Regime Shifts in Asian Equity and Real Estate Markets

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This paper applies a new statistical technology for identifying regime shifts to analyze recent data on real estate and equity markets in eight developing Far Eastern countries in the 1992-1998 time period. We find that regime shifts in volatility occurs in the summer of 1997; however, most of the regime shifts in returns occur in the spring of 1998. While the clustering of regime breaks does not seem to follow any obvious pattern, the country's exposure to trade and firm leverage are important. An analysis of Granger causality suggests that, in most cases, equity returns cause real estate returns but the converse is not true. We also find two-way causality in volatility, suggesting that a common factor drives volatility in these markets. Finally we provide evidence that the regime shifts generally imply higher relative risk for real estate securities after the estimated breaks.

The recent upheaval in the Far East has made economists reevaluate the relations among financial markets on the international stage and also within each country. The crisis, commonly dubbed the Asian flu began on July 1997 with the devaluation of the Thai baht. It quickly spread through all nations in the Far East, although with widely differing intensity and duration. A commonly reported driver of this crisis was the banking sector's overextension of credit to real estate. Allegedly, as real estate markets plummeted, banks suffered enormous losses due to their exposure to real estate developers; these problems then spread to the rest of the financial sector.[1] For example, for Thailand, Frank Flatters (2000, p. 261) offers the following analysis:

Among the factors contributing to the vulnerability of the system were the following: large and growing short-term liabilities relative to foreign reserves, which themselves were rapidly diminishing as the Bank of Thailand tried to maintain the baht's peg; the increasing oversupply of real estate, especially in

[1] Renaud (2000) provides an overview of the role of real estate in the Asian crisis focusing on Thailand; see also his earlier analysis of global real estate cycles (Renaud 1997).

Bangkok, which hurt the property and construction sectors directly, and also threatened the value of the principal form of collateral used in much bank lending.

A related, pithy observation comes from Paul Krugman (1999, p. ix):

How did a few bad real estate loans and a botched devaluation in Thailand a small, faraway country of which most people knew little—send dominoes toppling from Indonesia to South Korea?

We will show that one effect of the crisis was to reduce real estate returns and to increase real estate volatility and correlation with other asset classes. But this general effect played out differently across the individual countries. The real estate indexes of China. Korea, Malaysia, and Thailand peaked in 1995, well before the start of the crisis. This suggests that the events of 1997 and 1998 should have affected the.se countries differently than those who.se real estate markets continued to be strong into 1997.

While a wide variety of explanations for the crisis have emerged, including poor corporate governance, lack of proper banking supervision, IMF bungling, hedge fund herding, and so forth, much of the problem seemed to center in real estate markets. It is thus interesting to analyze how real estate and equity markets reacted during the time around the crisis. While a number of other studies have focused on the returns themselves, typically searching for increases in correlations,[2] our approach is different. We proceed in two stages. The first question we address is Granger causality: During this time period did real estate lead equity (stocks) or vice versa? We examine this question both for the return and volatility of real estate and equity in each country. The existence of Granger causality then motivates the second, and perhaps more interesting question: Did the crisis fundamentally change the relation between real estate and equity markets, or was it merely a manifestation of the natural dependencies in these markets? To answer this problem we test, separately within each of these developing eight countries, for statistically significant changes in the structural relation between equity and real estate markets. In this context, we use the term "structural relation" to refer not only to the lead/lag pattern and the strength of correlation across the equity and real estate asset markets, but also to the relation between the volatilities in those two markets within each country.

We define a shock or regime shift as the most statistically significant change in the posited structural relation during the span of time from well before to well after the crisis event. Thus, we are looking for the time around the crisis when the dynamics of the relation between the return and

[2] An example is Baig and Goldfajn (1998).

volatility of real estate and equity shifted the most. If we find no shock in a given country,[3] then we are tempted to conclude that much of the crisis was a manifestation of natural dependencies in these markets. This view is outlined in Forbes and Rigobon (2002). On the other hand, if we see a regime shift, it suggests that the fundamental relation between real estate and equity markets has changed. More specifically, using the recently developed statistical technique of Bai, Lumsdaine and Stock (1998), hereafter referred to as BLS,[4] we identify regime shifts in the time series of monthly real estate and equity index returns and volatilities in each country. We use monthly data to mitigate the effects of estimation in a very noisy series.[5] Our objective is not only to identify as precisely as possible the date of a regime break, but also to study the nature of any observed regime break.

The final segment of our analysis focuses on potential explanations for the observed pattern in regime breaks across countries, such as trade, leverage, corporate governance, or legal structures. Financial crises have generated a wide variety of economic explanations and models.[6] One important rationale underlying the market contagion effect is that trade linkages provide a channel tor the spread of financial problems. From Obstfeld (1999, p. 7):

> Thus, crises may contain a self-fulfilling element, just as bank runs do, which can generate multiple equilibria in international asset markets, and render the timing of crises somewhat indeterminate. What we see in these cases is a sharp break from an essentially tranquil equilibrium to a crisis state, rather than a gradual deterioration in domestic interest rates and other market-based indicators.

This effect is modeled in Allen and Gale (2000). They find that the possibility of contagion is highly dependent upon the completeness of the market for interregional claims. Related to these models is the idea that the spread of financial crises is exaggerated because of incomplete information; see, for example, Calvo and Mendoza (2000). Thus, a crisis in one country signals information about the financial condition of other countries that share underlying regional factors and trade patterns. This can lead to herding and the rampant withdrawal of foreign funds. This creates pressure on the domestic currencies and interest rates. In the Asian crisis, this capital flight, in particular the withdrawal of hedge fund capital, is often assumed to have played an important role. Brown, Goetzmann and Park (2000) show that while the funds" positions were volatile, these movements were not highly correlated with fluctuations in FX rates, thus casting doubts on the importance of the role that hedge funds played in

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[3] By "no shock" we mean that the identified regime break is not statistically significant. This is clarified in the following section.

[4] Bekaert, Harvey and Lumsdaine (1998) use this technique to test the timing of world equity market integration.

[5] See Harvey (1995) for elaboration.

[6] Calomiris (1995) presents an overview.

causing the crisis. More recently, Lin and Kuo (2000) assert that international hedge funds played a role in the baht crisis but were not a major force in the currency crises of Indonesia, Malaysia, or the Philippines.

Research dealing with the transmission of information shocks across markets has also focused on volatility relations across the relevant asset markets. Fleming, Kirby and Ostdiek (1998), FKO hereafter, analyze volatility shocks across debt, equity, and money markets. FKO's main goal is to investigate volatility linkages of two distinct types. In the first case, a common information shock affects traders' expectations in each market simultaneously. Reacting to this shock, traders adjust their speculative demand across markets. In the second case, an information shock perturbs expectations in one market. This will result in investors rebalancing their holdings in other markets in response to a change in the hedging component of their demand. FKO call this phenomenon information spillover.

Thus it is of interest to evaluate the type of information effects that characterize the Asian crisis. In particular, it all markets experience structural breaks simultaneously, then common information shocks appear to predominate. This then suggests that return expectations were affected in all markets concurrently. Conversely, information contagion or spillover effects are significant if the timing of regime shifts differs across markets. Observing the sequence of regime breaks can help us understand the drivers of this significant event. It is important to emphasize that we do not assume that a regime break occurred in a given country during the reported crisis period. The technique we employ identifies the single most significant break in the posited relation over the sample period. However, this break could be statistically insignificant.

The organization of the paper is as follows: The next section describes the statistical methodology. The third section describes our data set. The fourth section presents our empirical results, and the final section contains our conclusions. An appendix provides an analysis of the returns on real estate securities versus returns on the underlying real estate in these developing markets.

Methodology

The problem of detecting breaks in economic time series has received increasing attention by the econometric literature. Although several time series models[7] have been proposed to provide estimates of break dates, formal measures of the precision of these estimates were unavailable. The estimation of a confidence interval around the break date is important to economists, as it incorporates

[7] See, for example, Perron (1989) and Banerjee, Lumsdaine and Stock (1992).

a measure of sampling uncertainty into the analysis. The statistical method adopted here, devised by Bai, Lumsdaine and Stock (1998), provides inference about breaks, including interval estimation of the break date.[8]

The BLS technique searches for a single break in a multivariate time series and specifies asymptotic confidence intervals for the break point. We use this methodology to test for regime shifts in the (linear) relation between equity and real estate markets in each country separately. The technique is particularly appealing because it does not require that residuals are normally distributed. Here we illustrate the approach for equity and real estate return time series.

Month *t* real estate index return in local currency is the dependent variable in our model. Independent variables are the corresponding local equity returns in each of the five months *t* - 2 to *t* + 2 (to account for possible lead-lag relations) and the real estate return in month *t* - I (to account for first-order autocorrelation). A parallel analysis is done on monthly volatility, where we use the 12-month rolling volatility estimate.[9] For returns, we adopt the following specification:

$$y_t = \mu + Ay_{t-1} + \sum_{i=1}^{5} b_i x_{ti-3} + d_t(k)\left[\lambda + \alpha y_{t-1} + \sum_{i=1}^{5} \beta_i x_{t+i-3}\right] + \varepsilon_t. \qquad (1)$$

Here *k* is a potential break date, y_t is the real estate index return in month *t* for a given country, and x_t is the corresponding equity return in month *t.* The dummy $d_t(k)$ introduces a shift in the coefficients of Equation (1) at time *k.* This equation is also motivated by Dimson's (1979) approach to estimating betas with infrequent trading. We can interpret the b_is at different tags as betas and, ignoring serial autocorrelation, the aggregate of the b_is would be an estimate of the beta of the real estate index.[10] With this interpretation of Equation (1), the BLS technique selects the most significant shift in betas over the sample period. Analyzing the corresponding β_is will allow us to analyze the nature of any structural break in the relation between equity and real estate returns.

The above equation in stacked form becomes

$$y_t = V_t'\vartheta + d_t(k)V_t'S'S\delta + \varepsilon_t \qquad (2)$$

with $V_t' = (1, y_{t-1}, x_{t-2}, \ldots, x_{t+2})$ and $\vartheta = (\mu, A, b_1, \ldots, b_5)$ and $\delta = (\lambda, \alpha, \beta_1, \ldots, \beta_5)$.

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[8] A more detailed description of our methodology is available from the authors upon request.

[9] The adoption of a rolling 12-month standard deviation appears first in Officer (1973) and Merton (1980). Our results are not sensitive to the particular averaging length.

[10] In our case, the equity index is also relatively illiquid, so that Dimson's approach is warranted. When the equity index is liquid, calculating the beta of a real estate index requires just the use of lagged values of the equity index; see Geltner (1989, 1991) for an analysis of this topic.

In matrix form this is:

$$y_t = Z_t'(k)\mathrm{B} + \varepsilon_t \tag{3}$$

where $Z_t' = (V_t', d_t(k)V_t'S')$ and $\mathrm{B} = (\theta', (S\delta)')'$.

The model permits a wide variety of assumptions about parameter shifts. For example, the model is one of a full structural change if all coefficients are allowed to change. If it is assumed that only a subset of the coefficients undergoes a regime shift, then a partial structural model is appropriate. For example, if we suspect a break only in the intercept, then S = [1,0,0,0,0,0,0].[11]

A variety of tests for a break, based on Wald statistics, have been proposed in the literature. The null hypothesis is that $S\delta = 0$ for $k = k^* + 1, \ldots, T - k^*$, where k^* is some trimming value.[12] The test adopted in this paper, analogous to Quandt (1960), considers the maximum of the following F process:

$$\hat{F}(k) = T\{R\hat{B}(k)\}'\left\{R\left(T^{-1}\sum_{t=1}^{T} Z_t(k)\hat{\Sigma}_k^{-1}Z_t'(k)\right)^{-1}R'\right\}\{R\hat{B}(k)\}, \tag{4}$$

where $R = [0, I_R]$ is such that $RB = S\delta$; $\sum_k$ is the estimator of σ_ε^2, based on OLS residuals under the alternative hypothesis given k. The estimator for B is

$$\hat{B}(k) = \left\{\sum_{t=1}^{T} Z_t(k)Z_t'(k)\right\}^{-1}\sum_{t=1}^{T} Z_t(k)y_t. \tag{5}$$

The estimated break date is then $\hat{k}$A, the argmax of $\hat{F}\{k)$.

To summarize, we first identify a likely candidate for a break date in the posited relation as the date corresponding to the maximum of this Wald statistic over the sample period. This break is statistically significant if and only if that Wald statistic is above a chosen threshold, which is determined by the given significance level.

We also search for breaks in the volatility series. The rolled volatility is calculated as a moving standard deviation of 12 monthly returns for the real estate (σ_y) and equity (σ_x) index returns.[13] The

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[11] As reported in Bai. Lumsdaine and Stock (1998) tests for partial structural changes tend to have better power than those for full structural changes. In that case, (he unchanged parameters .should be estimated using all the available observations to gain efficiency. However, our analysis indicates that the breaks are statistically significant even when we use a full structural model rather than simply allowing a subset of the parameters to break.

[12] The trimming value used in this specification is k* =5.

[13] For this case, the trimming value we adopted was k* =4.

proposed model is the following:[14]

$$\sigma_{yt} = \mu + A\sigma_{yt-1} + b\sigma_{xt} + d_t(k)[\lambda + \beta\sigma_{xt}] + \varepsilon_t. \qquad (6)$$

The econometric specifications adopted in this paper represent a balance among the statistical significance of the estimated coefficients, economic rationale, and data availability constraints. As a check on the robustness of our results, different lead-lag specifications of the structural relation were also tested. The Wald statistics were also computed for time intervals different from the ones chosen for our analysis. The results, which are available on request from the authors, show that the Wald statistics and the estimated regime shifts are robust to these modifications.

This discussion and the theoretical analysis offered in FKO suggest one testable implication regarding identifying the existence and timing of volatility and return shocks, that is, in identifying breaks in the posited linear relations. In particular, whether events observed in Asia in this period are attributable to either common information shocks or information spillover (contagion) from one country to another is an empirically testable question. If common information shocks are associated with the Asian crisis, then we should see contemporaneous regime shifts in returns (volatility) between real estate and equity markets in various countries. On the other hand, information spillover effects dominate if there are sequential breaks in the returns (volatilities) among countries.

Data and Preliminary Statistics

We analyze equity and real estate indexes for our eight Asian markets: China, Hong Kong, Indonesia, Malaysia, Philippines, South Korea, Taiwan, and Thailand. For each of the markets, we use the major equity index in local currency to calculate a monthly time series of "local" returns. The corresponding real estate indexes are subsets of the equity indexes. The monthly equity and property indexes for each country are obtained from Bloomberg. Table 1 describes the indexes used. The varying composition of the real estate indexes has to be taken into consideration when interpreting our results. For example, only five real-estate-related stocks comprise the real estate index for China. Furthermore, as Table 2 indicates, the dates for which data are available differ slightly across each of the countries, again making cross-country comparisons a little more awkward. Finally, our study focuses on real estate returns derived from real-estate-related equities rather than more direct measures of real estate

[14] Note that, by construction, the rolled volatility series has positive serial correlation. We take this into account by including a lagged term in the regression model. However, since we are not interested in a break in the serial correlation pattern, we do not allow the serial correlation coefficient to vary.

performance due to data restrictions. In the appendix, we examine the relation between the performance of securitized real estate and the underlying real markets. The appendix shows, for most countries, that the real estate security index returns exhibit a fairly strong tendency to move with the underlying real estate returns and that real estate securities in each country have similar average returns, albeit higher variances, than the underlying real estate.

The means and standard deviations of monthly returns shown in Table 2 show quite distinct patterns. The mean real estate returns are negative in four countries: Indonesia, Korea, Taiwan, and Thailand. Equity returns are negative in the Philippines and Thailand. The mean monthly returns are -0.51 % for real estate and 0.4067(for equity: the standard deviations of real estate and equity returns average 13.8% and 10.4%. The highest real estate correlations arc among Hong Kong, Indonesia, Malaysia, the Philippines, and Thailand. These five countries appear to have a large common factor in real estate returns.

Figure 1 provides some perspective on the drop in values: it shows the performance of the real estate and equity indexes in each of the countries over our sample period. These indexes represent equity and securitized real estate prices. This figure suggests that there were two distinct peaks in real estate index values: one occurring around the beginning of 1994 for Korea, Malaysia, and Thailand, the second occurring in 1997 for Hong Kong, Indonesia, the Philippines, and Taiwan. China peaks in December 1993. This indicates that real estate markets in several of these countries had already suffered for two years before the 1997 currency crisis. The corresponding graph for equity index values presents a similar picture with peaks around the end of 1993 and in early 1997.

Table 1 ■ Index description.

	Real Estate Index	Equity Index
China	SIPRO: The China Stock Exchange Shenz Sub Prop Index is a capitalization-weighted index of the following five stocks: Dongguan Win-A, Shenz SP Econ-B, Shenz Zhenye-A, Shenz SP Econ-A, and Shenz Changche-A.	China Stock Exchange Composite Index
Hong Kong	AOP-HKSE: The Hong Kong All Ordinaries Properties Index is a capitalization-weighted index of all stocks that represent the properties sector of the HKSE. The index was developed with a base value of 2333.77 as of January 2, 1992.	HKSE Equity Index
Indonesia	JAKPROP: The Jakarta Construction, Property and Real Estate Index is a capitalization-weighted index of all stocks involved in the business of construction, property, and real estate of the Jakarta Composite Index. The index was developed with a base value of 100 as of December 28, 1995.	JCI Jakarta Composite Index
Malaysia	Kuala Lumpur Property Index: The Kuala Lumpur Property Index is a capitalization-weighted index of all stocks representative of the property sector of the EMAS Index.	EMAS Equity Index
Philippines	PSE: The PSE Property Index is a capitalization-weighted index composed of stocks representative of the property sector of the PSE.	PSE Philippine Stock Exchange Index
South Korea	Korea Property Index: It is a capitalization-weighted index of all stocks that represent the properties sector of the Kospi 200.	Kospi 200
Taiwan	TWSECON: The TWSE Construction Index is a capitalization-weighted index that measures the performance of the construction sector of the TWSE Index.	TWSE Stock Index
Thailand	SETPROP: The Thai Property Dev Index is a capitalization-weighted index of all stocks that represent the properties sector of the Thailand Stock Exchange Index.	Thailand Stock Exchange Index

This table describes the composition of the real estate and equity indexes used in our empirical analysis.

Table 2 ■ Descriptive statistics.

	Real Estate Returns		Equity Returns		
	Mean (μ)	St. Dev. (σ)	Mean (μ)	St. Dev. (σ)	Sample Size
China	1.064%	14.829%	1.936%	9.253%	Feb 95–Mar 99
Hong Kong	0.472%	13.702%	0.754%	9.832%	Nov 93–Mar 99
Indonesia	−3.284%	11.888%	0.056%	11.883%	Dec 95–Mar 99
Korea	−0.184%	13.690%	0.206%	10.522%	Dec 89–Mar 99
Malaysia	0.405%	14.629%	0.191%	10.188%	Oct 92–Mar 99
Philippines	0.190%	14.039%	−0.288%	10.059%	Oct 94–Mar 99
Taiwan	−0.405%	8.294%	1.023%	9.379%	Mar 93–Mar 99
Thailand	−2.335%	19.013%	−0.668%	11.841%	Feb 93–Mar 99

This table displays descriptive statistics (mean and standard deviation) for time series of equity and real estate indexes' returns for each of the countries included in the study. Equity and real estate returns are computed from local equity indexes' monthly time series obtained from Bloomberg.

Empirical Results

Granger Causality

We begin with an examination of the lead/lag relations between real estate and equity markets. Granger causality tests measure the predictive ability of the chosen time-series models. For example, the time series of real estate returns "Granger causes" the time series of equity returns if, after controlling for the past history of equity returns, real estate returns can offer a statistically significant explanation of the residual (unexplained variability) in the equity return series. Table 3 presents the results from Granger causality tests in each of the eight markets. Our test assumes autoregressive lags of one to four months[15] via the equation

$$z_t = \alpha_0 + \sum_{i=1}^{L} \beta_i x_{i-1} + \sum_{j=1}^{L} \alpha_j z_{t-j} + \varepsilon_t \quad \text{for } L = 1,\ 2,\ 3,\ 4. \tag{7}$$

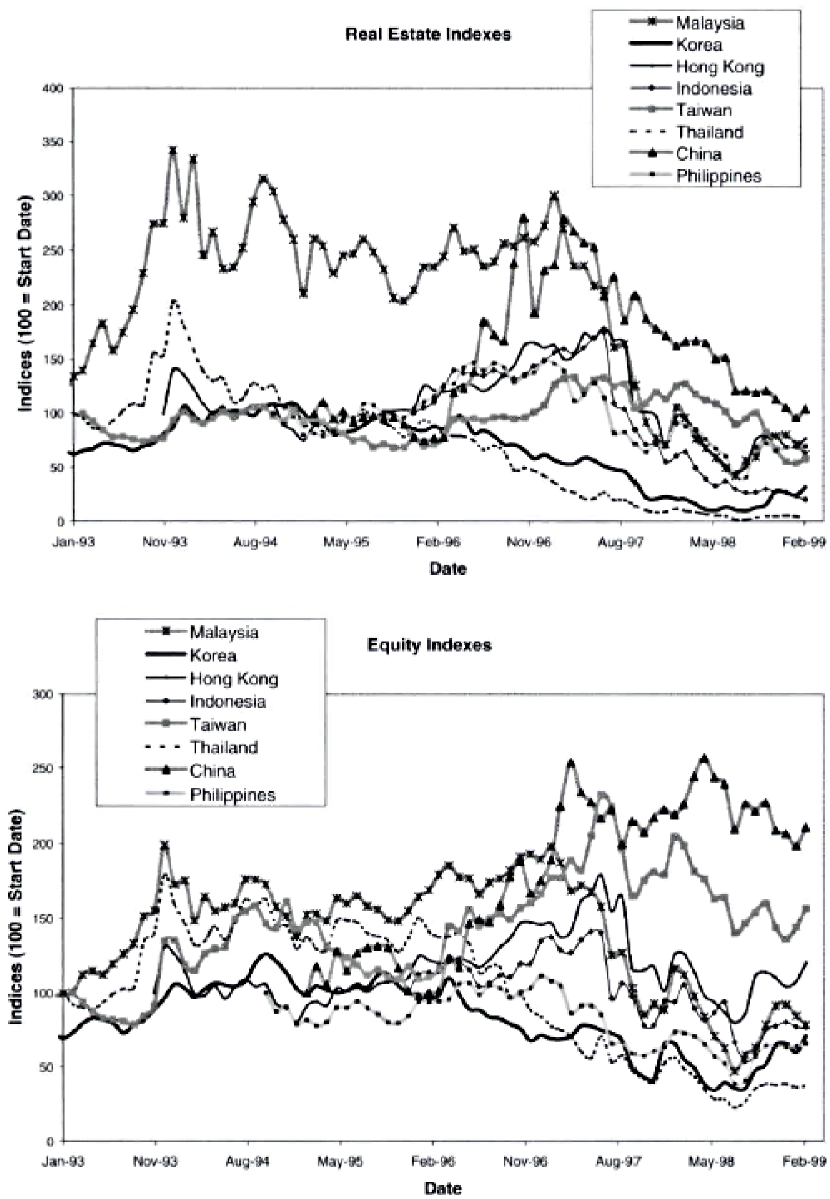
Our null hypothesis is that *x* {equity returns or volatility) does not Granger cause *z* (real estate returns or volatility); that is, the β_i are not significantly different from zero. The entries in Table 3 represent the F-statistics arising from the joint test that all β_i=0. The test statistic is

$$F = \frac{\frac{SS_1 - SS_0}{d}}{\frac{SS_1}{n-2d-1}}, \tag{8}$$

[15] We use up to four lags to allow for relatively long-term effects without sacrificing too many observations.

where SS_1 is the sum of squares from Equation (7); SS_0 is the sum of squares of Equation (7) under the null hypothesis restriction that all β_l are zero; d is the lag length; n is the number of observations. We test causality separately for returns and volatility.[16]

Figure 1 ■ Real estate and equity performance indexes. These figures display the performance of real estate and equity indexes in local currency for each of the countries in the sample, each starting from a base of 100 in the first available month of observations.



[16] By construction, the volatility series is highly persistent, which makes it more likely that the F-statistic in Equation (8) is insignificant. Hence, any evidence of Granger causality in the case of volatility can be interpreted with more confidence that in the case of returns.

Table 3 ■ Granger causality analysis.

	Observations	Lag = 1	Lag = 2	Lag = 3	Lag = 4
Panel A: Real Estate Granger Causes Equity Returns					
China	48	0.152	0.729	1.469	1.360
Hong Kong	63	0.207	1.984	1.573	1.588
Indonesia	38	0.042	0.018	0.830	0.662
Korea	110	0.002	2.241	3.036	4.072*
Malaysia	76	0.013	0.178	0.766	0.410
Philippines	52	1.380	0.957	1.052	0.985
Taiwan	71	0.304	0.531	0.462	0.353
Thailand	72	1.421	2.499	1.363	0.839
Panel B: Equity Granger Causes Real Estate Returns					
China	48	0.955	0.699	2.587	2.381
Hong Kong	63	0.009	1.753	1.610	1.587
Indonesia	38	0.230	0.130	1.230	1.128
Korea	110	0.437	3.472*	4.305*	4.465*
Malaysia	76	0.038	2.468	4.562*	3.242*
Philippines	52	7.307**	4.608*	3.238*	2.086
Taiwan	71	0.414	0.791	0.596	0.487
Thailand	72	2.489	3.630*	2.994	1.894
Panel C. Real Estate Granger Causes Equity Volatility					
China	37	2.175	0.977	4.755*	5.232*
Hong Kong	52	0.000	1.029	0.668	0.512
Indonesia	27	1.417	2.470	2.977	2.966
Korea	99	2.607	2.658	5.576**	4.181*
Malaysia	65	2.228	1.445	2.571	1.558
Philippines	41	11.115**	5.543**	4.186*	3.129
Taiwan	60	25.853**	13.492**	9.795**	7.475**
Thailand	61	0.005	0.241	1.240	0.900
Panel D: Equity Granger Causes Real Estate Volatility					
China	37	0.249	1.896	3.630*	4.773*
Hong Kong	52	0.010	2.912	1.995	1.501
Indonesia	27	1.285	2.842	3.619*	3.928*
Korea	99	4.877**	2.364	2.041	2.432
Malaysia	65	7.518**	3.531*	2.795	2.151
Philippines	41	3.512*	1.854	1.643	1.342
Taiwan	60	1.778	1.593	1.594	1.645
Thailand	61	0.136	0.156	1.674	1.531

This table presents a Granger causality analysis of the relation between real estate and equity indexes in our eight markets. The equation being tested is

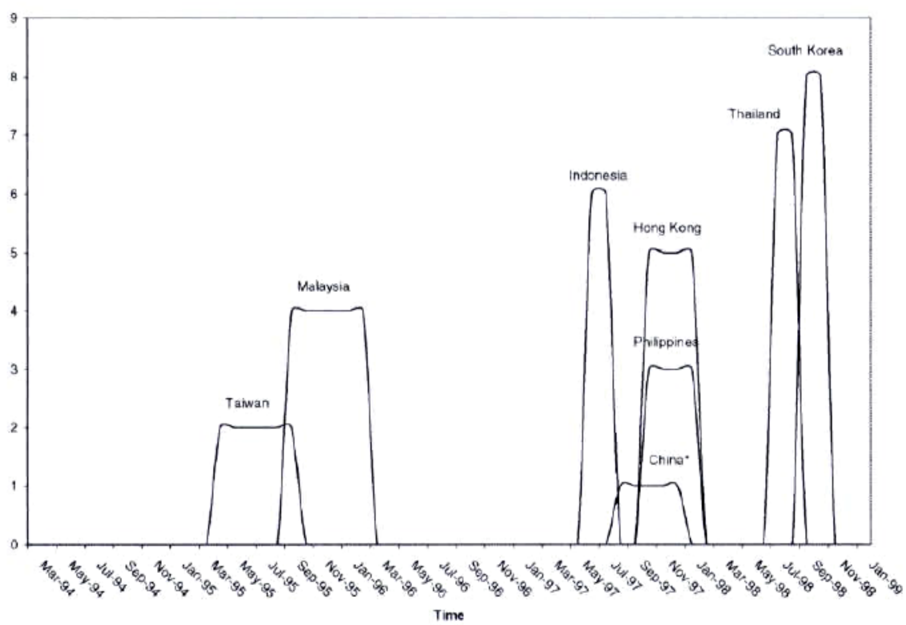
$$z_t = \alpha_0 + \sum_{i=1}^{L} \beta_i x_{t-i} + \sum_{j=1}^{L} \alpha_j z_{t-j} + \varepsilon_t \quad \text{for } L = 1, 2, 3, 4.$$

The table entries represent the F-statistic corresponding to the test that all β_i are zero. Significance levels are indicated by ** and * for the 0.01 and 0.05 levels, respectively.

Panel A of Table 3 shows very little indication that real estate returns Granger cause equity returns, casting doubt on the assertion that real estate might have caused the Asian crisis. Only one entry is significant at the 0.05 level; Korea at 4 lags. Panel B, on the other hand, provides evidence that equity returns Granger cause real estate returns. In Korea the relation is .significant at the 0.05 level at lags 2 to 4; for Malaysia, the relation is significant at the 0.05 level at lags 3 and 4. For the Philippines, the relation is significant at the 0.05 level at lags 1 to 3. For Thailand, the relation is significant at 2 lags. Overall, in half of these countries (the exceptions being China, Hong Kong, Indonesia, and Taiwan) equity returns appear to Granger cause real estate returns and there is only scant evidence that the converse is true.

When we turn to volatility, a different picture emerges. In three countries (China, South Korea, and the Philippines), the fact that real estate volatility seems to cause equity volatility and vice versa suggests very strongly that there is a common factor affecting the real estate/equity volatility relation in these countries. This implies that our simple Granger relation is misspecified, since we are missing a common explanatory variable for both series. This supports the existence of a common information shock for volatility across equity and real estate markets. Only in Hong Kong and Thailand do we find no statistical evidence of causality in either direction. For Indonesia and Malaysia, we see that equity volatility Granger causes real estate volatility, while the converse is the case in Taiwan. This analysis seems to suggest that the volatility relations are stronger and more complex than the return relations. Also, we can see that it is difficult to make broad generalizations about the countries in our sample. This point will be echoed in the following analysis of regime breaks.

Figure 2 ■ Confidence interval for break dates in returns. This figure displays confidence intervals at the 5% significance level around the estimated break date $\hat{k}$, that is, the one that maximizes the Wald statistic $F(\hat{k})$ over the sample interval, for the structural relation between real estate and equity returns. The procedure used to compute the confidence intervals is described in the text. The confidence interval measure of eight (left axis) is associated to the country for which we measure the most significant $F(\hat{k})$ in the sample. The confidence interval measure of one (left axis) is associated to the country for which we measure the least significant $F(\hat{k})$ in the sample. *Insignificant Wald statistic.



Regime Break Analysis

We now focus on whether there were breaks either in the historical intertemporal cross-correlation relation or in the volatility relation between real estate and equity. The former is the subject of Figure 2 and Tables 4 and 6, while the latter is the subject of Figure 3 and Tables 5 and 6. We proceed by estimating Equations (I) and (6) respectively for each possible break date in the sample history ranging from well before the crisis to substantially after the crisis, and by computing the Wald statistic as described in Equation (4).

With respect to the structural relation in returns between real estate and equity, Figure 2 and Table 4 reveal that no significant regime shift occurs for Indonesia.[17] The remaining seven countries all experience a statistically significant break.[18] The earliest regime shift occurred in China and the Philippines, in late 1996. These regime shifts are prior to the period generally associated with the inception of the Asian crisis (July 1997). The next structural break between real estate and equity returns occurs in the first half of 1998 in Hong Kong, Indonesia and Thailand. The confidence intervals for these countries overlap, and. as such, the breaks in these countries are assumed concurrent. All other countries—Malaysia, South Korea and Taiwan—appear to experience concurrent breaks in the latter half of 1998. This evidence suggests that structural breaks between real estate and equity market returns in each country seem to *occur after* the crisis period in the summer of 1997.

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[17] Stated more precisely, the identified regime break was not statistically significant. In this case because it occurred very near the end of our observed time period.

[18] In an earlier draft of this paper, we included Australia and Japan in our analysis. Australia exhibited no regime breaks. Japan had no significant return break, but had a volatility break in October 1988, roughly corresponding to the end of the real estate bubble. These countries are excluded from this analysis to allow us to focus on developing countries.

Table 4 ■ Analysis of the regression coefficients at the structural break date $\hat{k}$ for returns.

		Pre-break Coefficients							Post-break Coefficients						
Country	adj$R$-Squared	Intercept	X	$Y-1$	$X-1$	$X-2$	$X+1$	$X+2$	ΔIntercept	ΔX	$\Delta Y-1$	$\Delta X-1$	$\Delta X-2$	$\Delta X+1$	$\Delta X+2$
Malaysia	70.61%	0.006	−0.114	−0.033	−0.168	0.077	0.175	−0.050	0.159′	0.080	0.003*	−1.113*	−0.223*	−1.423′	−0.285
Thailand	49.62%*	−0.028	0.036	−0.024	−0.009	−0.331	0.122	0.422′	−0.197*	0.249	0.273	−0.983*	−2.404*	−1.179*	−2.065*
Hong Kong	94.45%	−0.005	1.128*	−0.067	0.147	0.076	0.078	−0.066	0.003	0.607*	0.134	−0.297	0.112	−0.196′	0.137
Taiwan	75.56%	−0.003	0.637*	−0.046	0.121	−0.022	−0.107′	0.094	−0.112*	0.180	−0.313	−0.531	−1.102*	−0.155	0.280
China	65.20%	0.020	1.428*	0.097	0.580′	−0.493′	−0.393′	0.047*	−0.075*	−0.509	−0.698*	−0.193*	0.454	0.492	0.170
Philippines	94.45	0.008	0.943*	0.019	0.119	0.358*	0.050	0.181	−0.012	0.332	−0.733*	0.903*	−0.652*	−0.241	−0.204
Indonesia°	43.62%	−0.014	0.668*	−0.038	0.290	0.593*	0.067	−0.133	−0.053	0.217	0.079	−0.515	−0.691*	−0.575*	0.468
Korea	77.85%	−0.011′	0.769	0.075	0.044	0.185*	0.058	−0.066	0.343*	0.026	−1.266*	1.663*	0.909*	−1.702*	−0.565*

′ Significance level of 10%.
* Significance level of 5% or less.
° Break not significant at less than 15%.

$$y_t = \mu + Ay_{t-1} + \sum_{i=1}^{5} b_i x_{ti-3} + d_t(\hat{k})\left[\lambda + \alpha y_{t-1} + \sum_{i=1}^{5} \beta_i x_{t+i-3}\right] + \varepsilon_t,$$

where y and x are, respectively, the real estate index return and the equity index return for the corresponding country in the table. The first column of the table shows the adjusted R^2, R_a^2, for the structural relationship above for each of the countries in the sample. The next seven columns report the estimated coefficients of the hypothesized structural relationship before the break occurred. The break date $\hat{k}$ has been identified through the Wald statistic described in the text. The last seven columns report the change in the structural coefficients after the break occurred.

Figure 3 ■ Confidence interval for break dates in return volatility. This figure displays confidence intervals at the 5% significance level around the estimated break date $\hat{k}$, that is, the one that maximizes the Wald statistic $F(\hat{k})$ over the sample interval, for the structural relation between real estate and equity return volatility. Rolled volatility time series are calculated as moving standard deviations of 12 monthly returns for the equity and real estate index returns. The procedure used to compute the confidence intervals is described in the text. The confidence interval measure of eight (left axis) is associated to the country for which we measure the most significant $F(\hat{k})$ in the sample. The confidence interval measure of one (left axis) is associated to the country for which we measure the least significant $F(\hat{k})$ in the sample.

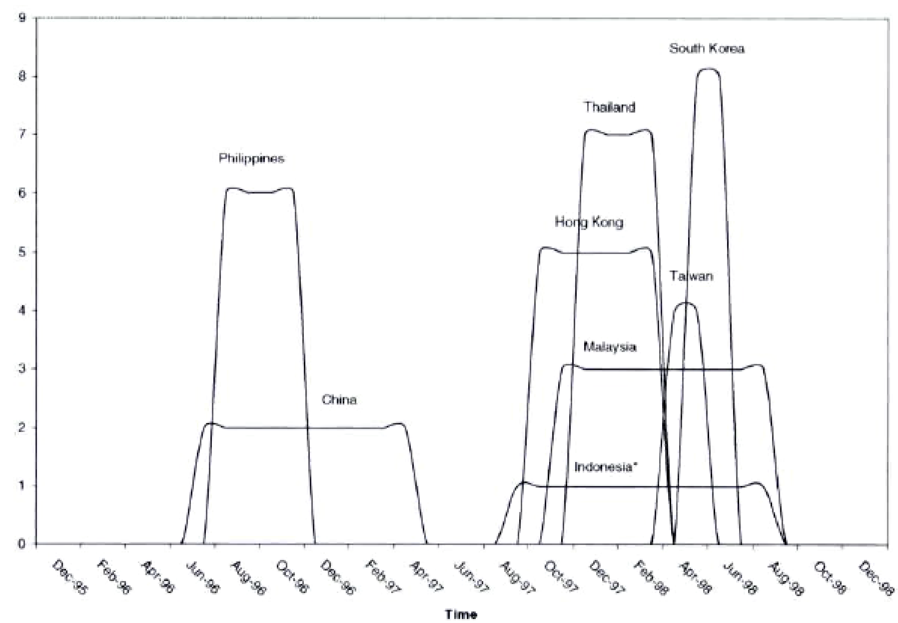

Table 5 ■ Analysis of the regression coefficients at the structural break date $\hat{k}$ for volatility.

		Pre-break Coefficients			Post-break Coefficients	
Country	adj$R$-Squared	Intercept	X	$Y-1$	ΔIntercept	ΔX
Malaysia	97.03%	0.047*	0.723*	0.188*	0.036*	0.273*
Thailand	97.07%	0.007	0.557*	0.508*	−0.047	0.704*
Hong Kong	97.02%	0.007	0.065*	0.377*	−0.089*	0.902*
Philippines	98.98%	−0.023*	1.423*	0.039	−0.002	0.184
China°	92.17%	−0.046	1.012*	0.709*	0.034	−0.480
Indonesia	92.80%	0.219	−3.075	0.223	−0.199	3.685
Korea	94.37%	0.007	0.002*	0.734*	0.032	0.052
Taiwan	66.49%	0.029*	0.115*	0.399*	−0.008	0.224*

^ Significance level of 10%.
*Significance level of 5% or less.
°Break not significant at less than 15%.

$$\sigma_{yt} = \mu + A\sigma_{yt-1} + b\sigma_{xt} + d_t\left(\hat{k}\right)[\lambda + \beta\sigma_{xt}] + \varepsilon_t$$

where σ_Y and σ_X are, respectively, the real estate index return volatility and the equity index return volatility for the corresponding country in the table. The first column of the table shows the adjusted R^2, R_a^2, for the structural relationship above for each of the countries in the sample. The next three columns report the estimated coefficients of the hypothesized structural relationship before the break occurred. The break date $\hat{k}$ has been identified through the Wald statistic described in the text. The last two columns report the change in the structural coefficients after the break occurred.

The existence and timing of the volatility breaks in the structural relation between real estate and equity markets differs somewhat from the break dates in returns. Figure 3 shows Taiwan and Malaysia experience concurrent regime shifts in the volatility relation around mid-1995 to early 1996: this period predates the period for returns. For the remaining countries, the sequence for breaks in volatility starts with Indonesia, which breaks around June 1997. Contemporaneous volatility breaks follow for Hong Kong and the Philippines in the first half of 1998. Finally, Korea and Thailand experience a structural break in volatility in summer 1998. The evidence on volatility breaks indicates that structural breaks in volatility between equity and real estate markets are associated with common information shocks, although there is some evidence of information spillover effects in 1997 and 1998. The difference in the return and volatility findings is partly attributable to the different regression fits of the return data relative to the volatility data. In essence, since the adjusted *R-s* arc higher for the volatility regressions, the constructed confidence intervals are tighter, making it easier to determine statistically significant differences in the timing of regime breaks.

Table 6 ■ Analysis of regime shifts.

Country	2.5th Percentile	Median	97.5th Percentile	MaxWald	*p*-value
Panel A: Analysis of Real Estate Indices Monthly Returns: Structural Break in All Parameters					
Malaysia	Nov–97	Apr–98^	Aug–98	22.74	<0.05
Thailand	Dec–97	Feb–98*	Mar–98	88.06	<0.01
Hong Kong	Oct–97	Jan–98*	Mar–98	42.53	<0.01
Taiwan	Apr–98	May–98*	May–98	33.42	<0.01
China	Jul–96	Dec–96^	Apr–97	21.43	<0.05
Philippines	Aug–96	Oct–96*	Nov–96	48.65	<0.01
Indonesia	Nov–98	Dec–98°	Dec–98	18.82	>0.10
South Korea	Apr–98	May–98*	May–98	75.15	<0.01

° Not significant at less than 10%. ^ Significance level of 5%. * Significance level of 1% or less.

Country	2.5th Percentile	Median	97.5th Percentile	MaxWald	*p*-value
Panel B: Analysis of Real Estate Indices Monthly Return Volatility: Structural Break in Selected Parameters					
Malaysia	Nov–95	Feb–96*	Apr–96	30.78	<0.01
Thailand	Sep–98	Oct–98*	Oct–98	113.88	<0.01
Hong Kong	Dec–97	Feb–98*	Mar–98	31.27	<0.01
Taiwan	Jun–95	Sep–95*	Nov–95	22.10	<0.01
China	Jul–97	Aug–97°	Dec–97	8.18	>0.15
Philippines	Dec–97	Feb–98*	Mar–98	24.17	<0.01
Indonesia	Aug–97	Sep–97*	Sep–97	42.54	<0.01
South Korea	Sep–98	Oct–98*	Oct–98	115.38	<0.01

° Not significant at less than 15%. ^ Significance level of 5%. * Significance level of 1% or less.

An analysis of the pre- and postbreak regressions, given in Table 4 for returns and Table 5 for volatility, sheds further light on the nature of these regime shifts. The postbreak coefficients should be interpreted as incremental changes to the prebreak coefficients. However, since the breaks tend to occur near the end of our data set, and because of possible multicollinearity, the individual coefficient changes have generally weak statistical significance. This is less of a problem with the volatility model, since it is more parsimonious. Table 4 shows that the regime shift increased the sensitivity of real estate returns to changes in equity returns.[19] This can be most easily seen by interpreting the coefficients as betas.

We focus on the values in the *X* and ΔX columns: these can be interpreted as the real estate betas prior to and after the estimated regime break. Note that all of the prebreak betas (the values in the *X* column) are significantly positive except for Malaysia and Thailand. The average beta is 0.68, which is a plausible beta for a real estate index. The changes in the beta after the break (given in the ΔX column) are positive except for China; the average increase in beta is 0.15. These results suggest that

[19] Indonesia did not exhibit a statistically significant structural break in returns during our sample period.

after the regime breaks in returns, the systematic risk of the real estate indexes increased. Thus, there is a stronger linkage between equity and real estate returns after the structural break. As such, diversification benefits from real estate decrease after the break.

Table *5* reveals that the regime shifts also changed the nature of the relation between equity volatility and real estate volatility. The volatility relation is stronger than the return relation between equity and real estate as evidenced by the generally higher adjusted R^2s. As in Table 4, we will confine our interpretation to the *X* and ΔX columns. The *X* column represents the degree to which volatility in the equity indexes is spread to the real estate indexes in each country. If we exclude Indonesia (which has a very curious coefficient of —3.075), all of the coefficients are positive and significant, as expected, with an average value of 0.557. The average of the *ΔX* column (again excluding Indonesia) is 0.266. This analysis indicates that, like the return analysis, there is an increase in the relative risk of real estate securities, on average.

Analyzing the Regime Breaks

In aggregate, our analysis of regime breaks for returns and volatilities allows us to recognize the existence of two groups in our sample of eight countries. The first group is China, the Philippines, and Taiwan. The second group is Hong Kong, Indonesia, Malaysia, and Thailand, South Korea, perhaps due to its more developed, industrial nature, seems not to fit into either group. Analysis of cross-country correlations for equity and real estate return and return volatility (noted earlier in this paper) corroborate this classification. In this section we attempt to uncover some rationale for this apparent grouping.

Table 7 summarizes some of the key firm and country characteristics that may enable us to interpret our findings. Panel A focuses on financial characteristics (all financial data are measured at the end of 1996): Panel B addresses the legal and governance characteristics of the given country.[20] Here the key results are the following:

[20] Many other economic, financial, and governance variables were analyzed. This table presents representative results. Tests of statistical significance are not reported because of the tiny sample sizes.

Table 7 ■ Legal, Governance, and Ownership Characteristics.

Panel A: Financial Characteristics

	Group	Leverage (Long-Term) %	Leverage (Short-Term) %	Budget Surplus (% of Total Budget)	Debt ÷ Exports %	Short-Term Debt ÷ Reserves %	External Debt ÷ GDP %
China	0	37.6	4.2	−0.9	70	39	18
Philippines	0	9.4	7.5	−0.2	117	194	68
Taiwan	0	7.0	29.6	−8.7	30	37	15
Hong Kong	1	15.4	5.1	1.3	144	0	220
Indonesia	1	29.9	21.2	0.0	198	152	53
Malaysia	1	15.5	11.3	−0.5	38	74	39
Thailand	1	25.0	30.1	1.2	124	134	65
South Korea	none						
Group 0 mean		18.0	13.8	−3.3	72.3	90.0	33.7
Group 1 mean		21.5	16.9	0.5	126.0	90.0	94.3

Panel B: Legal and Governance Characteristics

	Group	Corruption	Legal	Economic	Accounting	Regulatory	Family	Cash Flow Rights	Voting Rights	Creditors' Rights	Judicial Efficiency	Rule of Law
China	0	2.8	2	2.3	2.3	2.0						6.0
Philippines	0						44.6	21.3	24.4	0	4.8	2.7
Taiwan	0	3.1	2.6	2.6	2.9	2.8		16.0	18.9	2	6.8	8.5
Hong Kong	1	3.5	2.9	3.0	2.9	3.2	66.7	25.6	28.1	4	10.0	8.2
Indonesia	1	2.6	2.3	2.4	2.6	2.6	71.5	25.6	33.7	4	2.5	4.0
Malaysia	1						67.2	23.9	28.3	4	9.0	5.4
Thailand	1	2.9	2.7	2.6	2.4	2.7	61.6	32.8	35.3	3	3.3	6.3
South Korea	none	3.0	2.4	2.5	2.2	2.5	48.4	6.9	17.8	3	6.0	5.4
Group 0 mean		3.0	2.3	2.5	2.6	2.4	44.6	18.7	21.7	1.0	5.8	5.7
Group 1 mean		3.0	2.6	2.7	2.6	2.8	66.8	27.0	31.4	3.8	6.2	6.0

Columns 3 and 4 show the average leverage for the real estate companies that compose the real estate index in each of our countries. Although the overall leverage is similar in both groups, real estate companies in Group 0 had slightly lower levels *of* short- and long-term debt; for example, they have a ratio of short-term debt to total capital of 13.8% versus 16.9% for Group 1.

The budget deficits were significantly greater in Group 0 than in Group 1. This suggests that Group 0 countries were more vulnerable to macroeconomic shocks, which may help explain why their volatility regime breaks occur much before Group 1's.

The external debt to GDP, short-term debt to total reserves, and debt to export ratios are much higher for Group 1 countries, indicating that country indebtedness and trade play a role in the clustering of regime breaks. The trade linkages within Group 0 are also strong; for example, among the other seven countries in our sample, the largest market for Taiwan's imports is China (11.3% of all exports).

The country's legal and governance structure as measured by the components of the opacity index (which uses survey data to measure the quality of a country's financial and legal framework), family control, cash flow, voting rights and measures of judicial efficiency do not seem to play a very important role.

Conclusions

Anyone who claims to fully understand the economic disaster that has overtaken Asia proves, by that very certainty, that he doesn't know what he is talking about….The truth is that we have never seen anything quite like this.

—Paul Krugman, speech for CSFB, Hong Kong, March 1998

Since much of the chaos associated with the Asian crisis centered on real estate markets, our study investigates the structural relation between the real estate market and the equity markets in eight developing Asian countries. Our approach involved two basic steps. First, our Granger causality analysis suggests equity returns cause real estate returns and not the converse. Thus, we find little support for the hypothesis that real estate caused the crisis. The Granger causality analysis of volatility shows significant two-way causality, suggesting instead that a common factor, not specified in our reduced form model, tends to induce higher dispersion of beliefs among market participants in both equity and real estate emerging markets. Secondly, we apply the statistical technique of Bai, Lumsdaine and Stock (1998) to analyze the nature of the regime shifts and to test which type of information event is associated with the identified shift. We find that structural breaks in both returns and volatility were commonplace in these countries during the period 1997 to 1998. Most of these regime shifts appear to occur concurrently, which is evidence that common information effects were dominant in these markets. We also find evidence that the regime shifts in returns and volatilities generally imply higher risk for real estate securities after the estimated breaks, both in the form of total risk or volatility and in the form of systemic risk or beta with respect to the stock market. While the clustering of regime breaks does not seem to follow any obvious pattern, the country's exposure to trade and firm leverage are important. The legal and corporate governance structure of a country do not seem to be much help in explaining the observed regime breaks.

From our exploratory analysis we can see various manifestations of increased risk and decreased diversification opportunities after the crisis. Although a simple explanation that covers all countries does not emerge from our analysis we can see that the crisis caused major structural shifts in real estate and equity markets, generally implying higher relative risk for real estate securities. Our results also show that, in general, the crisis was not a manifestation of the natural dependencies in these countries, but that the crisis evolved in rather different ways in the countries we study.

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Appendix: Real Estate Securities and the Underlying Real Assets

As in most academic real estate studies, we use returns on real estate securities rather than returns on the underlying real estate. This choice is mainly motivated by the availability of longer time series data for real estate securities; the available data on the underlying real asset markets is insufficient to support any rigorous) us statistical analysis. In this appendix, we analyze the relation between real and securitized real estate returns in these markets during the time frame of our study, focusing on contemporaneous and lead/lag correlations between the real and securitized markets.

One reason for using real estate securities to study the Asian crisis is that foreign ownership of direct real estate varies across Asia. For example, while Hong Kong is relatively open to foreign investment, other countries, such as China and Indonesia, require foreign investors to use a joint venture arrangement involving local partners. While Asian countries have moved to relax these restrictions (e.g. South Korea allowed foreign ownership in July 1998), investment restrictions existed over much of our study period. In addition to restrictions on foreign ownership, relatively few Asian countries (Hong Kong, *e.g.)* have established property law, such as bankruptcy and foreclosure laws. Legal issues are thus a significant concern to overseas investors.[21] For example, the foreclosure process typically averages seven years in Thailand. In contrast, foreigners can own real estate securities. As such, real estate securities may be the only viable vehicles for foreign ownership of real estate.

[21] In a lecture at New York University on February 8, 2000, John Somers, Executive Vice President of TIAA-CRHF, slated that his organization's decision to invest internationally in Europe rather than Asia was due in part to established and tested property laws.

The preceding argument leaves unresolved the question of how closely returns on Asian real estate securities are related to the returns on the underlying real estate assets. To address this issue, we use return indexes based on actual net operating income and transaction prices from Property Market Intelligence (PMI). PMI provides online market research and benchmarking indicators for several Asian real estate markets, including China, Hong Kong, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, Taiwan, Thailand, and Vietnam.

In essence, PMI repackages market research from nine real estate organizations, including Brooke International, Cushman Wakefield, and Colliers Jardine. The companies provide PMI with net operating income and transaction prices; PMI then computes real estate indexes from these data. Although the PMI data are reported both on an annual and quarterly basis, only the last two years are reported on a quarterly basis.[22] Moreover, the data are classified according to the providers of information. We use indexes based on data that Brooke International (formerly Brooke Hillier Parker) provide to PMI, since they represent the longest time series of office real estate return data for each country. Since the number of semiannual index (return) periods ranges from 6 (5) for Indonesia to 13 (12) for Malaysia, our analysis is cursory at best. As such, the usual caveats apply.

Table 8 reports the means and variances of semiannual returns for real estate securities and underlying real estate in our eight Asian countries. The tests for means show no significant differences between direct and securitized real estate investment, although this is largely due to the paucity of observations. There is no apparent pattern in the differences; in four cases, direct investment has a higher mean and in four cases it has a lower mean. There is more consistency in the analysis of differences in standard deviations. As with U.S. real estate data, the standard deviation is higher for real estate securities than direct real estate. In our data, this difference is significant for all but Hong Kong, Indonesia, and Korea. Of greater interest is the comovement of real estate securities with the underlying real estate in each country. Figure 4 graphs the total return index for real estate securities and direct real estate investment for each of the eight countries in our sample, along with the correlation coefficient. Note that the correlations are negative for China (—0.18) and the Philippines (—0.45), which is curious. This negative correlation can help explain some anomalies in our earlier empirical analysis of these two countries.

[22] The PMI indexes that we use in this paper are based on data from Brooke International. These indexes are often termed "notional" indexes because they are, in large part, based on brokers' opinions of values and cap rates. PMI indexes based on data from other real estate organizations, such as Cushman and Wakefield, are driven by actual transaction prices. These indexes, however, are only available for a few of the countries in our sample and for a shorter time period than the PMI indexes.

Table 9 investigates the relation between the securitized and underlying assets further. Shifting now to returns rather than levels of the indexes, we analyze the lead and lag relations in each of the eight countries. Since the data are semiannual and relatively sparse, it is not surprising that few of the correlations are significant. The average correlations are positive; the largest is 0.507 at a lead of one (although only slightly larger than the correlation of 0.416 at one lag).

Table 8 ■ Means and standard deviations of returns on real estate securities and the underlying real estate.

	Mean (μ)		$\mu_1 = \mu_2$	Standard Deviation (σ)		$\sigma_1 = \sigma_2$
Country (Obs)	Securities (%)	Direct R.E. (%)	Prob (F)	Securities (%)	Direct R.E. (%)	Prob (T)
China (7)	8.97	−9.18	0.325	40.3	22.5	0.089**
Hong Kong (9)	1.87	−4.99	0.551	27.2	19.9	0.199
Indonesia (5)	−21.1	−4.65	0.367	34.3	17.2	0.105
Korea (10)	−12.5	−5.14	0.513	28.4	20.1	0.159
Malaysia (12)	5.40	−6.09	0.425	44.9	18.2	0.003*
Philippines (7)	−2.20	7.41	0.399	25.6	13.1	0.064**
Taiwan (11)	4.98	2.61	0.777	23.4	14.2	0.065**
Thailand (11)	−14.5	−10.95	0.825	48.6	17.6	0.002*

*Significant at the 5% level.
**Significant at the 10% level.
This table examines the first two moments of the returns on real estate securities and the underlying real estate assets in the eight countries studied. We first test for equality of the mean returns using a one-tailed F-test. The corresponding significance levels are given in Column 4. We then test for equality of the variance, using the Hsu statistic as an approximate solution to the Behrens–Fisher problem. The corresponding significance levels are given in Column 7. The number of observations (Obs) is reported next to each country.

This suggests that the relation between real and securitized markets is quite strong but that the lead/lag relations are more ambiguous.[23]

In summary, we rationalize focusing on real estate securities given the restrictions on foreign ownership of direct real estate in most Asian countries that we study. In addition, the lack of established property law is a concern to institutional investors. Also, for most countries, the real estate security index returns exhibit a fairly strong tendency to move with the underlying real estate returns. Weak evidence also exists that real estate securities in each country have similar average returns, albeit higher variances, than the underlying real estate.

[23] Empirical studies on the relation between real estate securities and direct real estate returns have somewhat differing conclusions. A number of articles suggest that a positive, lagged relation exists between securitized and unsecuritized real estate, with securitized returns leading unsecuritized returns or cap rates; see, for example, Gyourko and Keim (1992), Fisher, Geltner and Webb (1994), Barkham and Geltner (1995), and Geltner and Goetzmann (2000). Conversely, Liu and Mei (1992) find that returns on real estate investment trusts (REITs) can be predicted by capitalization rates based on actual transaction prices.

Figure 4 ■ Total return index for real estate securities and direct real estate investment. The return indexes are value weighted. The real estate securities indexes are from Bloomberg while the direct real estate indexes are from Property Market Intelligence (PMI). The PMI indexes used here are based on data from Brooke International.

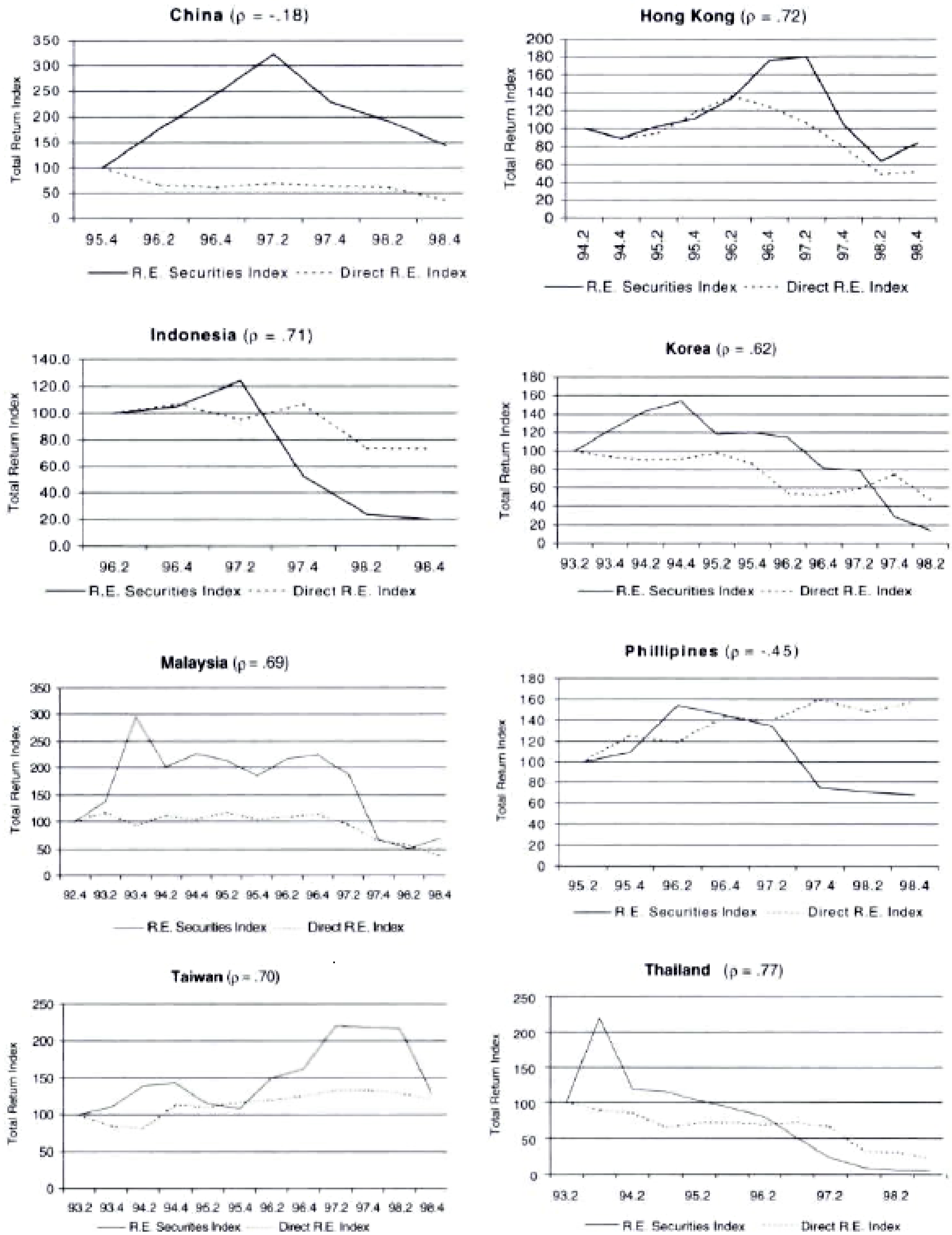

Table 9 ■ Correlation between securitized real estate and the underlying properties.

Country	Contem-poraneous	Lag (1)	Lag (2)	Lead (1)	Lead (2)	Number
China	−0.181	−0.321	0.156	0.127	−0.127	7
Significance	0.698	0.535	0.802	0.811	0.839	
Hong Kong	0.723	0.819	0.586	0.276	−0.555	10
Significance	0.018	0.007	0.126	0.473	0.153	
Indonesia	0.708	0.532	−0.117	0.926	0.275	6
Significance	0.115	0.356	0.882	0.024	0.724	
Korea	0.625	0.683	0.858	0.637	0.465	11
Significance	0.040	0.030	0.003	0.047	0.207	
Malaysia	0.694	0.796	0.358	0.666	0.427	13
Significance	0.009	0.002	0.279	0.018	0.190	
Philippines	−0.453	−0545	−0.904	−0.070	0.096	8
Significance	0.261	0.206	0.013	0.881	0.857	
Taiwan	0.698	0.567	0.552	0.678	0.50404	12
Significance	0.012	0.069	0.098	0.022	0.137	
Thailand	0.768	0.799	0.722	0.820	0.66598	12
Significance	0.004	0.003	0.018	0.002	0.036	
Average correlation	0.448	0.416	0.276	0.507	0.219	

The two-tailed probability that a correlation is statistically significant is reported in the second line of each row. Lag (1) refers to a one (semiannual) period lag of the underlying property index. In other words, "Lag (1)" refers to the correlation between the securitized return in period t and the underlying property return in period $t - 1$. Number refers to the number of semiannual periods.