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Contagion and Diversification: The Impact of the 1997 Asian Financial Crisis on the Integration of Asia-Pacific Real Estate Markets

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Abstract

A considerable amount of research has appeared in the finance and economics literature on the various `contagion' crises in Russia, Mexico and Asia and the impact of such crises on the world's capital markets. Relatively little research has appeared in the real estate literature on the impact that such crises may have on capital flows to real estate and the associated long run implications of this. In this paper we consider the impact that structural breaks may have on long run diversification benefits in real estate. This is achieved through the use of cointegration analysis that accounts for structural breaks that may have occurred before, during and after the 1997 Asian Crisis on a sample of Pacific-Asian countries. The results show that if no consideration is made for the crisis, an erroneous conclusion could be made that the benefits to real estate diversification are far greater than they really are.

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Introduction

`Contagion' is said to exist if an unexpected shock or crisis in one asset (or an asset in one country) is transmitted relatively quickly to other assets (or to assets in other countries). That is, the adverse behaviour of one asset is contagious and, for whatever reason, initiates similar behaviour in other assets or in other countries. A sizeable amount of research has appeared recently in the finance and economics literature on the various `contagion' crises associated with Russia, Mexico and Asia in the mid to late nineties, and the impact that such crises have had on the world's capital markets. Relatively little research has appeared in the real estate or other literature on the bearing that such crises may have on capital flows to real estate and the associated long run implications of this- in particular, will such crises affect diversification benefits? With increased globalisation the impact of financial and other crises can have important ramifications for portfolio managers intending to diversify into international real estate markets over the long run. This paper aims to analyse the effect of the 1997 Asian market 'contagion' upon the interdependence amongst several Asia-Pacific real estate markets. In particular, whether the benefits of diversifying amongst such real estate markets have altered.

The structure of the rest of the paper is as follows: Section two briefly considers the recent literature on contagion in financial markets in general and real estate markets in particular; section three considers how the methodology of cointegration can be used to indicate the likely diversification benefits that exist amongst markets; section four describes the data and results; while section five offers some conclusions.

Section Two: Brief Background

The international transmission of financial shocks is not a new phenomenon, yet the 1990s saw the emergence of a variant of financial shock that was unanticipated, severe and was transmitted to countries quite distant from the shock originator. For instance, Edwards (2000) notes the transmission of financial crises from Hong Kong to Mexico and Chile in 1997 and from Russia to various Latin American countries in 1998. In the financial world one means of communicating a `disease' (i.e. a financial crisis) is through capital flows. That the financial crises of the 1990s spread so quickly through so many countries from Asia, to Europe to Latin America even though the economic fundamentals in the affected countries often differed, has been the subject of a great deal of recent analysis.

Conventionally, economists measure contagion by comparing the covariance between relevant variables during a period of relative stability with that during a period of turmoil (cf. Forbes and Rigobon (1999)). Contagion is then defined as an increase in cross-correlation of the variables (countries) during the period of turmoil. From an investment viewpoint it is clearly important to ascertain whether contagion occurs, whether it is only crisis contingent and whether the co-movement in variables is persistent post-crisis. For instance, if there is an increase in the co-movement of assets during a period of turmoil (i.e. there is contagion) followed by a decrease in this co-movement some short time thereafter, then from an investor's viewpoint this has far different implications to a situation where the increase in co-movement brought about by the crisis persists over some long period. An underlying tenet of diversification is that shocks to assets in the diversified portfolio are asset specific. However if contagion occurs after a shock in one of the assets then the increase in asset correlations would undermine the rationale for diversification. However, if the increase in co-movement in assets is a relatively short-run phenomenon resulting from the shock, with asset correlations returning to historical patterns, then any fall in diversification benefits may similarly be expected to only be a short-run phenomenon. The real concern to the portfolio manager is when the co-movement persists for some considerable period beyond the shock.

Associated with (but not developing from) this concern are competing views of international contagion that have divergent implications for diversification strategies. For example, there is a school of thought arguing that the propagation of financial turmoil is contingent upon the crisis itself. If this view holds then the diversification impact falls more on tactical (short run) than on strategic (long run) asset allocations. In a study of international stock market contagion Rigobon (1999) summarised this school of thought as comprising: the multiple equilibria effect; the liquidity effect and the political effect. The multiple equilibria effect suggests that a crisis in the first country changes investor expectations in the second, upsetting the equilibrium of the economy there and causing a crash. Masson (1999) is a strong supporter of this theory and argues pure contagion involves changes in investor expectations that are not related to a country's macroeconomic fundamentals. The liquidity effect is similar and suggests that financial shocks such as margin calls in the first country force portfolio recompositions that increase investor nervousness in the second country, which may then generate asset sell-offs to increase liquidity even in the absence of any liquidity crisis in the second country. The political effect argues that there are pressures on central bank authorities to maintain exchange rate regimes. Adverse balance of payments in an adjustable peg system may not only generate speculative attacks on the currency, but there may be an ensuing lack of confidence in the currency by investors, with associated asset sell offs and capital movements (cf. Tobin (1998)). This school of thought supports a short run view of crises and hence implies that diversification benefits, if they held pre-crisis, will hold in the long run.

A competing school of thought argues that the propagation of shocks are independent of the crises themselves, rather than being crisis driven. Rigobon (1999) suggests that this view is built around notions of economic interdependence in trade, monetary policy co-ordination, herd behaviour, international interest rates and so on.... If this view holds then, as far as the portfolio manager is concerned, there are few diversification benefits over the long term since the argument is that economic interdependence implies (stock, real estate etc. etc.) market interdependence.

There are varying levels of support for each of these views in the literature. For instance, Kaminsky and Schmukler (1999) in a study of the impact of `good' and `bad' news effects on contagion found that some of the largest co-swings in Asian equity markets were driven by herd instinct rather than by news. In a later work Kaminsky and Reinhard (2000) take the view that `true' contagion is associated with herding behaviour on the part of investors, and find this to be more regional than global. On the other hand, in a study of the Korean crisis of 1997 Choe, Kho and Stulz (1999) found that herding behaviour was no more important during the crisis than outside the crisis period, and could not find evidence that foreign investors played a destabilizing role in Korea's equity markets. Rijckeghem and Weder (2001) found that contagion was more driven by liquidity shocks (common bank lending) than by trade shocks, although Diwan and Hoekman (1999) take something of a contrarian view on trade shocks. Bowe and Domuta (2001) found that both local and foreign investor expectations to be jointly important in the pricing behaviour of Asian stocks over a period incorporating the 1997 Asian financial crisis.

In terms of the diversification issue and whether crises `kill' risk reduction benefits, research on contagion has primarily centred upon the impact on equity markets. From the property analyst's viewpoint, however, it is also important to narrow the focus to real estate assets. For example, Renaud (2000) noted that the interdependent roles of real estate and banking in the Asian crises has highlighted the conspicuous need for much better price and quantity monitoring of real estate cycles. Research by Renaud, Zhang and Koeberle (2001) suggests that a real estate crisis in 1996/97 in Thailand precipitated a domestic financial crisis whose large cost was further amplified by a currency crisis in 1997, and it was from this point that the `Asian flu' spread quickly to other economies. In contrast to this a study by Kim (2000) on the Korean real estate market presented strong evidence to suggest that the real estate sector could not have been a major cause of the economic crisis in that country. Now, from an international diversification viewpoint (the focus of this paper) it is irrelevant whether real estate is a cause or an effect of financial crisis. The important question is whether there are common linkages in international real estate and whether these linkages change in time of crisis. Answers to these questions will determine the potential existence of either long term or short term diversification benefits in holding international real estate assets.

Section Three: The Usefulness of Cointegration Methodology

As indicated earlier, one approach to testing the existence of contagion is the use of cross correlation analysis. Contagion implies that cross correlations are significantly different after a shock. Arguably then, if cross correlations are high both pre- post- and during the turmoil then it suggests the markets are interdependent and there are few, if any, diversification benefits. However there is a difficulty with the cross correlation methodology. Forbes and Rigobon (1999) show that conventional cross-correlation coefficients are biased upwards during a period of increased volatility in just one of the relevant variables (markets). Consequently indications of possible co-movement will not be valid under such circumstances. These authors developed a simple adjustment procedure and then analysed a variety of stock markets associated with the Asian crisis of 1997, the 1994 Mexican peso collapse and the 1987 US stock market crash. Their finding was strongly supportive of stock market interdependence rather than contagion. That is, the cross market linkages did not change significantly pre- post- and during the turmoil.

The adjusted cross-correlation procedure is not unique in dealing with this issue of contagion - there are alternative approaches to determining the likely existence of contagion amongst assets. For example Sheng and Tu (2000) used a cointegration framework on stock market data sampled before and during the Asian financial crisis. Their research suggested that stock markets were not cointegrated before the crisis of 1997 but that there was some degree of cointegration during the crisis. In their approach Sheng and Tu pre-judged the sampling break – a procedure which may or may not have impacted on their results. In the present research on contagion in international real estate markets we will similarly use a cointegration framework, but in the first instance we will depart from the practice of pre-selecting sub-sampling periods. Instead we will adopt the procedure developed by Inoue (1999) which determines any break date endogenously. The Inoue (1999) procedure allows for a test of cointegrating rank within the presence of a trend-break. A significant advantage from the property analyst's viewpoint, however, is the fact that this is a Johansen (1991) type test and does not require prior specification of the structure of a cointegrating equation. That is, a whole portfolio can be analysed in one pass to examine the number of common linkages that may exist amongst the assets (real estate markets of different countries) given the presence of an unknown structural break (trend).

Distinctively, the Inoue (1999) procedure has an advantage over alternative tests for cointegration in the presence of structural breaks when one is trying to determine the cointegrating rank. This is particularly useful when a multivariate system is under analysis. In the presence of trend-breaks, Johansen based tests may incorrectly infer no or only a limited number of cointegrating vectors exist, when the system may in fact be highly cointegrated. As the rank of a system is intrinsically linked to the number of stochastic processes present within a system (cf. Stock and Watson, 1988) the rank can reveal useful information relating to how integrated the system is over the long-run. For example, since cointegrated variables share common stochastic trends, if the cointegrating rank of a system is, say, $r = n-1$, then there is a single common trend (i.e. $n - r = 1$) driving all n series. In economic terms, such a scenario would lead to no diversification benefits as all the markets will follow the same long-run trends. Hence, knowledge of the cointegrating rank of a system can help determine the degree of integration prevalent within the markets under analysis.

With trend-breaks, Johansen trace and maximum eigenvalue tests may not correctly identify the number of cointegrating equations existent within the system and thereby may overestimate the benefits to diversification (i.e. may underestimate the true rank of the system). An alternative procedure to test for cointegration in the presence of an unknown structural break has been developed by Gregory and Hansen (1996). These residual based tests will determine whether cointegration exists in the presence of a break, although a drawback is that the procedure cannot determine the rank, and thereby the number of stochastic processes operating within the system.

The Inoue (1999) methodology follows closely that of the Johansen type tests. Three models are examined (A, B and C) that allow for possible mean and trend breaks, with model B being recommended when the form of a possible trend-break is unknown.

As Inoue (1999) outlines, the models can be written as *n*-dimensional vector autoregressions (VAR) such that:

$$Y_t^i(\boldsymbol{x}_0) = \sum_{j=1}^{p} \Phi_j Y_{t-j}^i(\boldsymbol{x}_0) + u_t, i = A, B, \tag{1}$$

$$Y_t^A(\boldsymbol{x}) = X_t - \boldsymbol{m} - \tilde{\boldsymbol{m}} DU_t(\boldsymbol{x}),$$

$$Y_t^B(\boldsymbol{x}) = X_t - \boldsymbol{m} - \tilde{\boldsymbol{m}} DU_t(\boldsymbol{x}) - \boldsymbol{d}t - \tilde{\boldsymbol{d}} DT_t(\boldsymbol{x}),$$

$$Y_t^C = c + \tilde{m} DU_t(x_0) + \sum_{j=1}^{p} \Phi_j Y_{t-j}^C + u_t, Y_t^C = X_t, \tag{2}$$

where $u_1 \sim NID(0_{nx1,} \Omega), c, \boldsymbol{m}, \tilde{\boldsymbol{m}}, \boldsymbol{d}$ and $\tilde{\boldsymbol{d}}$ are n-dimensional vectors, $\{\boldsymbol{f}_j\}_j^p =_1$ are $n \times n$ matrices, $DU_t(\boldsymbol{x}) = I(t > [T\boldsymbol{x}])$ and $DT_t(\boldsymbol{x}) = (t - [T\boldsymbol{x}])I(t > [T\boldsymbol{x}])$ where $I(\boldsymbol{x})$ denotes the indicator function and $[x]$ denotes the integer part of $x. \boldsymbol{x}_0 \in \Xi$ is the break fraction where Ξ is a closed subset of (0,1).

The above equations can also be written in an error-correction form, such that:

$$\Delta Y_t^i(\boldsymbol{x}_0) = \Pi Y_{t-1}^i(\boldsymbol{x}_0) + \sum_{j=1}^{p-1} \Gamma_j \Delta Y_{t-j}^i(\boldsymbol{x}_0) + u_{t,} i = A, B, \tag{3}$$

$$\Delta Y_t^c = c + \tilde{\boldsymbol{m}} DU_t(\boldsymbol{x}_0) + \Pi Y_{t-1}^c + \sum_{j=1}^{p-1} \Gamma_j \Delta Y_{t-j}^c + u_{t,} \tag{4}$$

where $\{\Gamma_j\}_{j=1}^{p-1}$ and Π are $n \times n$ matrices, q and r are integers such that $1 \le q \le n$ and $0 \le r \le q$ and $\boldsymbol{a}$ and b are $n \times q$ matrices such that $ab' = \Pi$. From this Inoue (1999) develops trace and maximum eigenvalue statistics that are similar in taxonomy to Johansen (1991) such that the null hypothesis of

$$H_0 : \text{rank}(a) = \text{rank}(b) \leq r, \;\; \tilde{m} = \boldsymbol{d} = 0_{n\times 1},$$

can be tested against either the alternative:

$$H_1 : \text{rank}(\boldsymbol{a}) = \text{rank}(\boldsymbol{b}) = r + 1$$

using the trace stastistic:

$$\sup_{x\in\Xi}\{-T \sum_{j=r+1}^{T} \ln\,(1-\hat{l}^{i}_{j}(x))\,\}; \tag{5}$$

or, by applying the maximum eigenvalue statistic:

$$\sup_{x\in\Xi}\;\{-T\;\ln(1-\hat{\boldsymbol{l}}^{i}_{r+1}(\boldsymbol{x}))\}, \tag{6}$$

one can test against the alternative:

$$H_2 : \text{rank}(a) = \text{rank}(b) > r\,.$$

Inoue(1999) provides asymptotic critical values for these test statistics as well as evidence that these tests perform as well, if not better, than the Gregory and Hansen (1996) residual-based tests plus are more appropriate than the standard Johansen methodology where trend-breaks are present.

The above test statistics are therefore calculated in the empirical section to provide a direct comparison with the standard Johansen tests in order to determine the number of long-run constraints that exist amongst the real estate series under investigation and the benefits to diversification, once the 1997 crisis is explicitly taken into account.

The Hansen and Johansen (1999) procedure recursively estimates the eigenvalues in a cointegrated VAR to test for parameter constancy. In the paper this essentially operates as a check against the other procedures in identifying any change in variable relationships during a period of turmoil.

What will these tests tell us? Here we constructa small portfolio of international real estate markets based on both geographic region and trade flows. In total the analysis captures four countries as described later. A period of turmoil, such as the various financial crises of the 1990s (or indeed, the financial crisis that emerged after the terrorist attacks of September 11), often results in a change in relationships amongst variables such as: the creation of new relationships where none existed before; the disappearance of previously existing equilibrium relationships; or a change from one long run equilibrium relationship to some new long run equilibrium relationship. Applying a combination of various cointegration tests to the different portfolios will allow us to determine how financial contagion has affected the flow of potential benefits from diversifying internationally. The Inoue (1999) test will tell us whether a long run equilibrium relationship continued to exist in the presence of some unknown trend break (and the test will also tell us when this break occurred). We can then apply a conventional Johansen (1991) test on either side of the identified break to ascertain the extent to which the strength of the cointegrating relationship may have altered. The Hansen and Johansen (1999) recursive methodology operates as a supporting check against the other procedures.

All in all the research provides new and very useful information on the extent to which international contagion in real estate markets exists and on whether managers may need to adjust the composition of their property portfolios in the event of financial (or other) crises.

Section Four: Data Description and Results

Four countries are considered in the analysis: Singapore, Malaysia, Hong Kong and Japan. Japan enters as the premier economy in the Asia region while the remaining countries are members of ASEAN, an important trading alliance in the region. Data limitations prohibited the inclusion of other countries such as Thailand, Indonesia and Korea. Inability to include Thailand due to unavailability of sufficient real estate data is particularly disappointing since other research has suggested this country was an important player in the Asian financial crisis. Weekly price return indices from the first week in January, 1993 to the second week in December, 2001 were obtained from Datastream international. These were exchange adjusted for US dollars and the base date was set to January, 1993. The start date was simply a function of data availability for some of the countries. While all analysis was undertaken on the natural logarithm of the data figure 1 plots the series in unlogged form to obtain a clearer visual impression prior to our analysis. A visual inspection will also note how all the series, with the possible exception of Japan, roughly follow a positive drift over time until the 1997 crisis. The Japanese economy has had difficulty recovering from the general recession of 1990/91 and this has been reflected in its property sector. So as to generate a clearer impression of the impact of the 1997 crisis on the Japanese property market we have scaled Japan on the secondary (RHS) axis in figure 1. We note that from the time of the crisis, and particularly between mid 1997 to the end of 1998, a significant change occurs within all the price series before resuming something close to the previous pattern prior to the crisis. This trend-break clearly shows that the Asian crisis has had a major impact upon these securitised real estate markets.

Prior to undertaking any cointegration analysis it is necessary to ascertain the degree of integration for each series. Research by Perron (1989) showed that the existence of a structural break in a series can affect its stationarity properties. Unit root testing procedures developed by Zivot and Andrews allow for the testing of a unit root in the presence of a possible structural break in the series (a break in the intercept, slope or both – their models A, B and C). Table 1 presents the outcomes from both conventional ADF unit root tests along with Zivot and Andrews unit root tests. To limit the size of the table for the ZA tests we cease testing after the first indicated break rather than attempt to find all possible breaks in the series since our purpose is merely to define the primary stationarity properties of the series. Both conventional ADF and ZA tests indicate that the series are I(1). We note that all of the significant ZA results indicate a break date about mid to late 1997, which certainly coincides with the Asian financial crisis.

Table 1 about here

As both figure 1 and the Zivot and Andrews tests in table 1 indicate a break around the time of the 1997 financial crisis, the cointegration tests presented in table 2 are not only conducted for the full sample but also for a pre-crisis period and post-crisis period. The reason for doing this is that the cointegrating relationships that may be observed over time are not stable if the structural break is not taken into account. The lag order is chosen by the sequential method as used via the Inoue procedure with the Johansen analysis using the same lag order as that chosen by the Inoue method.

To split the data into two sub-samples, the earliest breakpoint identified by the Zivot and Andrews test is used (i.e 29-07-97) as an indicator for the end-point of the first sample. Similarly, we chose the start of the second sub-sample to begin at the last significant breakpoint established for any of the series by the Zivot and Andrews tests. For our data this is 21-10-97. Ensuring that no data series has another significant breakpoint during the sub-samples can reveal a differing degree of cointegration than for the full sample where breaks do occur.

The test results that are tabulated in table 2 do indeed show differing results for the sub-samples and full sample. For the full sample the results show no presence of any cointegrating equations, suggesting these real estate markets are not integrated and offer substantial diversification benefits. However, as previously discussed, the result for the full sample may be erroneous as the Johansen rank tests have not taken into account the possibility of a trend-break within the data, consequently the extent of diversification benefits to a portfolio manager may be widely exaggerated. Returning to table 2 we see that both sub-samples show evidence of two cointegrating equations, indicating the presence of two stochastic processes. In fact, the results strongly support the presence of at least two cointegrating equations at the 1% significance level, and much weaker evidence of three cointegrating equations at the 5% significance level for the trace test in the post-crisis period. These results strongly suggest that an international property investment manager must carefully consider whether any portfolio of Asia-Pacific real estate stocks are yielding diversification benefits. These results also cast doubt on the presence of contagion in international real estate markets since the rank of the system does not appear to have changed significantly pre- vs post-crisis.

To further test whether it would be possible to impose two cointegrating equations onto the full sample, the Johansen procedure is re-run restricting the model to contain two cointegrating equations. Then, an analysis of the recursive eigenvalues is conducted to test whether the cointegrating equations are stable (recursion initiated with 150 observations). Specifically, this is the parameter constancy test discussed in Johansen and Hansen (1999) [see also Darrat and Zhong (2001)]. The test statistic is given by:

$$LR = t\sum_{j=1}^{r}\{\ln[1-\hat{r}_j(t)-\ln[1-\hat{l}_j(t)]\} \quad for \quad t = T_0,.....,T \tag{7}$$

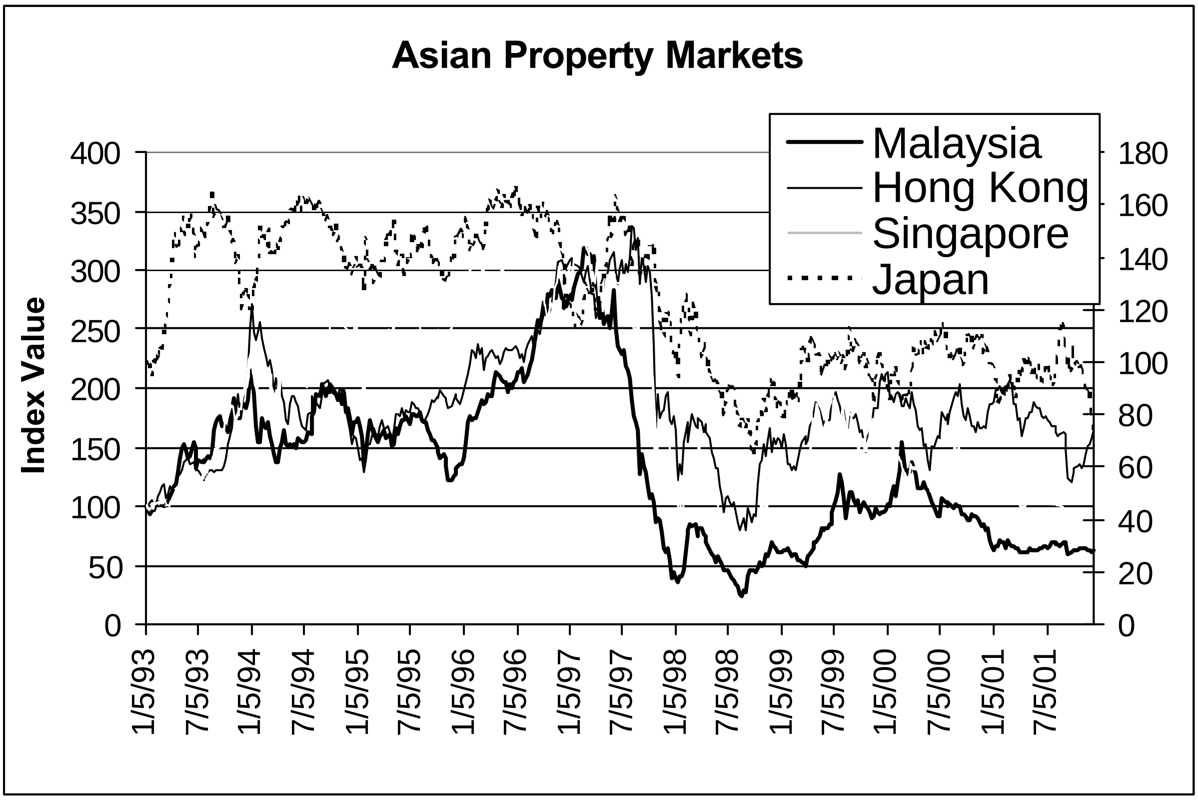
Where: T is the overall sample size and T_0 is the base-period sample size; $\hat{r}_j(t)$ and $\hat{l}_j(t)$ are the solutions to the restricted and unrestricted eigenvalue problems respectively; and r is the hypothesized number of cointegrating vectors. This likelihood ratio is distributed as a Chi-square and figure 2 shows the Chi-square test statistic computed over the sample period along with 1% and 5% critical values. It is noticeable that in June 1997 the null of parameter constancy is rejected, occurring within the same time-frame as the Zivot and Andrews breakpoints. This essentially indicates that even if two cointegrating equations are present within the full sample, there is a break in the data that leads these relationships to be unstable, even if it is for a short period.

To correct for the presence of a simple break in the mean or trend of an integrated real estate market, the Inoue results for all three models are presented in table 3 for the full sample period. These results show the presence of at least two cointegrating equations at the 5% level for all three model types and at least one cointegrating equation at the 1% level. So, broadly speaking, these results are highlighting the fact that most likely two cointegrating vectors are present within the system of the four real estate markets, since this would agree with the Johansen sub-sample test results shown in table 2. Moreover, the likely breakpoints given by the Inoue process are either in June or July 1997, coinciding with both the date that the recursive parameter constancy tests are first rejected, as well as with the Zivot and Andrews breakpoints.

Section Five: Summary and Conclusions

This paper set out to examine the question of whether contagion existed in international real estate markets and what the implications of the finding would mean for diversification into international real estate markets. Contagion was defined as the transmission of a shock or crisis from one market or asset to another. Here we were particularly interested in Asian property markets and the impact of the 1997 financial crisis. The tool chosen to examine the question was cointegration analysis. Specifically we queried whether Asian real estate markets were integrated over the long term once account was taken of (unknown) structural breaks. The paper showed that if the possibility of crises was ignored then a conventional Johansen procedure may yield incorrect results and may lead a portfolio manager to erringly diversify across assets that are not likely to yield as good a risk reduction benefit as anticipated. We showed this in three ways viz. (i) through the use of conventional Johansen methodology on a simple data split pre- and post-crisis in which we demonstrated that the number of stochastic processes were higher than was the case when the crisis was ignored; (ii) through the use of a parameter constancy test on the supposition that the pre- and post- number of cointegrating equations held for the full sample; and (iii) through the use of the Inoue technique which is an adaptation of the conventional Johansen procedure that allows for structural breaks. The Inoue procedure supported the notion of only two stochastic processes within the four asset system. Essentially this outcome suggests that there may well be only very restricted (if any) diversification benefits across Asian property markets. In terms of the contagion question it would seem, then, that Rigobon's (1999) conclusions regarding international stock markets may apply equally well to securitised property markets – there is no contagion, only interdependence. This has important ramifications for the portfolio manager seeking potential risk reduction benefits through international diversification in securitised real estate.

Figure 1


Asian Property Markets
Malaysia
Hong Kong
Singapore
Japan
Index Value
400
350
300
250
200
150
100
50
0
180
160
140
120
100
80
60
40
20
0
1/5/93
7/5/93
1/5/94
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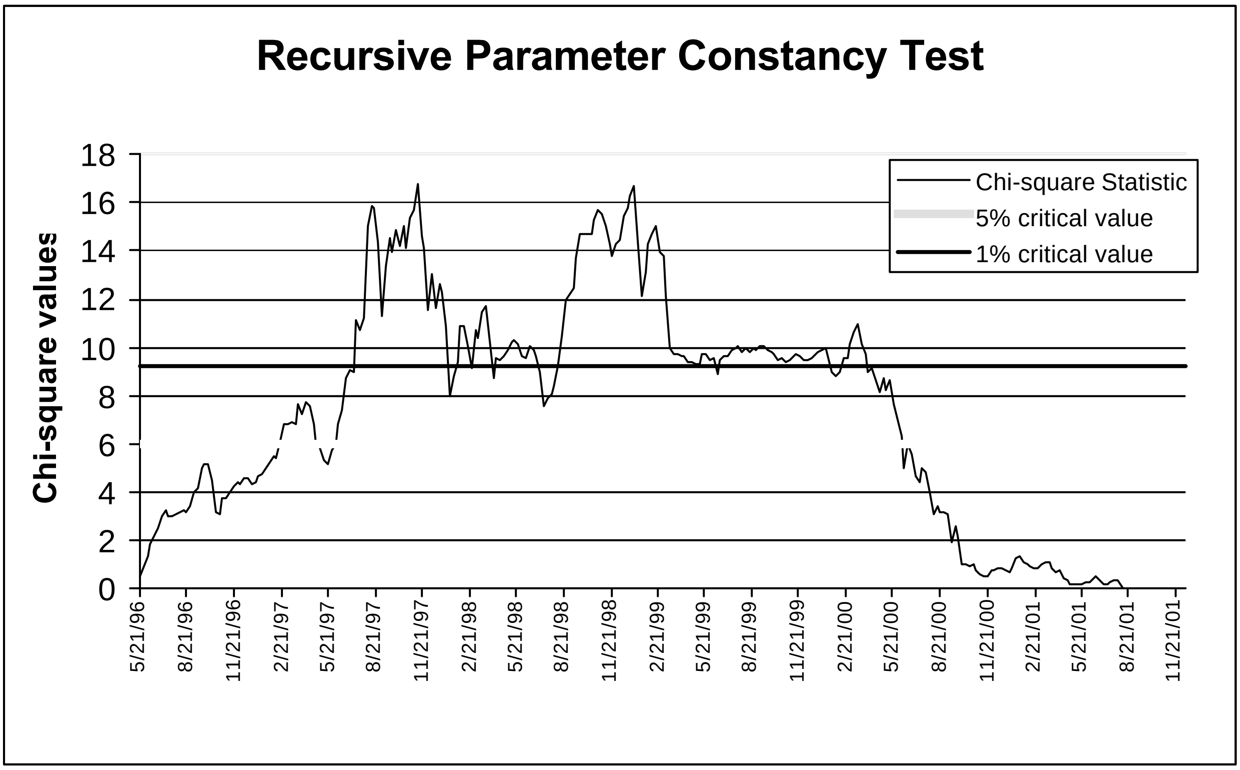
7/5/01

Figure 2



Recursive Parameter Constancy Test
Chi-square values
18
16
14
12
10
8
6
4
2
0
Chi-square Statistic
5% critical value
1% critical value
5/21/96
8/21/96
11/21/96
2/21/97
5/21/97
8/21/97
11/21/97
2/21/98
5/21/98
8/21/98
11/21/98
2/21/99
5/21/99
8/21/99
11/21/99
2/21/00
5/21/00
8/21/00
11/21/00
2/21/01
5/21/01
8/21/01
11/21/01

Table 1. Unit Root Tests.

	ADF Tests		*Zivot and Andrews Tests*		
Country	*(Levels)*	*(Returns)*	*A*	*B*	*C*
Hong Kong	-2.95	-8.80[a]	-5.24[b] (7-10-97)	-2.93	-5.0[c] (14-10-97)
Japan	-3.71	-9.66[a]	-6.04[a] (21-10-97)	-3.76	-6.02[a] (21-10-97)
Malaysia	-2.50	-8.61[a]	-4.68[c] (29-07-97)	-4.68[b] (05-08-97)	-4.55 (05-08-97)
Singapore	-2.36	-8.72[a]	-4.06 (5-08-97)	-2.61	-3.73

Augmented Dickey-Fuller (ADF) tests were performed on logarithmic values (levels) and their first differences (returns). A, B and C denote the three different model types presented in Zivot and Andrews (1992). The number of lags for the tests were determined by following a sequential, downward t-test on all autoregressive lags.

[a] Indicates significance at the 1% level. [b] indicates significance at the 5% level and [c] at the 10% level.

Table 2. Johansen Rank Tests.

	Full Sample (5/1/93 – 11/12/01)		*Pre- Crisis Sample (5/1/93 – 29/7/97)*		*Post- Crisis Sample (21/10/97 – 11/12/01)*	
	l_{Trace}	l_{Max}	l_{Trace}	l_{Max}	l_{Trace}	l_{Max}
r=0	62.73	24.88	95.98[a]	43.59[a]	111.3[a]	52.33[a]
r£1	37.84	18.4	52.39[a]	32.64[a]	58.95[a]	28.73[a]
r£2	19.44	13.76	19.75	12.81	30.22[b]	18.6
r£3	5.686	5.686	6.94	6.94	11.62	11.62

The results presented are the Johansen trace and maximum eigenvalue statistics. Results tabulated assume a trend component and critical values are taken from Osterwald-Lenum (1992). A sequential estimation procedure was used to determine lag order. [a] Indicates reject null at 1%, [b] at 5% and [c] at 10%

Table 3. Inoue Rank Tests.

H_0:	*Model A*		*Model B*		*Model C*	
	l_{Trace}	l_{Max}	l_{Trace}	l_{Max}	l_{Trace}	l_{Max}
r=0	91.491[a]	61.738[a]	123.32[a]	69.302[a]	94.186[a]	63.358[a]
	(22/07/97)		(29/07/97)		(24/06/97)	
r£1	50.619[b]	36.046[b]	62.3	40.577[b]	51.832[a]	36.788[b]
	(15/07/97)		(04/11/97)		(22/07/97)	
r£2	17.939	14.868	34.15	24.171	17.711	14.595
r£3	6.291	6.291	14.02	14.02	5.889	5.888

Critical values for the trace and maximum eigenvalue statistics are taken from Inoue (1999). [a] Indicates reject null at 1%, [b] at 5% and [c] at 10%

Bibliography

Bowe, Michael and Daniela Domuta "Foreign Investor Behaviour and the Asian Financial Crisis", Journal of International Financial Markets, Institutions and Money, vol.11, 2001, pp.395-422

Choe, Hyuk, Bong-Chan Kho and Rene Stulz "Do Foreign Investors Destabilise Stock Markets? The Korean Experience in 1997", Journal of Financial Economics, vol.54, 1999, pp.227-264

Darrat, Ali and Maosen Zhong "Equity Market Integration and Multinational Trade Accords: The Case of NAFTA", Social Science Research Network Working Paper Series, 2001.

Diwan, I. And Hoekman, B "Competition, Complementarity and Contagion in East Asia" in Agenor, P., Miller M. and Weber, A (eds) The Asian Financial Crisis: Causes, Contagion and Consequences, North Holland, London, 1999

Edwards, Sebastian "Interest Rates, Contagion and Capital Controls" NBER Working Paper Series No.7801, July, 2000

Forbes, Kristin and Roberto Rigobon "No Contagion, Only Interdependence: Measuring Stock Market Co-Movements", NBER Working Paper Series No.7267, July, 1999

Ghosh, C., R.S. Guttery and C.F.Sirmans "The Effects of the Real Estate Crisis on Institutional Stock Prices", Journal of Real Estate Economics, vol. 25, Winter, 1997, pp.591-614

Hansen, Henrik and Johansen, Soren "Some Tests for Parameter Constancy in Cointegrated VAR-models", Econometrics Journal, 1999, vol.2, pp.306-333

Inoue, Atsushi "Tests of Cointegrating Rank with a Trend-break", Journal of Econometrics, vol.90, 1999, pp.215-237

Johansen, S Likelihood-based Inference in Cointegrated Vector Autoregressive Models. Oxford University Press, Oxford, 1995

Johansen, S "Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models", Econometrica, vol.59, 1991, pp1551-1580

Kaminsky, Graciela and Carmen Reinhart "On Crises, Contagion and Confusion", Journal of International Economics, vol.51, 2000, pp145-168

Kaminsky, Graciela and Sergio Schmukler "What Triggers Market Jitters? A Chronicle of the Asian Crisis", Journal of International Money and Finance, vol.18, 1999, pp.537-560

Kim, Kyung-Hwan "Korea: Could a Real Estate Price Bubble have Caused the Economic Crisis?" in Mera, Koichi and Bertrand Renaud (eds) Asia's Financial Crisis and the Role of Real Estate" M.E.Sharpe, London, 2000

Masson, P "Contagion: Monsoonal Effects, Spillovers and Jumps Between Multiple Equilibria" in Agenor, P., Miller M. and Weber, A (eds) The Asian Financial Crisis: Causes, Contagion and Consequences, North Holland, London, 1999

Renaud, Bertrand "How Real Estate Contributed to the Thailand Financial Crisis" in Mera, Koichi and Bertrand Renaud (eds) Asia's Financial Crisis and the Role of Real Estate" M.E.Sharpe, London, 2000

Renaud, Bertrand, Ming Zhang and Stefan Koeberle "Real Estate and the Asian Crisis: Lessons of the Thai Experience" in Stephen J. Brown and Crocker H.Liu (eds) A Global Perspective on Real Estate Cycles, Kluwer, Boston, 2001

Rigobon, Roberto "On the Measurement of the International Propagation of Shocks" NBER Working Paper Series No.7354, September, 1999

Rijckeghem, Caroline and Beatrice Weder "Sources of Contagion: Is it Finance or Trade", Journal of International Economics, vol.54, 2001, pp.293-308

Sheng, Hsiao-Ching and Anthony Tu "A Study of Cointegration and Variance Decomposition Among National Equity Indices Before and During the Period of the Asian Financial Crisis", Journal of Multinational Financial Management, vol.10, 2000, pp345-365

Stock, J.H. and Watson, M.W "Testing for Common Trends" **Journal of the American Statistical Association**, vol.83, 1988, 1097-1107.

Tobin, James "Asian Financial Crisis" Japan and the World Economy, vol.10, 1998, pp.351-353