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An analysis of the trends and cyclical behaviours of house prices in the Asian markets

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Abstract *This paper examines the time-series behaviour of house prices for the four Asian markets, namely, Hong Kong, Singapore, Tokyo and Taipei, by using structural time-series methodology. The paper assumes two types of trend models to characterise and compare the long-run movement of house prices. It also examines the cyclical pattern hidden in the series. The long-run trend rate in these markets ranged between approximately 1.6 and 3.2 per cent per annum. Hong Kong, Singapore and Taipei have relatively higher figures, which could be expected in light of the rapidly growing economies. Surprisingly, their cyclical patterns were fairly similar, although causes of the cycles differed. The markets were found to have stochastic cycles of around one year, two to four years and seven to ten years, which were consistent with previous findings on real business cycles commonly observed internationally in other macroeconomic time series. However, the found stochastic nature suggests all these markets are not in a steady state and is still changing.*

Introduction

The housing market is one of the most volatile sectors of the economy and the behaviour of house prices has attracted many attentions of research. Housing research has always found the modeling of the long-run trends and short-run fluctuations a great challenge. While most studies have tended to narrow in house prices in their own countries, few have questioned on why most countries share similar house price behaviour. One common phenomenon is the sustained long-run growth in house price accompanied by recurring fluctuations around the growth path. While Korea, Singapore, Malaysia and Japan, and to a lesser extent in Australia, Canada, USA and West European countries have seemed to have very similar periods of rapid growth in property prices, their short-run fluctuations surrounding the long-run growth paths have been vastly different. In most countries short-term deviations from the long run growth paths are equally pronounced features of these price series.

A great number of house price studies has been done in the past few decades, but most of these studies focus on a single country. Multi-country

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comparison of house price behaviour and its causes are rare, exceptions being Kennedy and Anderson (1994), who investigated the relationship between house price and savings, and Culter (1995), who compares the UK and other G7 countries and found that all these countries experienced exceptional increase in house prices during second half of the 1980s. Recently, Englund and Ioannides (1997) have compared the dynamics of house prices in 15 OECD countries and revealed a remarkable degree of similarity. They find significant structure of autocorrelation, but though their study reveals the similarity and is not able to explain the causes. Bordo and Jeanne (2002) examine the boom and bust of asset prices for 15 OECD countries but only focus on the impact of monetary policy on asset prices.

While comparative studies of causal links between house prices and macroeconomic variables are important, a large proportion of house price volatility, well in excess of 50 per cent, is endogenous to the market. Existing studies of autocorrelation structures have found highly significant first-order correlations and oscillatory behaviour around a trend in most house price series. Unfortunately, this simple approach used in these studies limit their scope and is unable to yield deeper insights into the nature of trend, and cyclical components of time series. One common problem in these studies is that they do not investigate the underlying causes of the similarity in house price behaviour internationally. Such an investigation may have been limited in part by the great number of countries involved.

Globalization has made international investment very important, particular property investment (Wilson and Okunev, 1996). Property investment has traditionally been considered good investment, with property playing an important role in most Asian economies and housing being a form of savings for many households. Changes in property prices influence consumer price inflation, and affect a countries' competitiveness. This paper focuses four important property markets in Asian, Hong Kong, Singapore, Tokyo (Japan) and Taipei (Taiwan) because they have experienced persistent and large fluctuations and because they can serves as a barometer of economic activity in the region.

In this paper, using the Structural Time Series (STS) methodology suggested by Harvey (1989) and Harvey and Shephard (1993), we study international house price behaviour. We first attempted to characterise the long-run behaviour of house prices in the four Asian markets and determine which structural time-series long-run trend would best describe long-run behaviour of house prices there. We hope to understand the long-run movement of these markets through STS estimation. Second, we tried to characterise the short-run cyclical behaviour in the four markets and determine cycles hidden in the short-run movement of house prices there. In our effort to understand better the cyclical behaviour of house prices in these markets, we expect to observe some distinct time-series behaviours.

The significance of this study can be found in its elucidation of trend and cycle behaviour in these markets, which would help governments make policies and international property investors create more effective property management strategy. Since the causes of the house price fluctuations in these four housing markets have been examined and clearly described by many studies, this paper focuses analysing and comparing house price behaviour in the housing markets.

The rest of the paper is organised as follows. The next section gives an overview of house price behaviour and the causes in these markets. Next, the theoretical framework of house price time-series components and empirical methodology of the STS model is outlined. The following section presents estimates of time-series components and explains the results. Concluding remarks follow in the final section.

Background discussion

We begin by investigating house price figures and causes of house price fluctuations for the four Asian markets. The discussion is brief, and is centred on its connection to house prices behaviours in the latter section.

Historical development of house prices

These four housing markets experienced different levels of long-run movement over the past 25 years. Table I, Figure 1 and Figure 2[1] show the house price changes for these housing markets (the data sources are given in the Appendix). Of these housing markets, Singapore has experienced the highest rates of growth in house prices. From 1976 to 1998, the nominal average annual price increase was 12.8 per cent and in real terms it was 9.7 per cent. Taipei has had a lower trend rate. Nominal average prices rose by an average of 12.9 per cent over the same sample period. In real terms, however, there was an average of 6.9 per cent rise per annum.

Hong Kong and Tokyo house prices have been smoother in real prices than the other two housing markets. They have had a 3.7 per cent increase in real

	Hong Kong 1981Q1-1998Q4		Singapore 1975Q3-1999Q4		Taipei 1973Q2-1999Q1		Tokyo 1971Q3-1999Q4	
	Nominal	Real	Nominal	Real	Nominal	Real	Nominal	Real
(%)	81-98		76-98		73-99		771-96	
Annual growth	11.5	3.7	12.8	9.7	12.9	6.9	8.5	3.7
Overall increase	382	42	831	449	1576	327	452	89
Coefficient of variance	72.8	40.2	73.1	60.7	74.4	57.7	50.0	31.2

Table I.
Comparison of house price behaviour in the four Asian markets

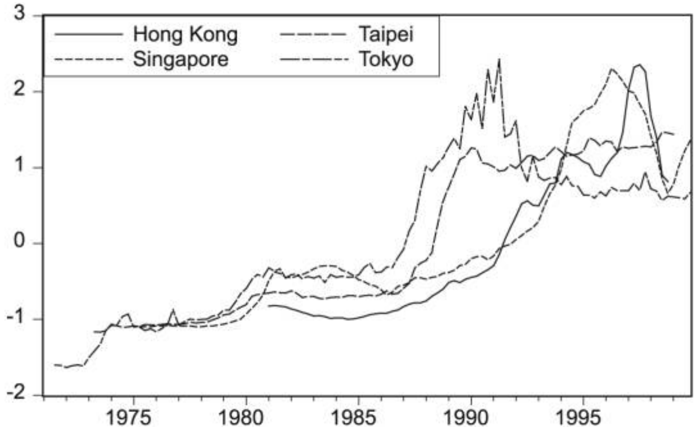

Figure 1.
Normal house price index (normalized)

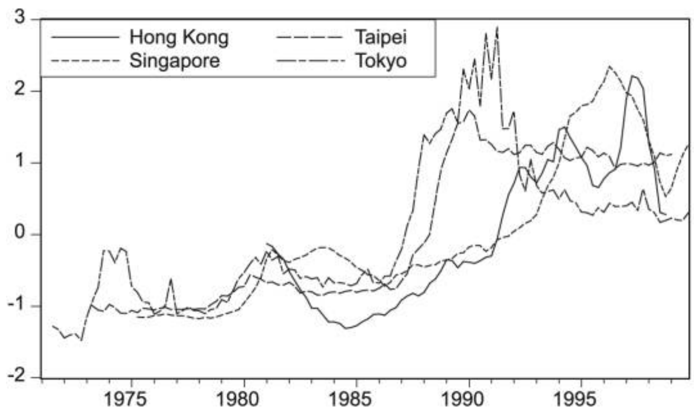

Figure 2.
Real house price index (normalized)

house prices but nominal prices have been 11.5 per cent and 8.5 per cent respectively. Over the sample period, Hong Kong, Singapore, Taipei and Tokyo real house price have increased by 42 per cent, 449 per cent, 327 per cent and 89 per cent respectively.

The four housing markets have experienced rather large variance in house prices, indicating that the house prices are highly volatile. There were periods of remarkable fluctuations in the rate of growth in house prices. Singapore and Taipei real house prices have coefficients of variance close to 60 per cent. Hong Kong and Tokyo are less volatile with 40 per cent and 31 per cent of coefficients of variance.

The causes of house price fluctuations

Figure 1 and Figure 2 clearly show that there were booms and busts in these housing markets. The Hong Kong housing market has a few booms during sample period. Its housing market experienced a boom when the economy rose sharply in 1978-1981, but from 1982 through 1984, it bust because of excessive speculation and oversupply in the early 1980s. Hong Kong's housing market began to revive during the economic expansion in the late 1980s. The emergence of negative real interest rates extended the boom to the early 1990s and caused sharp fluctuations in house prices (Tse *et al.*, 1998). The housing market continued its boom despite the restrictions on mortgage lending announced by the government and the banks in 1992. The speculative activities were brought to new heights. Although the government announced a task force to dampen speculation on land supply and property prices, the market recovered again in late 1996 and began another boom in 1997. At that time, the house prices rose rampantly owing to the shortage in supply, coupled with the continuation of negative real interest rates (Hui and Lui, 2002).

The Singapore housing market experienced two major residential real estate boom-bust cycles during our sample period. Phang (2002) indicates that the boom that took place between 1980 and 1984 occurred during a period of rapid economic growth and followed the liberalization of Central Provident Fund (CPF), which allowed CPF savings to be used for private housing mortgages. House prices increased more than 100 per cent between 1979 and 1983, and then dropped with the bust in 1985 coinciding with Singapore's first general recession since independence. The acceleration in public housing construction contributed the overheating of the economy there in the early 1980s, while the subsequent deceleration was ill-timed as it coincided with the recession and the weak economic conditions which followed. The housing market picked up again in 1987 and reached a peak in the 1996. This was a period of strong economic recovery and growth, which the regulations governing the purchase and financing of HDB resale flats were liberalized (Phang and Wong, 1997). A bust starting in 1996 followed the implementation of anti-speculation measures and was exacerbated by the Asian crisis of 1997.

The first Taipei's house price boom in the early 1970s was commonly seen to have been caused by the oil embargo. The sudden increase in oil price led directly to high inflation in most commodities as well as construction costs. Money supply is believed to be a complementary factor. The trade surplus causing foreign money expansion leads to increases in domestic money supply. A second boom involved the oil price increases in the late 1970s, which again resulted in increased costs on the supply side and expectation of price increases on demand side. The third boom in house prices is though to be brought about by the great increase in money supply in the late 1980s. The primary reason behind the increase of money supply was continuing high economic growth around 12 per cent to 13 per cent, as it was during Taiwas's previous boom periods (Hsieh, 1990; Wu, 1994; Chen and Patel, 1998, 2002).

Tokyo experienced three boom periods: 1973 to 1974, 1980 to 1981 and 1990 to 1991 during our sample period. The main cause for the earliest boom during sample period in Japan apparently was speculative demand triggered mainly by the overflow of currency (Matsumoto, 1986). The Nixon Shock in August 1971 increased money supply and the scale of loans to real estate agencies expanded until 1973 to make up 7 per cent of the entire balance of loans. The house price, however, suddenly began to fall at the end of 1974. The first oil crisis dramatically changed basic economic condition from rapid growth to steady growth. Tokyo's second boom was caused by an increase urban housing demand triggered mainly by Japan's highest population group turning about 30 years old (Ohtake and Motogsugu, 1996). The post-war baby boom, which occurred after the Second World War, peaked in 1947. The cause of the third boom is similar to the first boom of 1970s: speculative demand triggered mainly by the overflow of currency. The Plaza Accord of 1985 dramatically increased the exchange value of the Japanese, which caused the "high-yen slump". The government reacted with series of cuts in the official discount rate designed to expand the country's domestic demand (Tachi, 1993). Such easy money policies pushed office land prices higher, and the pressure spread from office areas to residential areas because land use regulation in Japan was very loose during that period.

As can be seen from the preceding analysis, the appreciation of house prices in these Asian markets can basically be attributed to limited land supply and a strong investment demand for both residential. The strong investment demand (widespread speculation) is believed to be main cause for great fluctuations in house prices. Liberalization of finance system and overflow of currency causing monetary growth is mainly responsible for highly appreciation of the asset prices. A summary of the causes of house price fluctuations for these four Asian markets is provided in Table II.

Theoretical framework and methodology

Theory of house price time-series properties

A visual inspection of graphics of these house price series in the last section clearly show trend, cyclical pattern and irregularity as important features. A trend in the house price series indicates the general direction in which the series is moving. Most time-series such as GNP or money supply exhibit persistent upward trend over time. House prices, similar to those series, have continuously increased for a long time. As seen in Figure 1 and Figure 2, house prices in these housing markets contain a clear upward trend. Generally, the house price increases have been inevitable because the falling supply of land has been accompanied by an increased demand for housing services. Consequently, the upward long-run trend is considered to be primarily demand sustained by rising income and demographic factors which account for both the increase in value as well as the stock of housing overtime. However, since demographic factors have risen more slowly than house prices in these countries, economic forces must have been the driving forces behind the

Markets	Boom periods	Short-run factor (major causes)	Long-run factor
Hong Kong[a]		Strong investment demand	1. Limited land supply
Singapore[b]	Early 1980s	Strong demand (caused by rapid economic growth and followed the liberalization of Central Provident Fund (CPF) regulation)	2. Residential demand
	Late 1980s and early 1990s	Strong demand (caused by rapid economic growth and liberalization of regulations governing the purchase and financing of HDB resale flats)	3. Economic growth
Taipei[c]	Early 1970s	Inflation (oil embargo raise construction cost) and investment demand (caused by increase of money supply)	
	Late 1970s	Inflation (oil embargo raise construction cost) and investment demand (caused by increase of money supply)	
	Late 1980s	Strong investment demand (caused by increase of money supply)	
Tokyo[d]	Early 1970s	Strong investment demand (triggered mainly by the overflow of currency)	
	Early 1980s	Postwar baby boom	
	Late 1980s	Strong investment demand (triggered mainly by the overflow of currency)	

Notes: [a]see Tse *et al.* (1998), Hui and Lui (2002); [b]see Phang and Wong (1997), Phang (2002); [c]see Hsieh (1990), Wu (1994), Chen and Patel (2002); [d]see Matsumoto (1986), Tachi (1993), Ohtake and Motogsugu (1996)

Table II.
A summary of the causes of house price fluctuations for the Asian markets

increased trend in house prices. The fast economic growth that these Asian nations have experienced during the past few decades has brought about income and monetary growth, boosting wealth and pushing up house prices through higher demand. The more income a household has, the more housing services it can afford to buy. On the other hand, the monetary growth raises the demand for houses because the money will flow into assets such as real assets or financial assets as a store of wealth. Although real assets such as houses compete with other assets, housing is normally perceived to be a good investment and a better inflation hedge than other financial assets (Hutchison, 1994).

House price cycles are generally believed to be the product of the short-run deviations from long-run upward trends reflecting lag response of supply to changes in effective demand. More precisely, the endogenous causal factor of price cycles is the long production period between new building orders and completions. A delayed supply response can initially cause prices to overshoot the level that would be justified by increase in effective demand. This overshooting is more likely to prompt house-builder to increase the stock of new developments beyond the level justified by the higher effective demand, subsequently causing price and development activity to decline until the excess stock approximates demand. A tendency of cyclical fluctuations in development is thus endogeneously propagated. Burns and Mitchell (1946) define business cycles as a type of fluctuation found in the aggregate economic activity of nations that organise their work mainly in business enterprises. That is, a cycle consists of expansions occurring at about the same time as many economic activities followed by their own general recessions, contractions, and revivals which were merged into the expansion phase of the next. In addition to the endogenous production lag, cycles generated by changes in monetary policy play an important role in stimulating and dampening housing market activity. Given the nature of housing finance, variable short-term interest rates significantly affect households' cash flow position. While interest rates fall, competition to capture the market share among building societies and banks intensifies, and the housing credit was also over-stretched. These monetary cycles have tended to correspond with increases in effective demand in the housing market.

Review of house price time-series studies

Although there has been many house price studies over the past few decades, few of them address time-series behaviour in term of magnitudes and durations. The existing literature on cycles in property markets have reported varying magnitudes and durations of cyclical patterns ranging between four and 18 years. Barras and Ferguson (1985), in their study of the UK for the post-war period, identified a short building cycle of 15 to 18 quarters (3.75 to 4.5 years) and a longer major building cycle of 26 or 35 quarters (6.5 or 8.75 years). Rosenthal (1986) suggests that there might be a cycle of six to eight years in house prices. Alexander and Barrow (1994) use spectral analysis and find a quarterly seasonal cycle in regional house prices in the UK. They also suggest five to ten year cycles in house prices across different regions in the UK. Brown (1990) indicates that UK residential market has generally followed the business cycle which appeared to be about eight to ten years in length. However, the problem with these studies is that they are mainly based on spectral analysis, which views cycles as having a fixed length. They cannot assess whether or not cycles, themselves, change over time.

The structural time-series model

Economists have shown interest in unobservable components for some time. For trend, seasonal and cyclical components deterministic specifications, such as fixed polynomials in time or cosine function, were used initially. The purely deterministic approach was replaced later by moving average methods, the most prominent example of which is the X11 for seasonal adjustment and the Hodrick-Prescott (HP) filter for trend removal. While these *ad-hoc* filters are simple and easy to use, they also have serious disadvantaged and limitations[2]. To overcome the problems associated with *ad-hoc* filtering, the structural time-series model, based on parametric models, has been developed. The advantage of working with STS model is that all the underlying assumptions are clear, making it possible to adapt signal extraction to the particular characteristics of the series and test the adequacy of the model to the available data. In forecasting, the STS model is unlike such early *ad-hoc* forecasting methods as exponential smoothing, which are implemented with no regard to properly defined statistical model. As an alternative to the traditional Box-Jenkins (1976) methodology, Harvey and Todd (1983) compared the forecasts made by a basic form of the structural model with the forecasts mad by autoregressive integrated moving average (ARIMA) models, they concluded that there are strong arguments in favour of using structural models in practice.

The basic STS model, using the notation of Harvey, as applied to the house price series (equation 1) may be written as:

$$y_t = \mu_t + \phi_t + \gamma_t + \varepsilon_t, t = 1, \ldots T \tag{1}$$

with:

$$\varepsilon_t \sim NID(0, \sigma^2_\varepsilon)$$

where y_t is the observed value of the house price series, μ_t is the trend component, γ_t is the cycle and ϵ_t is the irregular.

μ_t represents the long-run movement in the series, can be assumed to be stochastic, is specified as:

$$\mu_t = \mu_t + \beta_{t-1} + \eta_t \quad \eta_t \sim NID(0, \sigma^2_\eta) \tag{2a}$$

with:

$$\beta_t = \beta_{t-1} + \zeta_t \quad \zeta_t \sim NID(0, \sigma^2_\zeta) \tag{2b}$$

where β_t is the slope or gradient of the trend μ_t. The irregular $\epsilon_{t,}$ the level disturbance η_t and the slope disturbance ζ_t are mutually uncorrelated. Equations (2a) and (2b) incorporate a number of alternative specifications:

when $\sigma^2_\zeta = \sigma^2_\eta = 0$, the trend is deterministic and linear;

when σ^2_η and $\sigma^2_\zeta \neq 0$, the process will have a stochastic trend.

The statistical specification of cycles (equation 3), ϕ_t, is given by:

$$\begin{bmatrix} \phi_t \\ \phi_t^* \end{bmatrix} = \rho_\phi \begin{bmatrix} \cos\lambda_c & \sin\lambda_c \\ -\sin\lambda_c & \cos\lambda_c \end{bmatrix} \begin{bmatrix} \phi_{t-1} \\ \phi_{t-1}^* \end{bmatrix} + \begin{bmatrix} \psi_t \\ \psi_t^* \end{bmatrix}, \ t = 1, \ldots T \qquad (3)$$

where $\rho\phi$, in the range $0 < \rho\phi \leq 1$, is a damping factor, λ_c is the frequency, in radians, in the range $0 < \lambda_c \leq \pi$; ψ_t and ψ_t^* are two mutually uncorrelated NID disturbances with zero mean and common variance σ_ψ^2. The period of the cycles is equal to $2\pi/\lambda_c$.

The extent to which these components evolve over time can be examined by the values of σ_η^2,σ_ζ^2 and σ_ψ^2. The zero value for the parameter σ_η^2,σ_ζ^2 and σ_ψ^2 indicates that corresponding component is deterministic. These parameters can be estimated by maximum likelihood procedure in the time or frequency domain once the model has been written in a state space form. Such estimates were then placed within the state and error system matrices so that Kalman filter can be used to compute the unobserved components. In the following section, we decompose the house price series into their unobserved trend and cycle components using the Structural Time Series Analyser, Modeller and Predictor (STAMP) version 6.0.

Examination of time-series properties in house prices

This section examines the long-run movement and short-run fluctuations in the real house price series for these four Asian markets. The house price data are converted to natural logarithms.

Examination of long-run trend behaviour in house price series

Since there is no common view for the long-run behaviour of house prices, we assume there were two possible types time-series bahaviours by the STS estimation and examine their long-run movements. That is the specifications of the trend components are stochastic and deterministic respectively. Model I, which specifies the stochastic trend and slope for the time-series, suggests house price long-run behaviour in these Asian markets are stochastic. Model II, which specifies the deterministic trend, suggests their long-run behaviours are deterministic.

Table III summarises the estimations of the trend specifications I and II. Figures 3-6 are the graphic depicting, the original series along with the fitted trends. The Model I show that the stochastic trend models can characterise house price long-run movements for all these markets quite well. The estimations of the parameter suggest deterministic levels but stochastic slope of house prices in these markets, σ_η^2 equals zero and σ_ζ^2 appear to evolve over time. The stochastic slopes for these markets show the change in trends with up and down movement. It appears to suggest that the trend movements are

Table III. Test results for the trend components in house price series

	Parameter σ^2_η	Parameter σ^2_ζ	Stochastic level	Stochastic slope	Regression analysis Fixed level	Regression analysis Fixed slope	R^2	Std. err.	DW
*Specification I: Stochastic trend and slope**									
Hong Kong	0.00	$1.27^* 10^{-4}$	5.55	−0.028			0.50	0.045	1.97
	(0.00)	(−2.09)	(102.4)	(−1.26)					
Singapore	0.00	$6.2^* 10^{-4}$	4.86	0.04			0.50	0.041	1.88
	(0.00)	(−1.20)	(133.9)	(1.12)					
Taipei	0.00	$2.5^* 10^{-5}$	5.40	−0.012			0.28	0.048	2.00
	(0.00)	(−1.13)	(152.2)	(−0.47)					
Tokyo	0.00	$5.13^* 10^{-5}$	8.29	0.014			0.23	0.059	2.17
	(0.00)	(−2.60)	(166.1)	(0.91)					
Specification II: Deterministic trend									
Hong Kong					3.9	0.016	0.69	0.38	0.08
					(37.1)	(12.5)			
Singapore					2.77	0.020	0.84	0.25	0.05
					(41.8)	(23.1)			
Taipei					3.53	0.021	0.80	0.062	0.04
					(44.2)	(18.5)			
Tokyo					7.81	0.006	0.54	0.19	0.13
					(205.0)	(11.5)			

Notes: * Figures in parentheses are *t*-statistics[5]. Cycle components are also assumed in the model in order to remove their effects

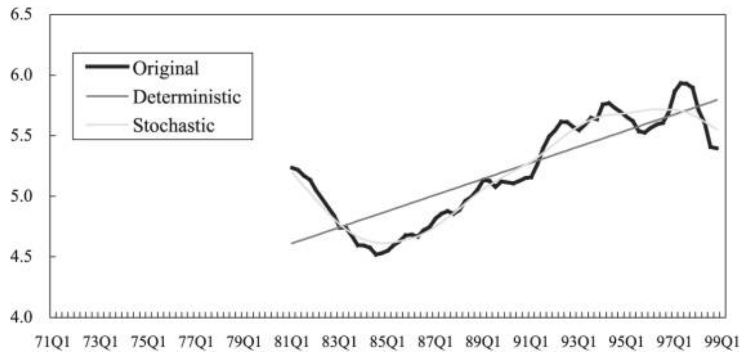

Figure 3.
Hong Kong house price behaviour and simulation

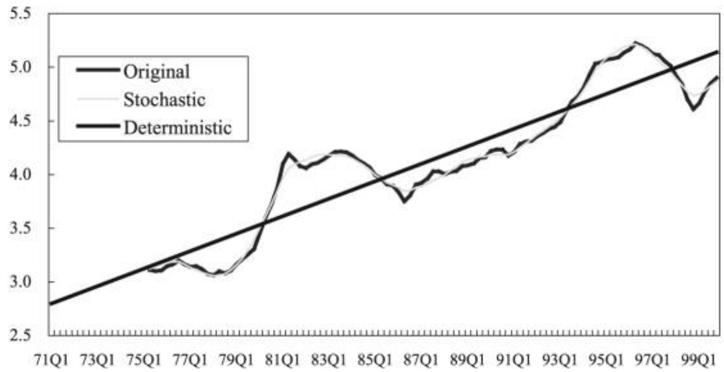

Figure 4.
Singapore house price behaviour and simulation

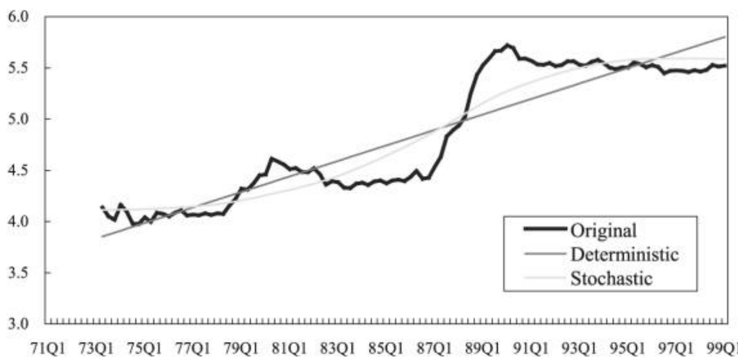

Figure 5.
Taipei house price behaviour and simulation

not stable in any of these markets. While the sample period we analyzed in this paper may not be easy to predict what will occur in the future. On the contrary, deterministic trends are clearly upward. The results of deterministic trends (specification II) show that Tokyo has a relatively low quarterly trend rate (slope coefficient) of 0.6 per cent (which is 2.4 per cent annualised annually) while Taipei and Singapore have a much higher trend rate about 2.0 per cent,

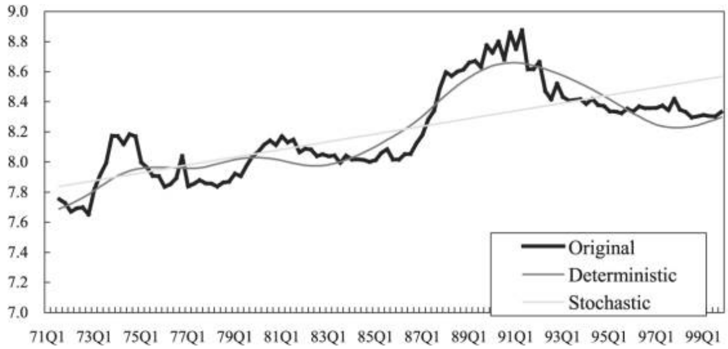

Figure 6.
Tokyo house price behaviour and simulation

almost triple the rate for Tokyo. Compared to these three markets, Hong Kong has a moderate rate of 1.6 per cent.

Nelson and Plosser (1982) argue that the trends in most macroeconomic time-series are stochastic. As tested by Alexander and Barrow (1994), UK house prices are a Differenced Stationary Process (DSP). Although the deterministic linear trend specification gives some indication of the long-run movement in house prices, it does not seem to be reasonable to assume that the trend is deterministic, as it constrains house prices to move for ever around a deterministic function of time. According to Milne (1991), however, who observed quality improvement of houses over his sample period, the trend might be picking up the effect on house prices of gradual improvements in the quality of the housing stock. It is likely that the long-run trends in Hong Kong, Singapore, Taipei and Tokyo house price series may be capturing the influence of similar quality improvements.

Examination of cyclical pattern in house price series

Given that a trend in structural time-series model will affect the estimation of cycles, we have to remove the trends from these house price series first. The standard approach for doing this is to assume that the trend is linear. Two commonly used methods to remove the trend are de-trending and difference in the series. A non-stationary series could be either Trend Stationary Process (TSP) or Differenced Stationary Process (DSP) and needs to be distinguished because if a TSP series is differenced for stationarity, it will yield a negative autocorrelated moving error term.

Using Kwiatkowski *et al.* (1992) (KPSS) tests, we first determine whether we should de-trend or difference the house prices. The results are reported in Table IV. The results of KPSS test are fairly sensitive to the choice of lag truncation parameter, l; the values of the test statistic decrease as l increases. Using the value of $l = 0$ we can reject the null hypothesis of trend stationary for these house price series. After correcting for autocorrelation,we still reject the null hypothesis of trend stationary for $l = 3$ to 6 for all these series. The values

Price series	Lag truncation parameter (l) 0	1	2	3	4	5	6	7	8	Inference
KPSS (η_t):										
Hong Kong	*0.714*	*0.378*	*0.267*	*0.212*	*0.180*	*0.160*	*0.146*	*0.136*	*0.128*	DSP
Singapore	*0.701*	*0.356*	*0.242*	*0.186*	*0.152*	*0.131*	0.117	0.105	0.098	DSP
Taipei	*0.765*	*0.390*	*0.265*	*0.203*	*0.166*	*0.149*	*0.125*	0.113	0.103	DSP
Tokyo	*0.909*	*0.471*	*0.321*	*0.247*	*0.203*	*0.175*	*0.153*	*0.140*	*0.129*	DSP
KPSS (η_u):										
Hong Kong	*5.792*	*2.916*	*1.960*	*1.486*	*1.203*	*1.107*	*0.884*	*0.785*	*0.709*	Non-stationary
Singapore	*7.000*	*3.549*	*2.398*	*1.824*	*1.482*	*1.256*	*1.096*	*0.977*	*0.886*	Non-stationary
Taipei	*9.325*	*4.701*	*3.158*	*2.387*	*1.925*	*1.617*	*1.399*	*1.235*	*1.109*	Non-stationary
Tokyo	*6.444*	*3.351*	*2.288*	*1.752*	*1.432*	*1.219*	*1.070*	*0.959*	*0.872*	Non-stationary
Price after difference:										
Hong Kong	*0.526*	0.332	0.259	0.221	0.204	0.198	0.197	0.196	0.195	Stationary
Singapore	0.318	0.187	0.144	0.121	0.107	0.097	0.092	0.088	0.085	Stationary
Taipei	0.252	0.189	0.164	0.140	0.122	0.110	0.100	0.093	0.090	Stationary
Tokyo	0.054	0.070	0.075	0.081	0.075	0.071	0.074	0.077	0.082	Stationary

Notes: KPSS test (η_t): null hypothesis: contain a unit root (not trend stationary), (η_u): null hypothesis: stationary, critical value for η_t: at 10 per cent equals 0.119, for η_u: at 10 per cent equals 0.347. Numbers italicized indicate significance at 10 percent level. Eight lags of KPSS test, which is suggested by Kwiatkowski *et al.* (1992) as the maximal value, are tested

Table IV.
Unit root tests for stationarity

of KPSS (η_u) test statistic indicate that, after first difference, these house price series contain stochastic linear trend that need to be removed for the purpose of our cycles analysis.

The results of the cycle estimation are shown in Table V. The STS model suggests that Hong Kong has house price series: one around 1.7 and the other 4.1 years. Singapore also has two cycles: around 0.9 and 7.9 years. For the other two markets, three cycles, around one, two to four and seven to ten years, are suggested. The estimated parameters ($\sigma^2_{\psi 1}, \sigma^2_{\psi 2}and\sigma^2_{\psi 3}$) suggest that almost all the cycle components in these housing markets vary over time. Only the four-year cycles in Taipei appear to be deterministic. The graphs of the original series and the estimated cycles are presented in Figures 7-10[3]. We present the short cycle, and medium and long cycles together with original series for comparison. We can see that the structural time-series estimation reveals the hidden cycles. The estimated medium and long cycle appear to characterize the behaviour of house prices quite well for these four Asian markets.

The empirical findings of the seven to ten year cycle in these housing markets is consistent with the argument of exogenous shock. The findings of two to four year cycles in these housing markets seems to imply endogenous cycles, probably caused by supply-side construction lags in housing markets. The one-year cycle in all three series appear to suggest that short-run fluctuations are common phenomena. Generally, the results reveal some similarity in the cyclical behaviour. However, as discussed in the previous

	Cycle 1 (years)	Cycle 2 (years)	Cycle 3 (years)
Hong Kong	1.7	4.1	NA
Singapore	0.9	NA	7.9
Taipei	1.2	4.4	10.4
Tokyo	1.0	3.2	8.5
Parameters	$\sigma^2_{\psi1}$	$\sigma^2_{\psi2}$	$\sigma^2_{\psi3}$
Hong Kong	$5.27^* \ 10^{-3}$	$3.29^* \ 10^{-2}$	NA
	(−1.97)	(0.64)	
Singapore	$2.43^* \ 10^{-3}$	NA	$1.10^* \ 10^{-2}$
	(−1.28)		(−0.08)
Taipei	0.00	0.00	$0.8^* \ 10^{-3}$
	(−1.08)	(−1.03)	(−0.33)
Tokyo	0.00	$2.85^* \ 10^{-5}$	$3.05^* \ 10^{-5}$
	(−1.33)	(−0.66)	(−0.83)

Note: [a]The figures in parentheses under the parameter estimates are *t*-statistics.

Table V. Estimation of structural time-series model for cyclical components

section, although they have similar cyclical patterns, the causes of these cycles are different. We could return to the fundamental cycle theory which claims the business cycles indeed exist economic activity as well as in the housing market. Our empirical result are consistent to the general belief that the property cycle is irregular, as Burn and Mitchell (1946) define the business cycles as recurrent and not periodic, because almost all the cycles are stochastic. This finding suggests none of these markets are steady and that they are still changing. Overall, our results seem to be in line with the existing empirical research on business cycles. Compared with previous house cycle studies in the UK Rosenthal (1986), Alexander and Barrow (1994), for example, in which cycles are usually identified by spectral technique, the length of cycles are very

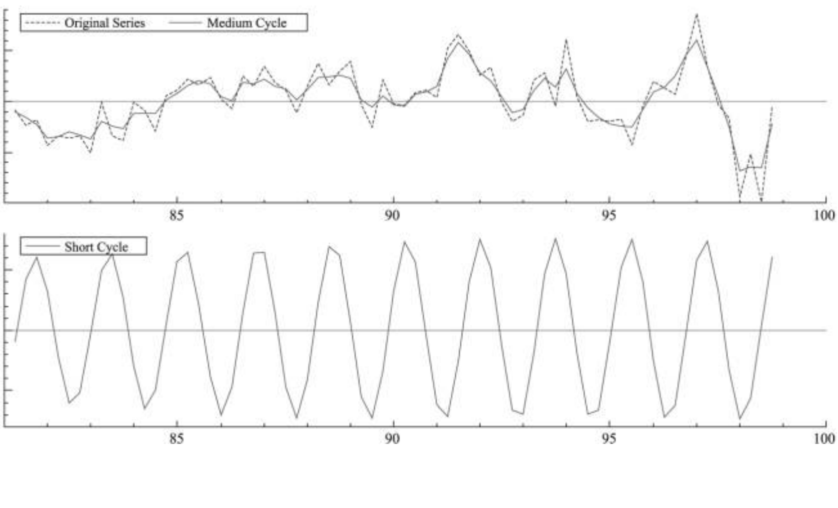

Figure 7. Hong Kong house prices and cycle estimations

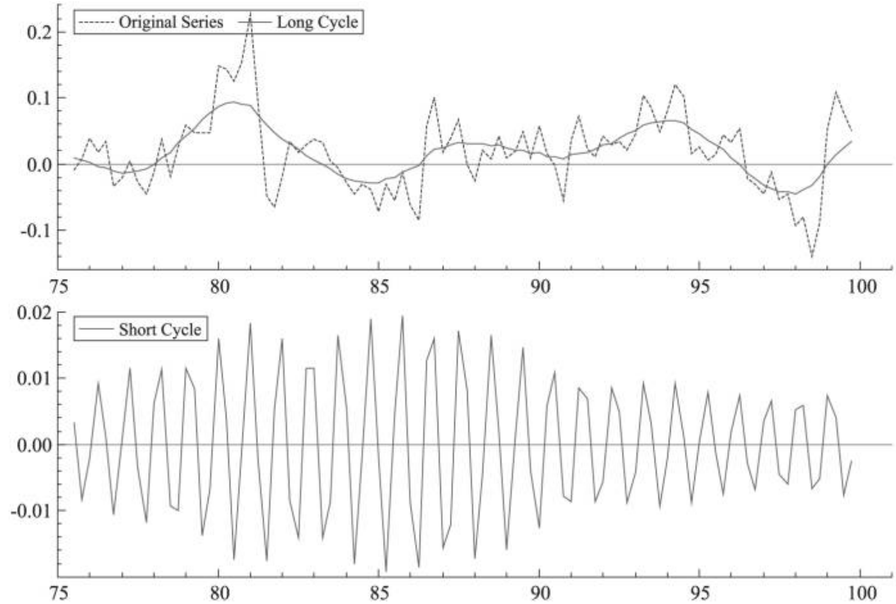

Figure 8.
Singapore house prices and cycle estimations

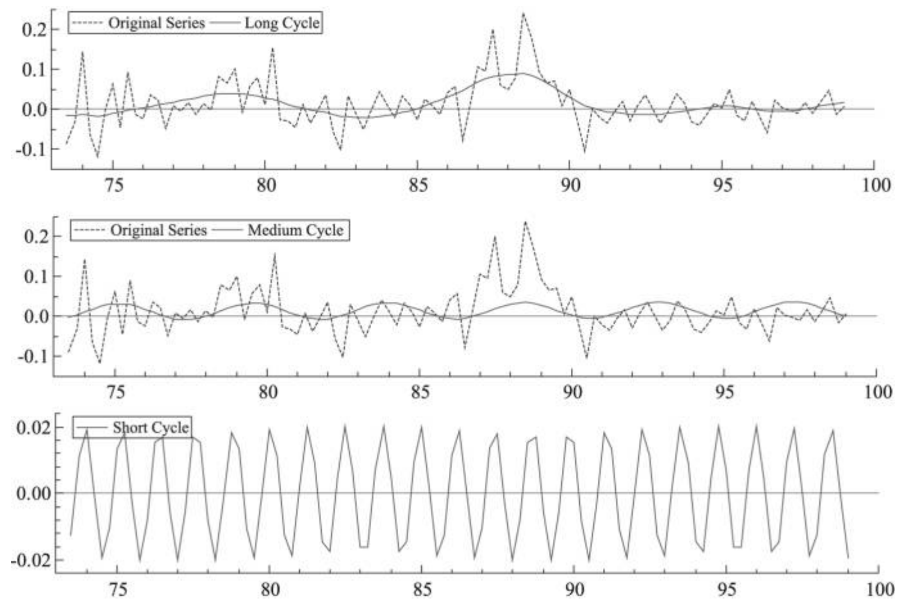

Figure 9.
Taipei house prices and cycle estimations

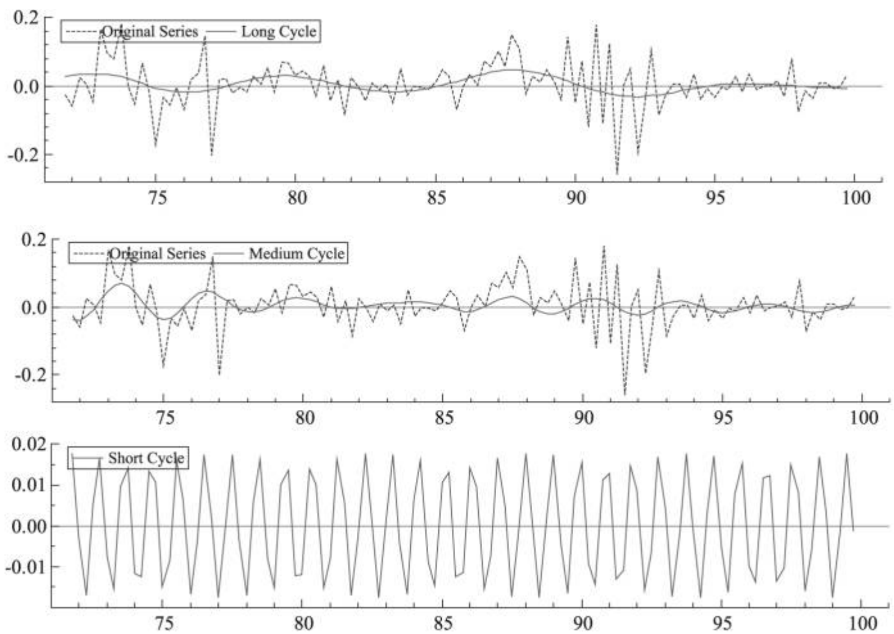

Figure 10.
Tokyo house prices and cycle estimations

consistent to ours. Our results also suggests the cyclical behaviour occurs not only in the Asian markets but also in the European country.

As noted in the section "Background discussion", the cyclical behaviour in these four Asian markets results basically from strong investment demand caused by increases of money supply (Hong Kong, Tokyo, Taipei) or liberalization of finance system (Singapore, Taipei). The causes of the booms in these markets are for domestic and these markets are not interacted, even though their cyclical behaviour was similar with regard to duration, which is quite interesting.

A number of points also emerge from the results of trend and cyclical analysis. First, although residential demand in these asian markets pushing up the house prices in the long run, economic growth is also the major factor. Second, the cyclical behaviours in these markets are caused by increases in investment demand. It is curious that the durations of cycle of are around seven to ten years. If this similarity is not coincident, it can best explained by business cycles. Third, Taipei and Tokyo have a great magnitude of short-run fluctuation. Their government may not have a well functioning housing finance system, which government might handicap to adjust house prices into equilibrium level, resulting large volatility in house price series. Fourth, the housing market is not efficient. This argument has been put forth by many studies, including the one done by Evans (1995). In efficient market, information is widely known and quickly distributed to all participants. However, given the belief that housing market is unlikely to be efficient, individual tends to over or under react to the price signals, which may explain the greater fluctuations in house prices. Since such information in these housing markets is not well known, price deviation may be relatively high.

Conclusion

This paper has examined the long-run trend and short-run movements of house prices in Hong Kong, Singapore, Taipei and Tokyo house price series. Based on the STS models, unobserved trend and cycle components are decomposed to accurately identify the stochastic properties of house series.

Examining the background of these four housing markets, we found Tokyo to have the least pressure for house price increases over the sample periods, which may be a result of slower economic growth. Taipei and Singapore had relatively higher pressure and Hong Kong had a relatively moderate one. On the surface, these four cities have very different institutional features and so one would assume they would exhibit very different house price behaviours with varying causes. Over the sample periods, the STS models suggest that there are two to three cycles in these house price series: around one year, two to four years and seven to ten years. With the exception of Hong Kong, the results suggest they all have stochastic cycles of around seven to ten years. Although the four cities do not share the same reasons for the cycles in their housing markets, they may all be affected by a general business cycle. Also, a two to four year endogenous supply-side cycle was observed in these series. Finally, a short one-year cycle is also found in all these series. All these cycle has stochastic nature, suggesting the markets are not in steady state and are still changing.

From our results we can make several implications. First, as indicated, economic growth was a common factor for these markets, so the slowing down economic growth may suggest that we may not expect to see continuing high asset appreciation in those market, which people seem to expected. Hence, future abnormal profits in this markets is unlikely. Second, the presence of seven to ten stochastic cycles years has also implications for both government and property investors. For the government, the fluctuation of house prices puts into perspective the current housing problems and the effects of government policy created to deal with them. The revealed duration and magnitude of cycles allow for better understanding of the course of house prices, which, in turn, helps government policy-makers take the best stance in reaction to the house price changes. These four housing markets are all characterized by a lot of speculative activities. Knowing this can allow each government to monitor the short-run house price behaviour and control the speculation activities causing dramatic changes. For investors, conventional wisdom suggests that a well-diversified portfolio should contain assets spread across different markets and, more recently, should be diversified internationally. The found cycles might increase the possibility of diligent investor in the housing market to reap abnormal profits by using a trading rule mainly based on the observed behaviour of house prices. The results of our study could provide some information for domestic or international property investors in their portfolio diversification strategies.

It is important to point out some of the limitations of this study. First, data collection for a long-run house price series presents a number of difficulties in these countries. For example, transaction data[4] on house prices are not available in Japan and Taiwan for a sufficiently long enough time periods that is required for time-series analysis. The house price data used for Taipei and Tokyo are listing price data, which is different from the transaction price data used in Singapore. Obviously, full comparability in this study is unlikely to be achieved as the data collected in each country reflect that country's institutional constraints. Second, although the house price indices are complied by weighting averaged, they are commonly recognized and used in these countries. The better adjustment for quality change in the series is desirable, but it is not an option available in this study. Third, because our purpose was to examine the time-series behaviour of house prices, we are not able to empirically verify the causes of the behaviour. Although we look for some explanations for these behaviours, these explanations could form the hypothesis for empirical testing in the future. Fourth, understanding of segmentation of these international markets might provide more insight of risk reduction, though this was not within the scope of our study. Finally, certain time-series properties such as seasonality or structural break are not discussed. Our purpose in this study was to examine the trend and cycle components. All this will leave further research.

Notes

1. The price indices have been normalized in order to compare.
2. For example, Harvey and Jaeger (1993) argue that mechanical detrending techniques such as the HP filter can lead to spurious cyclical behaviour.
3. The magnitude of short cycle is too small so it is not compared with original series.
4. Knight *et al.* (1994) indicate that listing prices may lead the market when functioning as a signal of sellers' intent. They have similar patterns but listing house prices are leading to transaction prices and have larger magnitude of the fluctuation.
5. The t-statistic, defined as the transformed parameter divided by its approximate standard error, provides a natural and very simple test of stochastic versus deterministic process. Although these t-statistics do not follow a Student t-distribution they do give a good indication as to the nature of the process.

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Appendix. Data sources

Hong Kong (1981Q1-1998Q4). The HK housing data are obtained from the China Economic and Information Centre (CEIC) database. It is a weighting averaged price series.

Singapore (1975Q2-1999Q4). It is the property price index of residential properties. The information of the house price indices are published every quarter in the Real Estate Statistics which are compiled by the Urban Redevelopment Authority of Singapore-based on the caveats lodged with the Registrar of Titles. The information is available five weeks after the end of each quarter. The price indices were computed based on weighted average method.

Taipei (1973Q2-1999Q1). The Department of Construction and Planning Administration of the Ministry of Interior provide and update the data on new pre-sale house prices in the Taipei area. The price indices were computed based on weighted average method.

Tokyo (1971Q3-1999Q4). The data are available in the monthly report on condominium prices Greater Tokyo area published by the Real Estate Economic Institute (REEI). The REEI collects monthly samples and compiles quarterly condominium price series using a simple average method. There are on average 96 sample observations for each quarter.

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