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The Dynamic Interrelationships between the Greater China Share Markets

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Abstract

This paper investigates the interrelationships between prices on the mainland Chinese share market and those in the neighbouring markets of Hong Kong and Taiwan. While there is a growing literature on interrelationships between share market including the emerging markets in Asia, very little is known about the role of mainland markets in the region. We consider the interrelationships between the Shanghai and Shenzhen exchanges and those in Hong Kong and Taiwan. We begin by combining the Shanghai and Shenzhen price indexes into a single value-weighted index and investigating its relationship to the indexes for Hong Kong and Taiwan. We find that the mainland markets are relatively isolated from the other two markets considered, although after the Asian crisis there is evidence that Hong Kong has weak predictive power for returns in the mainland. Hong Kong also clearly Granger-causes Taiwan although the reverse is not true. Both Hong Kong and Taiwan have strong contemporaneous relationships, a feature which is more marked after the Asian crisis. We also analysed the two mainland markets separately, both by themselves and with Hong Kong. We found some predictability of the prices in one market on the basis of lagged prices in the other although this was less apparent after the Asian crisis. Both before and after the 1997, there were strong contemporaneous relationships between the two mainland markets, vindicating our earlier decision to treat them as a single market.

1. Introduction

China's stock exchanges in Shanghai and Shenzhen are relatively new players in the Chinese economy and on the world financial scene. The two official stock exchanges, the Shanghai Stock Exchange and the Shenzhen Stock Exchange, were established in December 1990 and July 1991, respectively. Since their establishment, they have expanded rapidly in terms of capitalisation, turnover and number of firms listed with the result that China's stock market is now the second largest in Asia, behind only Japan. The speculation is that China's securities market has the potential to rank among the top four or five in the world within the coming decade (Ma and Folkerts-Landau 2001).

The Chinese stock market has some unique features. Two types of shares, A and B shares, are listed in the Shanghai and Shenzhen exchanges (Table 1).[1] A shares are denominated in the local currency (RMB or Renminbi). Foreign individuals or institutions are not allowed to buy and sell A shares. B shares are denominated in US dollars on the Shanghai Exchange and Hong Kong dollars on the Shenzhen Exchange. Only offshore investors are permitted to trade B shares. This restriction was, however, relaxed in early 2001 when it became permissible for individuals and legal persons in China to buy and sell B shares. Thus, for about a decade, the mainland Chinese markets and investors have been divided into two classes.

As is clear from the information in Table 1, B share markets have not expanded nearly as rapidly as A share markets with market capitalisation, turnover and number of stocks listed for A shares being almost ten times the corresponding figures for B shares. Moreover, the returns to A and B shares have behaved quite differently – it has been argued by Chen, Lee and Rui (2001), for example, that A shares are over-priced and that the returns to B shares move more closely with market fundamentals than do those for A share prices.[2]

There has been a growing interest in the interrelationships between national stock markets although research into the relationships between the two mainland Chinese markets and those in the rest of the world is in its infancy.

[1] Qi, Wu and Zhang (2000) distinguish 5 types of shares by further sub-dividing the A and B share according to ownership restrictions.
[2] Chakravarty, Sarkar and Wu (1998) also investigate the determinants of the A share premium but in terms of informational asymmetry and market segmentation. Su and Fleisher (1999) analyse the difference in volatility across the two boards.

The interest in interrelationships in general is many-facetted. First, there is an interest by international investors who are increasingly looking to emerging markets to diversify their portfolios and take advantage of the spectacularly high returns which have been reported for some new markets. This has lead to a focus on the international integration of stock markets, a question which has turned out to be rather more complicated than simply tracking correlations over time – see Ayuso and Blanco (2001) for a recent empirical study of this question.

A second source of interest is domestic investors: if there is a predictable relationship between one stock market and another, can this be used to make excess returns over a buy-and-hold strategy in the domestic market? While investors no doubt look to variables in addition to foreign stock returns, it is common to attribute daily movements in domestic stock prices to fluctuations in other closely related markets.

Thirdly, finance researchers are interested in interrelationships because they can throw light on the validity or otherwise of the semi-strong Efficient Markets Hypothesis (EMH) which states that in an informationally-efficient market returns cannot be predicted on the basis of any publicly available information, including returns in other markets.

We contribute to the growing knowledge of the operation of the mainland Chinese stock market by reporting on the results of an investigation into the dynamic interrelationships between the Shanghai and Shenzhen exchanges and between them and the two closely related exchanges in Taiwan and Hong Kong.

The structure of the paper is as follows. In the next section we provide a brief review of existing work and outline our contribution to the literature. We then set out our research procedures in section 3. We discuss the data in section 4 and present our main results in section 5, in which we focus on the relationship between the mainland Chinese market as a whole and the Hong Kong and Taiwan markets. We then move to presentation of further results when we examine the basis for the combination of the Shanghai and Shenzhen markets into a single entity and the effect of the Asian crisis of 1997-98 on the interrelationships between the markets examined earlier in the paper. Our conclusions are reported in the final section.

2. Overview of the Literature

Given the various reasons for interest in dynamic relationships between returns in different markets, it is not surprising that there has been considerable research in this area in the last decade. Early papers such as the one by Eun and Shim (1989) are defective in that they have ignored the non-stationarity of stock price indexes when specifying their model. Somewhat later papers by Corhay, Tourani Rad and Urbain (1993), Blackman, Holden and Thomas (1994) and Arshanapalli, Doukas and Lang (1995) introduced the notion of cointegration into the analysis and analysed the relationships between models mainly in these terms. In these and subsequent papers such as the one by Soydemir (2000) the cointegration analysis has often been supplemented by the more explicitly dynamic analysis of vector-error-correction models (VECMs), vector-autoregressive models (VARs) and the related dynamic tools of impulse-response functions (IRFs) and forecast-error-variance decompositions (FEVDs).

There have been several studies which have included applications to Asian markets, often in conjunction with developed markets; they include those by Eun and Shim (1989), Masih and Masih (1999), Cha and Oh (2000), Huang, Yang and Hu (2000) and Masih and Masih (2001). Of these papers all but the early paper by Eun and Shim use the notion of cointegration, estimate a simultaneous VAR or VECM models and employ IRFs and/or FEVDs. Only the paper by Huang, Yang and Hu (2000) include China among the Asian markets in their sample. Their sample consists of daily data for the period 1/10/1992-30/6/1997 for Hong Kong, Japan, Taiwan and the US as well as indexes for A share prices on the Shanghai and Shenzhen exchanges. They test the log share prices for stationarity and find that they are unambiguously I(1), as is common in the literature, and go on to test for cointegration but only in pairs of indexes rather than for the entire set of markets simultaneously. This seems a serious limitation since it is possible that there are cointegrating relationships between a number of variables without one existing between any two of them. Moreover, restricting the cointegration analysis to pairs precludes the possibility of finding more than one cointegrating relationship. Interestingly, they find that of all the possible pairs only Shanghai and Shenzhen are clearly cointegrated. Their bivariate focus is carried over to modelling – they estimate a series of bivariate VARs which they use for testing Granger causality between pairs of returns. They do not use the VARs for the standard dynamic analysis based on IRFs and FEVDs.

Thus, while there has been some investigation of the interrelationships between Asian share markets, only one of the papers cited has included mainland stock markets in their sample of countries but this paper has serious limitations in the extent of the analysis carried out. The aim of our paper is to overcome these problems and extend both their analysis and their sample period.

Like Huang, Yang and Hu (2000), we include both Shanghai and Shenzhen in our sample and, like them, we use indexes for A shares. Our main results are based on daily data for the period 5/10/1992 to 16/11/2001 for three markets: a value-weighted average of the Shanghai and Shenzhen markets (the "mainland" market), the Hong Kong market and the Taiwan market. We also report the results of additional analysis. First we provide a case for the combination of the two mainland markets by analysing them separately both alone and in combination with Hong King and we show that they are cointegrated and behave like a single market.

We then go on to analyse the effects of the Asian crisis of 1997-98 on our results. There has been considerable attention paid in recent research to possible changes in various relationships due to the Asian crisis. Thus, for example, there has been analysis of the effects of the crisis on the nature of trade flows and on exchange rate fluctuations (see, Nieh, 2002, for a recent reference). There has, however, been very little reported on the effects of the crisis on stock market interrelationships. We go some way to remedying this omission by repeating our analysis for two sub-periods: 5/10/1992-30/6/1997 and 1/7/1998-16/11/2001 which were chosen to highlight the possible effects of the Asian financial crisis. We compare the nature of equilibrium relationships as well as of dynamic responses before and after the crisis.

In each of these country combinations we test for cointegration and specify and estimate a VECM or VAR as appropriate. We then use the estimated model to address questions of long-run and short-run dynamic relationships among the stock price indexes. Before discussing our results we briefly describe our research procedures and data.

3. Research Procedure

We begin by testing each of the log price series for a unit root using the augmented Dickey-Fuller (ADF) test based on the following equation .[3]

$$(1) \qquad \Delta lnP_t = \alpha_0 + \alpha_1 \ln P_{t-1} + \alpha_2 t + \sum_{j=1}^{N} \beta_j \Delta \ln P_{t-j} + \varepsilon_t$$

where *lnP* represents the log of the share price index, Δ is the first-difference operator, *t* is a trend term and ε is a serially-uncorrelated random error term. We test the hypothesis $H_0:\alpha_1=0$ so that the log price process has a unit root under the null. We conduct the tests with and without the trend term and for various lag lengths. If the log price has a unit root we test the first difference in the log price (the continuously compounded return) for a unit root and if the null is rejected in this case we conclude that the log price is I(1). We note that Huang, Yang and Hu (2000) use the test devised by Zivot and Andrews (1992) which allows for an undetermined break in the data when testing for a unit root. However, they report that all series are non-stationary despite allowing for the break and we do not pursue this variant of the ADF test. Besides, we compute the test for sub-periods with a break coinciding with the Asian crisis which is the date most likely to result in a shift in the process generating the price indexes.

For those series which we find to be non-stationary we conduct cointegration tests since it is possible that even though the individual series are non-stationary a linear combination of them is stationary so that a long-run relationship can be identified between them. The test for cointegration which naturally follows from the ADF test above is the test due to Engle and Granger (1987) which tests the residuals from the regression of one I(1) variable on one or more others for stationarity and concludes that if the residuals are stationary, a stationary linear combination of the I(1) variables has been found so that they are cointegrated. This test, however, has several statistical weaknesses – see Campbell and Perron (1991). Besides, the technique cannot discover all possible cointegrating vectors. For these reasons, the simultaneous-equation ML procedure based on Johansen (1988) and Johansen and Juselius (1990) is preferred and is the one we implement. The Johansen test is based on the following simultaneous-equation model:

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[3] See Dickey and Fuller (1981).

(2) $\Delta \boldsymbol{lnP}_t = \gamma + \sum_{i=1}^{N-1} \Gamma_i \Delta \boldsymbol{lnP}_{t-i} + \Pi \boldsymbol{lnP}_{t-N} + \varepsilon_t$

where $\boldsymbol{lnP}$ is an m-vector of log share prices and Γ and Π are (mxm) coefficient vectors. The number of cointegrating relationships depends on the rank of Π. If the rank of Π is r then there exist two matrices, α and β, both (mxr) such that $\Pi = \alpha\beta'$ where β contains the r cointegrating vectors such that $\beta' \boldsymbol{lnP}$ are stationary even though the individual lnP series are themselves I(1) and α contains the corresponding error-correction coefficients. Johansen (1988) proposes tests based on the trace and maximum eigenvalues statistics and we report the results of the use of both of these tests.

In the case where no cointegrating relationships are found (the most common case, to anticipate our results) we estimate a VAR in the first differences of the log prices (i.e., the returns). Denoting the vector of returns by $\boldsymbol{x}$, the model can be written as:

(3) $x_t = \Phi(L)x_t + \varepsilon_t, \qquad t = 1,1,\ldots,T$

where $\Phi(L)$ is a pth-order matrix polynomial in the lag operator, L, where $L^n x_t \equiv x_{t-n}$. We assume that $\boldsymbol{x}_t$ is stationary and that $E(\varepsilon_t \varepsilon_t') = \Sigma$ is a positive definite matrix. We have ignored a constant (and other deterministic terms) for ease of exposition.

The two main tools for the analysis of the dynamic properties of our VAR model are the impulse response function (IRF) and the forecast-error-variance decomposition (FEVD). The IRF is easily derived from the vector moving-average (VMA) form of the model which can be obtained from (3) as:

(4) $x_t = A(L)\varepsilon_t$,

where $A(L) = (I-\Phi(L))^{-1}$, an infinite-order matrix polynomial in L. One way of generating IRFs from (4) is to set one of the elements of ε_t at a non-zero value and all the others at zero and then trace the effects through successive values of $\boldsymbol{x}_t$. However, this ignores the fact that the elements of ε_t will generally be correlated so that historically a shock to one of the elements of ε_t will be associated with changes in other of its elements. A common method of overcoming this difficulty is to re-define the error terms to make them orthogonal so that they can be shocked independently. This is generally achieved by using the Choleski decomposition of the contemporaneous covariance matrix of the errors, Σ. Since Σ is positive definite there exists a lower-triangular matrix (not necessarily unique), $\boldsymbol{Q}$, such that

(5) $\boldsymbol{QQ'} = \boldsymbol{\Sigma}$

The model can then be written in terms of the transformed errors, $\xi_t = \boldsymbol{Q}^{-1}\varepsilon_t$, which are orthogonal. In this case the value of the IRF for the ith element of $\boldsymbol{x}$ following a shock to the jth error term n periods after the shock is given by

(6) $IRF_{ij}(n) = \boldsymbol{e}_i'\boldsymbol{A}_n\boldsymbol{Q}\boldsymbol{e}_j, \qquad i,j = 1,2,\ldots,m;\ n = 0,1,2\ldots$

where $\boldsymbol{e}_i$ is the ith unit vector and $\boldsymbol{A}_n$ is the nth matrix in the matrix polynominal $\boldsymbol{A(L)}$.

While this is a popular procedure, it has the weakness that the orthogonalisation is not unique and the resulting IRFs are not unique but depend on the order in which the variables enter the model. An alternative method, recently suggested by Pesaran and Shin (1998), is to shock a particular error and then to shock all other errors in a way which preserves the historical relationship between them (or some other assumed correlations). They show that his involves computing the counterpart to (6) as:

(7) $IRF_{ij}^{G}(n) = \sigma_{jj}^{-1}\boldsymbol{e}_i'\boldsymbol{A}_n\boldsymbol{\Sigma}\boldsymbol{e}_j \qquad i,j = 1,2,\ldots,m;\ n = 0,1,2\ldots$

where σ_{jj} is the jth diagonal element of $\boldsymbol{\Sigma}$. The advantage of the use of the generalised IRFs is that they not affected by the ordering of the variables in the model. However, since the shocks in this case are not orthogonal, the IRFs do cannot simply be added as they can in the conventional Choleski case. This is not usually a serious weakness since they are generally inspected one at a time. A more serious drawback of the use of the generalised procedure of Pesaran and Shin is that the FEVDs associated with it do not sum to unity as they do when the Choleski decomposition is used. This will become evident from the tables presented below but will not affect our ability to interpret the results.

FEVDs based on the standard Choleski diagonalisation are defined as the proportion of the forecast error variance at a particular forecast horizon which is accounted for by the orthogonalised errors of each of the variables in turn. As in the case of the IRFs, the FEVDs are generally dependent on the order in which the variables appear in the model, a limitation which is overcome by generalised FEVDs which take account of the sample information on the contemporaneous correlations of the errors. Using the notation of the generalised IRFs, the generalised FEVD can be defined as:

(8) $$FEVD_{ij}^{G}(n) = \sigma_{jj}^{-1} \sum_{k=0}^{n} (e_i' A_k \Sigma e_j)^2 \Big/ \sum_{k=0}^{n} (e_i' A_k \Sigma A_k' e_i) ,$$

$$i,j = 1,2,\ldots,m;\ n = 1,2,3,\ldots$$

4. Data

With one exception, all the data were obtained from the Datastream International database. The exception is the capitalisation data for the Shanghai and Shenzhen markets which were obtained from the *Taiwan Economic Journal* database since they were not available from Datastream. Daily data were obtained for price indexes for Shanghai, Shenzhen, Taiwan and Hong Kong as well as capitalisation data for the two mainland exchanges. The data for Shanghai and Shenzhen were for the prices for A shares. The capitalisation data were used to construct a value-weighted A share index for the mainland as a whole.

We follow Huang, Yang and Hu (2000) in our use of A share prices. While B shares are available for purchase by foreign investors and are therefore likely to be a closer substitute for foreign shares, the market for B shares is very thin and recent evidence suggests substantial spurious autocorrelation due to thin trading.[4] We therefore use the A share indexes as more closely capturing the dominant trends in the mainland stock exchanges.

Our sample period runs from 5 October, 1992 to 16 November, 2001, the starting date being determined by the earliest date for which data for the Shenzhen data are available. We conducted tests both using the full sample and for sub-samples. The sub-samples were chosen to isolate the effects of the Asian financial crisis which started in early July, 1997 and continued in various countries into 1998. We experimented with two alternative divisions, the first of which omitted July 1997 and the second of which omitted all of July 1997 to June 1998. It turned out to make little difference which was used and we report results only for the sub-samples omitting the entire 1997-98 financial year.

Summary statistics are reported for returns calculated as the first differences in the logs of the price indexes in Table 2. They are reported for the full sample as well as for the two sub-samples.

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[4] See, e.g., Groenewold, Tang and Wu (2001).

Over the full sample the Shanghai portfolio has both the highest return and the highest standard deviation with Taiwan having both the lowest return and the lowest risk. Not surprisingly, the returns were higher before the crisis than they were after with the difference being more marked for the non-mainland markets although it is interesting that even the relatively isolated markets of Shanghai and Shenzhen showed the same trends.

The skewness, excess kurtosis and normality statistics have several interesting features. First, the returns are skewed for the mainland series but generally not for those for Taiwan and Hong Kong. Secondly, judging by the size of the statistics, the departures from normality were less pronounced after the crisis than before, with dramatic reductions for the mainland markets in particular. Nevertheless, overall the returns showed persistent and significant deviations from normality over both sub-periods, this being a common feature of all financial data.

Tests of stationarity of the log prices indexes are reported in Table 3.
With only one exception, all the evidence points to non-stationarity of the log price indexes. The results are not sensitive to lag length and presence of a trend in the testing equation. Table 4 reports similar statistics for the first difference in the log of the price indexes.

The results in Table 4 clearly show that all return series are stationary for all periods, at all lag lengths, whether a trend is included in the Dickey-Fuller equation or not. Thus we conclude that all the log share price series are I(1) and we turn next to an examination of cointegration. This analysis throws preliminary light on the question of the interrelationships between the markets since if two or more I(1) variables are cointegrated, then there exists a long-run equilibrium relationship between them and, by virtue of the Granger Representation Theorem, at least one of the variables Granger-causes another.[5]

For reasons outlined in Section 3, we use Johansen's test, the results for which are reported in Table 5. Again we report results for the full sample and for the two sub-samples. Given the unimportance of the trend in the tests of stationarity, we computed the Johansen statistics within a model without a trend. We chose the lag order in the model as the minimum lag consistent with the absence of autocorrelated residuals in all the model equations.

[5] See Engle and Granger (1987).

We began with a test involving just the two mainland series in order to examine the relationship between these two markets in isolation. There is clear evidence of a cointegrating relationship between them if data for the full sample are used; at the 5% level of significance, the null hypothesis that the number of cointegrating vectors is zero is clearly rejected by both the trace and eigenvalue tests. This points to a long-run equilibrium relationship between them, a relationship which is captured by the cointegrating vector reported in the last column of the table. Moreover, it makes for Granger causation between the price series in at least one direction, thus violating the semi-strong Efficient Markets Hypothesis (EMH).

A similar result is obtained for the two markets using data before the Asian crisis, reported in the second panel of the table; the null of no cointegrating relationship is clearly rejected at the 5% level by both tests. However, the outcome of the test is dramatically reversed in the second sub-sample – both trace and eigenvalue statistics are well short even of the 10% critical values. Interpreting this finding within the framework of the EMH, there is therefore evidence that the efficiency of the markets improved after the crisis although we would hesitate to attribute this improvement to the crisis itself – it may simply be the outcome of increasing maturity of the market in the second half of the decade.

We next combine the two mainland indexes with the price index for the Hong Kong market. For the sample period as a whole, there is weak evidence of cointegration – for both tests we can reject the null of no cointegration at the 10% but not at the 5% level. The estimated cointegrating vector reported in the last column of the table indicates that by far the strongest relationship is between the two mainland markets with little impact of a change in the Hong Kong index on the other two. The evidence for cointegration is weaker for the sub-periods – for the pre-crisis period there is evidence of cointegration at the 10% level from only one of the two tests and for the post-crisis period the test statistics are again quite far from their critical values (although, interestingly, not as far as when the two mainland indexes are tested together for this sub-sample).

Thus, there is evidence, at least for the pre-crisis period, that the two mainland markets have cointegrated prices but that they are not cointegrated with the Hong Kong market. Given the strong relationship between Shanghai and Shenzhen as well as evidence to be presented below of their strong dynamic interrelationship, we decided to experiment with a single mainland index constructed as the capitalisationweighted average of the Shanghai and Shenzhen indexes. The next results reported in Table 5 relate to the question of the cointegration of the mainland index and the Hong Kong index. Not surprisingly, in light of our previous findings, there is no evidence of cointegration between the Hong Kong and mainland index either for the full sample or for either of the sub-samples.

Finally, we add the index for Taiwan to the Hong Kong and mainland indexes and investigate the possibility of cointegration between the three indexes. The results show clearly that prices in the three markets are not cointegrated. This is true for the full sample as well as the two sub-samples and for both the trace and the eigenvalue tests.

We conclude on the basis of the cointegration analysis that prices for the three stock markets are not cointegrated so that there is no long-run equilibrium relationship between them. However, for the first part of the sample period there is strong evidence of cointegration between the two individual mainland markets of Shanghai and Shenzhen, evidence of inefficiency in the semi-strong sense which seems to have disappeared in the post-crisis period. Our evidence is consistent with but extends that of Huang, Yang and Hu (2000) who find cointegration (using the Gregory and Hansen, 1996, extension of the Engle-Granger test for cointegration) between the two mainland indexes for the period before the Asian crisis. Our results show that using the alternative and generally-preferred Johansen test there is evidence for cointegration before the crisis but none after the crisis. Their results are, therefore, sample-specific and reversed for a later sample period.

5. Main Findings

While we have information for four markets, we concentrate our attention on the results obtained by combining the two mainland Chinese markets. The cointegration results reported above indicate that at least for the first half of the sample period, the two markets were cointegrated and we report in more detail in the next section analysis based on considering the two markets separately which indicates that they behave very much like a single market relative to the other markets in the region.

Since the cointegration analysis shows that the prices in the three markets are not cointegrated, we estimate a VAR model in the first differences of the logs of the prices (i.e., the continuously-compounded returns). the lag length was chosen as the minimum lag length necessary for all three equations to be free of autocorrelation at the 5% level. This required five lags. A similar lag length was used for each of the sub-periods to ensure comparability.

The estimated VAR models, ons for the full sample and one for each of the sub-samples obtained by omitting the whole of 1997-98, are in Table 6. The explanatory power for the returns for all three markets is very low as is common for models of this type – daily returns are notoriously difficult to predict as they should be if the EMH holds. Of the three the equation for the Hong Kong market has the least explanatory power indicating that it is in this sense the most efficient. All three markets show autoregressive characteristics with at least one lag of the market's own return being significant in each case. In the case of the return for the mainland market, we found that the lagged return in each of the other two markets has weak predictive power. The Hong Kong market is relatively independent of the other two – only its own lagged returns have any significant predictive power. The market for Taiwan, on the other hand, is significantly influenced by the lagged returns on both of the other markets, particularly Hong Kong at one lag. Thus it appears that Taiwan is influenced significantly by the other two markets (as well as its own lagged returns) but it, in turn, has little effect on either Hong Kong or China. These conclusions are borne out by the Granger-causality statistics which show that Hong Kong Granger-causes Taiwan but there is no other causality in this set of three markets.

Consider next the results of estimating the model over two separate sub-periods obtained by deleting all the observations for 1997-98. There is no clear improvement in explanatory power and the variables which are significant in each equation are similar to those which feature in the full-sample results although for both sub-samples fewer variables are significant than is the case for the full sample. Granger causality tests also have the same outcome for the pre-crisis period – the only causality is that from Hong Kong to Taiwan – but there is additional causation after the crisis – from Hong Kong to mainland China, albeit only at the 10% level of significance. There is some evidence therefore that the mainland market became more closely linked to the Hong Kong market after the crisis but the regression result show that the link to Taiwan was weaker.

All in all, it appears that the mainland stock market is relatively isolated from the other two – it has little effect on either Hong Kong or Taiwan and is, in turn, little affected by them. On the other hand, the other two markets are related although the relationship is mainly one-way from Hong Kong to Taiwan. The isolation of the mainland market, however, was less marked after the Asian crisis than before although it was influenced by Hong Kong and not Taiwan.

The discussion so far has been based on the estimated VAR and concentrated on the significance of the estimated coefficients. We consider now the IRFs which show the dynamic interaction between the two markets and reflect the size and sign of the coefficients rather than their significance. We present first the two IRFs based on the model estimated from data for the full sample; they are given in Figure 1 where we can see the effects of a single shock on all markets.

The IRFs make it clear that the three markets are relatively isolated from each other over the sample as a whole. By far the greatest effect of a shock is on the market in which the shock occurs – the effects on the other two markets are relatively minor. There is some evidence to support the conclusion drawn from the regression results reported above that the influence of Hong Kong on Taiwan is greater than oin the opposite direction and that the influence of the mainland Chinese market on the other two is negligible.

It appears, therefore, that the mainland market is relatively isolated – shocks to it are felt mainly in its own market and it is, in turn relatively unaffected by shocks to the other markets. Taiwan and Hong Kong do show some interrelationships even though their shocks are felt mainly in their own markets.

Consider now the question as to whether these dynamic interrelationships changed as a result of the Asian crisis in 1997-98. We present IRFs for the two sub-samples in Figure 2 which contains nine graphs, one for the effects of each of the three shocks on each of the three markets separately with each graph showing the effects before and after the crisis. The size of the effects are not strictly comparable to those in Figure 1 since we standardised the variables separately for each sub-sample before deriving the IRFs in Figure 2. All shocks are equal to one standard deviation of the equation error term and comparisons across sub-samples may simply reflect the differences in the size of these standard deviations and therefore the differences in the magnitude of the shock if the shocks are not standardised across the two halves of the sample.

It is clear that the own-effects are little different after the Asian crisis than before and that mainland China is relatively isolated after as well as before 1997. Interestingly, the interrelationships between Taiwan and Hong Kong seem to have strengthened after the crisis – shocks which have unit own effects had effects on the other market of around 0.1 before the break and around 0.2 after the break showing that contemporaneous effects between these two markets has strengthened. Further, the general volatility of the responses of one to the other has increased in general over the period. These conclusions are largely supported by the evidence provided by the FEVDs reported in Table 7.

As is common in FEVDs and as we saw in the IRFs, the own effects dominate so that most of the forecast error variance is accounted for by the errors in the market being analysed. The first sub-period results are quite similar to those for the sample as a whole but there is evidence of somewhat greater interdependence in the post-crisis period – in each case more of the forecast error variance is accounted for by shocks to the other two markets, this being particularly true of the relationships between Hong Kong and the mainland markets.

We can conclude this section by remarking that the mainland Chinese market has been relatively isolated from the other two markets considered. This was borne out by the regression results but particularly by the dynamics – both the IRFs and the FEVDs showed clearly that shocks to the mainland market were felt primarily in that market itself and that shocks in the other two markets had relatively little impact on the mainland Chinese markets. However, there is some evidence that the interrelationships strengthened during the course of the 1990s, particularly between the mainland market and Hong Kong. It is unfortunate (from a statistical point of view) that the return of Hong Kong to the People's Republic of China and the Asian crisis occurred more or less simultaneously so that their effects are difficult to disentangle. Thus whether the modest growth in interrelationships is due to the one or the other is difficult to discern at this level of aggregation.

6. Further Analysis

In the previous section we presented our main results based on the combination of the two markets of Shanghai and Shenzhen into a single market by using a value-weighted average of their prices to represent the mainland market. In this section we present a further analysis where the two mainland markets are treated separately. We begin by considering them in isolation from the other markets before adding the Hong Kong market to the model.

6.1 Shanghai and Shenzhen

We begin with the two mainland markets of Shanghai and Shenzhen in isolation and consider the estimated dynamic model. Recall from section 4 that the logs of the price indexes are cointegrated for the full sample and for the first of the two sub-samples but not for the second sub-sample. Thus we could estimate a VECM for the two samples for which the indexes are cointegrated. That, however, would have made the comparison of responses before and after the crisis difficult. Given our interest in the effect of the crisis on the interrelationships, we decided to estimate an unrestricted VAR in the first differences of the logs for each of the period. Since the VECM is simply the VAR with an error-correction term added, it is possible to compare the two estimated models. A comparison for the whole sample shows that the coefficients of the VAR are almost identical to their counterparts in the VECM – the signs are all the same and the magnitudes are very similar. Thus, while strictly-speaking the VARs for the full sample and the first sub-sample are mis-specified, there seems to be little effect on the estimated coefficients and we proceed with a consideration of the VARs only. The results for the full sample and the two sub-samples are reported in Table 8.

Consider the full sample results first. The explanatory power of the equations is low in both cases but consistent with previous results. Explanatory power is somewhat higher for the Shanghai equation than it is for the Shenzhen one and in both equations there are some significant lags of the dependent variable, indicating violation of the weak EMH, although this effect is stronger for Shanghai. For both equations at least one lag of the return in the other market is significant, indicating violation of the semi-strong EMH, and it is interesting that in the equation for Shenzhen lagged Shanghai returns seem to be more important than lagged returns for Shenzhen itself. The test for Granger causality indicates two-way causality in which each Granger-causes the other.

In the first of the two sub-samples (pre-crisis) the explanatory power of the Shanghai equation is marginally better than for the sample as a whole but identical for the Shenzhen equation. Lagged returns for both markets have a significant effect on the Shanghai return but no lagged returns are significant at the 5% in the Shenzhen equation although several are significant at the 10% level. These features are reflected in the Granger causality test results – Shenzhen Granger-causes Shanghai at the 1% level but causation in the opposite direction fails evens at 10%. In the post-crisis period the explanatory power of both equations is much weaker as evidenced by the adjusted R^2 figures and in neither equation is any lagged return significant even at the 10% level. The Granger-causality tests now indicate that there is no causation in either direction. Thus the predictability that was evident before the crisis on the basis of lagged returns in both markets is altogether absent after the crisis suggesting a marked improvement of the efficiency of the two markets if we view the results in the framework of the EMH. these results are, of course, consistent with the cointegration results reported in section 4.

Consider next the IRFs and FEVDs. We present first the IRFs based on the model estimated from data for the full sample; they are given in Figure 3.

The first graph in Figure 3 shows the effects on both the Shanghai and Shenzhen markets of the shock to the error in the equation for the return in the Shanghai market and the second shows the effect on the two markets of a shock to Shenzhen. They are remarkably similar – a shock to one market has only a slightly larger effect on that market's own return and this is true for both markets. In both cases the effect of the shock dies out very quickly; in fact, there is little effect on either market after the initial shock is felt. These results point to a high degree of integration between the two markets – shocks are transmitted across markets very quickly and it is difficult to distinguish between the markets in terms of the effects of the shocks.

We also present IRFs for the two sub-samples in Figure 4 which contains four graphs, one for the effects of each of the two shocks on each of the two markets separately with each graph showing the effects before and after the crisis. Recall that the size of the effects are not strictly comparable to those in Figure 3 since we standardised the variables separately for each sub-sample before deriving the IRFs in Figure 4.

The four graphs in Figure 4 show that the own-effects are almost identical over the two sub-periods – the initial effects are indistinguishable and all shocks die out quickly. The cross-market effects differ somewhat in magnitude but are similar in shape. In both cases the initial effect of the shock is bigger after the crisis, suggesting that the markets are more integrated after the crisis than before. This contrasts with the results described in Table 8 which show that causality between the two markets was weaker after the crisis than it was before. However, it should be recalled that the causality and predictability were based on significance and the IRFs reflect the size and sign of the estimated coefficients, whether significant or not. Moreover, the VAR does not capture contemporaneous effects while the IFRs do. Hence it is likely that the two markets were more integrated after the crisis than before in the sense of contemporaneous correlations because, e.g., they reacted to very similar shocks but there was weaker predictability so that shocks in one market were not transmitted to the other with a lag.

The conclusions drawn from the IRFs are confirmed by the information gained from the FEVDs reported in Table 9. Clearly for the sample as a whole the Shanghai error explains the major part of Shanghai's forecast error at all horizons and similarly for Shenzhen. However, the errors in the other market also contribute substantially to each market's forecast error – over a third in each case, in contrast to the results reported in the previous section, for example, where the errors in the other markets contributed less than 5% to the errors variance. In all cases there is little variation across the forecast horizon. For the sub-periods, the results are broadly similar for the pre-crisis period but markedly different for the post-crisis period when the relative contributions of the two errors are approximately the same for each market confirming the results we obtained above.

The implications of the IRFs and FEVDs are that the markets are closely integrated in that a shock in a particular market has a similar effect in each of the markets and that these features are more marked after the crisis than they were before. There is no evidence, however, that the cross-market predictability has become stronger – the effect is largely contemporaneous.

The above results suggest that we would be justified in treating the two markets as one as we did in the previous section. Before coming to a firm conclusion of this nature, however, we add the Hong Kong market to the model, Hong Kong being the market which is likely to be the most closely related to the mainland markets. This will allow us to ascertain whether the results we have just reported survive the addition of a further market and whether either of the two mainland markets is more closely related to Hong Kong than the other, a feature which would undermine our combination of the two markets into a single market.

6.2 Shanghai, Shenzhen and Hong Kong

The estimated VARs in the returns for these three markets are reported in Table 10 which has three panels, the first with the full-sample results, the second with the results for the first sub-sample and the third with the results for the post-crisis period. Consider the full-sample results first. The explanatory power is somewhat higher than for the two-equation model indicating that the inclusion of the Hong Kong returns increases the ability of the VAR to explain the returns over the period. As in the case of the two-variable model, more of the Shanghai returns than the Shenzhen returns can be explained. The explanatory power of the equation for the Hong Kong return is lower than for either of the mainland exchanges, not surprisingly if they are interpreted in terms of the EMH since it is likely that the Hong Kong market, being more mature than either of the mainland markets would be more efficient.

Some lagged values of returns for both Shanghai and Shenzhen are significant in each of the Shanghai and Shenzhen equations and a lagged Shanghai return is significant in the Hong Kong equation. On the other hand, lagged Hong Kong returns have no predictive power (at the 5% level) for either the Shanghai or Hong Kong returns but one lagged Hong Kong return is significant in the Shenzhen equation. Thus the two mainland markets seem to be more strongly interconnected with each other than they are with the Hong Kong market although the latter does have an effect on the Shenzhen market and is, in turn, influenced by the Shanghai market. Granger causation results confirm this conclusion: there is two-way causation between Shanghai and Shenzhen as there was in the two variable model but Hong neither causes nor is caused by either of the mainland markets.

The results for the pre-crisis period are quite similar to those for the whole sample: Shanghai and Shenzhen both have some predictive power for each other while Hong Kong has predictive power only for Shenzhen but is predicted by Shanghai. The Granger results are not quite as clear-cut; there is again two-way causation between Shanghai and Shenzhen returns (but only at the 10% level for the Shanghai to Shenzhen direction), Hong Kong causes neither Shanghai not Shenzhen but is, in this case, caused by Shanghai. So, there is some weak relationship between the mainland exchanges and Hong Kong but it seems that the relationship runs from Shanghai to Hong Kong to Shenzhen rather than being clearly stronger with its neighbouring market of Shenzhen.

In the second sub-sample the explanatory power of all the equations is higher than in the full sample and for Shenzhen and Hong Kong they are also higher than in the pre-crisis period suggesting an increase in predictability. However, the significance of the individual coefficients is quite different compared to the other two periods – only two lagged Hong Kong returns are significant at the 5% level in each of the Shanghai and Shenzhen equations and no variables are significant in the equation explaining the returns in Hong Kong. This is strongly confirmed by the results of the Granger-causality tests: Shanghai and Shenzhen cause nothing (neither each other or Hong Kong) and Hong Kong Granger-causes both of the mainland exchanges.

We turn next to the dynamic interactions as portrayed by the IRFs and FEVDs. The IRFs are shown in Figures 5 and 6, the first showing IRFs based on the full sample and comparing the effects of shocks across markets and the second comparing shocks across the two sub-samples. What stands out from these IRFs is the similarity of Shanghai and Shenzhen relative to Hong Kong. As indicated earlier on the basis of the results for Shanghai and Shenzhen on their own, these two mainland markets seem to behave as one and clearly the addition of the Hong Kong market to the model has done nothing to change this feature. Moreover, there is not a pronounced difference in the response of the two mainland Chinese markets to shocks originating in Hong Kong. This is also true when we compare effects before and after the Asian crisis as we do in Figure 6. The own effects are almost identical across the periods for each of the three markets and, as for the cross-market effects, a Hong Kong shock has very similar effects on Shanghai and Shenzhen and, vice versa, the effects on Hong Kong of Shanghai and Shenzhen shocks is very similar. The cross-market effects, though, all appear to be more volatile after the crisis.

These conclusions are confirmed when we inspect the FEVDs which are reported in Table 11. On the whole Hong Kong seems only very loosely connected to the mainland markets compared to their connections to each other although the interconnection seems to be a little more substantial after the crisis.

Thus it is clear that the relationship between the two mainland stock markets is very much stronger than either market's relationship to Hong Kong and we were quite justified in treating them as a single market for the purposes of our main results presented in section 5.

5. Conclusions

This paper has examined the inter-relationships between the stock markets of the Chinese mainland – Shanghai and Shenzhen – and Hong Kong and Taiwan. We examined them both before and after the Asian crisis of 1997-98 using VAR models which we used for the analysis of individual coefficients, tests of Granger causality as well as a basis for impulse response functions (IRFs) and forecast-error-variance decompositions (FEVDs).

Or main results focussed on the relationship between a single mainland index, calculated as a value-weighted average of the Shanghai and Shenzhen indexes, and the indexes for Hong Kong and Taiwan. We found that the mainland Chinese market had been relatively isolated from the other two markets considered. This was borne out by the regression results but particularly by the dynamics – both the IRFs and the FEVDs showed clearly that shocks to the mainland market were felt primarily in that market itself and that shocks in the other two markets had relatively little impact on the mainland Chinese markets. However, we found some evidence that the interrelationships strengthened during the course of the 1990s, particularly between the mainland markets and Hong Kong but whether the modest growth in interrelationships is due to the occurrence of the Asian crisis in 1997-98 or the greater integration of the Chinese economy into the world economy (one aspect of which was the return of Hong Kong to the People's Republic) will require more detailed and disaggregated structural modelling.

We then explored the effects of treating the two mainland markets separately, both to test the assumption underlying their combination in the main results and to assess whether the other two markets had differential impacts on these two markets. We found that our assumption that they could be treated as a single market was vindicated – in all cases the a shock to Shanghai was felt mainly in Shenzhen and vice versa with little spillover to Taiwan or Hong Kong and, in addition, the two mainland markets responded in a very similar manner to outside shocks.

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Table 1. Summary Statistics of China's Stock Exchanges (as at the end of 2000)

	Shanghai	Shenzhen
A shares		
Date of establishment	December 19, 1990	April 3, 1991
Capitalisation (bn yuan)	2660	2086
Turnover (bn yuan)	3103	2925
No. of companies listed	559	499
B shares		
First listing	February 1992	February 1992
Capitalisation (bn yuan)	33	30
Turnover (bn yuan)	34	20
No. of companies listed	55	38

Note: yuan is the Chinese currency unit. In 2000, US$1 = 8 yuan app.
Source: Ma and Folkerts-Landau (2001), appendix, pp.15 and 18.

Table 2. Summary Statistics

	Mean	St Dev	Skewness	Kurtosis	Normality
Full Sample: 5/10/1992 - 16/11/2001					
DLSH	0.0004	0.0289	32.91	204.73	42909.7 [.000]
DLSZ	0.0002	0.0261	19.67	163.26	26985.4 [.000]
DLML	0.0003	0.0269	27.42	186.84	35587.3 [.000]
DLHK	0.0003	0.0186	0.61	83.09	6889.1 [.000]
DLTW	0.0001	0.0167	-0.58	26.06	678.2 [.000]
Sub-Sample 1: 5/10/1992 - 30/6/1997					
DLSH	0.0005	0.0376	20.79	91.86	8835.8 [.000]
DLSZ	0.0004	0.0329	13.87	82.23	6927.3 [.000]
DLML	0.0004	0.0344	18.19	88.80	8184.0 [.000]
DLHK	0.0008	0.0143	-5.84	25.77	695.5 [.000]
DLTW	0.0007	0.0151	0.16	22.52	505.2 [.000]
Sub-Sample 2: 1/7/1998 - 16/11/2001					
DLSH	0.0002	0.0147	3.42	41.99	1767.2 [.000]
DLSZ	0.0002	0.0153	2.53	37.40	1399.4 [.000]
DLML	0.0002	0.0148	3.13	40.83	1669.6 [.000]
DLHK	0.0003	0.0192	0.55	13.60	184.4 [.000]
DLTW	-0.0006	0.0189	0.51	12.26	149.8 [.000]

Notes: the mnemonics are: DL = change in logs, SH = Shanghai, SZ = Shenzhen, CH = China (a value-weighted average of the Shanghai and Shenzhen data), HK = Hong Kong and TW = Taiwan. The skewness and kurtosis statistics are N(0,1)-distributed under the null hypothesis of normal returns and the Normality statistic is the Jarque-Bera statistic which is χ^2 – distributed with 2 degrees of freedom under the same null. Figures in brackets after the Normality statistics are prob values.

Table 3. Stationarity Tests: Log Price Indexes

	Shanghai		Shenzhen		Mainland		Hong Kong		Taiwan	
Test	**No Trend**	**Trend**	**No Trend**	**Trend**	**No Trend**	**Trend**	**No Trend**	**Trend**	**No Trend**	**Trend**
Full Sample: 5/10/1992-16/11/2001										
DF	-1.63	-2.78	-1.01	-2.10	-1.44	-2.57	-2.42	-2.35	-1.94	-1.27
ADF(1)	-1.64	-2.80	-1.03	-2.11	-1.46	-2.61	-2.44	-2.41	-1.95	-1.29
ADF(2)	-1.69	-2.90	-1.08	-2.17	-1.50	-2.67	-2.41	-2.33	-2.01	-1.39
ADF(3)	-1.86	-3.20	-1.10	-2.20	-1.62	-2.87	-2.49	-2.57	-2.06	-1.47
ADF(4)	-1.96	-3.38	-1.22	-2.34	-1.72	-3.03	-2.46	-2.49	-1.98	-1.32
ADF(5)	-2.03	-3.52	-1.23	-2.36	-1.80	-3.18	-2.44	-2.42	-2.02	-1.40
ADF(6)	-1.91	-3.31	-1.14	-2.25	-1.67	-2.96	-2.42	-2.37	-1.97	-1.30
Sub-Sample 1: 5/10/1992-30/6/1997										
DF	-1.99	-2.02	-0.83	-0.94	-1.61	-1.69	-1.05	-2.10	-0.89	-1.54
ADF(1)	-1.98	-2.04	-0.84	-0.95	-1.64	-1.73	-1.11	-2.22	-0.85	-1.50
ADF(2)	-2.11	-2.17	-0.95	-1.05	-1.74	-1.82	-1.14	-2.30	-0.91	-1.57
ADF(3)	-2.39	-2.45	-0.97	-1.07	-1.93	-2.00	-1.17	-2.37	-0.98	-1.66
ADF(4)	-2.56	-2.62	-1.14	-1.22	-2.09	-2.16	-1.15	-2.32	-0.96	-1.64
ADF(5)	-2.71	-2.76	-1.18	-1.26	-2.25	-2.32	-1.13	-2.28	-1.01	-1.70
ADF(6)	-2.50	-2.55	-1.03	-1.12	-2.02	-2.10	-1.08	-2.17	-0.93	-1.61
Sub-Sample 2: 1/7/1998-16/11/2001										
DF	-1.17	-1.05	-1.16	-0.77	-1.17	-1.05	-1.79	-1.18	-0.60	-1.40
ADF(1)	-1.20	-1.13	-1.19	-0.85	-1.19	-1.13	-1.81	-1.24	-0.65	-1.45
ADF(2)	-1.13	-0.92	-1.11	-0.63	-1.12	-0.92	-1.79	-1.19	-0.74	-1.52
ADF(3)	-1.19	-1.13	-1.18	-0.83	-1.18	-1.13	-1.82	-1.24	-0.79	-1.56
ADF(4)	-1.21	-1.20	-1.21	-0.93	-1.21	-1.20	-1.82	-1.26	-0.60	-1.39
ADF(5)	-1.20	-1.16	-1.19	-0.86	-1.19	-1.16	-1.77	-1.12	-0.70	-1.48
ADF(6)	-1.16	-1.03	-1.15	-0.74	-1.15	-1.03	-1.78	-1.15	-0.64	-1.43

Notes: DF = Dickey-Fuller test, and ADF = augmented Dickey-Fuller test; 5% critical value = -2.8633 for the test without trend and –3.4143 with trend.

Table 4. Stationarity Tests: First Differences of Log Price Indexes

	Shanghai		Shenzhen		Mainland		Hong Kong		Taiwan	
Test	No Trend	Trend	No Trend	Trend	No Trend	Trend	No Trend	Trend	No Trend	Trend
Full Sample: 5/10/1992-16/11/2001										
DF	-48.36	-48.35	-48.18	-48.18	-48.06	-48.05	-47.62	-47.63	-48.27	-48.33
ADF(1)	-33.22	-33.21	-33.04	-33.03	-33.42	-33.42	-35.09	-35.11	-32.66	-32.72
ADF(2)	-24.96	-24.95	-26.73	-26.73	-25.67	-25.66	-25.93	-25.95	-26.21	-26.27
ADF(3)	-21.05	-21.05	-21.65	-21.65	-21.45	-21.45	23.63	-23.65	-24.52	-24.60
ADF(4)	-18.60	-18.59	-19.53	-19.53	-18.73	-18.72	-21.80	-21.83	-21.19	-21.27
ADF(5)	-18.52	-18.51	-19.33	-19.33	-18.85	-18.84	-20.34	-20.37	-20.15	-20.24
ADF(6)	-17.72	-17.71	-18.30	-18.30	-17.94	-17.94	-19.40	-19.43	-18.72	-18.82
Sub-Sample 1: 5/10/1992-30/6/1997										
DF	-34.81	-34.81	-34.76	-34.81	-34.59	-34.59	-33.14	-33.12	-35.94	-35.92
ADF(1)	-23.51	-23.51	-23.26	-23.31	-23.62	-23.62	-23.27	-23.26	-24.00	-23.99
ADF(2)	-17.68	-17.68	-19.15	-19.21	-18.23	-18.24	-18.86	-18.85	-18.88	-18.87
ADF(3)	-14.94	-14.94	-15.46	-15.52	-15.26	-15.26	-16.99	-16.99	-16.83	-16.82
ADF(4)	-13.16	-13.16	-13.85	-13.91	-13.22	-13.23	-15.58	-15.57	-14.67	-14.66
ADF(5)	-13.19	-13.19	-13.88	-13.95	-13.44	-13.45	-14.96	-14.96	-14.19	-14.19
ADF(6)	-12.68	-12.68	-13.14	-13.22	-12.85	-12.86	-13.80	-13.79	-13.56	-13.56
Sub-Sample 2: 1/7/1998-16/11/2001										
DF	-28.88	-28.88	-28.80	-28.81	-28.86	-28.86	-28.50	-28.56	-28.76	-28.77
ADF(1)	-22.41	-22.42	-22.41	-22.42	-22.44	-22.45	-21.14	-21.22	-19.68	-19.69
ADF(2)	-16.56	-16.57	-16.68	-16.69	-16.60	-16.61	-16.62	-16.70	-15.98	-15.99
ADF(3)	-14.13	-14.14	-14.06	-14.08	-14.12	-14.13	-14.34	-14.43	-15.53	-15.55
ADF(4)	-12.96	-12.97	-13.05	-13.08	-12.97	-12.99	-13.93	-14.04	-12.99	-13.01
ADF(5)	-12.44	-12.46	-12.45	-12.48	-12.46	-12.48	-12.35	-12.46	-12.25	-12.28
ADF(6)	-11.56	-11.58	-11.71	-11.75	-11.65	-11.67	-11.31	-11.44	-11.24	-11.27

Notes: DF = Dickey-Fuller test, and ADF = augmented Dickey-Fuller test; 5% critical value = -2.8633 for the test without trend and –3.4143 with trend.

Table 5. Cointegration Tests

Variables	Lag Order	Test	H_0	H_A	Statistic	95% cv	90% cv	Coint. Vector
Full Sample: 5/10/1992-16/11/2001								
Shanghai, Shenzhen	8	Maximal Eigenvalue	$r = 0$	$r = 1$	19.44	14.88	12.98	LSH: 0.1643 (-0.1000) LSZ: -0.1201 (0.7308)
			$r \leq 1$	$r = 2$	1.12	8.07	6.50	
		Trace	$r = 0$	$r = 1$	20.56	17.86	5.75	
			$r \leq 1$	$r = 2$	1.12	8.07	6.50	
Shanghai, Shenzhen, Hong Kong	8	Maximal Eigenvalue	$r = 0$	$r = 1$	19.53	21.12	19.02	LSH: 0.1663 (-1.0000) LSZ: -0.1193 (0.7173) LHK: -0.0071 (0.0429)
			$r \leq 1$	$r = 2$	9.34	14.88	12.98	
		Trace	$r = 0$	$r = 1$	30.38	31.54	28.78	
			$r \leq 1$	$r = 2$	10.86	17.86	15.75	
Mainland, Hong Kong	7	Maximal Eigenvalue	$r = 0$	$r = 1$	8.11	14.88	12.98	No Cointegrating Vector
			$r \leq 1$	$r = 2$	3.01	8.07	6.50	
		Trace	$r = 0$	$r = 1$	11.12	17.86	15.75	
			$r \leq 1$	$r = 2$	3.01	8.07	6.50	
Mainland, Hong Kong, Taiwan	6	Maximal Eigenvalue	$r = 0$	$r = 1$	9.79	21.12	19.02	No Cointegrating Vector
			$r \leq 1$	$r = 2$	5.65	14.88	12.98	
		Trace	$r = 0$	$r = 1$	17.76	31.54	28.78	
			$r \leq 1$	$r = 2$	7.98	17.86	15.75	
Sub-Sample 1: 5/10/1992-30/6/1997								
Shanghai, Shenzhen	5	Maximal Eigenvalue	$r = 0$	$r = 1$	18.75	14.88	12.98	LSH: 0.2009 (-1.0000) LSZ: -0.1082 (0.5388)
			$r \leq 1$	$r = 2$	1.09	8.07	6.50	
		Trace	$r = 0$	$r = 1$	19.83	17.86	15.75	
			$r \leq 1$	$r = 2$	1.09	8.07	6.50	
Shanghai, Shenzhen, Hong Kong	6	Maximal Eigenvalue	$r = 0$	$r = 1$	19.54	21.12	19.02	LSH: 0.1975 (-1.0000) LSZ: -0.0982 (0.4971) LHK: 0.0038 (-0.0191)
			$r \leq 1$	$r = 2$	6.20	14.88	12.98	
		Trace	$r = 0$	$r = 1$	25.80	31.54	28.78	
			$r \leq 1$	$r = 2$	6.26	17.86	15.75	
Mainland, Hong Kong	6	Maximal Eigenvalue	$r = 0$	$r = 1$	8.86	14.88	12.98	No Cointegrating Vector
			$r \leq 1$	$r = 2$	0.76	8.07	6.50	
		Trace	$r = 0$	$r = 1$	9.62	17.86	15.75	
			$r \leq 1$	$r = 2$	0.76	8.07	6.50	
Mainland, Hong Kong, Taiwan	6	Maximal Eigenvalue	$r = 0$	$r = 1$	10.19	21.12	19.02	No Cointegrating Vector
			$r \leq 1$	$r = 2$	5.73	14.88	12.98	
		Trace	$r = 0$	$r = 1$	16.68	31.54	28.78	
			$r \leq 1$	$r = 2$	6.50	17.86	15.75	

Table 5. Continued

Variables	Lag Order	Test	H_0	H_A	Statistic	95% cv	90% cv	Coint. Vector
Sub-Sample 2: 1/7/1998-16/11/2001								
Shanghai, Shenzhen	5	Maximal Eigenvalue	$r = 0$	$r = 1$	3.90	14.88	12.98	No Cointegrating Vector
			$r \leq 1$	$r = 2$	1.59	8.07	6.50	
		Trace	$r = 0$	$r = 1$	5.49	17.86	15.75	
			$r \leq 1$	$r = 2$	1.59	8.07	6.50	
Shanghai, Shenzhen, Hong Kong	5	Maximal Eigenvalue	$r = 0$	$r = 1$	10.83	21.12	19.02	No Cointegrating Vector
			$r \leq 1$	$r = 2$	4.60	14.88	12.98	
		Trace	$r = 0$	$r = 1$	19.00	31.54	28.78	
			$r \leq 1$	$r = 2$	8.16	17.86	15.75	
Mainland, Hong Kong	5	Maximal Eigenvalue	$r = 0$	$r = 1$	9.07	14.88	12.98	No Cointegrating Vector
			$r \leq 1$	$r = 2$	4.36	8.07	6.50	
		Trace	$r = 0$	$r = 1$	13.43	17.86	15.75	
			$r \leq 1$	$r = 2$	4.36	8.07	6.50	
Mainland, Hong Kong, Taiwan	5	Maximal Eigenvalue	$r = 0$	$r = 1$	13.53	21.12	19.02	No Cointegrating Vector
			$r \leq 1$	$r = 2$	5.81	14.88	12.98	
		Trace	$r = 0$	$r = 1$	23.22	31.54	28.78	
			$r \leq 1$	$r = 2$	9.69	17.86	15.75	

Table 6. VAR for Mainland China, Hong Kong and Taiwan Stock Markets

	Mainland Equation			Hong Kong Equation			Taiwan Equation		
Full Sample: 5/10/1992-16/11/2001									
Regressor	**Coefficient**	**t-stat**	**p-value**	**Coefficient**	**t-stat**	**p-value**	**Coefficient**	**t-stat**	**p-value**
DLML(-1)	0.0025	0.12	[0.904]	-0.0181	-1.28	[0.202]	0.0020	0.16	[0.876]
DLML(-2)	0.0170	0.83	[0.407]	-0.0120	-0.84	[0.399]	-0.0261	-2.06	[0.040]
DLML(-3)	0.0692	3.38	[0.001]	-0.0142	-1.01	[0.314]	-0.0110	-0.87	[0.385]
DLML(-4)	0.0553	2.69	[0.007]	-0.0157	-1.11	[0.269]	0.0082	0.65	[0.518]
DLML(-5)	0.0452	2.20	[0.028]	-0.0068	-0.48	[0.631]	-0.0063	-0.50	[0.619]
DLHK(-1)	0.0128	0.42	[0.675]	0.0301	1.44	[0.151]	0.1075	5.73	[0.000]
DLHK(-2)	-0.0330	-1.08	[0.280]	-0.0337	-1.60	[0.111]	-0.0001	0.00	[0.997]
DLHK(-3)	0.0527	1.73	[0.084]	0.0855	4.07	[0.000]	0.0272	1.44	[0.149]
DLHK(-4)	0.0172	0.56	[0.574]	-0.0385	-1.82	[0.069]	0.0011	0.06	[0.954]
DLHK(-5)	0.0583	1.91	[0.056]	-0.0263	-1.24	[0.213]	0.0347	1.84	[0.066]
DLTW(-1)	0.0378	1.11	[0.265]	-0.0201	-0.86	[0.392]	-0.0139	-0.66	[0.506]
DLTW(-2)	-0.0255	-0.75	[0.452]	0.0229	0.98	[0.329]	0.0482	2.30	[0.021]
DLTW(-3)	-0.0018	-0.05	[0.959]	0.0286	1.22	[0.222]	0.0242	1.15	[0.248]
DLTW(-4)	0.0381	1.13	[0.260]	0.0274	1.17	[0.241]	-0.0698	-3.34	[0.001]
DLTW(-5)	0.0617	1.83	[0.067]	-0.0109	-0.47	[0.640]	0.0213	1.02	[0.307]
INT	0.0002	0.41	[0.685]	0.0003	0.79	[0.431]	0.0001	0.15	[0.880]
	$\overline{R}^2$: 0.0117	SC: 2.8961 [0.089]		$\overline{R}^2$: 0.0096	SC: 1.1199 [0.290]		$\overline{R}^2$: .0200	SC: 0.3838 [0.536]	
Granger:									
DLML			25.5118 [0.000]			5.4207 [0.367]			5.8532 [0.321]
DLHK			7.7836 [0.169]			25.7224 [0.000]			36.7946 [0.000]
DLTW			6.0939 [0.297]			4.6171 [0.464]			19.1096 [0.002]

Table 6. Continued

Sub-Sample 1: 5/10/1992-30/6/1997									
Regressor	**Coefficient**	**t-stat**	**p-value**	**Coefficient**	**t-stat**	**p-value**	**Coefficient**	**t-stat**	**p-value**
DLML(-1)	-0.0009	-0.03	[0.976]	0.0033	0.27	[0.785]	0.0069	0.55	[0.582]
DLML(-2)	0.0335	1.17	[0.241]	-0.0106	-0.89	[0.376]	-0.0272	-2.19	[0.029]
DLML(-3)	0.0714	2.51	[0.012]	-0.0092	-0.77	[0.443]	-0.0090	-0.72	[0.469]
DLML(-4)	0.0553	1.94	[0.053]	-0.0139	-1.16	[0.245]	0.0081	0.65	[0.515]
DLML(-5)	0.0535	1.87	[0.062]	0.0005	0.04	[0.967]	-0.0028	-0.23	[0.821]
DLHK(-1)	-0.0343	-0.50	[0.619]	0.0528	1.83	[0.068]	0.0749	2.49	[0.013]
DLHK(-2)	-0.0803	-1.17	[0.244]	0.0321	1.11	[0.267]	-0.0322	-1.07	[0.284]
DLHK(-3)	0.0984	1.43	[0.154]	0.0266	0.92	[0.359]	0.0043	0.14	[0.886]
DLHK(-4)	0.0540	0.78	[0.434]	-0.0269	-0.93	[0.353]	-0.0184	-0.61	[0.541]
DLHK(-5)	0.1077	1.56	[0.119]	-0.0228	-0.79	[0.431]	0.0737	2.45	[0.015]
DLTW(-1)	0.0439	0.66	[0.506]	-0.0153	-0.55	[0.582]	-0.0311	-1.08	[0.281]
DLTW(-2)	-0.0499	-0.76	[0.450]	0.0163	0.59	[0.557]	0.0473	1.64	[0.101]
DLTW(-3)	-0.0060	-0.09	[0.927]	0.0138	0.50	[0.617]	0.0457	1.59	[0.112]
DLTW(-4)	0.0621	0.94	[0.345]	0.0298	1.08	[0.281]	-0.0153	-0.53	[0.595]
DLTW(-5)	0.1317	2.01	[0.045]	0.0112	0.41	[0.684]	0.0216	0.76	[0.450]
INT	0.0001	0.08	[0.937]	0.0007	1.73	[0.084]	0.0006	1.46	[0.146]
	$\overline{R}^2$: 0.0120	SC: 0.3541 [0.552]		$\overline{R}^2$: -0.0022	SC: 0.7656 [0.382]		$\overline{R}^2$: 0.0090	SC: 0.8858 [0.347]	
Granger:									
DLML			16.1756 [0.006]			2.8987 [0.716]			6.1472 [0.292]
DLHK			6.8761 [0.230]			7.1970 [0.206]			13.0117 [0.023]
DLTW			5.7364 [0.333]			2.2296 [0.817]			7.3901 [0.193]

Table 6. Continued

Second Period: 1/7/1998-16/11/2001									
Regressor	Coefficient	t-stat	p-value	Coefficient	t-stat	p-value	Coefficient	t-stat	p-value
DLML(-1)	0.0220	0.65	[0.517]	-0.0792	-1.78	[0.075]	-0.0299	-0.69	[0.489]
DLML(-2)	-0.0863	-2.53	[0.011]	-0.0492	-1.11	[0.269]	-0.0313	-0.72	[0.470]
DLML(-3)	0.0650	1.91	[0.056]	0.0183	0.41	[0.681]	-0.0061	-0.14	[0.887]
DLML(-4)	0.0238	0.70	[0.483]	-0.0358	-0.81	[0.420]	0.0063	0.15	[0.884]
DLML(-5)	-0.0215	-0.63	[0.527]	0.0006	0.01	[0.989]	-0.0283	-0.66	[0.511]
DLHK(-1)	0.0222	0.83	[0.404]	0.0422	1.21	[0.226]	0.1217	3.59	[0.000]
DLHK(-2)	0.0027	0.10	[0.919]	-0.0327	-0.93	[0.351]	0.0386	1.13	[0.258]
DLHK(-3)	0.0573	2.13	[0.034]	0.0179	0.51	[0.610]	-0.0058	-0.17	[0.865]
DLHK(-4)	0.0213	0.79	[0.428]	0.0106	0.30	[0.763]	0.0321	0.94	[0.346]
DLHK(-5)	0.0613	2.29	[0.022]	-0.0762	-2.18	[0.030]	0.0358	1.05	[0.293]
DLTW(-1)	0.0389	1.42	[0.156]	0.0192	0.54	[0.591]	0.0056	0.16	[0.872]
DLTW(-2)	-0.0107	-0.39	[0.695]	0.0389	1.09	[0.275]	0.0426	1.23	[0.219]
DLTW(-3)	0.0064	0.23	[0.816]	0.0232	0.65	[0.515]	0.0177	0.51	[0.611]
DLTW(-4)	0.0059	0.22	[0.829]	0.0186	0.52	[0.602]	-0.1163	-3.36	[0.001]
DLTW(-5)	0.0226	0.83	[0.409]	0.0097	0.27	[0.786]	0.0446	1.29	[0.199]
INT	0.0002	0.44	[0.661]	0.0004	0.65	[0.514]	-0.0007	-1.04	[0.299]
	$\overline{R}^2$: 0.0162	SC: 0.0389 [0.844]		$\overline{R}^2$: 0.0010	SC: 0.5105 [0.475]		$\overline{R}^2$: 0.0200	SC: 0.7542 [0.385]	
Granger:									
DLML		11.7471 [0.038]			5.5750 [0.350]				1.6193 [0.899]
DLHK		10.6939 [0.058]			7.6106 [0.179]				16.4848 [0.006]
DLTW		2.8015 [0.731]			2.3218 [0.803]				14.6076 [0.012]

Note: DLML = first difference in the log of the value-weighted average of the Shanghai and Shenzehn indexes (=mainland index), DLHK is the first difference in the log of the Hong Kong index and DLTW is the first difference in the log of the Taiwan index. SC is a test statistic for a test of first- to fourth-order autocorrelation in the equation residuals with prob values in brackets. Granger statistics are for an LM test of the hypothesis that all lags of the indicated variable are jointly zero. Prob values in brackets.

Table 7. FEVDs for Mainland China, Hong Kong and Taiwan

Full Sample: 5/10/1992 – 16/11/2001

	Mainland			Hong Kong			Taiwan		
Horizon	DLML	DLHK	DLTW	DLML	DLHK	DLTW	DLML	DLHK	DLTW
0	1.00000	0.00134	0.00038	0.00134	1.00000	0.03866	0.00038	0.03866	1.00000
1	0.99930	0.00152	0.00101	0.00198	0.99899	0.03875	0.00042	0.05176	0.98626
2	0.99852	0.00201	0.00140	0.00235	0.99831	0.03884	0.00236	0.05164	0.98430
3	0.99739	0.00332	0.00147	0.00258	0.99732	0.04025	0.00266	0.05276	0.98307
4	0.99646	0.00379	0.00224	0.00336	0.99609	0.04044	0.00270	0.05256	0.98284
5	0.99310	0.00608	0.00421	0.00363	0.99583	0.04053	0.00300	0.05340	0.98190
6	0.99296	0.00622	0.00423	0.00365	0.99581	0.04053	0.00302	0.05340	0.98189
7	0.99292	0.00623	0.00427	0.00367	0.99579	0.04053	0.00304	0.05341	0.98185
8	0.99282	0.00632	0.00431	0.00368	0.99575	0.04057	0.00305	0.05341	0.98184
9	0.99279	0.00634	0.00432	0.00369	0.99575	0.04057	0.00306	0.05342	0.98183
10	0.99278	0.00635	0.00433	0.00369	0.99575	0.04057	0.00306	0.05342	0.98182
11	0.99277	0.00635	0.00433	0.00369	0.99575	0.04057	0.00306	0.05342	0.98182
12	0.99277	0.00635	0.00433	0.00369	0.99575	0.04057	0.00306	0.05343	0.98182
13	0.99277	0.00635	0.00433	0.00369	0.99575	0.04057	0.00306	0.05343	0.98182
14	0.99277	0.00635	0.00433	0.00369	0.99575	0.04057	0.00306	0.05343	0.98182
15	0.99277	0.00635	0.00433	0.00369	0.99575	0.04057	0.00306	0.05343	0.98182

Sub-Sample 1: 5/10/1992 – 30/6/1997

	Mainland			Hong Kong			Taiwan		
Horizon	DLML	DLHK	DLTW	DLML	DLHK	DLTW	DLML	DLHK	DLTW
0	1.00000	0.00028	0.00000	0.00028	1.00000	0.01405	0.00000	0.01405	1.00000
1	0.99949	0.00043	0.00031	0.00036	0.99969	0.01410	0.00029	0.01865	0.99464
2	0.99774	0.00166	0.00098	0.00095	0.99879	0.01450	0.00417	0.01915	0.98992
3	0.99644	0.00305	0.00099	0.00138	0.99818	0.01475	0.00452	0.01930	0.98949
4	0.99518	0.00369	0.00181	0.00266	0.99595	0.01555	0.00474	0.01946	0.98914
5	0.98965	0.00651	0.00530	0.00269	0.99569	0.01570	0.00497	0.02384	0.98494
6	0.98954	0.00663	0.00530	0.00274	0.99564	0.01571	0.00497	0.02384	0.98494
7	0.98947	0.00664	0.00535	0.00278	0.99559	0.01571	0.00501	0.02384	0.98489
8	0.98932	0.00671	0.00545	0.00279	0.99558	0.01571	0.00502	0.02386	0.98487
9	0.98926	0.00674	0.00550	0.00279	0.99557	0.01572	0.00502	0.02387	0.98486
10	0.98918	0.00678	0.00555	0.00279	0.99557	0.01572	0.00503	0.02387	0.98485
11	0.98917	0.00678	0.00555	0.00279	0.99557	0.01572	0.00503	0.02387	0.98485
12	0.98917	0.00678	0.00555	0.00279	0.99557	0.01572	0.00503	0.02387	0.98485
13	0.98917	0.00679	0.00555	0.00279	0.99557	0.01572	0.00503	0.02387	0.98485
14	0.98917	0.00679	0.00555	0.00279	0.99557	0.01572	0.00503	0.02387	0.98485
15	0.98917	0.00679	0.00556	0.00279	0.99557	0.01572	0.00503	0.02387	0.98485

Table 7. Continued

Sub-Sample 2: 1/7/1998 – 16/11/2001									
	Mainland			Hong Kong			Taiwan		
Horizon	DLML	DLHK	DLTW	DLML	DLHK	DLTW	DLML	DLHK	DLTW
0	1.00000	0.01087	0.00512	0.01087	1.00000	0.04971	0.00512	0.04971	1.00000
1	0.99613	0.01261	0.00839	0.01381	0.99616	0.05000	0.00515	0.06404	0.98533
2	0.99596	0.01251	0.00856	0.01556	0.99339	0.05050	0.00573	0.06628	0.98273
3	0.99069	0.01863	0.00919	0.01597	0.99255	0.05124	0.00584	0.06624	0.98258
4	0.98917	0.02018	0.00974	0.01658	0.99142	0.05165	0.00578	0.06563	0.98154
5	0.98174	0.02633	0.01139	0.01679	0.99133	0.05145	0.00617	0.06641	0.98048
6	0.98157	0.02643	0.01147	0.01683	0.99125	0.05148	0.00621	0.06655	0.98035
7	0.98155	0.02643	0.01147	0.01684	0.99123	0.05149	0.00621	0.06656	0.98034
8	0.98153	0.02643	0.01149	0.01686	0.99121	0.05150	0.00621	0.06655	0.98032
9	0.98153	0.02643	0.01149	0.01686	0.99119	0.05151	0.00621	0.06658	0.98031
10	0.98148	0.02649	0.01150	0.01686	0.99119	0.05151	0.00621	0.06658	0.98030
11	0.98148	0.02649	0.01150	0.01686	0.99119	0.05151	0.00621	0.06658	0.98030
12	0.98147	0.02649	0.01150	0.01686	0.99119	0.05151	0.00621	0.06658	0.98030
13	0.98147	0.02649	0.01150	0.01686	0.99119	0.05151	0.00621	0.06658	0.98030
14	0.98147	0.02649	0.01150	0.01686	0.99119	0.05151	0.00621	0.06658	0.98030
15	0.98147	0.02649	0.01150	0.01686	0.99119	0.05151	0.00621	0.06658	0.98030

Note: DLML = first difference in the log of the value-weighted average of the Shanghai and Shenzehn indexes (=mainland index), DLHK is the first difference in the log of the Hong Kong index and DLTW is the first difference in the log of the Taiwan index.

Table 8. VAR for Shanghai and Shenzhen

	Full Sample: 5/10/1992-16/11/2001				Sub-Sample1: 5/10/1992-30/6/1997				Sub-Sample2: 1/7/1998-16/11/2001			
	Shanghai Eqn.		Shenzhen Eqn.		Shanghai Eqn.		Shenzhen Eqn.		Shanghai Eqn.		Shenzhen Eqn.	
Regressor	**Coeff**	**t-stat**	**Coeff**	**t-stat**	**Coeff**	**t-stat**	**Coeff**	**t-stat**	**Coeff**	**t-stat**	**Coeff**	**t-stat**
DLSH(-1)	-0.0499	-1.63	0.0329	1.18	-0.0505	-1.25	0.0313	0.88	0.1113	0.59	0.0702	0.36
DLSH(-2)	0.0774	2.52	0.0224	0.80	0.0812	2.01	0.0252	0.71	0.1141	0.61	0.1563	0.80
DLSH(-3)	0.1383	4.54	0.0676	2.44	0.1381	3.45	0.0665	1.88	0.1556	0.83	0.1108	0.57
DLSH(-4)	0.0487	1.59	0.0613	2.20	0.0504	1.25	0.0649	1.83	-0.2008	-1.07	-0.2374	-1.21
DLSH(-5)	-0.0435	-1.43	0.0594	2.14	-0.0448	-1.12	0.0585	1.65	0.1953	1.04	0.2581	1.32
DLSH(-6)	-0.0208	-0.68	-0.0015	-0.05	-0.0229	-0.57	-0.0030	-0.09	-0.2845	-1.52	-0.2975	-1.52
DLSH(-7)	0.0443	1.46	-0.0133	-0.48	0.0419	1.05	-0.0144	-0.41	0.0367	0.20	-0.0092	-0.05
DLSZ(-1)	0.0725	2.15	-0.0259	-0.84	0.0755	1.65	-0.0275	-0.68	-0.0733	-0.41	-0.0279	-0.15
DLSZ(-2)	-0.0602	-1.78	0.0151	0.49	-0.0432	-0.94	0.0348	0.86	-0.1865	-1.04	-0.2246	-1.19
DLSZ(-3)	-0.0550	-1.63	-0.0325	-1.06	-0.0545	-1.19	-0.0425	-1.05	-0.0741	-0.41	-0.0325	-0.17
DLSZ(-4)	0.0068	0.20	0.0275	0.90	0.0069	0.15	0.0301	0.75	0.2180	1.22	0.2595	1.39
DLSZ(-5)	0.1163	3.46	-0.0349	-1.14	0.1376	3.02	-0.0256	-0.64	-0.2052	-1.15	-0.2697	-1.44
DLSZ(-6)	-0.0627	-1.85	-0.0677	-2.20	-0.0731	-1.60	-0.0781	-1.93	0.2320	1.29	0.2399	1.28
DLSZ(-7)	-0.0971	-2.88	-0.0081	-0.26	-0.1092	-2.38	-0.0088	-0.22	-0.0438	-0.24	-0.0111	-0.06
INT	0.0003	0.55	0.0002	0.37	0.0004	0.39	0.0003	0.35	0.0002	0.42	0.0002	0.31
$\bar{R}^2$	0.0269		0.0141		0.0287		0.0141		0.0064		0.0074	
AC	0.0803 [0.777]		0.0003 [0.986]		0.1257 [0.723]		0.0026 [0.959]		0.4281 [0.513]		0.0197 [0.888]	
Granger:												
DLSH	32.4738 [0.000]		17.2187 [0.016]		19.2669 [0.007]		10.8217 [0.147]		5.5637 [0.592]		6.2797 [0.507]	
DLSZ	33.6070 [0.000]		8.9720 [0.255]		22.2636 [0.002]		7.1730 [0.411]		5.6463 [0.582]		6.8696 [0.443]	

Note: DLSH = first difference in the log of the index for Shanghai; DLSZ = first difference in the log of the index for Shenzhen. AC is a test statistic for a test of first- to fourth-order autocorrelation in the equation residuals with prob values in brackets. The Granger statistics are for an LM test of the joint significance of the lags of the indicated variable.

Table 9. Generalised Forecast Error Variance Decompositions: Shanghai and Shenzhen

	Full Sample: 5/10/1992 - 16/11/2001				Sub-Sample 1: 5/10/1992 – 30/6/1997				Sub-Sample 2: 1/7/1998 - 16/11/2001			
	Shanghai forecast error		Shenzhen forecast error		Shanghai forecast error		Shenzhen forecast error		Shanghai forecast error		Shenzhen forecast error	
Horizon	DLSH	DLSZ	DLSH	DLSZ	DLSH	DLSZ	DLSH	DLSZ	DLSH	DLSZ	DLSH	DLSZ
0	1.00000	0.55173	0.55173	1.00000	1.00000	0.49613	0.49613	1.00000	1.00000	0.96774	0.96774	1.00000
1	0.99805	0.55149	0.55169	0.99941	0.99776	0.49598	0.49607	0.99937	0.99981	0.96739	0.96776	0.99985
2	0.99647	0.54982	0.55217	0.99920	0.99683	0.49429	0.49710	0.99904	0.99852	0.96715	0.96630	0.99909
3	0.99582	0.54718	0.55304	0.99662	0.99619	0.49164	0.49768	0.99604	0.99829	0.96654	0.96639	0.99869
4	0.99578	0.54755	0.55645	0.99463	0.99615	0.49205	0.50225	0.99337	0.99657	0.96542	0.96421	0.99707
5	0.99143	0.55018	0.55695	0.99233	0.98944	0.49671	0.50346	0.99062	0.99512	0.96438	0.96204	0.99527
6	0.98885	0.55234	0.55668	0.99234	0.98605	0.49960	0.50313	0.99064	0.99408	0.96288	0.96121	0.99373
7	0.98635	0.55263	0.55668	0.99234	0.98286	0.50032	0.50312	0.99064	0.99404	0.96283	0.96105	0.99347
8	0.98618	0.55265	0.55671	0.99232	0.98271	0.50033	0.50315	0.99061	0.99402	0.96281	0.96105	0.99346
9	0.98615	0.55265	0.55671	0.99231	0.98269	0.50033	0.50314	0.99060	0.99402	0.96281	0.96104	0.99345
10	0.98596	0.55273	0.55676	0.99228	0.98246	0.50045	0.50321	0.99057	0.99401	0.96280	0.96102	0.99343
11	0.98594	0.55278	0.55678	0.99228	0.98241	0.50057	0.50324	0.99056	0.99401	0.96280	0.96102	0.99343
12	0.98587	0.55279	0.55678	0.99228	0.98232	0.50057	0.50324	0.99056	0.99400	0.96279	0.96101	0.99341
13	0.98587	0.55279	0.55678	0.99228	0.98232	0.50057	0.50324	0.99056	0.99400	0.96279	0.96101	0.99341
14	0.98587	0.55279	0.55678	0.99228	0.98231	0.50058	0.50324	0.99056	0.99400	0.96278	0.96101	0.99341
15	0.98587	0.55279	0.55678	0.99228	0.98231	0.50057	0.50324	0.99056	0.99400	0.96278	0.96101	0.99341

Note: DLSH = first difference in the log of the index for Shanghai; DLSZ = first difference in the log of the index for Shenzhen.

Table 10. VARs for Shanghai, Shenzhen & Hong Kong Stock Markets

	Shanghai Equation			Shenzhen Equation			Hong Kong Equation		
Full Sample: 5/10/1992-16/11/2001									
Regressor	**Coefficient**	**t-stat**	**p-value**	**Coefficient**	**t-stat**	**p-value**	**Coefficient**	**t-stat**	**p-value**
DLSH(-1)	-0.0483	-1.57	[0.116]	0.0338	1.21	[0.226]	-0.0027	-0.14	[0.892]
DLSH(-2)	0.0767	2.50	[0.013]	0.0215	0.77	[0.443]	-0.0019	-0.09	[0.925]
DLSH(-3)	0.1405	4.61	[0.000]	0.0713	2.57	[0.010]	-0.0295	-1.49	[0.135]
DLSH(-4)	0.0502	1.64	[0.102]	0.0623	2.24	[0.025]	-0.0214	-1.08	[0.281]
DLSH(-5)	-0.0426	-1.40	[0.163]	0.0617	2.22	[0.026]	0.0153	0.77	[0.439]
DLSH(-6)	-0.0196	-0.64	[0.522]	0.0002	0.01	[0.993]	-0.0382	-1.93	[0.054]
DLSH(-7)	0.0489	1.60	[0.109]	-0.0104	-0.38	[0.707]	0.0304	1.54	[0.124]
DLSZ(-1)	0.0695	2.05	[0.040]	-0.0280	-0.91	[0.363]	-0.0197	-0.90	[0.369]
DLSZ(-2)	-0.0592	-1.74	[0.082]	0.0148	0.48	[0.633]	-0.0095	-0.43	[0.668]
DLSZ(-3)	-0.0599	-1.77	[0.076]	-0.0369	-1.20	[0.229]	0.0223	1.02	[0.307]
DLSZ(-4)	0.0045	0.13	[0.894]	0.0263	0.86	[0.392]	0.0046	0.21	[0.835]
DLSZ(-5)	0.1156	3.43	[0.001]	-0.0383	-1.25	[0.212]	-0.0281	-1.29	[0.198]
DLSZ(-6)	-0.0625	-1.84	[0.065]	-0.0660	-2.14	[0.032]	0.0188	0.86	[0.392]
DLSZ(-7)	-0.0993	-2.93	[0.003]	-0.0077	-0.25	[0.802]	-0.0319	-1.46	[0.145]
DLHK(-1)	0.0300	0.94	[0.347]	0.0283	0.98	[0.330]	0.0281	1.36	[0.173]
DLHK(-2)	-0.0454	-1.42	[0.154]	-0.0082	-0.28	[0.776]	-0.0346	-1.68	[0.094]
DLHK(-3)	0.0509	1.59	[0.111]	0.0445	1.53	[0.125]	0.0906	4.39	[0.000]
DLHK(-4)	0.0201	0.63	[0.530]	0.0076	0.26	[0.795]	-0.0286	-1.38	[0.168]
DLHK(-5)	0.0524	1.64	[0.100]	0.0845	2.92	[0.004]	-0.0258	-1.25	[0.212]
DLHK(-6)	0.0054	0.17	[0.865]	-0.0097	-0.33	[0.738]	-0.0192	-0.93	[0.353]
DLHK(-7)	0.0039	0.12	[0.903]	-0.0056	-0.19	[0.847]	-0.0300	-1.45	[0.146]
INT	0.0003	0.49	[0.625]	0.0002	0.29	[0.772]	0.0003	0.82	[0.411]
	$\overline{R}^2$: 0.0274	SC: 0.0037 [0.952]		$\overline{R}^2$: 0.0160	SC: 0.0784 [0.779]		$\overline{R}^2$: 0.0123	SC: 0.0005 [0.983]	
Granger:									
DLSH			33.3635 [0.000]			18.3765 [0.010]			11.4569 [0.120]
DLSZ			33.5973 [0.000]			9.4360 [0.223]			7.1099 [0.418]
DLHK			8.1411 [0.320]			11.6253 [0.114]			7.0129 [0.220]

Table 10. Continued

	Shanghai Equation			Shenzhen Equation			Hong Kong Equation		
Sub-Sample 1: 5/10/1992-30/6/1997									
Regressor	Coefficient	t-stat	p-value	Coefficient	t-stat	p-value	Coefficient	t-stat	p-value
DLSH(-1)	-0.0485	-1.20	[0.231]	0.0326	0.91	[0.361]	0.0068	0.43	[0.665]
DLSH(-2)	0.0804	1.98	[0.048]	0.0243	0.68	[0.496]	-0.0132	-0.84	[0.400]
DLSH(-3)	0.1431	3.56	[0.000]	0.0733	2.07	[0.039]	-0.0280	-1.81	[0.071]
DLSH(-4)	0.0521	1.29	[0.197]	0.0682	1.91	[0.056]	-0.0267	-1.71	[0.087]
DLSH(-5)	-0.0438	-1.09	[0.277]	0.0650	1.83	[0.068]	0.0080	0.51	[0.608]
DLSH(-6)	-0.0205	-0.51	[0.611]	0.0003	0.01	[0.992]	-0.0382	-2.45	[0.014]
DLSH(-7)	0.0495	1.23	[0.219]	-0.0089	-0.25	[0.802]	0.0241	1.55	[0.121]
DLSZ(-1)	0.0700	1.52	[0.128]	-0.0317	-0.78	[0.436]	-0.0065	-0.37	[0.715]
DLSZ(-2)	-0.0431	-0.93	[0.351]	0.0318	0.78	[0.434]	0.0056	0.31	[0.753]
DLSZ(-3)	-0.0619	-1.35	[0.177]	-0.0503	-1.24	[0.214]	0.0276	1.56	[0.118]
DLSZ(-4)	0.0030	0.06	[0.949]	0.0269	0.67	[0.506]	0.0122	0.69	[0.491]
DLSZ(-5)	0.1369	3.00	[0.003]	-0.0327	-0.81	[0.419]	-0.0100	-0.57	[0.572]
DLSZ(-6)	-0.0770	-1.67	[0.095]	-0.0807	-1.99	[0.047]	0.0220	1.24	[0.216]
DLSZ(-7)	-0.1140	-2.48	[0.013]	-0.0106	-0.26	[0.794]	-0.0313	-1.76	[0.078]
DLHK(-1)	0.0079	0.11	[0.915]	0.0188	0.29	[0.775]	0.0537	1.86	[0.063]
DLHK(-2)	-0.1233	-1.66	[0.098]	0.0154	0.23	[0.815]	0.0262	0.91	[0.362]
DLHK(-3)	0.0900	1.21	[0.227]	0.0656	1.00	[0.319]	0.0276	0.96	[0.338]
DLHK(-4)	0.0606	0.81	[0.416]	0.0101	0.15	[0.877]	-0.0235	-0.82	[0.414]
DLHK(-5)	0.0874	1.18	[0.240]	0.1670	2.55	[0.011]	-0.0169	-0.59	[0.556]
DLHK(-6)	0.0682	0.92	[0.360]	0.0392	0.60	[0.551]	-0.0540	-1.88	[0.061]
DLHK(-7)	0.0201	0.27	[0.788]	0.0106	0.16	[0.872]	0.0023	0.08	[0.937]
INT	0.0002	0.23	[0.819]	0.0001	0.06	[0.950]	0.0008	1.94	[0.053]
	$\overline{R}^2$: 0.0291	SC: 0.0250 [0.874]		$\overline{R}^2$: 0.0154	SC: 0.0347 [0.852]		$\overline{R}^2$: 0.0082	SC: 0.0740 [0.786]	
Granger:									
DLSH			20.2677 [0.005]			12.3946 [0.088]			17.5465 [0.014]
DLSZ			22.8635 [0.002]			8.0606 [0.327]			8.8513 [0.264]
DLHK			7.5712 [0.372]			8.6856 [0.276]			10.5112 [0.161]

Table 10. Continued

	Shanghai Equation			Shenzhen Equation			Hong Kong Equation		
Sub-Sample 2: 1/7/1998 – 16/11/2001									
Regressor	**Coefficient**	**t-stat**	**p-value**	**Coefficient**	**t-stat**	**p-value**	**Coefficient**	**t-stat**	**p-value**
DLSH(-1)	0.1015	0.54	[0.592]	0.0618	0.31	[0.754]	0.1917	0.77	[0.442]
DLSH(-2)	0.1063	0.56	[0.574]	0.1393	0.71	[0.480]	0.0248	0.10	[0.921]
DLSH(-3)	0.1301	0.69	[0.489]	0.0822	0.42	[0.675]	-0.3262	-1.32	[0.188]
DLSH(-4)	-0.1597	-0.85	[0.396]	-0.1845	-0.94	[0.347]	0.3748	1.51	[0.130]
DLSH(-5)	0.2000	1.06	[0.289]	0.2570	1.31	[0.190]	-0.2097	-0.85	[0.397]
DLSH(-6)	-0.2890	-1.54	[0.124]	-0.2990	-1.52	[0.128]	-0.2471	-1.00	[0.318]
DLSH(-7)	0.0230	0.12	[0.902]	-0.0225	-0.12	[0.908]	0.3661	1.48	[0.138]
DLSZ(-1)	-0.0709	-0.39	[0.697]	-0.0295	-0.16	[0.876]	-0.2571	-1.07	[0.283]
DLSZ(-2)	-0.1834	-1.01	[0.313]	-0.2117	-1.12	[0.264]	-0.0727	-0.30	[0.761]
DLSZ(-3)	-0.0544	-0.30	[0.762]	-0.0110	-0.06	[0.953]	0.3402	1.44	[0.151]
DLSZ(-4)	0.1809	1.01	[0.315]	0.2093	1.12	[0.264]	-0.4048	-1.71	[0.088]
DLSZ(-5)	-0.2106	-1.17	[0.243]	-0.2706	-1.44	[0.150]	0.2042	0.86	[0.390]
DLSZ(-6)	0.2460	1.37	[0.172]	0.2520	1.34	[0.180]	0.1889	0.80	[0.426]
DLSZ(-7)	-0.0231	-0.13	[0.897]	0.0107	0.06	[0.954]	-0.3140	-1.33	[0.184]
DLHK(-1)	0.0210	0.81	[0.420]	0.0321	1.18	[0.237]	0.0566	1.65	[0.099]
DLHK(-2)	0.0106	0.40	[0.686]	0.0016	0.06	[0.952]	-0.0162	-0.47	[0.638]
DLHK(-3)	0.0611	2.34	[0.019]	0.0645	2.37	[0.018]	0.0196	0.57	[0.568]
DLHK(-4)	0.0157	0.61	[0.545]	0.0233	0.86	[0.391]	0.0185	0.54	[0.589]
DLHK(-5)	0.0609	2.34	[0.020]	0.0761	2.81	[0.005]	-0.0639	-1.87	[0.063]
DLHK(-6)	-0.0195	-0.74	[0.457]	-0.0187	-0.68	[0.496]	0.0260	0.75	[0.453]
DLHK(-7)	-0.0296	-1.13	[0.259]	-0.0346	-1.27	[0.205]	0.0058	0.17	[0.867]
INT	0.0002	0.36	[0.722]	0.0001	0.23	[0.817]	0.0003	0.47	[0.637]
	$\bar{R}^2$: 0.0148	SC: 3.3828 [0.066]		$\bar{R}^2$: 0.0200	SC: 2.0822 [0.149]		$\bar{R}^2$: 0.0055	SC: 2.7405 [0.098]	
Granger:									
DLSH			5.0260 [0.657]			5.5182 [0.597]			8.8315 [0.265]
DLSZ			5.3278 [0.620]			6.2395 [0.512]			9.4333 [0.223]
DLHK			14.4903 [0.043]			18.2042 [0.011]			7.4307 [0.385]

Note: DLSH = first difference in the log of the index for Shanghai; DLSZ = first difference in the log of the index for Shenzhen; DLHK = first difference in the log of the index for Hong Kong.
SC is a test statistic for a test of first- to fourth-order autocorrelation in the equation residuals with prob values in brackets.
Granger is the LM statistic for a test that all the lags of the indicated variables are jointly zero with prob values in brackets.

Table 11. FEVDs for Shanghai, Shenzhen and Hong Kong

Full Sample: 5/10/1992 – 16/11/2001

	Shanghai			Shenzhen			Hong Kong		
Horizon	DLSH	DLSZ	DLHK	DLSH	DLSZ	DLHK	DLSH	DLSZ	DLHK
0	1.00000	0.55133	0.00065	0.55133	1.00000	0.00313	0.00065	0.00313	1.00000
1	0.99774	0.55090	0.00112	0.55107	0.99900	0.00351	0.00122	0.00398	0.99905
2	0.99526	0.54879	0.00199	0.55148	0.99878	0.00352	0.00144	0.00431	0.99878
3	0.99352	0.54546	0.00309	0.55187	0.99507	0.00443	0.00186	0.00427	0.99781
4	0.99322	0.54567	0.00341	0.55517	0.99306	0.00453	0.00293	0.00484	0.99677
5	0.98817	0.54788	0.00444	0.55375	0.98732	0.00793	0.00305	0.00559	0.99596
6	0.98545	0.54993	0.00449	0.55348	0.98733	0.00795	0.00524	0.00596	0.99326
7	0.98293	0.55021	0.00448	0.55346	0.98732	0.00796	0.00530	0.00618	0.99231
8	0.98276	0.55021	0.00451	0.55346	0.98726	0.00801	0.00530	0.00618	0.99231
9	0.98275	0.55022	0.00451	0.55347	0.98723	0.00801	0.00539	0.00622	0.99222
10	0.98251	0.55032	0.00451	0.55350	0.98721	0.00803	0.00543	0.00626	0.99218
11	0.98246	0.55036	0.00455	0.55353	0.98718	0.00804	0.00543	0.00626	0.99217
12	0.98237	0.55034	0.00457	0.55352	0.98716	0.00804	0.00543	0.00630	0.99212
13	0.98237	0.55034	0.00457	0.55352	0.98716	0.00804	0.00544	0.00631	0.99211
14	0.98236	0.55034	0.00458	0.55352	0.98716	0.00804	0.00544	0.00631	0.99210
15	0.98236	0.55034	0.00458	0.55352	0.98716	0.00805	0.00544	0.00631	0.99210

Sub-Sample 1: 5/10/1992 – 30/6/1997

	Shanghai			Shenzhen			Hong Kong		
Horizon	DLSH	DLSZ	DLHK	DLSH	DLSZ	DLHK	DLSH	DLSZ	DLHK
0	1.00000	0.49691	0.00002	0.49691	1.00000	0.00218	0.00002	0.00218	1.00000
1	0.99806	0.49670	0.00006	0.49674	0.99926	0.00222	0.00008	0.00217	0.99984
2	0.99478	0.49382	0.00240	0.49763	0.99892	0.00229	0.00069	0.00226	0.99913
3	0.99284	0.49035	0.00348	0.49780	0.99469	0.00294	0.00149	0.00238	0.99655
4	0.99245	0.49048	0.00387	0.50245	0.99186	0.00296	0.00399	0.00289	0.99371
5	0.98519	0.49473	0.00495	0.50111	0.98393	0.00790	0.00400	0.00304	0.99353
6	0.98051	0.49694	0.00595	0.50057	0.98361	0.00811	0.00922	0.00356	0.98660
7	0.97710	0.49749	0.00609	0.50050	0.98349	0.00821	0.00920	0.00496	0.98351
8	0.97688	0.49747	0.00617	0.50049	0.98347	0.00824	0.00921	0.00497	0.98350
9	0.97688	0.49747	0.00617	0.50048	0.98335	0.00826	0.00930	0.00515	0.98333
10	0.97658	0.49761	0.00621	0.50055	0.98333	0.00826	0.00938	0.00526	0.98322
11	0.97652	0.49772	0.00624	0.50065	0.98322	0.00830	0.00940	0.00532	0.98316
12	0.97636	0.49766	0.00630	0.50063	0.98320	0.00831	0.00943	0.00541	0.98307
13	0.97636	0.49766	0.00630	0.50063	0.98320	0.00831	0.00943	0.00547	0.98296
14	0.97634	0.49767	0.00631	0.50063	0.98320	0.00831	0.00944	0.00547	0.98295
15	0.97634	0.49766	0.00631	0.50063	0.98320	0.00831	0.00944	0.00548	0.98295

Table 11. Continued

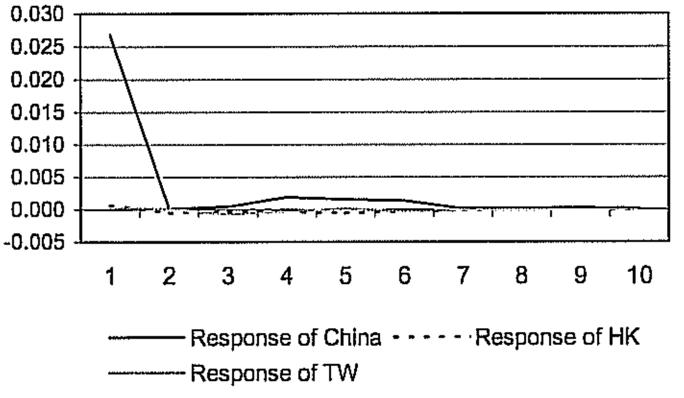
Sub-Sample 2: 1/7/1998 – 16/11/2001

	Shanghai			Shenzhen			Hong Kong		
Horizon	DLSH	DLSZ	DLHK	DLSH	DLSZ	DLHK	DLSH	DLSZ	DLHK
0	1.00000	0.96777	0.01107	0.96777	1.00000	0.01244	0.01107	0.01244	1.00000
1	0.99910	0.96677	0.01195	0.96623	0.99829	0.01429	0.01335	0.01526	0.99576
2	0.99763	0.96640	0.01188	0.96488	0.99763	0.01421	0.01529	0.01736	0.99380
3	0.99183	0.96055	0.01859	0.95954	0.99178	0.02082	0.01563	0.01812	0.99094
4	0.98982	0.95905	0.01969	0.95660	0.98924	0.02271	0.01628	0.01930	0.98746
5	0.98237	0.95219	0.02485	0.94587	0.97857	0.03038	0.01651	0.01942	0.98714
6	0.98055	0.94991	0.02549	0.94434	0.97629	0.03094	0.01759	0.02003	0.98434
7	0.97878	0.94818	0.02721	0.94235	0.97414	0.03292	0.01901	0.02089	0.98131
8	0.97878	0.94818	0.02721	0.94235	0.97413	0.03292	0.01902	0.02089	0.98099
9	0.97875	0.94817	0.02721	0.94233	0.97412	0.03292	0.01907	0.02091	0.98081
10	0.97857	0.94800	0.02738	0.94206	0.97384	0.03318	0.01907	0.02091	0.98079
11	0.97856	0.94799	0.02739	0.94205	0.97382	0.03319	0.01913	0.02095	0.98068
12	0.97846	0.94786	0.02744	0.94192	0.97366	0.03324	0.01916	0.02097	0.98064
13	0.97845	0.94786	0.02744	0.94192	0.97366	0.03324	0.01917	0.02097	0.98062
14	0.97843	0.94784	0.02744	0.94190	0.97363	0.03324	0.01918	0.02098	0.98059
15	0.97843	0.94784	0.02744	0.94189	0.97363	0.03325	0.01918	0.02098	0.98059

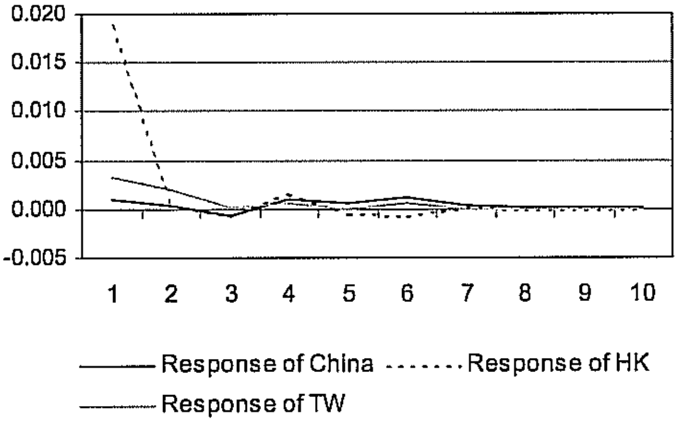
Note: DLSH = first difference in the log of the index for Shanghai; DLSZ = first difference in the log of the index for Shenzhen; DLHK = first difference in the log of the index for Hong Kong.

Figure 1. IRFs for Mainland China, Hong Kong and Taiwan (Full Sample)

Response to Shock to Mainland China



Response to Shock to Hong Kong



Response to Shock to Taiwan

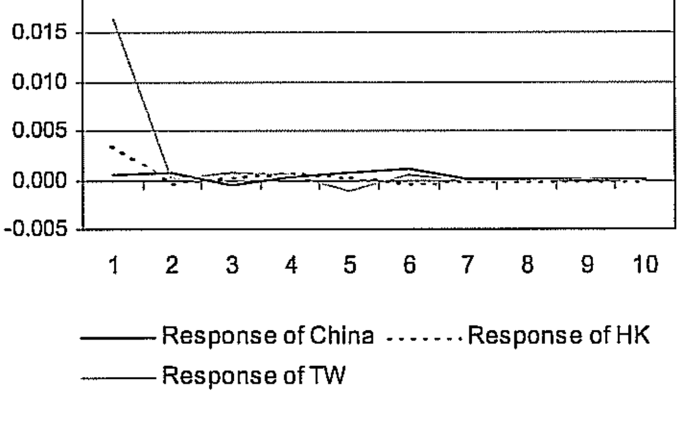


Figure 2. IRFs for Mainland China, Hong Kong and Taiwan (Sub-Samples)

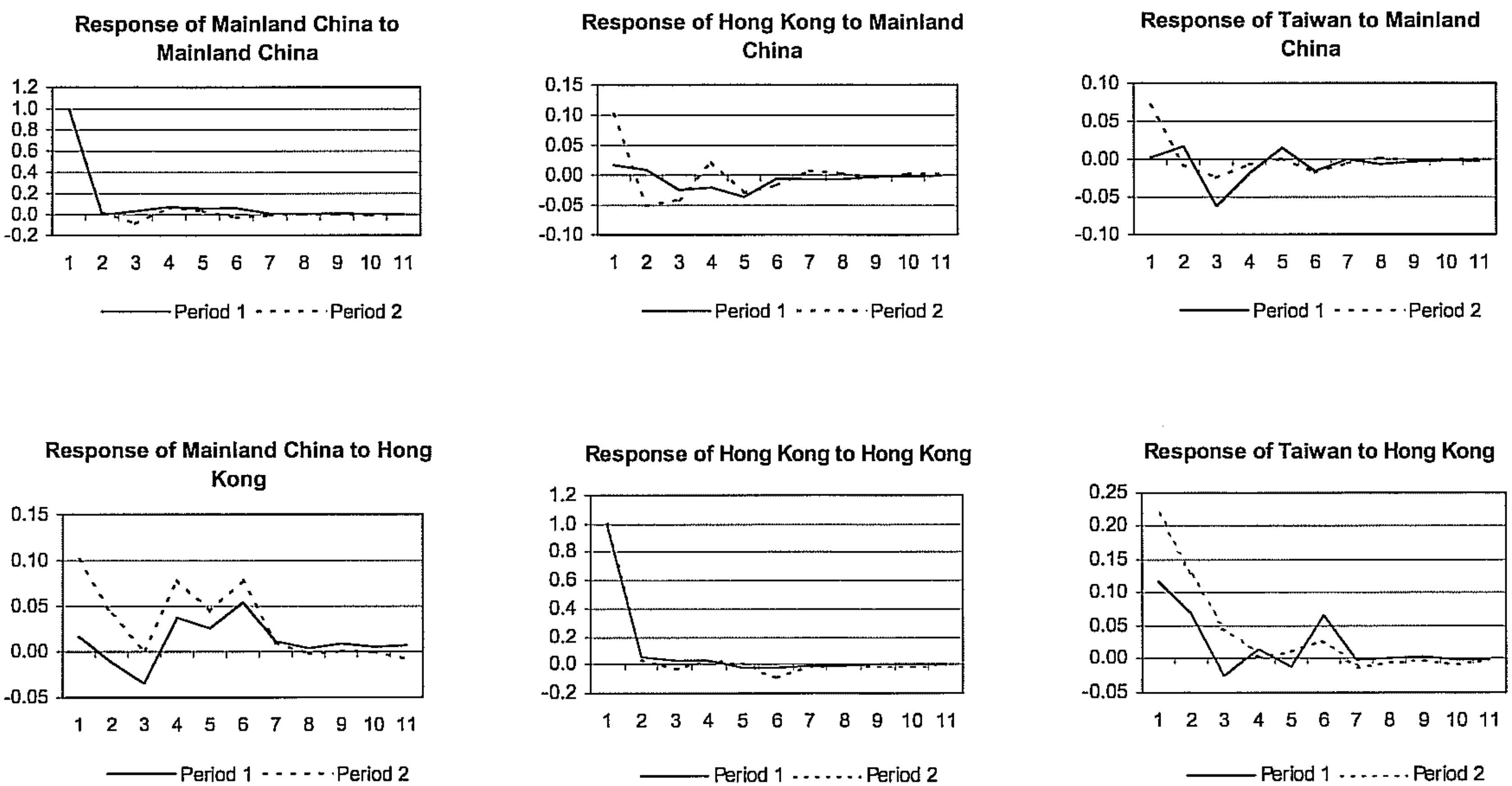
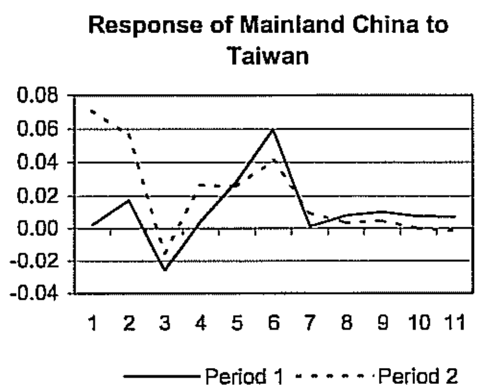
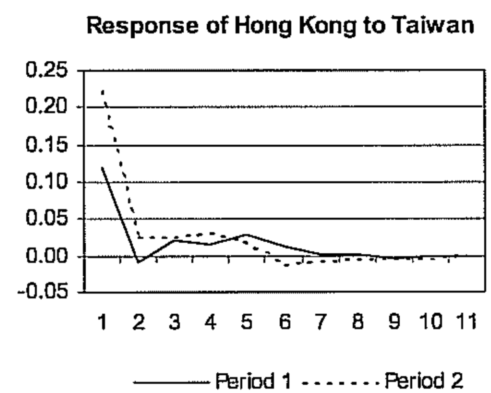


Figure 2. Continued





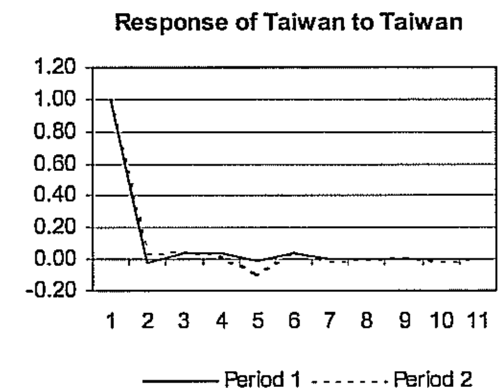
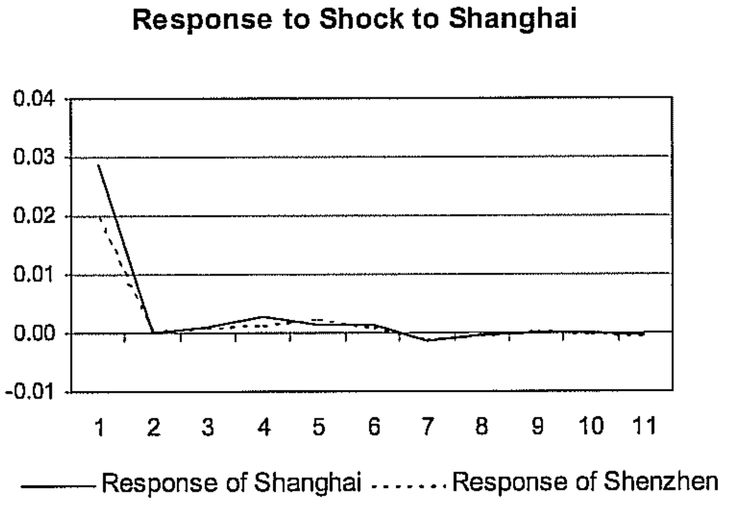


Figure 3. Impulse Response Functions: Shanghai and Shenzhen
(Full Sample)



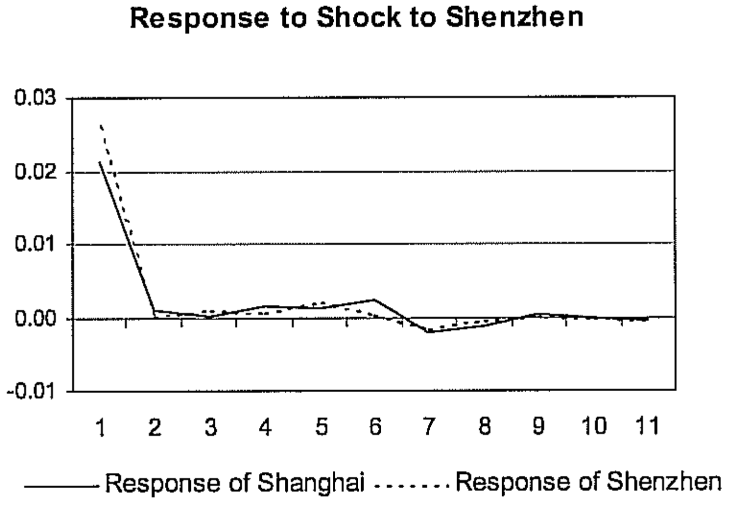


Figure 4. Impulse Response Functions: Shanghai and Shenzhen (Sub-Samples)

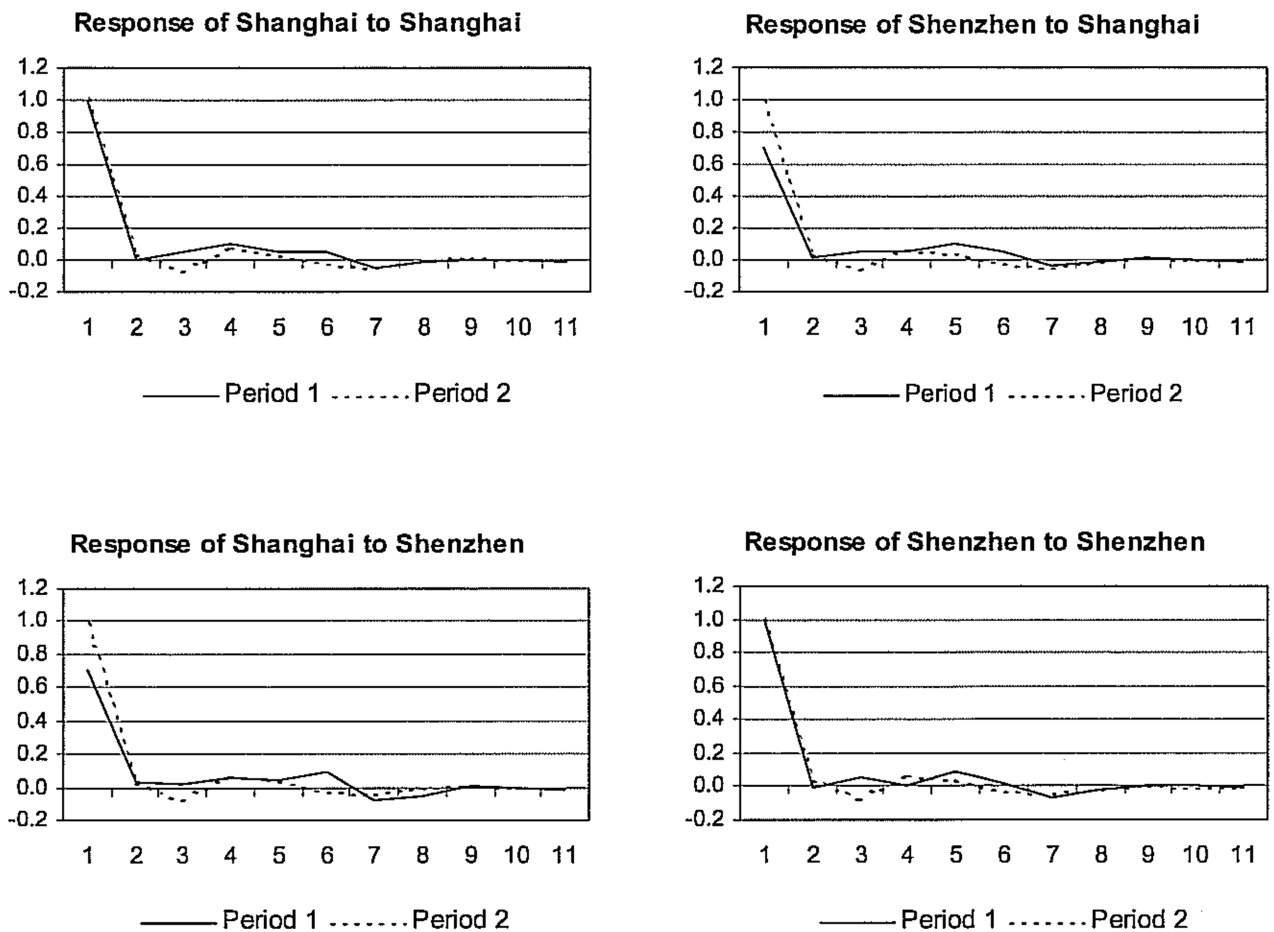
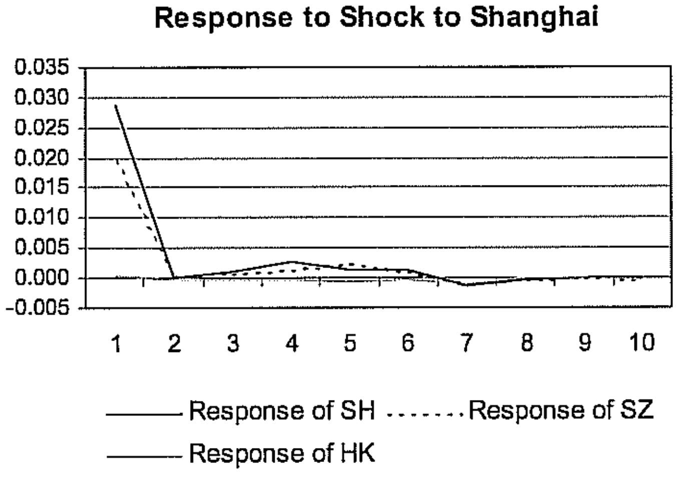
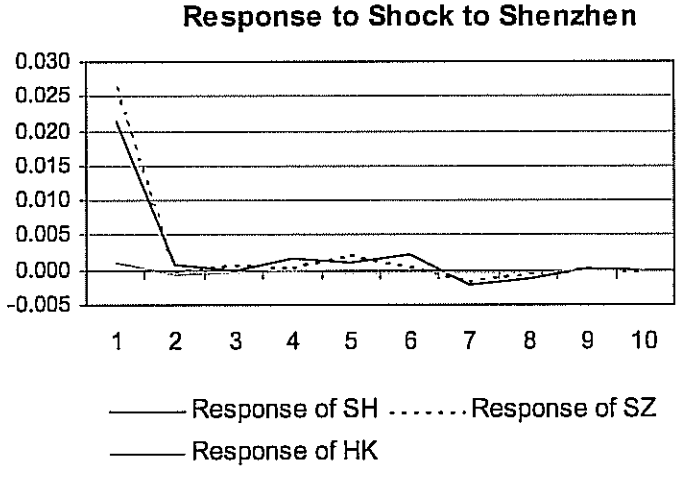


Figure 5. IRFs for Shanghai, Shenzhen and Hong Kong (Full Sample)





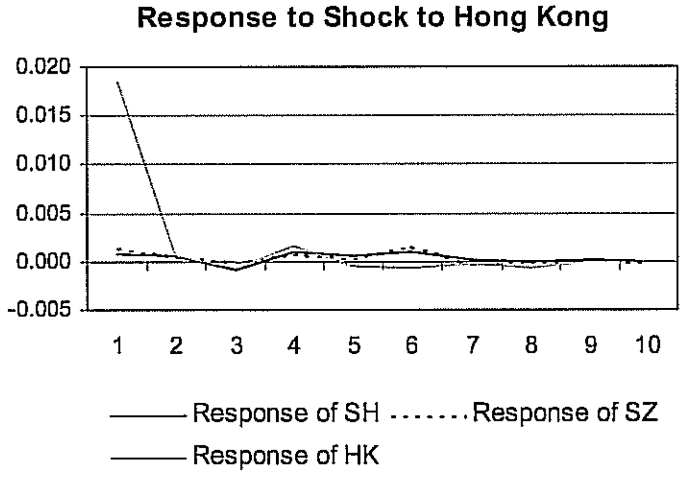
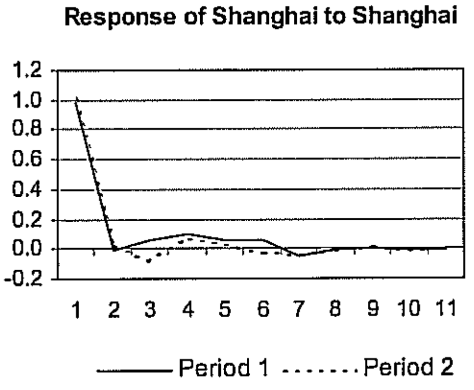
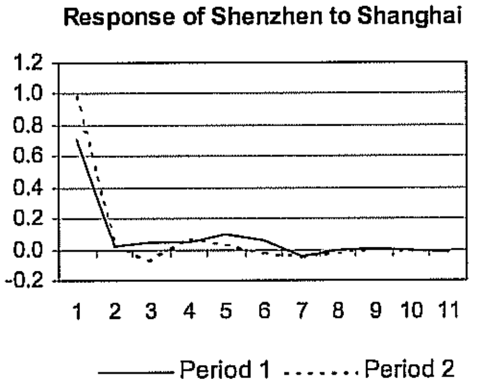


Figure 6. Shanghai, Shenzhen and Hong Kong (Sub-Samples)





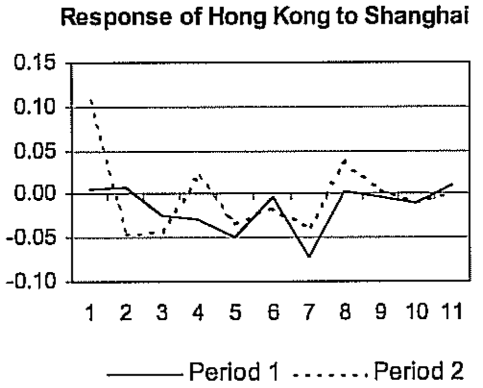
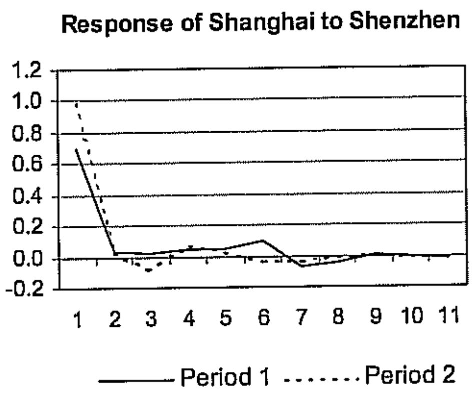
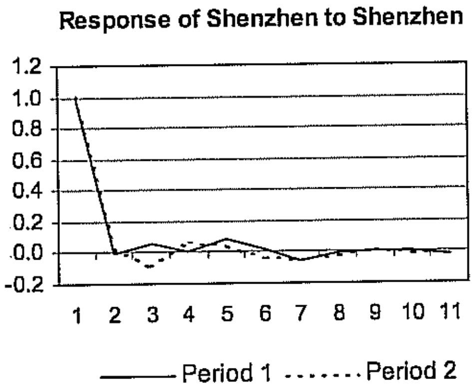


Figure 6. Continued





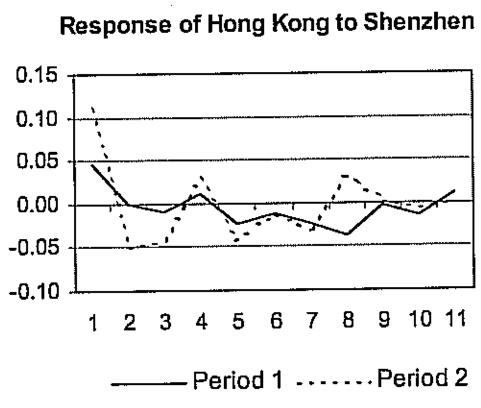


Figure 6. Continued