. Thirdly, because we observe that the effect of China's market is not significant for G7 countries with monthly data, but significant with weekly data. This can be interpreted as that the effect of China's market on G7 countries are present only in the shorter term, not in the longer term. Finally, Asian countries are indeed more affected by China's market than G7 countries.

Our results can provide investment management implications for international institutional and individual investors in allocating their portfolios. Although international capital asset pricing theories suggest that the world market portfolio or the US market portfolio is the only systematic risk which cannot be diversified away through international diversifications, our findings suggest that the increasing influence of China's equity market in international asset pricing application cannot be ignored.

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Appendix

Table 1A. The market indices selected for the sample countries

Developed country	Equity Index	Asian emerging market	Equity index
US	S&P 500 COMPOSITE	China	SHANGHAI A SHARE COMPOSITE
Canada	S&P/TSX COMPOSITE	Hong Kong	HANG SENG
France	FRANCE CAC 40	India	INDIA S&P BSE 100
Germany	DAX 30 PERFORMANCE	Indonesia	IDX COMPOSITE
Italy	MILAN MIBTEL	Korea	KOREA SE COMPOSITE
Japan	NIKKEI 225 STOCK AVERAGE	Malaysia	FTSE BURSA MALAYSIA KLCI
UK	FTSE 100	Philippines	PHILIPPINE SE I
		Singapore	MSCI SINGAPORE
		Taiwan	TAIWAN WEIGHTED
		Thailand	BANGKOK S.E.T.