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Spillovers of the U.S. Subprime Financial Turmoil to
Mainland China and Hong Kong SAR:
Evidence from Stock Markets

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**Spillovers of the U.S. Subprime Financial Turmoil to
Mainland China and Hong Kong SAR: Evidence from Stock Markets[1]**

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Abstract

This paper focuses on evidence from stock markets as it investigates the spillovers from the United States to mainland China and Hong Kong SAR during the subprime crisis. Using both univariate and multivariate GARCH models, this paper finds that China's stock market is not immune to the financial crisis, as evidenced by the price and volatility spillovers from the United States. In addition, HK's equity returns have exhibited more significant price and volatility spillovers from the United States than China's returns, and past volatility shocks in the United States have a more persistent effect on future volatility in HK than in China, reflecting HK's role as an international financial center. Moreover, the impact of the volatility from the United States on China's stock markets has been more persistent than that from HK, due mainly to the United States as the origin of the subprime crisis. Finally, as expected, the conditional correlation between China and HK has outweighed their conditional correlations with the United States, echoing increasing financial integration between China and HK.
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I. INTRODUCTION

The subprime turmoil that began in the summer of 2007 initially manifested itself as a problem for U.S. financial institutions. At first, the turmoil was simmering within the United States, but subsequently it boiled over and set off vortices and currents not only in the U.S. financial markets, but also in the global markets. As a result of this tremendous financial turmoil, dramatic changes have taken place in the financial landscape and the global financial markets have been seriously affected.

The linkages between emerging market (EM) economies and advanced economies have become a major topic of debate during this episode of financial turbulence. Some argue that the ripple-effect of the mature market turbulence on EM countries has so far been muted and uneven, and that EM economies are still relatively unscathed, in part because the use of structured products was much less prevalent. On the other hand, others claim that the increasing global financial integration has potentially raised EM economies' vulnerability to abrupt reversals in market confidence related to those subprime external shocks and spillover effects. That is, distant events in the United States can have sharp impacts on EM economies.

The question therefore naturally arises whether such financial turmoil has actually had any tangible effects on the daily movements of the stock prices in mainland China (China) and Hong Kong SAR (HK). This question remains relevant because China and HK experienced a long run-up in asset prices, including equities, despite the partial reversal since late 2008. Moreover, China and HK's resilience will likely continue to be tested if financial uncertainty remains protracted and the global economic slowdown worsens.

This paper examines whether the U.S. subprime financial turmoil has had any statistically significant effect on both the daily returns and the conditional volatility of stock prices in China and HK. To capture the possible spillover effects, we employ a two-stage procedure; in the first stage we estimate a group of univariate GARCH models (referred to as UGARCH models below), and in the second stage we set up a group of multivariate GARCH models (referred to as MGARCH models below) to further identify the sources and magnitudes of the spillovers.

Using both univariate and multivariate GARCH models, this paper finds that (i) China's stock market has not been immune to the financial crisis and there is no decoupling story, as clearly evidenced by the price and volatility spillovers from the United States to China in MGARCH models; (ii) HK's equity returns exhibit more significant price and volatility spillovers from the United States, and past volatility shocks in the United States have a more persistent effect on future volatility in HK than in China, indicating that HK has been more affected due to its role as an international financial center; (iii) the lower cross-volatility between HK and China than between the United States and China shows that the impact of the United States on China is greater than that of HK in the context of volatility persistence, due mainly to the United States as the origin of the subprime crisis; and (iv) as expected, the

conditional correlation between China and HK has outweighed their correlations with the United States, echoing increasing financial integration between China and HK.

This paper contributes to the existing literature in three important ways:

- First, as far as we know, this paper is the first attempt to gauge the impact of the U.S. subprime turmoil on China and HK's stock markets using a group of univariate and multivariate GARCH models.

- Second, this paper compares the different responses of China and HK's stock markets to the subprime turmoil, reflecting the different degree of China and HK's financial openness and integration with the rest of the world.

- Third, this paper can be helpful to the authorities in designing policy responses to the external shocks, particularly given the background of increasing capital account liberalization in mainland China.

The remainder of the paper is organized as follows: Section II provides some stylized facts regarding stock prices in the United States, China and HK, followed by a preliminary discussion of some spillover channels and basic characteristics of China and HK's stock markets. Section III briefly reviews the related literature, while Section IV describes the data properties and methodology. Section V discusses the results of the estimated UGARCH and MGARCH models. Section VI concludes and provides policy implications.

II. PERFORMANCE OF CHINA AND HK'S STOCK MARKETS—STYLIZED FACTS AND SOME PRELIMINARY OBSERVATIONS

This section first traces developments in the stock prices of several advanced and EM stock markets during the recent run-up and correction, and demonstrates this cycle by showing the previous peak and trough as well as market changes during the period September 15 – October 31, 2008, when the financial distress worsened dramatically following Lehman's collapse. The section then discusses three characteristics of China and HK's stock markets.

China and HK's financial systems have coped relatively well with shocks from international capital markets, owing to the good fortune of having little exposure to the securitized products. However, China and HK do not seem to have been immune to the events in international markets. As Table 1 shows, by end-October 2008 stock prices in major economies had declined at least 30 percent since their peak in October 2007. In particular, those in China and HK experienced the largest declines (71 percent and 56 percent respectively, Figure 1). Coupled with the stock price declines, volatility in the U.S. stock market had risen since late 2006, with a noticeable spike in mid-2007 and September-October 2008 in the wake of the subprime crisis and the increased financial stress after Lehman's collapse (Figure 2).

Such co-movement between advanced and EM stock markets is unlikely to be a coincidence. Some transmission channels translate the Wall Street hurricane into the fluctuations in EM stock markets. The possible spillover channels from the United States to China and HK are as follows:

- **Loss exposures**. Financial institutions in China and HK had some direct loss exposures to the U.S. subprime crisis. For instance, the direct exposure of the Chinese financial system to U.S. structured credit products is reported to be about $10 billion.[2] The direct exposure to subprime-related assets accounted for 3.7 percent of total banking assets (CBRC, 2008). Moreover, there are several channels through which Lehman's collapse had a further impact on China and HK's financial institutions, such as loan exposures, credit derivatives exposures and bond exposures. It was reported that seven Chinese listed banks announced total bond holdings of $721 million in the bankrupt U.S. investment bank Lehman Brothers as of September 22, 2008. HK banks' total exposure to U.S. subprime securities and structured assets remained well below ½ percent of banking system assets (IMF, 2008a).

- **Loss of confidence**. China and HK's stock markets were increasingly affected by the indirect influence of confidence shocks. For example, at the beginning of the subprime crisis in August 2007, China and HK's stock markets were still moving up. However, with the increasing number of news releases about the losses at China's financial institutions and the pessimistic projections for the US economy, market sentiment in China and HK's stock markets shifted to the downside. Both stock markets substantially echoed the incidents of the bankruptcy of Lehman, the sale of Merrill Lynch and the rescue plan of the AIG.

- **Uncertain direction of capital flows.** Capital flows to China and HK could be affected by the subprime crisis, which might have two opposite effects. On the one hand, the credit crunch effect in advanced economies drove foreign capital out of China and HK to meet foreign investors' liquidity needs. On the other hand, some foreign investors saw China and HK as still-resilience markets in which to invest.[3] For example, in the first two quarters of 2008, China experienced a hot money inflow of about USD 130 billion, even larger than that for the whole of 2007 (US$ 124.9 billion), while in the third and fourth quarter it experienced a hot money

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[2] According to China's Securities Daily (Sep 2008), the individual exposures included $191.4 million at China Construction Bank (CCB), $151.8 million at the Industrial and Commercial Bank of China (ICBC), $128.8 million at the Bank of China (BOC), $76 million at the CITIC Bank, $70 million at the China Merchants Bank, $70.02 million at the Bank of Communications and $33.6 million at the Industrial Bank. Also, there might be more reported losses due to the loss in Ping An Insurance Company, and the inaccuracy of China's financial reporting system.

[3] Before the start of the subprime crisis, there were already foreign capital inflows in the expectation of gaining the benefit of an exchange rate appreciation and asset price rise. However, with the deteriorating global situation and declining expectation of asset appreciation, the capital outflows due to deleveraging outweighed those capital inflows.

outflow of about USD 7.2 billion and 90 billion (Figure 3) [4]. The U.S. Resident's Net Foreign Transactions in Foreign Corporate Stocks, as a proxy of capital flows to China and HK, has also showed more volatility in capital flows to HK since the beginning of the subprime crisis (Figure 4). Therefore, the volatility of large capital flows could potentially increase stock price volatility in China and HK.

- **Slower export growth.** China and HK's stock markets might also be negatively affected by the global slowdown and the consequent reduction in external demand. Slower export growth from China and HK to the United States would be a material drag on both economies' growth. The impact of market expectations for slower export growth could be detrimental to stock market sentiment.

Moreover, three characteristics of China and HK's stock markets need to be briefly discussed for the purpose of this analysis below.

- **The development of China's stock market has been greatly supported by the tremendous structural changes in the past four years.** Before 2005, the two-tier share structure, under which about two-thirds of the shares of China's listed companies were nontradable, had a negative effect on the development of the stock market.[5] The uncertainties related to this split structure prevented the market from recovering from the previous decline, and affected the overall credibility of Chinese stock market. To cope with this problem, the Chinese authorities initiated the so called "reform of nontradable shares" in the capital market in 2005. With the gradual floating of nontradable shares in the stock market, the real market value of the shares began to be realized and contributed to the rising stock prices since 2005. The institutional reform has been a key driving factor in China's stock market development.

- **China and HK's financial markets are not homogeneous in their openness.** China is still in the process of opening up its capital account and there are various sorts of restrictions on inward and outward capital flows, while HK is an open market to all foreign investors and issuers, and does not impose any restrictions on its residents investing or obtaining funding in foreign financial markets. This difference manifests itself in the very openness of the HK stock market and banking sector to Chinese issuers and institutions as opposed to the relatively limited openness of China's financial market to HK's institutions.

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[4] Hot money refers to the residual of foreign exchange reserves minus trade surplus and foreign direct investment.

[5] In the early 1990s, the policy-makers initiated "non-tradable shares" because the government wanted to retain substantial shareholdings so that it could influence these companies. Because they are not in circulation, these non-tradable shares have no real market value, or at least it is difficult to measure their market value.

- **Policy choices and financial market development in China have important implications for HK to maintain its status as an international financial center with the increasing financial integration between the two sides.** On the one hand, HK has been playing an important role in the opening up of China's capital account and the development of China's financial markets. On the other hand, China's rapid economic growth and financial market development provided tremendous scope for HK to fortify its competitiveness as a leading international and regional financial center. This bilateral promotion has laid a foundation for the increasing comovements of stock prices on both sides.

III. RELATED LITERATURE

A substantial amount of theoretical and empirical work has documented how stock returns and volatility are transmitted across economies.

On the theoretical side, a number of theoretical analyses based on the "revision of expectations" have been promoted. For instance, Kodres and Pritsker (1998) suggest that the existence of feedback traders and asymmetric information could lead to the propagation of shocks through portfolio rebalancing effects without changes in fundamentals. Calvo (1999), and Calvo and Mendoza (2000) argue that comovements in stock markets are caused by herd behavior among portfolio managers.

On the empirical side, correlation and contagion have been used to study spillovers. The correlation of stock returns across different markets has been widely applied to evaluate the spillover effects across stock markets. For example, after controlling for own-country news and a few other fundamental factors, Baig and Goldfajn's research (1999) shows that the cross-country correlations in the stock markets remain large and significant. By identifying potential channels for financial market spillovers in twelve transition economies, Gelos and Sahay (2000) demonstrated that a visible increase in stock market correlations during the 1994-99 period, points to increased financial market integration. Chan-Lau, Mathieson, and Yao, using extreme value theory to uncover nonlinear relationships and analyze contagion in financial markets, found that contagion is higher for negative returns than for positive returns (2004).

Beyond correlation analysis, Vector Autoregression (VAR) models have also been used to gauge spillover effects. Using a variety of statistical methods including VAR models, Guimaraes-Filho et al. (IMF, 2008b) found that spillovers from the United States to Asian economies have grown stronger over time. By examining both the sources and size of spillovers across major industrial country regions, Bayoumi and Swiston (2007) concluded that global financial conditions were the main source of spillovers, and that the reduction in global financial volatility as a result of a more stable U.S. environment was crucial for lower global output volatility and greater financial certainty.

GARCH models are another set of techniques to weigh the spillover effects. For example, Chan-Lau and Ivaschenko (2003) found that the price changes and volatility spillovers generated from the United States—*the Wall Street virus* hypothesis—are the most important carrier of the price change spillovers between the United States and the Asian region, while volatility spillovers within Asia do not appear to play an important role. Booth, Martikainen, and Tse (1997) analyzed the price and volatility spillovers across Scandinavian stock markets using a multivariate EGARCH model and found that volatility transmission is asymmetric, spillovers being more pronounced for bad than good news. Worthington and Higgs (2001) examined the transmission of equity returns and volatility among Asian stock markets and investigated the differences that exist in this regard between the developed and emerging markets by using MGARCH to identify the source and magnitude of spillovers. Their results indicate the presence of large and predominantly positive mean and volatility spillovers. Nevertheless, mean spillovers from the developed to the emerging markets are not homogenous across the emerging markets, and own-volatility spillovers are generally higher than cross-volatility spillovers for all markets, but especially for the emerging markets.

Some other methodologies have also been used to discuss the spillovers. For example, Jobst and Kamil (IMF, 2008c), using multivariate extreme value theory (EVT) to quantify the joint behavior of extreme realizations of returns across different markets, find that the degree of financial contagion between stock markets in the United States and Latin America appears to be greater during periods of financial turmoil.

There are some very recent studies on the spillovers from advanced to emerging markets through stock market channels. The Global Financial Stability Report (IMF, 2008d), by developing an empirical (panel and VAR) framework to assess what drives EM stock prices, found that global factors can act as a channel for spillovers when the international economic environment changes.

IV. DATA AND METHODOLOGY

The analysis in this paper uses daily close-of-day stock market price indices based on national currencies in the United States, China and HK. Price returns are calculated as changes in log stock market prices, $R_t = LnP_t - LnP_{t-1}$ (Figure 5).[6]

Our framework tests whether the subprime financial turmoil has had any significant effect on daily changes in stock prices. This requires us to control for the effect of various domestic underlying factors (such as the state of monetary conditions and economic activity) and global financial market volatility variables. Therefore, two groups of independent variables are used: (i) domestic control variables in China and HK, and (ii) global financial market volatility variables.

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[6] The price returns are not corrected for dividends.

Following Liu, Pauwels, and Chan (2008), we took the unanticipated effects or the "surprise" from these domestic factors to control for the effect owing to domestic macroeconomic conditions. We measure the surprises from these underlying macroeconomic factors by using the unanticipated effects of these monthly macroeconomic indicators or macroeconomic surprises on stock prices, which are measured as the differences between the official data on their release dates (real-time data) and their corresponding market forecasts that reflect market expectations (see Appendix C for a description of these market forecasts)[7]. Specifically, the interest rate differential (which attempts to reflect the interest rate parity condition), surprises in M2 growth, CPI inflation, and industrial production are taken as domestic control variables. The effect of external balances on stock prices is accounted for by surprises in the monthly changes of China's trade balance and the difference between HK's export and import growth.[8]

The market forecasts are obtained from Bloomberg and the Consensus Forecast, which conduct regular surveys of financial institutions both in China and abroad every month before the official data releases of these monthly indicators (Appendix C). The sample used for the analysis of this paper spans the period from January 1, 2005 to October 31, 2008.

On the global market variables, we take the Chicago Board Options Exchange's Volatility Index (VIX) and Lehman Brothers Swaption Volatility Index (LBSPX) as the variables to capture market volatility and interest rate volatility.[9] A detailed description of all domestic and global variables and their definitions are presented in Table 2.

In order to test whether the subprime financial turmoil has had any significant effect on daily changes in stock prices, we use GARCH models to analyze stock return and conditional volatilities across the different stock markets described in the previous section. For asset returns, the GARCH class of models involves the estimation of an equation for asset returns and a conditional variance (σ_t^2) specification.

For this analysis, we establish two groups of GARCH models: (i) a group of UGARCH models with subprime events; and (ii) a group of MGARCH models. These two groups of models are specified as follows.

UGARCH   models

An important feature in the UGARCH models is that we construct a variable for subprime events by collecting daily financial news pertaining to the subprime turmoil (Appendix A lists the events) following the rule below:

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[7] The surprise data (differences between the official data on their release dates and their corresponding market forecasts that reflect market expectations) are taken as the value for this release date, while 0 is taken as the value for other days in the corresponding month.

[8] Since there is no trade balance survey data for HK in Bloomberg, we used the difference between export and import growth as a proxy for HK's trade balances.

[9] The LBSPX is the weighted average of 1-6 month swaption (swap on interest rate options) volatilities.

event =1, if there is subprime negative news
event =0, otherwise

The event models are designed to capture the responses of China and HK's stock markets to subprime events. In the case where asset returns follow an autoregressive process and are dependent on other variables, the model specification takes the following form:

$$R_t = \text{constant} + \zeta_t R_{t-1} + \lambda X_{t-1} + \varphi V_t^f + \delta \text{event}_t + \epsilon_t \tag{1}$$

where the price return, R_t, is a linear function of its 1-day lagged-return. The vector X_{t-1} represents control variables, the vector V_t^f represents measures of global financial market volatility, "event_t" represents subprime events, and ϵ_t is the error term in the return equation.

The conditional variance of the error term, σ_t^2 is given by :

$$\sigma_t^2 = \alpha_0 + \alpha_1 \epsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2 + \mu \text{event} \tag{2}$$

where the regressors ϵ_{t-1}^2, and σ_{t-1}^2 are commonly denoted as the ARCH and GARCH components, respectively.

MGARCH models

While modeling volatility of the equity returns with the subprime events variable is a main focus of attention in this paper, understanding the co-movements of equity returns is also of great interest. It is therefore important to extend the considerations to multivariate GARCH models, which have been widely used to investigate volatility and correlation transmission and spillover effects (Tse and Tsui, 2002; and Bae, Karolyi, and Stulz, 2003). Since MGARCH models explicitly parameterize the conditional cross-moments, they can take account of the correlation in various stock returns and their volatility better than univariate GARCH models. Therefore, to further identify the sources and magnitudes of the spillover impact, we establish a group of MGARCH models.

Theoretically, the specification of an MGARCH model should be reasonably parsimonious while maintaining flexibility. For the purpose of the following analysis, a common form, Diagonal VECH model, is employed that restricts A and B to be diagonals.[10] This Diagonal VECH model, where the coefficient matrices are rank one matrices, is identical to the Diagonal BEKK model (Engle,1982; Bollerslev 1986; Nelson,1991). One important feature of this specification is that it reduces the number of parameters estimated and guarantees that the conditional covariance matrix is positive semi-definite. Also, this specification allows us to identify the own-volatility spillover effects as well as cross-volatility spillover effects.

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[10] A is the coefficient matrix for the ARCH term and B is the coefficient matrix for the GARCH term. They are all specified as rank one matrices.

Since the standardized residual showed evidence of excess kurtosis, we assume that the errors follow a Student's *t*-distribution to model the thick tail in the residuals.

The following MGARCH models are developed to examine the joint processes relating to the daily rates of return for the three markets, namely the United States, China, and HK, from January 1, 2005 to October 31, 2008. The sample period is also chosen to include only the subprime turmoil period (January 1, 2007–October 31, 2008) for the purpose of emphasizing the subprime crisis period. The following conditional expected return equation accommodates each market's own returns and the returns of other markets lagged one period. Moreover, for China and HK stock markets, we also include the domestic macroeconomic variables and external shock variables that have been used in the previous UGARCH models. That is, the surprise data (differences between the official data on their release dates and their corresponding market forecasts that reflect market expectations) are taken as the value for this release date, while 0 is taken as the value for other days in the corresponding month.

$$R_t = constant + \zeta_t R_{t-1} + \eta R^f_{t-1} + \lambda X_{t-1} + \varphi V^f_t + \varepsilon_t \qquad (3)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon^2_{t-1} + \beta_1 \sigma_{t-1}^2$$
(4)

The difference between equations (1) and (3) is that the latter has the lagged return on the United States, China and HK stock markets, R^f_{t-1}, where the superscript "f" refers to the foreign country relative to the independent variable for that equation, which is assumed to be the source of spillovers, replacing the subprime events variable in equations (1) and (2).

V. EMPIRICAL RESULTS

Following the above-mentioned steps, we obtain two groups of GARCH models: one is a group of UGARCH models, the other is a group of MGARCH models. Moreover, in each group, we run regressions respectively on composite stock prices (i.e., S&P 500 Index in the United States) and the financial equity index (i.e., S&P 500 Financials Index in the United States).

Autocorrelation functions for stock price returns implied persistence in the series and suggest an AR formulation for the returns equation. ADF tests (Table 4) suggest that the log change in the stock price series was I(0); the ADF tests also suggest that the VIX and LBSPX index were I (1). The Akaike Information and Schwarz Information Criteria suggest one lag of the dependent variable and regressors in the estimated equations (Table 5).

The squared returns also exhibit patterns of persistence and clustering within China and HK over time (Figure 6). ARCH tests confirm the appropriateness of a GARCH formulation. The distribution of squared returns was also markedly skewed and leptokurtic, suggesting that the error term was nonnormally distributed (Table 6).[11]

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[11] Since the stock returns are calculated as changes in log stock prices, the nonnormal distribution of squared retruns is not surprising because the distribution is truncated at zero.

A. UGARCH Models

In each UGARCH model, we take different dependent variables for China and HK. For China, we use three stock price indices: the Shanghai Composite Index, the Shanghai financial index and FXI to capture the spillover to the general equity index and the financial index [12]. For HK, in the same vein, we use two stock price indices: the Hang Seng index and the Hang Seng financial index.

We now examine the empirical findings regarding the effect of the subprime events on both the mean and the conditional variance of China and HK's stock price returns by taking January 2007 to October 2008 as the sample period to interpret the econometric results.

China

Table 7, which presents the empirical findings for China, shows that in all cases, the AR(1)-GARCH(1,1) specifications yield acceptable models of returns and conditional variance for the sample periods.

We first look at the intercept terms and the lagged daily return variable of the stock prices. The intercept terms for the Shanghai Composite Index and financial index are insignificant, while that for the FXI is significant at the 10 percent level. The sign of the FXI is negative, indicating that the FXI declines at a pace of 0.02 percent per day on average, holding other things equal. Moreover, the lagged daily return variable is significant in the FXI model. This distinctive performance of FXI might be due to the fact that its companies are listed in HK stock market, which is more responsive to external shocks.

We then look at the set of control variables pertaining to monetary conditions, economic activity, and external imbalances. The interest rate differential variable is statistically significant and with a negative sign for the Shanghai Composite Index and FXI, indicating that monetary tightening has a negative effect on China's stock prices. Most other domestic macroeconomic variables are statistically insignificant. These results show that the "surprises" in domestic macroeconomic information have had no major impact on stock price returns in China.[13]

We now discuss the effect of external shocks on daily stock prices. The global market volatility variables and subprime events are generally statistically insignificant in all three

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[12] FXI Index is iShare FTSE/Xinhua China 25 index fund, whose investment includes the 25 largest Chinese corporations (including 11 large financial corporations). It is priced in U.S. dollars.

[13] In the context of explanatory power, some other factors might be more important. For instance, the initialization of so called "reform of non-tradable shares" in 2005 played a role in boosting stock prices. The gradual floating of non-tradable shares enhanced the realization of true market value of the shares and promoted the efficiency of the stock market in allocating the financial resources. Given the specific purpose of this paper, we do not discuss the other determinants of stock prices.

models. These findings suggest that external shocks have not had any significant influence on China's daily stock prices.[14]

The results from the variance equations of the GARCH (1,1) model are presented in the bottom panel of Table 7. We find that the signs of the coefficients of the ARCH, GARCH and subprime events for all three models are both positive and statistically significant, indicating that the subprime turmoil has increased the conditional volatility of the financial sector and HK-listed companies' stock prices. Moreover, the coefficients of these variance equations were also nonnegative in all cases, as required, to ensure that the conditional variances are well defined. In addition, in all cases, $\alpha_1+\beta_1$ was less than 1, producing (positive) finite estimates of unconditional variances. More interestingly, the subprime events variables are significant in the models of Shanghai Composite Index and FXI, indicating that the volatility of the financial sector and FXI equity indices have responded to the external subprime shocks, which were basically driven by the financial sectors in advanced economies.

Hong Kong

Table 8, which presents the empirical findings for HK, shows that while there are similarities to the models on China, such as similar insignificance of most domestic macroeconomic variables, several distinguishing features stand out.

First, in contrast to that of China, the intercept term for all HK models is positive, reflecting that HK's stock prices increase at a pace of 0.01 percent per day on average, holding other things equal.

Second, the interest rate differentials are also statistically significant, but with positive signs. This might reflect HK's role as an international financial center which attracts capital inflows to the HK stock market when HK's interest rate is higher than that of the United States.

Third, the VIX, one of the global market volatility variables, is significant in both models with negative signs, indicating the negative impact of market volatility on HK stock price returns.

Lastly and most importantly, the subprime event variable is not only statistically significant in the variance equation (with positive signs), but also in the mean equation (with negative signs), indicating that the subprime events have had material negative effects on the conditional volatility and levels of HK stock price returns.

B. MGARCH models

We run two groups of MGARCH models based on composite and financial stock prices in the United States, China and HK.

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[14] In these UGARCH models, the reasons for the insignificance of the intercept and the insignificant impact of global market volatility and subprime events on Shanghai stock prices could be three fold: the Shanghai stock prices during January 2005-October 2008 have been rising; Chinese stock markets are less open; these UGARCH models could not systemically capture the sources and magnitudes of spillovers from the United States and HK. This last issue is addressed by MGARCH models.

The estimated coefficients and standard errors for the conditional mean return equations using composite indices are presented in Table 9. The price spillovers from the United States to HK have been more significant than to China with a coefficient of 0.27 to China and 0.76 to HK. This may reflect China's less financial openness than HK.

The conditional variance covariance equations incorporated in the current paper's multivariate GARCH methodology effectively capture the volatility and cross volatility spillovers between the three markets. Table 10 presents the estimated coefficients for the variance covariance matrix of equations using composite indices. These quantify the effects of the lagged own and cross innovations and lagged own and cross volatility persistence on the present own and cross volatility of the three markets.

Own-volatility spillovers in all three markets are large and significant indicating the existing strong ARCH effect. Specifically, the own-volatility spillovers in the United States are 0.04, while those for China and HK are 0.13 and 0.16, respectively. These are in line with the previous study that own-volatility spillover effects are generally higher for emerging markets than for developed markets (Worthington and Higgs, 2001). In terms of cross-volatility effects, the cross-volatility effects between the United States and China and HK were 0.07 and 0.08 respectively, and the cross-volatility effects between HK and China were 0.15, indicating higher cross-volatility between China and HK. This could be taken as further evidence that China and HK have become more financially integrated with each other than with the United States

In the GARCH set of parameters, most of the estimated coefficients are significant (Table 10). The lagged volatility persistence was 0.97 and 0.83 for the United States and HK respectively, while that for China is insignificant. This indicates a higher own volatility persistence in more developed and open stock markets. In addition, the cross-volatility persistence between the United States and China and HK was 0.40 and 0.90, respectively, while the cross-volatility between HK and China was 0.37. That is, past volatility shocks in the United States have a more persistent effect on future volatility in HK than in China, which is further evidence of HK's position as an international financial center. In addition, this lower cross-volatility between HK and China also shows that the United States has a slightly larger impact on China than HK in the context of volatility persistence, due mainly to the United States as the origin of the subprime crisis

Conditional correlation analysis shows that the correlation between the U.S. S&P 500 index and the Shanghai Composite index has been much lower than that between the U.S. S&P 500 index and the Hang Seng index. In addition, the correlation between the Shanghai Composite index and the Hang Seng index has been the highest among the three stock markets. These results indicate limited openness in China, but the correlation between China and HK has outweighed correlation with the United States, echoing increasing financial integration between China and HK (Figure 7).

To assess the reliability of the results, we employ a battery of robustness checks by testing different dependent variables and sample period using UGARCH and MGARCH models. First, the results of the mean equation and variance equations generally hold for UGARCH and MGARCH models using financial sector stock prices (Table 7, 8, 11 and 12, Figure 8).

The minor differences are that the coefficients for mean spillover effects and ARCH effects are slightly lower, while the GARCH effects are higher than those in the composite index models with China's own-volatility coefficient is now significant. Second, besides incorporating various additional dependent and explanatory variables and making various changes in the estimation methodology used in the previous part of this section, we conduct robustness checks for all UGARCH and MGARCH models, with respect to the extended starting sample date from January 1, 2007 to January 1, 2005 (Table 7 and 8). Overall, we find that the results are rather robust with respect to the sample period, additional dependent and explanatory variables, and various changes in the estimation methodology (Table 9 to 12).

VI. CONCLUSIONS AND POLICY IMPLICATIONS

The paper finds that China's stock market is not immune to the financial crisis, as evidenced by the price and volatility spillovers from the United States. In addition, HK's equity returns have exhibited more significant price and volatility spillovers from the United States than China's returns, and past volatility shocks in the United States have a more persistent effect on future volatility in HK than in China, reflecting HK's role as an international financial center. Moreover, the impact of the volatility from the United States on China's stock markets has been more somewhat persistent than that from HK, likely due to the United States as the origin of the subprime crisis. Finally, as expected, the conditional correlation between China and HK has outweighed their correlations with the United States, echoing increasing financial integration between China and HK.

Based on this empirical evidence, a number of policy implications arise from the interlinkage between national and global developments and between economic and financial market developments.

- **There is no "decoupling" story for China and HK.** No economy can be totally immune to the subprime financial turmoil. Our regression results strongly support this. In our case, even though the Chinese and HK economies may be diversifying their exports and becoming less dependent on the United States, their financial markets are still very much, if not more, influenced by U.S. monetary and financial conditions. China and HK have become increasingly integrated into the global financial system, and the authorities should be alert to the drift toward negative spillover effects.

- **Greater attention should be paid to the risk of a virulent feedback loop between the financial markets and the economy.** The deteriorating subprime crisis has increased the downside risks to the United States and global economies, potentially taking their toll on the economies of China and HK.

- **International policy coordination has become more important.** The tendency for the markets to transmit volatility rapidly leaves little time for policy-makers to intervene. Recent unprecedented circumstances have called for commensurate action to be taken by central banks, given the rising interdependence among economies. The fact that recent policy actions have been taken by both advanced and emerging market central banks (including China) underlines the need for coordination. Moreover, as evidenced by the increasing volatility spillover between China and

HK's stock markets in our empirical work, the interdependence has been increasing with the strengthening financial integration between the two markets, necessitating further cooperation between the mainland and HK authorities.

- **The Chinese authorities should be more cautious in their approach to capital account liberalization.** Given increasing trade openness and financial spillovers from the international market, the capital account is de facto becoming more open over time irrespective of government attempts to control it (Prasad and Rajan, 2008). In this natural opening-up process, it become more urgent for the authorities to strengthen financial markets and relevant infrastructure (governance, the exchange rate system, the supervisory system, etc.) alongside the de facto capital account liberalization. It is argued that in the Asian financial crisis, China suffered less than other Asian countries just because of its lower level of financial openness. And even now, some consider that China's limited exposure to the subprime crisis is due mainly to its lower level of financial openness. However, in the era of financial globalization, this limited financial openness, which has insulated China well in the past, may be much harder to maintain in the future. The key issue will be how to choose a pragmatic approach to capital account liberalization.

Table 1. Emerging Stock Market Peaks and Troughs: Current Episode
(In percent)

	Peak (Oct. 31, 2007) to Current (Oct. 31, 2008)	Period after Lehman's Collapse (Sep. 15 to Oct. 31, 2008)
Brazil	-43.00	-28.94
Hong Kong SAR	-55.45	-27.82
Korea	-46.09	-24.69
Mexico	-35.56	-20.77
South Africa	-33.00	-20.36
China	-70.97	-16.87
India	-50.66	-30.09
Russia	-65.21	-42.36
Germany	-37.80	-20.00
Japan	-46.48	-26.34
United Kingdom	-34.88	-19.19
United States	-37.73	-22.92

Sources: Bloomberg L.P. and authors' calculations.

Table 2. Data Description and Transformation

Series Name	Description	Unit of Series	Underlying Source	Transformation
Shanghai Composite Index (LOGSHCOMP)	Shanghai Stock Exchange Composite Index	Daily index	Bloomberg	Dlog
Shanghai Financial Index (LOGSHFSUB)	Shanghai Stock Exchange 180 A Share Index	Daily index	Bloomberg	Dlog
FXI US Equity (FXI)	iShares FTSE/Xinhua China 25 index fund	Daily index	Bloomberg	Dlog
HSI Index (LOGHSI)	Hang Seng Index	Daily index	Bloomberg	Dlog
HSF Index (LOGHSF)	Hang Seng Financial Index	Daily index	Bloomberg	Dlog
SPX Index (LOGSPX)	S&P 500 Index	Daily index	Bloomberg	Dlog
S5FINL Index (LOGSPXFINL)	S&P 500 Financial Index	Daily index	Bloomberg	Dlog
Interest difference between China and the U.S. (CHNINTDIFF)	Interest rate differential between Chibor and U.S Libor (1 month)	Monthly, in percent	Bloomberg	level
Interest difference between Hong Kong and the U.S. (HKINTDIFF)	Interest rate differential between Hibor and U.S. Libor (1 month)	Monthly, in percent	Bloomberg	level
Industrial Production in China (CHNIP)	Industrial production	Monthly, in percent	Bloomberg	Difference between actual and survey data
Money supply in China (CHNMS)	Money supply	Monthly, in percent	Bloomberg; Concensus Forecast Database	Difference between actual and survey data
CPI in China (CHNCPI)	Consumer price index	Monthly, in percent	Bloomberg	Difference between actual and survey data
Trade balance in China (CHNTRAVOL)	Trade balance	Monthly, in percent	Bloomberg; Concensus Forecast Database	Difference between actual and survey data
Money supply in Hong Kong (HKMS)	Money supply	Monthly, in percent	Bloomberg; Concensus Forecast Database	Difference between actual and survey data
CPI in Hong Kong (HKCPI)	Consumer price index	Monthly, in percent	Bloomberg	Difference between actual and survey data
Trade balance in Hong Kong (HKTRADE)	Trade balance	Monthly, in percent	Bloomberg; Concensus Forecast Database	Difference between actual and survey data
Market volatility (VIX)	The implied volatility of the S&P500 index	Monthly	Bloomberg	Difference
Interest rate volatility (LBSPX)	The implied volatility of interest rate swaptions with maturities between one and six month	Monthly	Bloomberg	Difference
Subprime events (EVENT)	Negative news on subprime crisis	Number	Bloomberg, Reuters	Level

Sources: Bloomberg L.P.; and Consensus Forecast.

Table 3. Daily Equity Price Returns: Summary Statistics

	S&P 500 Index	S&P 500 Financial Index	Shanghai Composite Index	Shanghai Financial Index	iShares FTSE/Xinhua China 25 Index	Hang Seng Index	Hang Seng Financial Index
Mean	-0.0002	-0.0007	0.0003	0.0010	0.0003	0.0000	-0.0003
Median	0.0004	0.0000	0.0003	0.0000	0.0007	0.0004	0.0000
Maximum	0.11	0.12	0.09	0.10	0.18	0.13	0.16
Minimum	-0.09	-0.17	-0.09	-0.10	-0.16	-0.14	-0.15
Std. Dev.	0.01	0.02	0.02	0.02	0.03	0.02	0.02
Skewness	-0.14	-0.31	-0.33	-0.07	-0.02	0.12	0.31
Kurtosis	22.05	17.69	6.20	5.06	11.94	16.36	24.00
Jarque-Bera	15126.82	9004.53	445.01	177.65	3332.30	7435.98	18389.62
Probability	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Sum	-0.22	-0.68	0.31	1.01	0.29	-0.02	-0.25
Sum Sq. Dev.	0.16	0.43	0.39	0.59	0.76	0.31	0.30
Observations	1000	1000	1000	1000	1000	1000	1000

Sources: Bloomberg L.P. and authors' calculations.

Note: All equity indices are calculated in log difference. The Jarque-Bera test is a goodness-of-fit measure of departure from normality, based on the sum of sample kurtosis and skewness.

Table 4. Equity Prices and Volatility Indices: Augmentted Dickey-Fuller Tests Statistics

Variables	ADF Test	Judgment Parameters (c,t,k)
Shanghai Composite Index	-58.8***	(c,0,0)
Shanghai Financial Sector index	-35.1***	(c,0,0)
iShares FTSE/Xinhua China 25 Index	-39.0***	(c,0,0)
Hang Seng Index	-38.7***	(c,0,2)
Hang Seng Financial Index	-36.0***	(c,0,2)
S&P 500 Index	-19.5*	(c,0,1)
VIX	-4.2***	(c,0,4)
Interest rate volatility	-3.2**	(c,0,1)
Interest difference between China and the United States	-1.9*	(0,0,12)
CPI in China	-9.4***	(c,0,20)
Industrial Production in China	-11.1***	(c,0,25)
Money supply in China	-17.8***	(c,0,23)
Trade balance in China	-26.6***	(c,0,23)
Interest difference between HK and the United States	-3.6***	(c,0,2)
Trade balance in Hong Kong	-25.1***	(c,0,22)
Money supply in Hong Kong	-69.9***	(c,0,0)
CPI in Hong Kong	-69.9***	(c,0,0)

Sources: Bloomberg L.P. and authors' calculations.

Note: All indicators are tested in the form of those as denoted in Table 2. *, ** and *** represent the Judgment parameters c,t and k represent intercept, trend and lags used in the ADF test significance at 10%，5% and 1% level.

Table 5. VAR Lag Order Selection Criteria

	Shanghai Composite Index	Shanghai Financial Index	iShares FTSE/Xinhua China 25 Index	Hang Seng Index	Hang Seng Financial Index
Lags	1	1	1	1	1
Log likelihood	2524.23	2311.85	2202.56	2624.87	2647.42
Akaike info criterion	-5.03	-4.60	-4.39	-5.23	-5.28
Schwarz criterion	-4.98	-4.55	-4.34	-5.19	-5.23

Sources: Bloomberg L.P. and authors' calculations.

Note: Two lags are tested and one lag is selected based on the minimum Akaike information criterion and Schwarz criterion value

Table 6. The Distribution of Squared Returns

	Shanghai Composite Index	Shanghai Financial Index	iShares FTSE/Xinhua China 25 Index	Hang Seng Index	Hang Seng Financial Index
Mean	0.0004	0.0006	0.0008	0.0003	0.0003
Median	0.0001	0.0002	0.0001	0.0000	0.0000
Maximum	0.0086	0.0095	0.0341	0.0184	0.0255
Minimum	0.0000	0.0000	0.0000	0.0000	0.0000
Std. Dev.	0.0009	0.0012	0.0025	0.0012	0.0014
Skewness	5.10	3.98	8.22	9.87	11.31
Kurtosis	35.91	22.76	88.50	121.51	158.74
Jarque-Bera	49465.32	18910.14	315860.81	601423.76	1031880.16
Probability	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Sum	0.39	0.59	0.76	0.31	0.30
Sum Sq. Dev.	0.00	0.00	0.01	0.00	0.00
Observations	1000	1000	1000	1000	1000

Sources: Bloomberg L.P. and authors' calculations.

Note: The Jarque-Bera test is a goodness-of-fit measure of departure from normality, based on the sum of sample kurtosis and skewness.

Table 7. Regression Results of the Event Models: China

Dependent variables	Jan. 1, 2007-Oct. 31, 2008			Jan. 1, 2005-Oct. 31, 2008		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
	Shanghai Composite Index	Shanghai Financial Index	iShares FTSE/Xinhua China 25 Index	Shanghai Composite Index	Shanghai Financial Index	iShares FTSE/Xinhu a China 25 Index
Mean equation						
Intercept	-0.0035	-0.0012	-0.0166*	0.0024	0.0051	0.0016
	(0.0081)	(0.0095)	(0.0089)	(0.0032)	(0.0042)	(0.0041)
Daily equity return (lagged)	-0.0576	-0.0188	-0.2348***	-0.0298	-0.0557	-0.1233***
	(0.0565)	(0.0577)	(0.0518)	(0.0328)	(0.0357)	(0.0352)
Interest rate differential	-0.0036**	-0.0030	-0.0043**	-0.0012**	-0.0012*	-0.0008
	(0.0017)	(0.002)	(0.002)	(0.0005)	(0.0007)	(0.0007)
Macroeconomic news on						
industrial production growth	0.0002	-0.0002	0.0064	0.0002	0.0001	0.0008
	(0.0045)	(0.0069)	(0.0054)	(0.0008)	(0.001)	(0.001)
Trade balance	-0.0007	-0.0007	-0.002***	0.0004	0.0005	-0.0003
	(0.0035)	(0.0038)	(0.0007)	(0.0007)	(0.0009)	(0.0006)
Broad money growth	0.0028	0.0001	0.0073	0.0015	0.0021	0.0010
	(0.0081)	(0.0099)	(0.0117)	(0.0052)	(0.0078)	(0.0043)
CPI inflation	-0.0117	-0.0052	-0.0168*	0.0002	0.0019	0.0052
	(0.0095)	(0.0172)	(0.0088)	(0.0057)	(0.0095)	(0.0047)
Mature market volatility						
VIX	-0.0297*	-0.0184	0.0280	-0.0286*	-0.0293	0.0155
	(0.0176)	(0.0219)	(0.0334)	(0.0151)	(0.0192)	(0.0202)
Interest rate volatility	0.0053	0.0024	0.0066	0.0007	-0.0008	-0.0039
	(0.008)	(0.0099)	(0.0107)	(0.0046)	(0.006)	(0.0057)
Subprime events	-0.0034	-0.0051	-0.0042	-0.0005	-0.0016	-0.0044
	(0.0027)	(0.0032)	(0.0033)	(0.0023)	(0.0028)	(0.0032)
Variance equation						
Intercept	0.0001*	0.0002**	0.0000	0***	0**	0***
	(0.0001)	(0.0001)	(0)	(0)	(0)	(0)
ARCH term (α)	0.081**	0.0962**	0.0761***	0.0568***	0.0326***	0.0941***
	(0.0358)	(0.0468)	(0.0237)	(0.0098)	(0.0075)	(0.0157)
GARCH term (β)	0.6677***	0.5782***	0.8661***	0.9183***	0.9524***	0.8579***
	(0.1482)	(0.1752)	(0.039)	(0.0138)	(0.0129)	(0.0243)
Subprime events	0.0001	0.0002*	0.0002***	0***	0*	0.0002***
	(0)	(0.0001)	(0.0001)	(0)	(0)	(0)

Sources: Bloomberg L.P. and authors' calculations.

Note: The dependent variable is the daily return of the equity prices and all explanatory variables are lagged one period. Berndt-Hall-Hall-Hausman (BHHH) is used as the optimization algorithm. All regressions follow the GARCH (1,1) model and are estimated by maximum likelihood. Standard errors are presented in parentheses.***significant at 1 percent level; **significant at 5 percent level; *significant at 10 percent level.

Table 8. Regression Results of the Event Models: Hong Kong SAR

Dependent variables	Jan. 1, 2007-Oct. 31, 2008		Jan. 1, 2005-Oct. 31, 2008	
	Model 1	Model 2	Model 1	Model 2
	Hang Seng Index	Hang Seng Financial Index	Hang Seng Index	Hang Seng Financial Index
Mean Equation				
Intercept	0.0108***	0.0087***	0.0038**	0.0021
	(0.0033)	(0.0027)	(0.0017)	(0.0015)
Daily equity return (lagged)	-0.0685	-0.0288	-0.0232	0.0238
	(0.0545)	(0.0546)	(0.0376)	(0.0356)
Interest rate differential	0.0047**	0.0052***	-0.0002	-0.0003
	(0.0018)	(0.0016)	(0.0006)	(0.0004)
Macroeconomic news on				
Trade balance	0	0	0	0
	(0.0001)	(0.0001)	(0.0002)	(0.0001)
Broad money growth	0	-0.0001	-0.0001	-0.0001**
	(0.0003)	(0.0003)	(0.0001)	(0.0001)
CPI inflation	0.0004	0	0.0039	0.0029
	(0.0081)	(0.007)	(0.0038)	(0.0029)
Mature market volatility				
VIX	-0.0439***	-0.0389**	-0.034***	-0.0221**
	(0.0162)	(0.0157)	(0.0106)	(0.0092)
Interest rate volatility	0.0027	0.004	0.0018	0.0012
	(0.0034)	(0.0032)	(0.0027)	(0.0022)
Subprime events	-0.0043**	-0.0037**	-0.0023	-0.0019
	(0.0021)	(0.0019)	(0.0019)	(0.0017)
Variance equation				
Intercept	0	0	0***	0***
	(0)	(0)	(0)	(0)
ARCH term (α)	0.1556***	0.1843***	0.0952***	0.1174***
	(0.0397)	(0.0384)	(0.0176)	(0.0181)
GARCH term (β)	0.8068***	0.7943***	0.8515***	0.8327***
	(0.0526)	(0.0409)	(0.0292)	(0.0261)
Subprime events	0.0001**	0.0001***	0.0001***	0.0001***
	(0)	(0)	(0)	(0)

Sources: Bloomberg L.P. and authors' calculations.
Note: The dependent variable is the daily return of the equity prices and all explanatory variables are lagged one period.
Berndt-Hall-Hall-Hausman (BHHH) is used as the optimization algorithm. All regressions follow the GARCH (1,1) model and are estimated by maximum likelihood. Standard errors are presented in parentheses.***significant at 1 percent level;
**significant at 5 percent level; *significant at 10 percent level.

Table 9. Estimated Coefficients for Conditional Mean Return Equations

	Jan. 1, 2007-Oct. 31, 2008						Jan. 1, 2005-Oct. 31, 2008					
	U.S. (i=1)		China (i=2)		Hong Kong (i=3)		U.S. (i=1)		China (i=2)		Hong Kong (i=3)	
	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
α	0.0005	(0.0004)	0.0108	(0.0066)	0.0058**	(0.0026)	0.0005**	(0.0002)	0.0032	(0.0028)	0.0038***	(0.0013)
α_{i1}	-0.0868*	(0.0469)	0.2651***	(0.0613)	0.7569***	(0.0465)	-0.0662**	(0.0333)	0.1951***	(0.0445)	0.6051***	(0.0306)
α_{i2}	0.01	(0.0173)	-0.07	(0.0533)	-0.0694***	(0.0265)	0.02	(0.0146)	-0.02	(0.0292)	0.00	(0.0161)
α_{i3}	-0.0531**	(0.0256)	0.01	(0.0513)	-0.04	(0.0397)	-0.0681***	(0.0208)	0.02	(0.0346)	-0.0669**	(0.0276)

Sources: Bloomberg L.P. and authors' calculations.

Note: A common form, Diagonal VECH model, is employed that restricts A and B to be diagonals. All regressions follow the GARCH (1,1) model and are estimated by maximum likelihood using the Berndt-Hall-Hall-Hausman (BHHH) maximization algorithm. Standard errors are presented in parentheses. ***significant at 1 percent level; **significant at 5 percent level; *significant at 10 percent level.

Table 10. Estimated Coefficients for Variance Covariance Equations

	Jan. 1, 2007-Oct. 31, 2008						Jan. 1, 2005-Oct. 31, 2008					
	U.S. (i=1)		China (i=2)		Hong Kong (i=3)		U.S. (i=1)		China (i=2)		Hong Kong (i=3)	
	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
M_{i1}	0.0000	(0)	0***	(0)	0**	(0)	0.0000	(0)	0.0000	(0)	0.0000	(0)
M_{i2}	0***	(0)	0***	(0)	0***	(0)	0.0000	(0)	0***	(0)	0.0000	(0)
M_{i3}	0**	(0)	0***	(0)	0***	(0)	0.0000	(0)	0.0000	(0)	0.0000	(0)
A_{i1}	0.0408***	(0.0094)	0.0733***	(0.0162)	0.0808***	(0.0144)	0.0385***	(0.0068)	0.037***	(0.0054)	0.0501***	(0.0065)
A_{i2}	0.0733***	(0.0162)	0.1315***	(0.0496)	0.145***	(0.036)	0.037***	(0.0054)	0.0354***	(0.0076)	0.0481***	(0.0069)
A_{i3}	0.0808***	(0.0144)	0.145***	(0.036)	0.1598***	(0.038)	0.0501***	(0.0065)	0.0481***	(0.0069)	0.0652***	(0.0105)
B_{i1}	0.9707***	(0.0073)	0.4028***	(0.1424)	0.8987***	(0.0182)	0.9691***	(0.0052)	0.9628***	(0.0053)	0.9586***	(0.0048)
B_{i2}	0.4028***	(0.1424)	0.17	(0.1182)	0.3729***	(0.1364)	0.9628***	(0.0053)	0.9565***	(0.0092)	0.9523***	(0.006)
B_{i3}	0.8987***	(0.0182)	0.3729***	(0.1364)	0.832***	(0.0329)	0.9586***	(0.0048)	0.9523***	(0.006)	0.9482***	(0.0076)

Sources: Bloomberg L.P. and authors' calculations.

Note: A common form, Diagonal VECH model, is employed that restricts A and B to be diagonals. All regressions follow the GARCH (1,1) model and are estimated by maximum likelihood using the Berndt-Hall-Hall-Hausman (BHHH) maximization algorithm. Standard errors are presented in parentheses. ***significant at 1 percent level; **significant at 5 percent level; *significant at 10 percent level.

Table 11. Estimated Coefficients for Conditional Mean Return Equations Using Financial Sector Indices

| | Jan. 1, 2007-Oct. 31, 2008 | | | | | | Jan. 1, 2005-Oct. 31, 2008 | | | | | |
| | U.S. (i=1) | | China (i=2) | | Hong Kong (i=3) | | U.S. (i=1) | | China (i=2) | | Hong Kong (i=3) | |
	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
α	0.0002	(0.0005)	0.0067	(0.0078)	0.0027	(0.0027)	0.0003	(0.0003)	0.0074*	(0.0038)	0.0027**	(0.0011)
$\alpha i1$	-0.0525	(0.0428)	0.2461***	(0.0423)	0.3353***	(0.0259)	-0.0493	(0.0316)	0.2101***	(0.0398)	0.3076***	(0.0183)
$\alpha i2$	0.0225	(0.014)	0.0000	(0)	0***	(0)	0.0133	(0.0126)	0.0000	(0)	0***	(0)
$\alpha i3$	-0.1591***	(0.04)	-0.0075	(0.0525)	-0.0510	(0.0389)	-0.0913***	(0.0323)	0.0314	(0.0459)	-0.0117	(0.0266)

Sources: Bloomberg L.P. and authors' calculations.

Note: A common form, Diagonal VECH model, is employed that restricts A and B to be diagonals. All regressions follow the GARCH (1,1) model and are estimated by maximum likelihood using the Berndt-Hall-Hall-Hausman (BHHH) maximization algorithm. Standard errors are presented in parentheses. ***significant at 1 percent level; **significant at 5 percent level; *significant at 10 percent level.

Table 12. Estimated Coefficients for Variance Covariance Equations Using Financial Sector Indices

| | Jan. 1, 2007-Oct. 31, 2008 | | | | | | Jan. 1, 2005-Oct. 31, 2008 | | | | | |
| | U.S. (i=1) | | China (i=2) | | Hong Kong (i=3) | | U.S. (i=1) | | China (i=2) | | Hong Kong (i=3) | |
	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
$M i1$	0.0000	(0)	0.0000	(0)	0.0000	(0)	0.0000	(0)	0.0000	(0)	0.0000	(0)
$M i2$	0.0000	(0)	0**	(0)	0*	(0)	0.0000	(0)	0.0000	(0)	0**	(0)
$M i3$	0.0000	(0)	0*	(0)	0.0000	(0)	0.0000	(0)	0**	(0)	0**	(0)
$A i1$	0.0195***	(0.0054)	0.0317***	(0.0086)	0.0468***	(0.0081)	0.0488***	(0.0082)	0.0292***	(0.0042)	0.0584***	(0.007)
$A i2$	0.0317***	(0.0086)	0.0516**	(0.0229)	0.0761***	(0.0189)	0.0292***	(0.0042)	0.0175***	(0.0039)	0.035***	(0.005)
$A i3$	0.0468***	(0.0081)	0.0761***	(0.0189)	0.1122***	(0.0218)	0.0584***	(0.007)	0.035***	(0.005)	0.07***	(0.0109)
$B i1$	0.9919***	(0.0049)	0.9338***	(0.0268)	0.9487***	(0.0087)	0.9615***	(0.0064)	0.9728***	(0.0037)	0.9488***	(0.006)
$B i2$	0.9338***	(0.0268)	0.8791***	(0.0499)	0.8932***	(0.0276)	0.9728***	(0.0037)	0.9842***	(0.0034)	0.96***	(0.0055)
$B i3$	0.9487***	(0.0087)	0.8932***	(0.0276)	0.9074***	(0.0159)	0.9488***	(0.006)	0.96***	(0.0055)	0.9363***	(0.0099)

Sources: Bloomberg L.P. and authors' calculations.

Note: A common form, Diagonal VECH model, is employed that restricts A and B to be diagonals. All regressions follow the GARCH (1,1) model and are estimated by maximum likelihood using the Berndt-Hall-Hall-Hausman (BHHH) maximization algorithm. Standard errors are presented in parentheses. ***significant at 1 percent level; **significant at 5 percent level; *significant at 10 percent level.
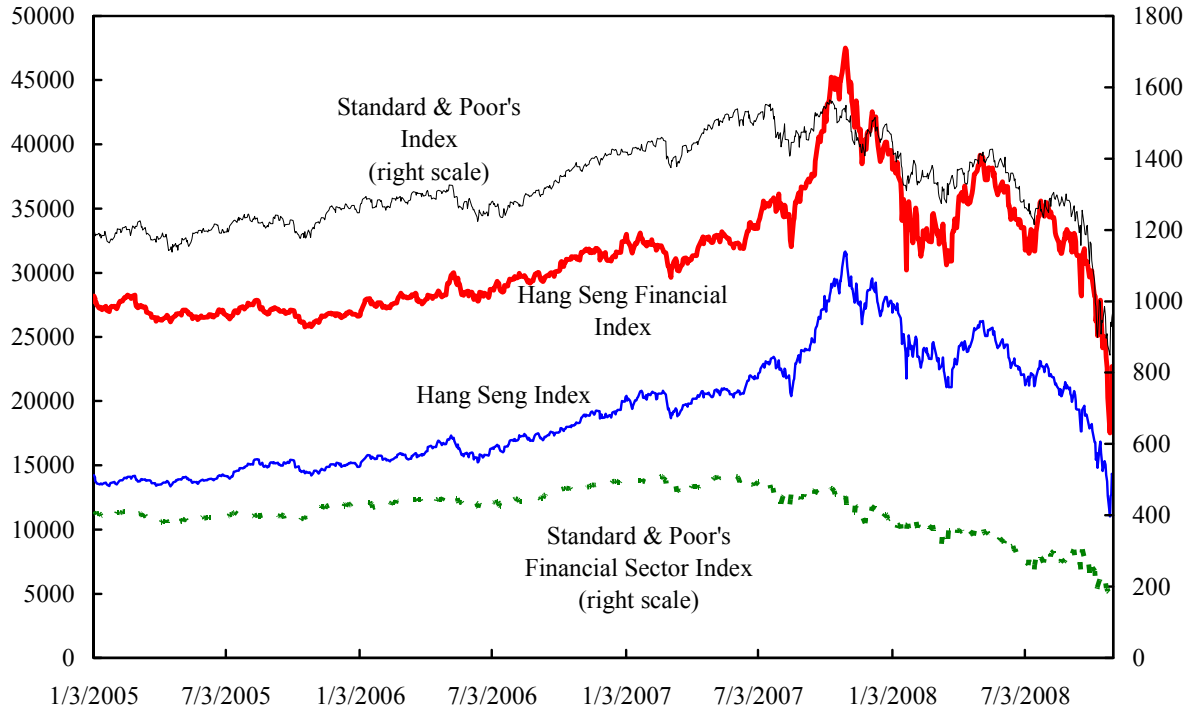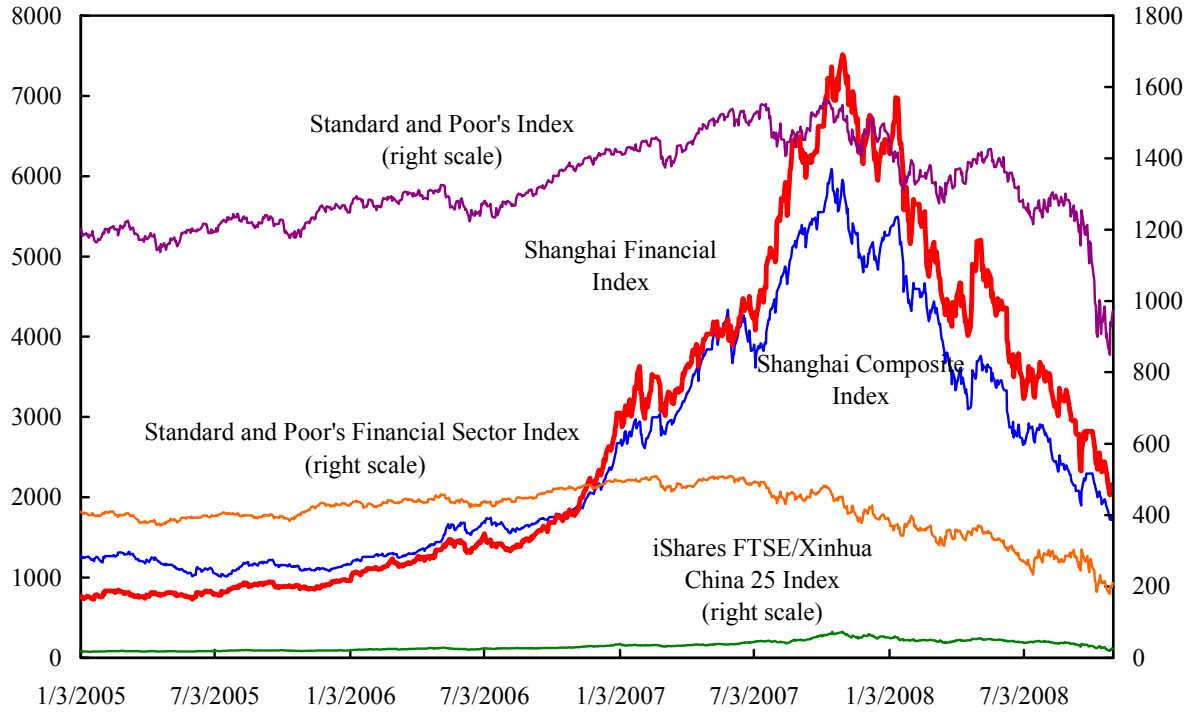
Figure 1. Stock Price Indices

Source: Bloomberg L.P.

Figure 2. U.S. Market Volatility
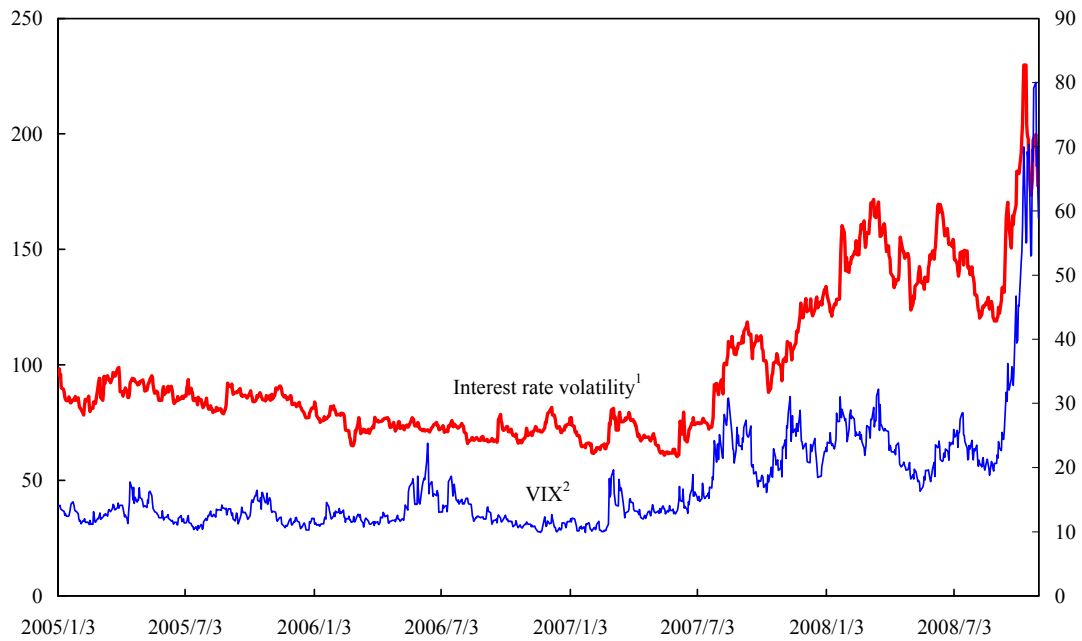
Source: Bloomberg L.P.
Note:[1]The implied volatility of interest rate swaptions with maturities between one and six month. [2]VIX represents the implied volatility of the S&P 500 index.

Figure 3.   Hot Money Flows to China
(In billions of U.S. dollars)
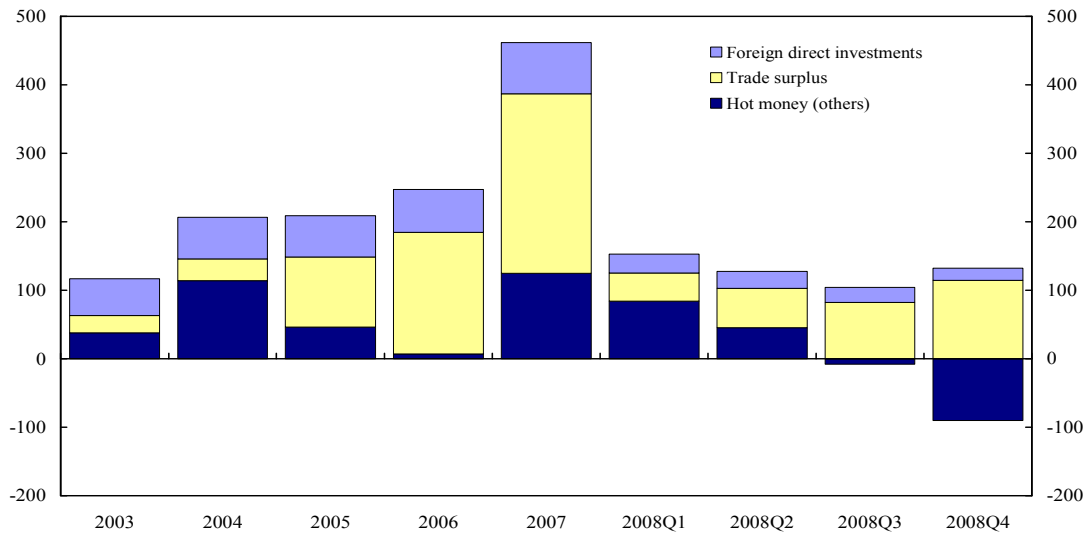
Source: State Administration of Foreign Exchange in China.
Note: Newly added foreign exchange reserve is equal to the sum of foreign direct investments, trade surplus and hot money (other)

Figure 4.   U.S. Resident's Net Foreign Transactions in Foreign Corporate Stocks
(In millions of U.S. dollars)
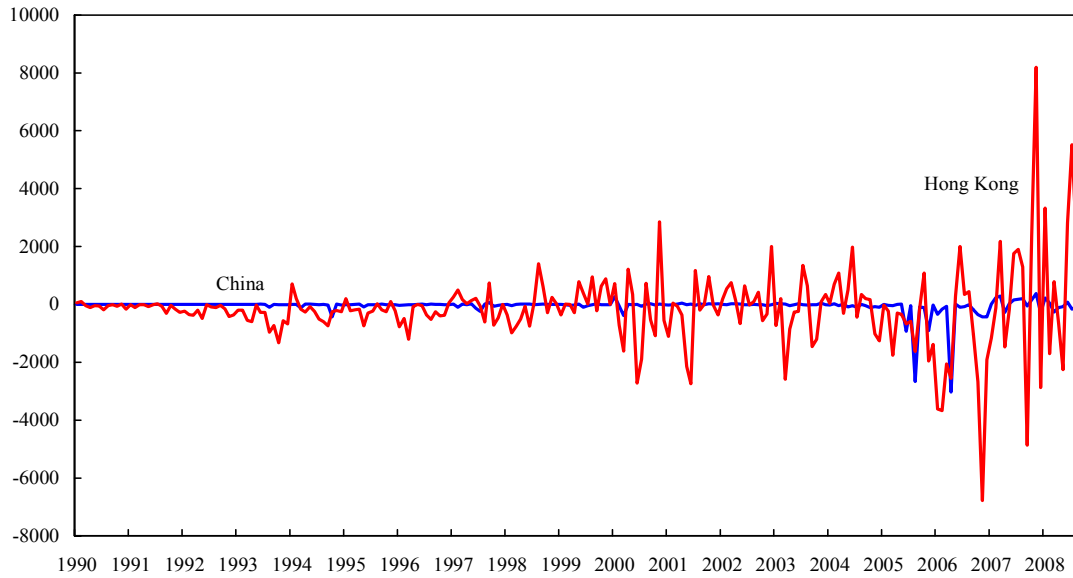
Sources: Haver Database; and U.S. Treasury.
Note: The U.S. Resident's Net Foreign Transactions in Foreign Corporate Stocks are used as a proxy of capital flows to China and Hong Kong.

Figure 5. Daily Equity Returns (January 1, 2007-October 31, 2008)
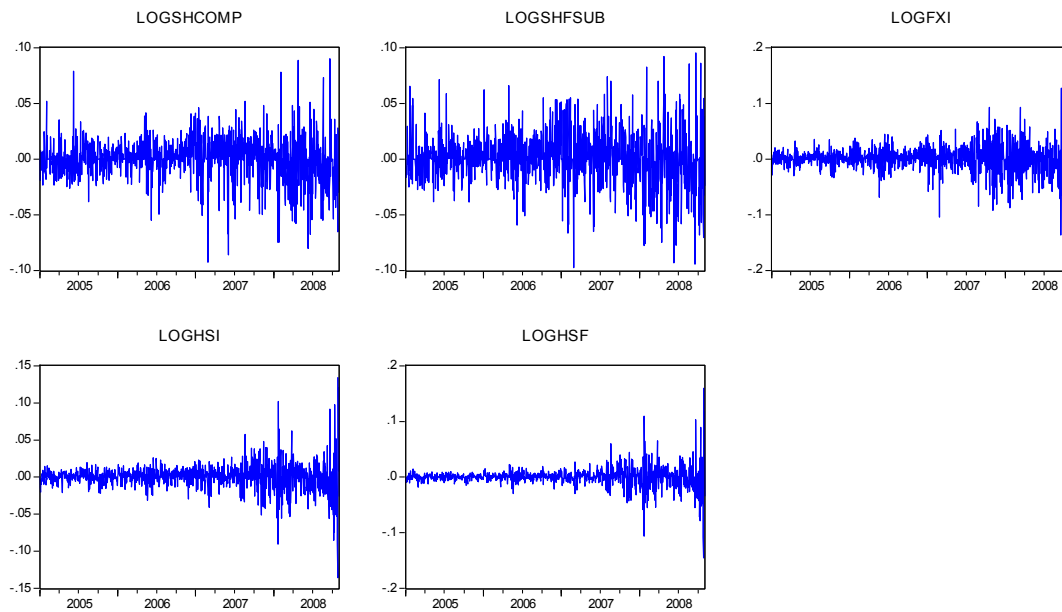
Sources: Bloomberg L.P. and authors' calculations.
Note: LOGSHCOMP, LOGSHFSUB, LOGFXI, LOGHSI,and LOGHSF represent the log difference in Shanghai Composite Index, Shanghai Financial Index, iShares FTSE/Xinhua China 25 index fund, Hang Seng Index, and Hang Seng Financial Index, respectively.

Figure 6. Squared Returns (January 1, 2007-October 31, 2008)
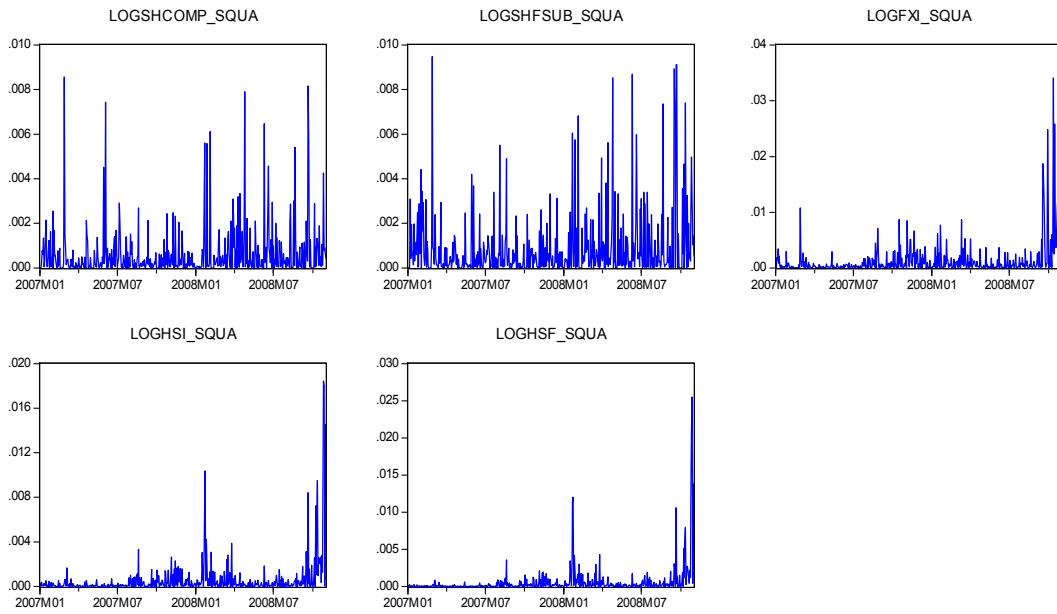
Sources: Bloomberg L.P. and authors' calculations.

Note: LOGSHCOMP, LOGSHFSUB, LOGFXI, LOGHSI,and LOGHSF represent the log difference in Shanghai Composite Index, Shanghai Financial Index, iShares FTSE/Xinhua China 25 index fund, Hang Seng Index, and Hang Seng Financial Index, respectively.

Figure 7. Conditional Correlation between the Composite Indices (January 1, 2007-October 31, 2008)

Conditional Correlation

Cor(LOGSPX,LOGSHCOMP)   Cor(LOGSPX,LOGHSI)   Cor(LOGSHCOMP,LOGHSI)
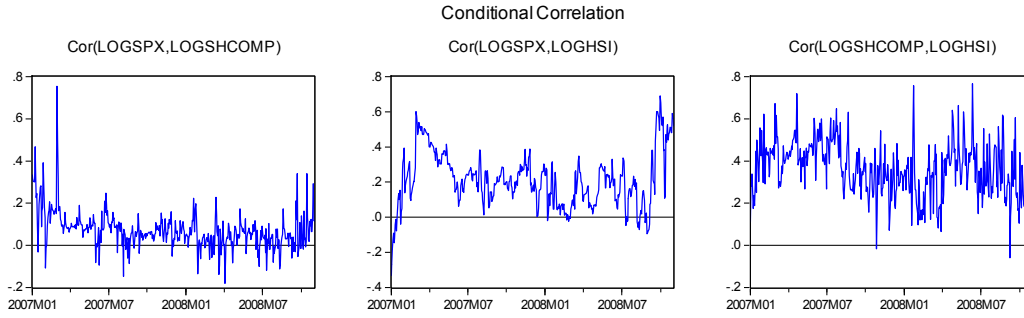
Sources: Bloomberg L.P. and authors' calculations.
Note: LOGSPX, LOGSHCOMP,and LOGHSI represent the log difference in Standard & Poor's Index, Shanghai Composite Index, and Hang Seng Index, respectively.

Figure 8. Conditional Correlation between the Financial Indices (January 1, 2007-October 31, 2008)

Conditional Correlation

Cor(LOGSPXFINL,LOGSHFSUB)   Cor(LOGSPXFINL,LOGHSF)   Cor(LOGSHFSUB,LOGHSF)
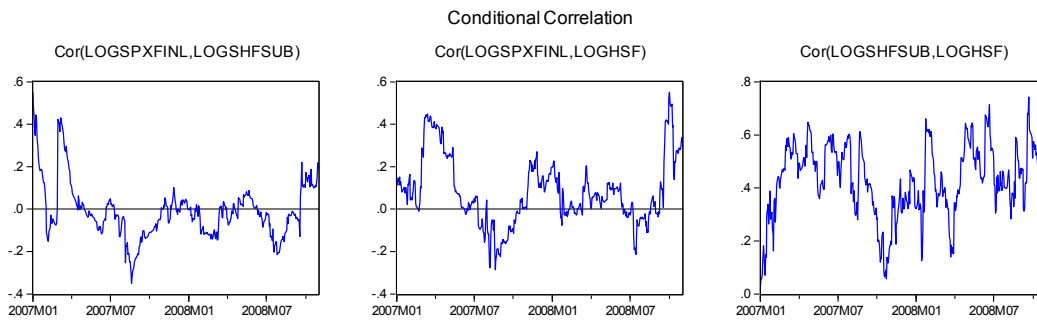
Sources: Bloomberg L.P. and authors' calculations.
Note: LOGSPXFINL, LOGSHFSUB and LOGHSF represent the log difference in Standard & Poor's Financial Index, Shanghai Financial Index, and Hang Seng Financial Index, respectively.

Appendix A. Lists of Subprime Events

Date	Events
2006-12-28	Ownit Mortgage Solutions files for bankruptcy.
2007-2-12	ResMae Mortgage files for bankruptcy.
2007-2-20	Nova Star Financial reports a surprise loss.
2007-3-2	Fremont General stops making subprime loans and puts its subprime business up for sale.
2007-3-8	New Century Financial, the second largest subprime lender in 2006, stops making loans.
2007-3-20	People's Choice files for bankruptcy.
2007-4-2	New Century Financial files for bankruptcy.
2007-4-6	American Home Mortgage writes down the value of risky mortgages rated one step above subprime.
2007-4-24	The National Association of Realtors announces that sales of existing homes fell 8.4 percent in March from February, the sharpest month-to-month drop in 18 years.
2007-5-9	The FOMC states in their minutes, "The correction of the housing sector was likely to continue to weigh heavily on economic activity through most of this year, somewhat longer than previously expected."
2007-5-25	The National Association of Realtors reports that sales of existing homes fell by 2.6 percent in April the slowest sales pace since June 2003. The number of unsold homes left on the market reached a record total of 4.2 million.
2007-6-6	ZipRealty Inc., a national real-estate brokerage firm, announces that the number of homes listed for sale in 18 major U.S. metropolitan areas at the end of May was up 5.1 percent from April. This is a striking deviation from the general trend as tracked by the Credit Suisse Group.
2007-6-12	RealtyTrac announces U.S. foreclosure filings surged 90 percent in May from May 2006. Foreclosure filings were up 19 percent from April.
2007-6-14	Goldman Sachs reports flat profit from a year ago due to mortgage market problems.
2007-6-22	Bear Stearns pledges up to $3.2 billion to bail out one of its hedge funds because of bad bets on subprime mortgages.
2007-7-10	Standard and Poor's and Moody's downgrade bonds backed by subprime mortgages. Fitch follows suit.
2007-7-18	Bear Stearns announces its two hedge funds that invested heavily in the subprime market are essentially worthless, having lost over 90 percent of their value, equal to over $1.4 billion.
2007-7-19	The Dow Jones industrials close above 14,000 for the first time.
2007-7-25	National Australia Bank tumbles on new $830m provision.
2007-7-31	Home prices continue to fall, marking the 18th consecutive decline, beginning in December 2005, in the growth rate of housing prices. The 10-City Composite index showed an annual decline of 3.4 percent (it's biggest since 1991) and the 20-City Composite reported an annual decline of 2.8 percent.
2007-8-1	Two hedge funds managed by Bear Stearns that invested heavily in subprime mortgages declare bankruptcy. Investors in the funds file suit against Bear Stearns, alleging that the investment bank misled them about the extent of the funds' exposure.
2007-8-6	American Home Mortgage files for bankruptcy.
2007-8-9	BNP Paribas, a French bank, suspends three of its funds because of exposure to U.S. mortgages.
2007-8-13	Aegis Mortgage files for bankruptcy.
2007-8-16	Countrywide Financial, the nation's largest mortgage lender, draws down $11.5 billion from its credit lines.
2007-8-22	RealtyTrac Inc announces foreclosures were up 93 percent in July 2007 from July 2006. The National foreclosure rate in July was one filing for every 693 households. There were 179,599 filings reported last month, up from 92,845 a year ago.
2007-8-27	National Association of Realtors reports that existing home sales declined by 0.2 percent in July, leaving the level of sales 9.0 percent below the level 12 months prior.
2007-9-5	The National Association of Realtors releases statistics on pending sales for existing homes. The figures reveal a 16.1 percent decline in July from a year ago and a 12.2 percent decline from the prior month. The July 89.9 levels is the second lowest in the history of the index and its lowest since the September 11th.
2007-9-6	The Mortgage Bankers Association releases a quarterly report showing that the delinquency rate for mortgage loans on one-to-four-unit residential properties was 5.12 percent of all loans outstanding in

the second quarter of 2007, up 28 basis points from the first quarter of 2007, and up 73 basis points from one year ago. Compared to this time last year, the seriously delinquent rate is 23 basis points higher for prime loans and 304 basis points higher for subprime loans.

2007-9-7	The U.S. Department of Labor's Bureau of Labor Statistics (BLS) releases figures showing that employers cut 4,000 jobs from payrolls last month, the first net decrease since 2003. Following the release of the report, the Dow Jones Industrial Average dropped 200.87 points.
2007-9-12	David Shulman, senior economist for the quarterly Anderson Forecast by the University of California at Los Angeles, lowers his forecast for housing starts to an annual rate of 1 million to 1.1 million, down from a range of 1.2 million to 1.3 million.
2007-9-14	Merrill Lynch & Co.signals that the subprime mortgage crisis may hurt third-quarter earnings. The New York-based firm reports that it made ``fair value adjustments'' for potential losses to date on unspecified holdings and financing commitments.
2007-9-17	Merrill Lynch & Co. Inc.'s $1.3 billion bet on subprime lending takes a turn for the worse when the world's largest brokerage confirms job cuts at its First Franklin Financial Corp. unit. Recently filed reports with U.S. banking regulators show that Merrill Lynch Bank & Trust Co., where a lot of the First Franklin franchise is housed, lost $111 million through the first half of 2007.
2007-9-18	RealtyTrac Inc. announces that home foreclosure filings surged to 243,000 in August, up 115 percent from August 2006 and 36 percent from July, marking the highest number of foreclosure filings since RealtyTrac began tracking monthly filings. The mortgage lending crisis intensifies as Impac Mortgage Holdings Inc. says it will quit most lending activities.
2007-9-19	The Commerce Department reports that construction of new homes fell by 2.6 percent in August to the slowest pace in 12 years.
2007-9-21	HSBC Holdings announces its plans to close its U.S. subprime unit, Decision One Mortgage, and record an impairment charge of about $880 million. HSBC states that it no longer believes the mortgage business is sustainable.
2007-9-25	The National Association of Realtors releases new housing statistics that reveal sales of existing single-family homes dropped by 4.3 percent in August, compared to July. The 10-City Composite index shows an annual decline of 4.5 percent– the largest in 16 years.
2007-9-27	Luminent Mortgage Capital, a home-loan investment company, downgrades its second-quarter profit as the company struggles to gain access to credit and bankers seize assets.
2007-10-1	UBS reports its first quarterly loss in nine years. The largest wealth manager in the world plans to write down $3.4 billion in its fixed-income portfolio and other departments and to cut 1,500 jobs in its investment bank.
2007-10-3	Residential foreclosures in New York City hit 698 during the third quarter. It represents a 64 percent increase from the same period last year. Yet the spike in New York pales in comparison to the third quarter increases in Los Angeles (247 percent) and Miami (168 percent). Miami's foreclosure rate per household is 116 percent higher than Los Angeles and 852 percent higher than New York City.
2007-10-4	Moody's Investors Service, reports that subprime mortgage bonds originated in the first half of 2007 include loans that are going delinquent at the fastest recorded rate. The Moody's report predicts that accelerating delinquencies from 2007 bonds are likely to surpass the number of delinquencies in 2006, which hit a peal not seen since 2000.
2007-10-5	Merrill disclose $5.5bn in subprime loss.
2007-10-9	US subprime losses may reach $150 billion: S&P news.
2007-10-10	The National Association for Realtors revises down its outlook for home sales. It lowers its prediction for existing home sales for the year from 5.92 million to 5.78 million.
2007-10-12	Paulson & Co., which has made money by betting on increasing foreclosures this year, announces its intention to donate $15 million to the Center for Responsible Lending and the National Association of Consumer.
2007-10-15	Citigroup acknowledges that its risk management models failed its customers and shareholders during this summer's credit crisis, leading to the company's 57 percent drop in third-quarter profit. Citigroup was forced to write off $3.55 billion and set aside $2.24 billion to cover anticipated losses.
2007-10-16	The National Association of Home Builders reports that its housing market index dropped to 18, its lowest level since the inception of the index in 1985. The housing market index has declined for eight straight months.
2007-10-17	The National League of Cities releases a report in which 7 out of 10 finance officers from major cities throughout the country offer pessimistic predictions for the economic future of their cities.
2007-10-18	Standard & Poor's cuts the credit ratings on $23.35 billion of securities backed by pools of home loans that were offered to borrowers during the first half of the year. The downgrades even hit

securities rated AAA, which is the highest of the 10 investment-grade ratings and the rating of government debt.

2007-10-24 Merrill Lynch writes down $7.9 billion due to exposure to collateralized debt obligations, complex debt instruments, and subprime mortgages. As a result, the firm takes a $2.3 billion loss, the largest in the firm's history.

2007-10-29 John Robbins, former chairman of the Mortgage Bankers Association, says approximately a half of million U.S. mortgage borrowers each year for the next few years risk foreclosure.

2007-10-30 Shareholders sue Merrill Lynch & Co for issuing false and misleading statements regarding its expo sure to risk mortgage investments. Reports from the S&P/Case-Shiller index indicate that housing prices have again fallen at record rates.

2007-11-1 GMAC, Radian Post Losses as U.S. Home Slump Deepens; After Write-Down, Credit Suisse's profit falls 31 percent.

2007-11-2 Banks are expecting $200 billion losses, worse than expected.

2007-11-4 On top of the $5.9 billion write-down reported in early October, Citigroup says it will take an additional $8 billion to $11 billion write-down related to subprime mortgages.

2007-11-6 David Trone, a securities analyst at Fox-Pitt Kelton, downgrades Morgan Stanley amid speculation that the brokerage firm will suffer losses of $6 billion due to the reduced value of credit investments.

2007-11-8 Testifying before the Joint Economic Committee, Federal Reserve Chairman Ben Bernanke expresses his concern over the subprime housing crisis.

2007-11-12 Subprime Losses may reach $400 billion, analysts expected.

2007-11-14 HSBC Holdings PLC reports that it took a $3.4 billion impairment charge at its U.S. consumer finance division, HSBC Finance Corp. According to RealtyTrac, foreclosure filings rose in 77 of the largest 100 metropolitan areas from the prior quarter. Overall, residential foreclosure filings nearly doubled in the third quarter from a year earlier.

2007-11-15 Barclays Group PLC takes a $2.7 billion write-down for losses on securities linked to the U.S. subprime mortgage market collapse.

2007-11-19 Fannie Mae shares are down 7.3 percent to $37.70 on reports from Credit Suisse that the government sponsored entity may report a loss of between $1 billion to $5 billion on its subprime AAA portfolio.

2007-11-20 Subprime crisis is widely seen spilling into 2009. Losses top out at $270 billion.

2007-11-21 Shares of Countrywide, the largest U.S. Mortgage Lender, close below $10 for the first time in more than five years.

2007-11-22 U.S. subprime losses may hit $300 billion, OECD estimates.

2007-11-28 The National Association of Realtors reports that sales of existing single-family homes and condominiums dropped by 1.2 percent in October. The median price of a home sold in October declined to $207,800, a drop of 5.1 percent from October 2006. It is the single largest one year decline on record.

2007-11-29 According to RealtyTrac, there were 222,451 foreclosure filings last month. It is a 94 percent increase from October 2006. The 2 percent increase from September 2007 indicates that the subprime crisis is only getting worse.

2007-12-5 The Wall Street Journal reports that New York Attorney General Andrew M. Cuomo sent out subpoenas to major Wall Street firms including Merrill Lynch, Morgan Stanley, Deutsche Bank, Bear Sterns, and Lehman Brothers over the late summer to explore further their role in the packaging and selling of subprime mortgages.

2007-12-10 Swiss bank UBS announced it would write down an additional $10 billion in subprime losses –possibly resulting in a net loss for all of 2007.

2007-12-11 Washington Mutual announced that it expected its fourth quarter loan losses would reach $1.6 Billion. In addition, it expected that 3,000 Washington Mutual employees would be laid off as a result of investments in subprime mortgage-backed securities.

2007-12-12 Florida Fund reduced by $1.9 billion after SIV losses.

2007-12-14 Citigroup rescues SIVs with $58 billion debt bailout; UBS confirms sub-prime $18.4 billion loss.

2007-12-18 The Commerce Department reported that housing construction was down 3.7 percent for the month of November. This marked a 24.2 percent drop in new home construction in the 12 month period and the lowest level of home construction in more than 16 years.

2007-12-19 Morgan Stanley announced it would be writing down an additional $9.4 billion in losses on subprimelinked investments. The company also announced it would be selling a $5 billion dollar stake to a foreign investment fund.

2007-12-20	Investment bank Bear Stearns announced the first quarterly loss in the institution's eight-decade history.
2008-1-4	The Labor department announced that the unemployment rate skyrocketed from 4.7 percent to 5 percent in December. The fall to 5 percent made December's unemployment jump the largest unemployment increase since the days after Sept. 11, 2001.
2008-1-10	Countrywide Financial reported that late mortgage payments and foreclosures reached the highest level ever recorded this past December.
2008-1-11	Merrill Lynch announced it would need to write down more than double its initial projection related to subprime mortgage losses. Bank of America announced that it would buy Countrywide Financial, the nation's largest mortgage lender. This acquisition ended days of speculation that Countrywide, due to its role in the proliferation of subprime mortgages, would be forced to declare bankruptcy.
2008-1-15	Citigroup the largest bank in the United States announced that its mortgage portfolio dropped in value by $18.1 Billion. This news led Citigroup to its first quarterly loss in 16 years.
2008-1-17	Lehman Brothers said it would no longer continue the practice of wholesale mortgage lending. As a pioneer in issuing mortgage backed securities, Lehman Brothers also announced it would cut 1,300 jobs. These job cuts come on top of 2,500 other jobs eliminated since June 2007.
2008-1-28	New home sales dropped 26.4 percent in 2007, according to a Commerce Department report. In addition, the median price of new homes fell by 10.4 percent from December 2006 - the biggest 12 month decline in 37 years.
2008-1-29	The number of houses in foreclosure rose 79 percent in 2007, according to Reality Trac. December also marked the fifth straight month where 200,000 or more foreclosure filings were made.
2008-1-30	Subprime related losses pushed UBS its worst year of performance in its institutional history. Standard and Poor's announced it would be cutting the credit ratings of $534 billion in subprime mortgage backed securities. Downgrades of these securities could lead to another $265 billion in losses for the financial industry.
2008-1-31	Subprime, CDO Bank losses may exceed $265 billion
.2008-2-1	At a hearing of the Joint Economic Committee, the commissioner of the Bureau of Labor Statistics announced that 17,000 jobs were lost in January – a stark contrast to the employment gains that were forecast.
2008-2-11	Credit writedowns may total $175 billion , analyst expected.
2008-2-12	IndyMac posts record loss, calls reserves adequate.
2008-2-15	The nation's fourth largest bond insurer, FGIC announced it would seek to split its company into two.
2008-2-19	Credit Suisse announced it would write down $1 billion in subprime losses. Up to this point, Credit Suisse had been one of the few major international financial institutions who hadn't been affected by the subprime collapse.
2008-2-25	In January, the median home price fell and, for the sixth straight month, existing home sales dropped. The 0.4 percent drop in sales along with the 4.6 percent drop in price have been spurred by lenders making it more difficult for families to take out mortgages, making it more costly to receive a loan.
2008-2-29	A report from market analysts at UBS shows that subprime losses could reach $600 billion. This new report on expected losses marks a 50 percent rise from previous estimations made just months ago.
2008-3-3	The Commerce Departments revealed that construction spending plummeted by 1.7 percent in the month of January. This is the single biggest single month drop in the sector in 14 years; HSBC in $17bn credit crisis loss.
2008-3-6	Numbers released by the Mortgage Bankers Association showed that by the end of 2007, 2.04 percent of all mortgages were in the foreclosure process. This marks the highest level of foreclosure ever recorded in its report.
2008-3-7	Employers cut 63,000 jobs in February, the largest single month decline in the workforce in almost five years. Also, December and January numbers were revised to reflect dimmer employment markets than previously reported.
2008-3-13	Subprime losses may reach 285 billion dollars: S&P.
2008-3-17	Investment bank Bear Stearns announced that it will sell itself to JPMorgan Chase for $2 a share – a 93 percent discount on the current stock price. This fire sale comes as worldwide markets showed concern that Bear Stearns was close to folding under the pressure of their subprime liabilities.
2008-3-18	On the heels of the collapse of Bear Stearns, Wachovia has released a report showing that Merrill Lynch is the most at risk major broker behind Bear Stearns due to their vulnerability from subprime

securities.

2008-3-20	Citigroup announced that it will be cutting another 2,000 jobs. This is on top of the 4,200 layoffs already announced by Citigroup in January.
2008-3-24	JPMorgan Chase announced it would raise its offer for embattled Bear Stearns Co to $10 a share from the previous bid of $2/share. Even by quintupling the price JPMorgan is willing to pay, Bear Stearns is valued 90 percent lower that it was when its stock reaches its $170 high last year.
2008-3-25	The S&P/Case-Shiller index reported that home prices dropped once again in the month of January. January's drop represents the 19th straight month that home prices dropped and the largest single-month drop in the 20 year history of the report.
2008-3-31	US Treasury Backs Regulatory Overhaul, Broader Fed Role
2008-4-1	UBS writes down another $19 billion; Deutsche Bank to write down $4B
2008-4-8	IMF says writedowns on US assets could total $945bn
2008-4-11	China (CBRC) urges caution after subprime crisis
2008-4-14	Wachovia's Loss a Grim Sign for Banks
2008-4-15	OECD raises subprime loss tally to $350-420 billion
2008-4-23	Subprime write-downs hit $269 billion
2008-4-29	$800 Billion more in Subprime, Alt-A Mortgages May Head `Underwater'
2008-5-6	Fannie Mae loses $2.2-billion
2008-5-9	Citigroup to wind down $400bn of assets
2008-5-14	Subprime losses by global banks total US$400 billion: Fitch
2008-5-19	Banks Keep $35 Billion Markdown Off Income Statements
2008-5-20	Credit Crisis Will Extend Into 2009, $170 billion in additional writeoffs
2008-5-26	UBS Falls After Saying More Mortgage Losses Possible
2008-6-2	Morgan Stanley, Merrill, Lehman Ratings Cut by S&P
2008-6-5	MBIA, Ambac, $1 Trillion of Debt, Lose S&P AAA Rating
2008-6-9	Lehman Brothers to post $3 billion loss; sets $6 billion stock sale
2008-6-12	KeyCorp to raise $1.5 billion, cut dividend 50 percent
2008-6-18	Paulson & Co. Says Writedowns May Reach $1.3 Trillion
2008-6-25	Countrywide Sued by California Over Mortgage Loans
2008-6-30	Florida Sues Countrywide
2008-7-7	Freddie Mac, Fannie Mae Plunge on Capital Concerns
2008-7-8	IndyMac Falls After Regulators Say It Isn't `Well Capitalized'
2008-7-10	U.S. Mulls Future of Fannie, Freddie
2008-7-28	Merrill Has $5.7 Billion of Writedowns, Sells Shares
2008-8-6	Freddie Mac Posts Fourth Straight Loss, Cuts Dividend
2008-8-7	Yes, That's $2 Trillion of Debt-Related Losses
2008-8-8	Fannie Mae Posts Fourth Straight Loss, Cuts Dividend
2008-8-15	Fannie, Freddie debt faces confidence crisis overseas
2008-8-20	Fannie Mae and Freddie Mac shares fall on fears of size of potential losses
2008-8-26	Housing slump hits BMO's bottom line
2008-9-9	KDB's Attempt to Invest In Lehman Appears Over; Counterparty credit risks climb on Lehman, WaMu
2008-9-10	Lehman Sees $3.9 Billion Loss and Plans to Shed Assets
2008-9-15	Lehman Files Biggest Bankruptcy After Suitors Balk; AIG's Ratings Cut by S&P, Moody's, Threatening Fund Raising
2008-9-16	WaMu Falls as S&P Cuts Lender's Credit Rating to Junk; Goldman Sachs net plunges; Morgan Stanley profit falls 3 percent
2008-9-17	AIG was on the verge of collapse, and its share plunged 45 percent.
2008-9-23	Uncertainty about the bailout plan's prospects

2008-9-24	Uncertainty about the bailout plan's prospects
2008-9-25	Washington Mutual collapsed
2008-9-29	Emergency Economic Stabilization Act defeated 228-205 in the United States House of Representatives; Federal Deposit Insurance Corporation announces that Citigroup Inc. would acquire banking operations of Wachovia.[103]
2008-10-1	The financial crisis is spreading to Europe.
2008-10-2	Fears of recession overshadowed hopes of rescue plan
2008-10-3	Fears of recession deepened
2008-10-6	Worst week for the stock market in 75 years. The Dow Jones lost 22.1 percent, its worst week on record, down 40.3 percent since October 9, 2007. The Standard & Poor's 500 index lost 18.2 percent, its worst week since 1933, down 42.5 percent in since its own high October 9, 2007.
2008-10-7	Bank of America reports third quarter earnings of $1.2 billion, less than analyst expectations. In an effort to get through the credit crisis, BofA cut its dividend by half and announced plans to raise an additional $10bn in capital.
2008-10-8	The International Monetary Fund, in its bleakest forecast in years, sees major global downturn.
2008-10-9	Worries of worsening credit crisis and global recession.
2008-10-10	Japanese company Yamato Life files for bankruptcy becoming what is viewed as the first direct casualty in Japan from the fallout of the US subprime mortgage crisis.
2008-10-15	Retail sales sank 1.2 percent in September 2008
2008-10-16	Concerns that the banks had been rescued too late to stop a slump in the world economy
2008-10-21	ING Groep's Senior Debt Rating Cut to Aa3 by Moody's
2008-10-22	Wachovia reports 23.9 billion loss
2008-10-28	Bank of England estimates world credit loss at '£1.8 trillion'
2008-10-30	The Commerce Department reported U.S. GDP fell at an annual rate of 0.3 percent in the July-September period. Contraction at 0.3 percent pace suggests the onset of recession.

Sources: Bloomberg L.P. and Reuters.

Note: These ongoing news events about the subprime crisis are used to capture their possible impact on price and volatility of equity markets.

Appendix B. Members of FXI US Equity

	Sector	Name
1	Non-financial	China Mobile Ltd
2	Financial	Industrial & Commercial Bank of China - H
3	Financial	China Life Insurance Co-H
4	Non-financial	PetroChina Co Ltd-H
5	Non-financial	CNOOC Ltd
6	Financial	PING AN Insurance Group Co-H
7	Financial	Bank of China Ltd - H
8	Non-financial	China Petroleum & Chemical Co-H
9	Non-financial	China TeleCom CoRP Ltd-H
10	Financial	China Construction Bank-H
11	Financial	China Merchants Bank - H
12	Financial	Bank of Communication Co-H
13	Financial	Bank of China HONG KONG Holding Ltd
14	Non-financial	China UNICOM Ltd
15	Non-financial	China Shenhua Energy Co - H
16	Non-financial	China Coal Energy Co - H
17	Non-financial	China Communications Const-H
18	Financial	China Merchants Holdings International
19	Non-financial	China NETCOM Group Corp HK Ltd
20	Non-financial	China COSCO Holdings-H
21	Non-financial	Huaneng Power International Inc-H
22	Non-financial	Datang International Power Generating Co-H
23	Non-financial	Aluminum Corp of China Ltd-H
24	Financial	China CITIC Bank - H
25	Non-financial	AIR China Limited-H

Source: Bloomberg L.P.

Annex C Table 1. Market Forecasts of Monthly Economic Indicators: China

	China							
	Money supply (M2)		Trade volume		Industrial Production		CPI	
	Survey	Actual	Survey	Actual	Survey	Actual	Survey	Actual
2005M1	14.6	14.1	11.1	6.5	14.4	20.9	2.3	1.9
2005M2	14.1	13.9	6.5	4.6	20.9	7.6	2.3	3.9
2005M3	13.9	14.0	10.9	13.5	15.2	15.1	3.0	2.7
2005M4	14.0	14.1	5.7	4.6	14.6	16.0	2.7	1.8
2005M5	14.1	14.6	4.6	9.0	15.8	16.6	1.8	1.8
2005M6	14.6	15.7	8.8	9.7	16.3	16.8	1.8	1.6
2005M7	16.0	16.3	9.8	10.4	16.8	16.1	1.5	1.8
2005M8	16.2	17.3	10.4	10.0	15.7	16.0	1.8	1.3
2005M9	17.0	17.9	10.3	7.6	15.9	16.5	1.2	0.9
2005M10	17.6	18.0	9.7	12.0	16.3	16.1	1.1	1.2
2005M11	17.8	18.3	11.5	10.5	16.0	16.6	1.4	1.3
2005M12	18.1	17.6	11.6	11.0	16.4	16.5	1.4	1.6
2006M1	17.5	19.2	6.4	9.5	14.4	20.9	1.8	1.9
2006M2	18.1	18.8	7.5	2.5	20.9	7.6	1.5	0.9
2006M3	18.3	18.8	5.7	11.2	16.0	17.8	1.3	0.8
2006M4	18.5	18.9	7.7	10.5	17.0	16.6	1.2	1.2
2006M5	18.6	19.1	12.0	13.0	16.5	17.9	1.3	1.3
2006M6	19.1	18.4	12.8	14.5	17.4	19.5	1.5	1.5
2006M7	18.0	18.4	14.3	14.6	18.9	16.7	1.6	1.0
2006M8	18.0	17.9	14.6	18.8	16.9	15.7	1.3	1.3
2006M9	17.6	16.8	14.4	15.3	15.8	16.1	1.5	1.5
2006M10	16.5	17.1	17.7	23.8	16.0	14.7	1.6	1.4
2006M11	16.9	16.8	23.8	22.9	15.0	14.9	1.5	1.9
2006M12	16.6	16.9	21.6	21.0	15.0	14.7	1.9	2.8
2007M1	16.5	15.9	15.5	15.9	15.0	18.5	2.6	15.5
2007M2	16.3	17.8	7.3	23.8	15.0	18.5	2.8	7.3
2007M3	17.0	17.3	20.0	6.9	15.0	18.5	2.7	20.0
2007M4	17.0	17.1	15.0	16.9	15.6	17.6	3.1	15.0
2007M5	16.9	16.7	19.5	22.5	17.5	17.4	3.3	19.5
2007M6	16.6	17.1	23.8	26.9	17.0	18.1	3.6	23.8
2007M7	17.0	18.5	23.1	24.4	17.5	19.4	4.6	23.1
2007M8	18.2	18.1	25.9	25.0	18.5	18.0	5.9	25.9
2007M9	18.0	18.5	21.6	23.9	17.9	17.5	6.3	21.6
2007M10	18.3	18.5	30.8	27.1	17.5	18.9	6.3	30.8
2007M11	18.2	18.5	26.6	26.3	18.5	17.9	6.5	26.6
2007M12	18.2	16.7	24.4	22.7	18.0	17.3	6.5	24.4
2008M1	16.5	18.9	17.0	19.5	17.2	17.4	7.0	17.0
2008M2	17.8	17.5	22.5	15.5	16.9	15.4	7.9	22.5
2008M3	17.2	16.3	12.0	13.4	16.5	17.8	8.2	12.0
2008M4	16.2	16.9	15.5	16.7	17.5	15.7	8.2	15.5
2008M5	17.0	18.1	21.3	20.2	16.0	16.0	8.0	21.3
2008M6	17.5	17.4	22.7	21.4	15.6	16.0	7.3	22.7
2008M7	17.1	16.4	20.3	25.3	15.9	14.7	6.5	20.3
2008M8	16.6	16.0	23.6	28.7	14.5	12.8	5.4	23.6
2008M9	16.0	15.3	24.5	29.3	13.4	11.4	4.6	4.6
2008M10	15.2	15.0	30.0	35.2	11.1	8.2	4.2	4.0

Sources: Bloomberg L.P.; and Consensus Forecast.
Note: We take the difference in the growth rate between export and import as the indicator
reflecting the trade balance in China. In addition, we take M2 as the indicator of money supply in China.

Annex C Table 2. Market Forecasts of Monthly Economic Indicators: HK

	Hong Kong					
	Money supply		Trade balance		CPI	
	Survey	Actual	Survey	Actual	Survey	Actual
2005M1	5.1	18.1	2.4	-2.4	-0.5	-0.5
2005M2	5.2	11.0	-2.4	5.5	0.8	0.8
2005M3	4.3	2.9	2.3	1.0	0.8	0.8
2005M4	5.5	-0.7	1.0	4.0	0.5	0.5
2005M5	5.4	-3.2	4.0	0.9	0.8	0.8
2005M6	5.3	-6.3	1.4	2.1	1.2	1.2
2005M7	5.3	-4.0	0.7	1.6	1.3	1.3
2005M8	5.0	-5.3	0.6	-0.2	1.4	1.4
2005M9	5.3	-5.5	0.5	1.9	1.6	1.6
2005M10	5.7	-6.9	-0.5	1.9	1.3	1.8
2005M11	5.8	-12.9	0.6	-2.1	1.2	1.7
2005M12	5.6	-15.6	0.8	-3.9	1.3	1.8
2006M1	5.8	-17.8	2.0	3.6	1.9	2.6
2006M2	5.4	22.7	0.3	-7.8	1.6	1.6
2006M3	5.8	-7.8	1.2	-1.3	1.6	1.8
2006M4	5.7	-4.0	-1.3	-1.8	1.9	1.9
2006M5	5.2	5.2	-1.1	-2.6	2.1	2.1
2006M6	5.5	-2.1	-2.1	-3.2	2.2	2.2
2006M7	5.8	-1.9	-2.2	-0.7	2.3	2.3
2006M8	6.1	1.6	-0.4	-2.4	2.5	2.5
2006M9	6.6	4.7	-2.5	-3.5	2.1	2.1
2006M10	5.8	9.3	-3.8	-3.3	2.0	2.0
2006M11	7.0	6.5	-1.5	-2.1	2.2	2.2
2006M12	6.5	11.4	0.6	-0.8	2.3	2.3
2007M1	7.3	8.1	-11.9	-4.9	2.0	2.3
2007M2	7.0	-20.2	-26.7	10.3	0.8	2.5
2007M3	7.2	17.4	12.1	-4.2	2.4	2.1
2007M4	7.9	9.4	-1.9	-2.1	1.3	2.1
2007M5	9.6	-29.3	-43.7	1.0	1.2	1.5
2007M6	10.0	43.1	32.3	-1.9	1.3	1.4
2007M7	9.8	11.9	-1.1	-1.2	1.5	1.5
2007M8	10.4	10.8	1.3	-1.5	1.6	1.7
2007M9	10.9	31.7	22.2	-0.8	1.6	1.8
2007M10	11.5	33.0	23.5	-2.3	3.2	2.7
2007M11	12.0	33.7	24.7	-2.7	3.4	3.4
2007M12	12.6	17.1	7.6	-2.1	3.8	3.6
2008M1	13.3	19.5	8.2	-1.1	3.2	3.3
2008M2	13.5	15.5	5.5	-4.3	6.3	4.9
2008M3	13.2	9.3	-2.9	1.0	4.2	4.3
2008M4	12.8	14.8	7.6	3.2	5.4	5.5
2008M5	13.8	14.6	2.7	-5.1	5.7	5.7
2008M6	13.0	-10.3	-22.7	-1.9	6.1	5.8
2008M7	13.1	12.7	4.4	-4.3	6.3	6.0
2008M8	13.3	12.2	-1.1	0.4	4.6	6.1
2008M9	12.1	-7.4	0.4	-0.3	4.5	3.0

Sources: Bloomberg L.P.; and Consensus Forecast.
  Note: For the data availability reason, we take the difference between the growth in export
and import as the indicator reflecting the trade balance in HK. Similarly, we take M1 as the
indicator of money supply in HK.

REFERENCES

Bae, Kee-Hong and G. Andrew Karolyi and René M. Stulz, 2003, "A New Approach to Measuring Financial Contagion," *The Review of Financial Studies,* Vol. 16, pp. 717–63.

Baig, Taimur and Ilan Goldfajn, 1999, "Financial Market Contagion in the Asian Crisis," Staff Papers Vol. 46, No. 2 (Washington: International Monetary Fund).

_____Taimur and Ilan Goldfajn, 1999, "Financial Market Contagion in the Asian Crisis," *Staff Papers,* International Monetary Fund, Vol. 46, No. 2, pp. 167–95.

Bayoumi, Taimim and Andrew Swiston, "Foreign Entanglements: Estimating the Source and Size of Spillovers Across Industrial Countries," Working Paper No. WP/07/182 (Washington: International Monetary Fund).

Bollerslev, Tim, 1986, "Generalized Autoregressive Conditional Heteroscedasticity", *Journal of Econometrics,* Vol. 31, pp. 307–27.

Booth, G. Geoffrey, Teppo Martikainen, and Yiuman Tse, 1997, "Price and Volatility Spillovers in Scandinavian Stock Markets," *Journal of Banking & Finance,* Vol. 21, No. 6, pp. 811–23.

Calvo, G.A., 1999, "Contagion in Emerging Markets: When Wall Street is a Carrier," (Maryland: University of Maryland).

_____G.A. and E. Mendoza, 2000, "Rational Contagion and the Globalization of Securities Markets," *Journal of International Economics*, Vol. 51 (1), pp.79–113.

Chan-Lau, Jorge Antonio, Donald J. Mathieson, and James Yudong. Yao, 2004, "Extreme Contagion in Stock Markets," *Staff Papers,* International Monetary Fund, Vol. 51, (June), No. 2, pp. 169–94.

_____, Jorge Antonio and Iryna Ivaschenko, 2003, "Asian Flu or Wall Street Virus? Tech and Non-tech Spillovers in the United States and Asia," *Journal of Multinational Financial Management*, Vol. 13, No. 4–5 (December), pp.302–22.

Engle, R.F.,1982, "Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of UK Inflation". *Econometrica*, Vol. 50: pp. 987–1008.

Gelos, Gaston and Ratna Sahay, 2000, "Financial Market Spillovers in Transition Economies," IMF Working Paper 00/71 (Washington: International Monetary Fund).

Gonzalez-Hermosillo, Brenda, 2008, "Investors' Risk Appetite and Global Financial Market Conditions," IMF Working Paper 08/85 (Washington: International Monetary Fund).

Hamao, Y., R.W. Masulis, and V. Ng, 1990, "Correlations in Price Changes and Volatility Across International Stock Markets," *Review of Financial Studies*, Vol. 3, No. 2, pp. 281–307.

International Monetary Fund, 2008a, *China: Staff Report for the 2007 Article IV Consultation,* IMF Staff Country Report No SM/07/398 (Washington).

———, 2008b, "Can Asia Decouple? Investigating Spillovers from the United States to Asia," in *Regional Economic Outlook—Asia and Pacific*, World Economic and Financial Surveys (Washington, April).

———, 2008c, "Latin American Linkages to Global Financial Market Turbulence," in *Regional Economic Outlook—Western Hemisphere*, World Economic and Financial Surveys (Washington, April).

———, 2008d, Chapter 4, "Spillovers to Emerging Stock Markets," *Global Financial Stability Report,* World Economic and Financial Surveys (Washington, October).

Kalra, Sanjay, 2008, "Global Volatility and Forex Returns in East Asia," IMF Working Paper, WP/08/208, (Washington: International Monetary Fund).

Kodres, Laura.E., and Matthew. Pritsker, 2002, "A Rational Expectations Model of Financial Contagion," *Journal of Finance*, Vol. 57, pp. 769–99.

Liu, Li-gang, Laurent Pauwels, and Jun-yu Chan, 2008, "Do External Political Pressures Affect The Renminbi Exchange Rate?" Working Paper No. 05/2008 (Hong Kong: Monetary Authority).

Nelson, D.B., 1991, "Conditional Heteroskedasticity in Asset Returns: A New Approach," *Econometrica*, Vol. 59, No. 2, pp. 347–70.

Prasad , Eswar S. and Raghuram Rajan, 2008, "A Pragmatic Approach to Capital Account Liberalization," NBER Working Paper 14051, (Cambridge, Massachusetts: National Bureau of Economic Research).

Silvennoinen, Annastiina and Timo Terasvirta, 2008, "Multivariate GARCH models," SSE/EFI Working Paper Series in Economics and Finance No. 669 (January).

Tse, Y. K., and K. C. Tsui, 2002, "A Multivariate Generalized Autoregressive Conditional Heteroscedasticity Model with Time-Varying Correlations," *Journal of Business and Economic Statistics,* Vol. 20, No. 3 (July), pp. 351–62.

Worthington, Andrew and Helen Higgs, 2001, "A Multivariate GARCH Analysis of Equity Returns and Volatility in Asian Stock Markets," Economics and Finance Discussion Papers and Working Papers series No. 089 (Brisbane: Queensland University of Technology School).

Xinhua News Agency, 2008, "The Impacts of Global Financial Turmoil on China's Banking Industry is Limited," (China Banking Regulatory Commission, October 2008).