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Property Prices and Speculative Bubbles: Evidence from Hong Kong SAR

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Abstract

This paper examines the determinants of residential property prices in Hong Kong SAR during 1980–98. It uses time-series analysis techniques to characterize price developments, establish empirical regularities, and provide measures of the deviations of actual price changes from "trend." The analysis suggests that at the peak of the boom, in mid-1997, the level of property prices may have been 40–45 percent above levels suggested by developments in "fundamentals." The analysis highlights the role of demand-side factors, and the data are not inconsistent with the notion that the property market may be subject to speculative bubbles.

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I. INTRODUCTION

The property sector plays a crucial role in Hong Kong SAR (HKSAR) on account of its relative size, interlinkages with almost all macroeconomic variables, competitiveness, and as a determinant of banking sector and stock market performance. Value added in development, construction, and real estate services industries accounts for well over a quarter of HKSAR's GDP, and influences investment, saving, and consumption choices of households and businesses. Property prices are an important component of cost affecting the productive capacity of the HKSAR's service-oriented economy. More generally, the sector provides interesting insights into the behavior of an advanced real estate market in an open economy setting.

The property market came under closer scrutiny in 1998 when economic activity in the HKSAR dropped sharply and property prices declined by an average of 40 percent. At the time, there was widespread apprehension that the market might fall further, with adverse effects on activity and the financial position of the banking system. Against this background, the government took a number of measures to support the market, including a temporary moratorium on land sales. These actions raised fundamental issues regarding the determinants of property prices, the existence of speculative bubbles, the structure of the real estate industry, and the role of the government in the property sector. More recent developments suggest that the property market may have bottomed out. Land sales have resumed, and the outcomes of the auctions have exceeded market expectations.

This paper examines residential property prices in the HKSAR during 1980–98. Using ARIMA models, it first characterizes the time series properties of price changes, establishes empirical regularities, and provides measures of the deviations of actual price changes from "trend," in particular to assess developments during the 1996–98 cycle. The actual price changes appear to be well-explained by the estimated models and lie within acceptable bounds of the predicted values. Furthermore, the paper analyzes the relationship between price changes and demand and supply factors within the framework of the efficient markets hypothesis. Towards this end, an empirical model with "fundamentals" and speculative bubble variables is estimated. The estimated model suggests that demand side factors may be relatively more important in explaining price changes. In addition, the data do not reject the notion that the property market may be subject to speculative bubbles.

The remainder of the paper is organized as follows. Section II outlines developments in HKSAR housing market since 1980, with special focus on the most recent cycle during 1996–98, and motivates the empirical analysis by identifying some salient institutional features of the market. Section III provides a selective overview of the theoretical and empirical issues in modeling property prices, and sets up the framework for the empirical analysis. Section IV presents time series models of the HKSAR property market. Section V concludes.

II. THE PROPERTY MARKET IN THE HKSAR: AN OVERVIEW

A. Developments in the Property Market

Over the period 1980–1998, a number of phases in the price series can be distinguished (Figure 1).[2] After an upswing, real property prices fell during 1981–1985 in the wake of rising mortgage interest rates, a slowdown in population and economic growth, and uncertainty about the prospects for the transfer of sovereignty to the People's Republic of China in 1997. The bust turned into a boom during 1985–1993 as negative real interest rates generated a rise in property prices, with a brief slowdown in 1990 due to Tianamen Square events and the Gulf crisis. The upswing ended during 1994–1995 as US interest rates increased in early 1994, leading to higher mortgage interest rates.

After a short correction, a boom began in early 1996, reflecting a shift in market sentiment as labor market conditions improved and HKSAR banks reduced lending rates. The turnaround was underpinned by rapid population growth owing to the return of emigrants, and a sustained increase in household income together with a steady decline in unemployment. While fundamentals in part were responsible for the rapid increase in prices, there appeared to be signs of an asset price bubble. Indeed, prompted by concerns that the price gains were being driven by speculative activities, especially for luxury properties, the government took measures in March 1997 to curb speculation. Prices stabilized briefly following the policy announcement, but rose again in the run-up to the handover to China. The boom continued into mid-1997.

The Asian financial crisis hit confidence hard in HKSAR, with a sharp downward adjustment in asset prices as interest rates rose following repeated speculative attacks on the Hong Kong dollar. Residential property prices declined by about 40 percent from their peak in the third quarter of 1997, while rents—which typically adjust more slowly than prices owing to the prevalence of 2–3 year lease contracts—fell by about 20 percent. This reflected the combination of the bursting of the asset price bubble and the price adjustment required to restore competitiveness under the linked exchange rate system. Other contributing factors included increasing supply; declining affordability, due to a combination of high prices, rising interest rates, and slowing wage growth; weakening consumer confidence, owing in part to rising unemployment; and a tightening in bank lending.

With successive and substantial price cuts, intensive sales promotion packages, and flexible mortgage arrangements offered by developers failing to rejuvenate the market, the government announced in May and June 1998 two packages of measures to stabilize the

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[2]The overall indices of residential property prices published by HKSAR Census and Statistics Department were used. These indices were deflated by the CPI(A) index to obtain real indices.

Figure 1. Real property prices in the Hong Kong SAR, 1980-98
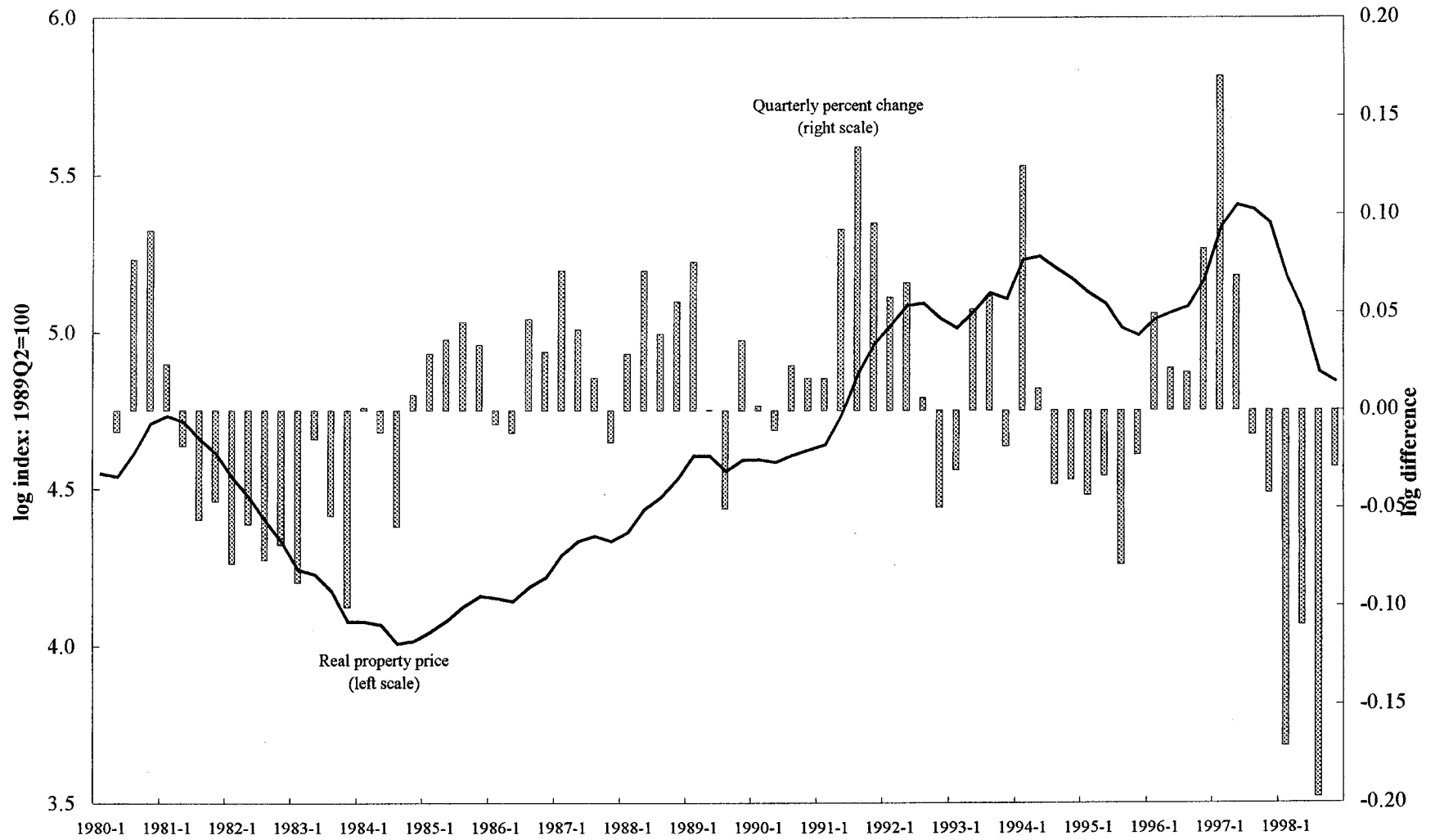
Source: HKSAR authorities; and Fund staff estimates.

property market, which included, *inter alia*, the suspension of most of the anti-speculation measures previously imposed on the sales of pre-completion flats, the imposition of a moratorium on all government land sales until March 31, 1999, and an increase in the allocation of concessionary loans to eligible home buyers for the purchase of flats. These measures seem to have helped to stabilize market sentiment; there are tentative signs of a recovery in the market, and the government has resumed land sales. Preliminary first quarter data for 1999 suggest relative stability in residential property prices.

B. Salient Features of the Property Market

Limited land supply, difficult terrain, and the locational preferences of the population and businesses have constrained supply across the entire spectrum of the property market in HKSAR.[3] On the demand side, a strongly performing economy and rising wealth of the middle class have influenced expectations about housing standards and reinforced the demand for better quality housing. Meanwhile, due to continuous, substantial immigration there has also been strong underlying demand for inexpensive, basic quality housing.

The private sector and the government have responded differently to these pressures. In the private sector, the economics of real estate has required the adoption of the most intensive form of development, i.e., high-rise apartment blocks with a mixture of individually owned and collectively managed property. In the public sector, the demand pressures have resulted in a massive stock of small, basic quality dwellings. Despite the relatively low housing standards, residential property prices in HKSAR are among the highest in the world. The incongruity between rising affluence and expectations on one side, and relatively poor but expensive housing on the other, have naturally affected government policy toward the housing sector. Reflecting these concerns, housing policies traditionally have been an exception to the HKSAR's noninterventionist approach.

Land policy

Land leases have played a critical role in the HKSAR. The government administers and manages land by granting leases through public auction, tender, and private treaty grant.[4]

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[3]See Wong and Stanley (1992), Fu (1995), and Raymond et. al. (1997) for an overview of the property market structure and policies.

[4]Land for noninstitutional uses is generally leased to the highest bidder at public auctions, with lease terms of 50 years. Some sites were granted on 75-year leases, while agricultural land was granted on 999-year leases chiefly to indigenous people in the New Territories; such leases are no longer available. The reservation price for a given site is based on the market price prevailing one week before the auction. Most leases are transferable, and the land market is a market for land leases. As each lease term requires a large lump-sum

(continued...)

Until 1985, the government controlled the supply of new land for development and could affect the market price through timing and size of land releases. During 1985–95, however, an annual limit of 50 hectares, which was provided for in the Joint Declaration, applied to all land sales. The Land Commission, set up in 1985, monitored the amount of land sold each year, and could allow sales in excess of the 50 hectares limit. Revenue from land transactions that conferred a benefit extending beyond June 30, 1997, was shared equally between the former Hong Kong government and the government of the HKSAR, after deducting the cost incurred in developing the new sites. The transfer of sovereignty on July 1, 1997, marked the transfer of ownership of all land in the HKSAR from the British Crown to the Government of the People's Republic of China. [5] Since the transfer of sovereignty, the 50 hectares limit has been lifted, and the government is again in a position to control the supply of new land for development and affect the market price.

Realizing the importance of ensuring a steady supply of land for development, the HKSAR government elaborated its first five-year land disposal program in July 1997. [6] Market participants initially welcomed the new land disposal program, as it was expected to help reduce uncertainty over land supply over the medium term. However, the severe impact of the Asian crisis on property prices prompted the government to suspend, in June 1998, all land sales by auction or public tender until end–March 1999. Measures aimed at stabilizing the property market included relaxation of some anti-speculation measures as speculation was no longer deemed to be a problem.[7]

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[4](...continued)
premium and a small annual rent, the premium attached to any given land lease approximates the land value.

[5]See Dodsworth and Mihalejek (1997). All leaseholds in the New Territories and New Kowloon were to expire on June 27, 1997; without the Joint Declaration and the Basic Law, land and property owners in this area would have had no guarantee of lease renewals (92 percent of the land mass of the HKSAR).

[6]Under the program, details of land sales for the next two fiscal years were announced, and the program of land disposal over the following three years was outlined. The program envisaged a significant increase in land supply for housing development then considered sufficient to meet ambitious housing production targets.

[7]Eased anti-speculative measures included relaxation of the resale restrictions on uncompleted flats before assignment; quota expansion for the schemes permitting low- and middle-income families to take advantage of favorable market conditions; withdrawal by the Hong Kong Monetary Authority of its 40 percent guideline on the property exposure of banks; and a scheme by the Hong Kong Mortgage Corporation enabling home buyers to secure mortgages up to a loan-to-value ratio of 85 percent.

In view of the special features of the land market and the steady increase in property prices, a key issue has been whether the policy of auctioning off land to the highest bidder has negatively affected the supply of property and amplified the secular rise in prices. Several factors suggest that may not be the case:

● In the residential market, the historical correlation between land supply and net private housing supply is relatively weak, even allowing for a lag of 2–3 years between the land sales and housing completions. However, the negative correlation between land sales and housing prices (with about a year's lag) is relatively strong.[8]

● Under agreements negotiated in the Land Commission, the 50 hectare limit was consistently breached, especially with respect to land for housing development.

● Most of the land for commercial development has traditionally been supplied through redevelopment of old sites. There is evidence to suggest that the incentive to acquire such land, and the speed of redevelopment, depend primarily on the market response in the forward sales market which is generally driven by sentiment about the macroeconomic outlook.

● In the short run, the restrictive land policy may have actually encouraged the production of housing units as anticipated higher future rents may have been capitalized into higher current housing prices (Peng and Wheaton (1994)). In the long run, the main effect of the land policy seems to have been to encourage the construction of high-rise apartment buildings and raising the density of development.

Private residential property market

The HKSAR government has only rarely intervened in the private residential market, generally leaving the property cycle to run its course. In recent years, however, prompted by signs of widespread speculation, the government intervened twice to cool escalating property prices (in early 1994 and early 1997). In 1998, prompted by the severe impact of the Asian crisis, the government intervened to arrest the steep decline in property prices. Many of the measures were aimed at the forward sales of apartments. Forward sales developed spontaneously during the early 1990s in response to the persistent housing shortage. This market innovation allowed the developers to act as wholesalers and unload their stock to speculators (or end-users). The speculators in turn served as retail distributors for developers. It has been argued that restrictions on forward sales would raise both the

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[8]See Peng and Wheaton (1994) for the period 1965–90. Property companies typically acquire land long before developing the sites in order to build up strategic "land banks." Intensive bidding in land auctions is generally interpreted by market analysts as a signal of developers' confidence in the longer-term outlook for the property market, rather than a leading short-term indicator of property prices.

risks of property development (by eliminating an important leading indicator for private developers) and the overall costs of property development (by forcing developers to hold on to their stock until final sale), thereby reducing the incentives for developers to acquire developable land. However, the activities of speculators were regarded as having amplified price fluctuations. The measures restricting the pre-sale of uncompleted apartments taken in 1994 proved effective, as the share of speculative sales (defined as those effected within two years of the last purchase of an apartment) fell to 10 percent of total sales in November 1995 from 20 percent in early 1994.

Real estate industry

The structure of the real estate industry has been a source of considerable debate. At one end, there is a view that the "cartelized" structure has considerable influence on property prices in HKSAR.[9] There have also been complaints about barriers to entry: given the high cost of acquiring land, resources needed to enter the sector are large; new entrants face higher finance costs in the absence of a track record and have less bargaining power in hiring professionals and contractors; and some tendering procedures are restricted to holders of land in the New Territories. It has also been suggested that prolonged vacancies, downward price rigidity, and the release of flats in batches rather than on a continuous basis, may indicate the existence of oligopolistic behavior (Consumer Council, 1996). However, Enright *et al.* (1997) concluded that cartelization had not made domestic property developers inefficient, since they successfully sold their services outside HKSAR. The report also noted that the very high property costs in HKSAR should primarily be attributed to the scarcity of land and the government's ability to influence land supply, rather than the oligopolistic behavior of property developers.

Public housing program

The government operates an extensive public housing program, that started in 1954 in response to an acute housing crisis that developed after World War II. Currently, about 35 percent of HKSAR's population lives in public rental housing. [10] In the early 1980s, public housing policy shifted from mass production to a more quality-oriented approach. Housing production in the public sector nevertheless continued to exceed that in the private sector:

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[9]The market for residential property development is dominated by a small number of firms. During 1991–1994, 25 percent of the housing units were supplied by 1 firm; 55 percent came from 4 developers; and 7 firms supplied 70 percent of new private housing (Consumer Council (1996)); since 1981, all new firms have together had a market share of less than 5 percent.

[10]Massive immigration from mainland China during 1945–1950 increased HKSAR's pre-war population of 600,000 by 250 percent. Likewise, in 1980–81, nearly ½ million people crossed over during an 18–month period.

the total housing stock of slightly over 2 million units as of end-1998 included 680,000 public rental units and about 240,000 subsidized housing units.

The main elements of the public housing program are public rental housing, subsidized home ownership schemes, financial assistance for home buyers, and facilitation of private housing production. The most important agency involved in the implementation of the public housing program is the quasi-autonomous, nongovernmental Housing Authority. As public housing is built on land provided by the government at "cost of production," which is normally only a fraction of the land premium paid by private property developers and passed onto the property owners, the practice of granting land outright for public housing projects has resulted in a large implicit subsidy that is not transparently classified as social spending in the fiscal accounts.[11]

Reflecting the broad aim of the housing policy to help all households gain access to adequate and affordable housing and to encourage home ownership in the community, the February 1998 White Paper on Long Term Housing Strategy set out the government's housing targets to include: production of 85,000 flats a year in the public and private sectors, starting from 1999/2000 (of which 35,000 flats are to be supplied by the private sector); raising the home ownership rate to 70 percent by 2007 from 52 percent in 1997; and reducing the average waiting time for public rental housing to three years by 2005.

The extent of HKSAR's public housing program has potential implications for developments in private real estate market, as public and private housing to a certain extent are substitutes. Long waiting periods for public housing affect the demand for private rental housing, while low public housing rents and rising affluence enable many tenants to participate in the private residential market (the government estimated that in 1995, at least 13 percent of the families living in public housing also owned their own property).

III. Determinants of Property Prices: A Selective Literature Review

A. Conceptual Framework

The efficient markets hypothesis (EMH) with a standard asset pricing model provides a useful framework to analyze property prices. Under suitable assumptions, the asset price in

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[11]Responding to efficiency and equity concerns about the public housing program including long waiting periods for public housing while many current occupants had sufficient means to move to private housing, the Housing Authority initiated strengthened means-testing for tenants and applicants in 1996, with families above prescribed levels required to pay market rents. In January 1997, the government raised public housing rents (until then estimated at about ⅓ of market rent), and since July 1997 has also made efforts to limit public rental housing growth and to increase the share of housing for sale on subsidized terms.

time period t, P_t, can be expressed as the sum of its long-run equilibrium price (P_t^*) and a bubble term (B_t).[12] The bubble term, in turn, can be specified as a "bubble builder" (representing the expectation of future price appreciation) or a "bubble burster" (the possibility of a price drop if P_t exceeds P_t^* by a certain limit).

A number of non-trivial modeling issues are involved in tests of the EMH and speculative bubbles. The main source of scepticism about the tests is that they are, effectively, joint tests of market efficiency and of model specification. There are additional issues in the tests for speculative bubbles. First, there are problems related to the *indeterminacy of the solution*. Under rational expectations, the dependence of agents' decisions on both current and expected future market prices (so that current prices are functions of future prices, and vice versa) implies that there are two endogenous variables to solve for, but only one equation. Second, as in the tests of the EMH, tests of speculative bubbles involve a joint test of the null hypothesis of no self-fulfilling deviations from the fundamental price and the specification of the asset market. Third, as the crash probability of the bubble increases, the rational bubble model implies an explosive path of asset price when a bubble exists.

B. Empirical Testing

There is an extensive literature which examines property price movements in terms of fundamentals such as user and supplier cost factors, demographics, and general economic conditions. The related issue of market efficiency is also taken up by some studies (see Cho

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[12]Following Fama (1970), an efficient market is one in which prices reflect all relevant information fully and instantaneously, and the current price of an asset is an unbiased predictor of its future value if new information arrives randomly. In discrete time, let the expected rate of return (r) on an asset between time t and t+1 be $E_t[r_{t+1}] = E_t[(P_{t+1} - P_t + d_{t+1})/P_t]$, where E is the expectations operator, P is the unit price of the asset, and d is an appropriate dividend/rent. If $E_t[r_{t+1}] - \rho = 0$ is a fair game, where ρ is a constant then, by substitution, $P_t = E_t[(P_{t+1} + d_{t+1})]/(1 + \rho)$. (A stochastic process y_t is considered a fair game if $E_t[y_{t+1}] = 0$; here $E_t[y_{t+1}] = E_t[r_{t+1}] - r_t$.) Solving forward for n periods, and using iterative expectations:

$$P_t = \sum_{i=0}^{n} \frac{E_t[d_{t+i}]}{(1+\rho)^n} + \frac{E_t[P_{t+n}]}{(1+\rho)^n} = P_t^* + B_t$$

If the second bracketed term converges to zero for sufficiently large n, then the equation represents the long-run equilibrium price P_t^*, and the current value of the asset is represented as the sum of expected present values of all future dividends/rents. If the second term does not converge to zero, then the asset price includes speculative bubbles B_t.

(1996) for a useful survey). On the role of fundamentals, Mankiw and Weil (1989) report that the entry of the baby boom generation into home-buying years was the major cause of the increase in real house prices in the US in the 1970s. Poterba (1991) reports a significant effect of shifts in income and construction costs on real prices and weaker evidence for the role of demographic factors for the period 1980–90 in 39 US cities. Case and Shiller (1990) and Clapp and Giacotto (1994) correlate house prices with currently available public economic information, including construction costs, income growth, tax rates, and unemployment rates, and show that macroeconomic variables can be used to forecast house prices, concluding that housing markets are not consistent with the EMH. Meese and Wallace (1993, 1994) add a disequilibrium variable to the standard fundamentals, and conclude that fundamentals could explain price movements over long periods but are less useful in explaining short-run fluctuations.

Only a few studies test for speculative bubbles explicitly. Abraham and Henderschott (1996), examine 30 US metropolitan cities over 1977–92 to show that changes in market fundamentals (such as income, employment, and real interest rates) and adjustment dynamics (which include a bubble builder and a bubble burster) together explain about 60 percent of the variation in price movements, and individually a little over 40 percent. Kim and Suh (1993) use the method of forward expectations à la Blanchard and Kahn (1980) in an asset demand (with future capital gains as an argument) and supply framework and report a growing rational bubble in land prices in Japan and Korea between 1974 and 1989; the evidence for a bubble in Korean *house* prices is weaker. Using cross equation restrictions, Clayton (1994) reject the joint null hypothesis of rational expectations and the asset based housing price model using quarterly data for Vancouver during 1979–91. For Japan during 1956–93, Ito and Iwaisako (1995) find considerable correlation between stock and land prices, and varying degrees of correlation between asset price increases and fundamentals such as interest rates and growth.

IV. EMPIRICAL MODELS OF THE HKSAR PROPERTY MARKET

The key features of the HKSAR property market outlined above and the literature review suggest a number of factors that could be considered in modeling the behavior of property prices. Among these are macroeconomic determinants of demand for residential property, supply factors affecting land and housing availability including government policy, structural features of the property market, and the nature of the HKSAR economy more generally (including the linked exchange rate). It is useful to distinguish among factors which have an effect on the *level* of property prices and those that affect *variability*, keeping in mind that there may be an overlap between the two sets of factors and that larger variability may in part be associated with high levels. Section II suggests that government land policy may effectively be less restrictive than often suggested, and the nature of the relation between land policy and property prices may not be as close as often asserted. There are also reasons to believe that, despite "cartelization", the real estate industry is

reasonably efficient. Furthermore, it is possible that these factors may be more critical to the *level* of property prices, while short-run variations may be more closely associated with factors such as household income and housing costs. The remainder of this paper, therefore, focuses on macroeconomic determinants of property price, leaving the implications of government policy and market microstructure as issues for future research.

A. Data Properties

Quarterly data for the period 1980–98 were used in the analysis (see Figure 2). [13] For property prices, the overall indices of residential property prices (PPI) and rental prices (RI) computed by the Ratings and Valuation Department were used. These indices were deflated by the CPI index (CPI) to obtain real indices of property prices (RPPI) and rental prices (RRI). To capture the cost of borrowing, the best lending rate (BLR) was used as a proxy for the mortgage interest rate; the BLR was deflated by CPI inflation to derive a real (ex-post) interest rate (RINT). A real construction cost index (CCI) and the real effective exchange rate (REER) were also included as explanatory variables. The scale variables included real GDP (RGDP), per capita real GDP (PCRGDP), nominal wage (NW), real wage (W), and population (POP). Some supply side factors such as the number of new apartments completed in a quarter—private (FPVT) and total public (PUBTOT)—were also included in the analysis. These housing supply volume indicators could also be viewed as proxies for the government land policy, albeit imperfect ones since virtually no estimates of the lag structure in the construction industry are readily available. All variables, except the interest rate, were converted to log levels (denoted by small letters, e.g., rppi for real property prices).

Seasonality and unit root properties of the data series were examined. The stable seasonality tests are reported in Table 1. For the series that exhibited stable seasonality, the seasonally adjusted series were used in the analysis (labeled, e.g., rrisa for the log level of the seasonally adjusted real rental price index). The augmented Dickey-Fuller tests for the data series are reported in Table 2 for the periods 1980–95 and 1980–98, respectively (see below for an explanation of the sample periods). The data series are integrated of order I(1) or I(0).

Two sets of models for property prices were estimated: *univariate time series models* to model the "trend" behavior of the property price changes and to assess deviation of actual changes from "trend" values; and *models motivated by the efficient markets hypothesis* where property price changes are assumed to be determined by "fundamentals" and "speculative bubbles". The latter models permit an examination of the hypothesis that property prices may be subject to speculative bubbles and allows a comparison to other models of housing markets (in the US), in addition to providing a measure of the deviation of actual price changes from "trend" values.

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[13] The primary data sources are the Hong Kong Monthly Digest of Statistics, HKMA Monthly Bulletin, and government property market surveys.

Figure 2. Hong Kong SAR: Selected Determinants of Property Markets, 1980-98
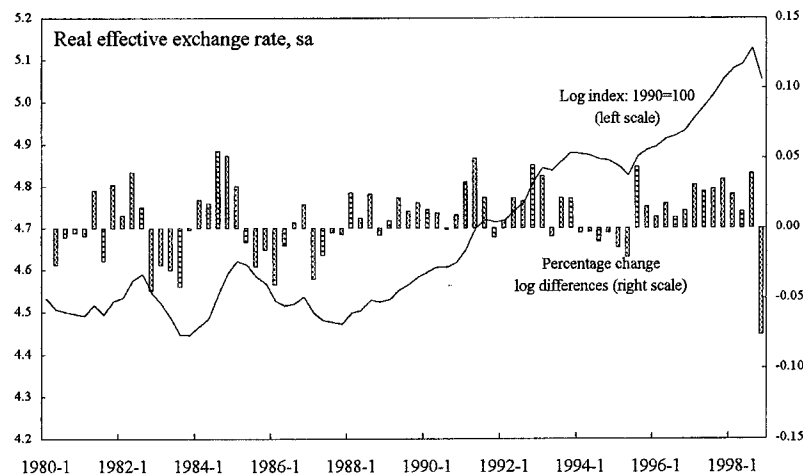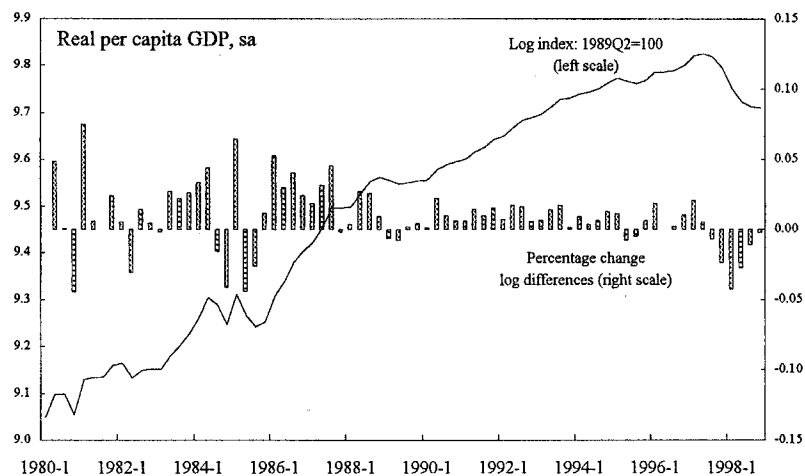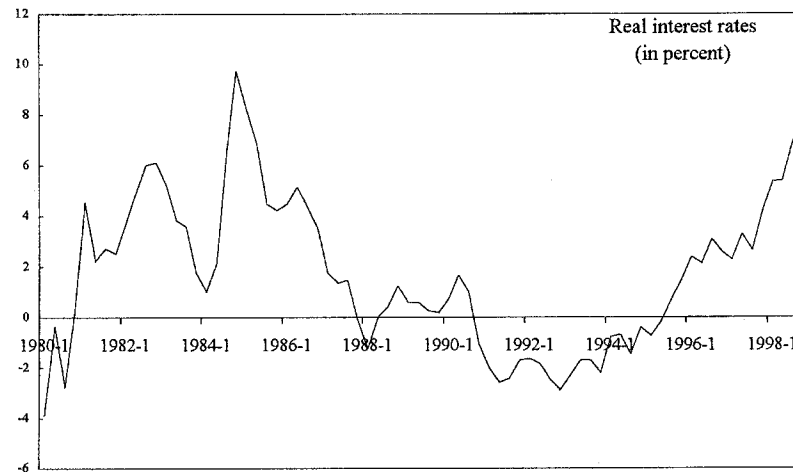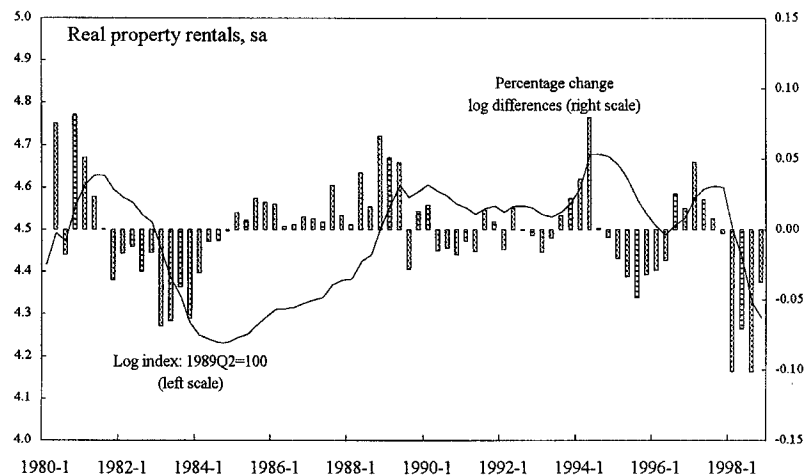
Sources: HKSAR authorities; and Fund staff estimates.

Table 1. Hong Kong SAR: Seasonality analysis 1/
Sample period: 1980–98

| Variable | Stable seasonality at the 1 percent level | |
	Yes	No
ppi		x
rppi		x
ri	x	
rri	x	
BLR		x
RINT		x
cpi		x
cci	x	
rer	x	
rgdp	x	
pcrdgp	x	
nw		x
w		x
emp	x	
pop	x	
fpvt	x	
pubtot 2/		x

Sources: HKSAR authorities; and Fund staff estimates.

1/ Seasonal multiplicative factors are calculated using the X11 method for all variables, except for RINT for which nonnegative values imply that additive factors are required.
2/ Sample period starts in 1984(1).

Table 2. Hong Kong SAR: Augmented Dickey–Fuller test statistics 1/ 2/ 3/
Sample period: 1980–98

	I(0)	I(1)
ppi	—	−3.51 *
rppi	—	−3.71 *
ri	—	−3.49 *
rri	—	−3.95 *
risa	—	
rrisa	—	−3.65 *
BLR	—	−6.68 **
RINT	—	−6.30 **
rer	—	−4.30 **
rersa	—	−3.98 **
cpi	—	−4.98 **
cci	−3.71 *	−4.74 **
ccisa	—	−3.96 *
rgdp	−4.64 **	−7.89 **
pcrdgp	−4.00 **	−7.81 **
nw	—	−11.54 **
w	—	−12.92 **
rgdpsa	—	−8.95 **
pcrgdpsa	—	−8.90 **
emp	—	−11.73 **
pop	—	−4.72 **
empsa	—	−9.59 **
popsa	—	−11.35 **
fpvt	−8.57 **	−19.22 **
pubtot 4/	−6.21 **	−10.19 **
fpvtsa	−7.71 **	−18.96 **

Sources: HKSAR authorities; and Fund staff estimates.

1/ The values reported for each variable and null order are the augmented Dickey-Fuller statistics. For a given variable x and null order I(0), the ADF statistic is testing a null hypothesis of a unit root in x against the alternative of a stationary root; for a null order I(1), the statistic is testing a null hypothesis of a unit root in Δx against an alternative of a stationary root in Δx. Each estimated equation contains a constant and a time trend. The maximum available sample is used, and varies across the null order.
2/ Here, and in the remainder of the paper, * and ** denote significance at the 5% and 1% level, respectively.
3/ "—" indicates that the ADF was not significant at the 5 or 10 percent level for various lags.
4/ The sample period starts in 1984(1).

B. Univariate Time Series Models

ARIMA models of real property prices were constructed to obtain a univariate representation of the series. Log differences were used in model building. A simple search procedure was used to determine the appropriate ARIMA specification for property price changes. First, the autocorrelation and partial autocorrelation statistics were computed (Table 3). While the former suggested that a higher order (possibly third order) ARIMA process was required, the partial autocorrelation function appeared to suggest that a lower order process may suffice. As an initial step, the maximal ARIMA order was set at (4,1,4). With these transformations and specifications, the general form of the estimated ARIMA models (where u is the error term) was:

$$drppi_t = a_0 + \sum_{i=1}^{4} a_i \, drppi_{t-i} + \sum_{i=1}^{4} \theta_i \, u_{t-i}$$

Second, the Schwartz Information Criterion was used to order the estimated models.[14] Third, the residuals from the ordered set of admissible models from step 2 were examined for possible misspecification. Using this search procedure, two acceptable ARIMA models of property prices are reported in Table 4. The models are ARIMA(1,1,0) and ARIMA (0,1,3).

The acceptable models have a number of interesting properties. First, the models fit the data reasonably well and the diagnostic statistics indicate no evidence of misspecification (Figure 3). The lagged values and moving average components can explain almost 40–50 percent of the variation in property price changes. The correlation between actual and fitted property price changes is over 60 percent; the correlation between one-period lagged changes and fitted values is over 75 percent. Second, the coefficient on the one-period lag in the ARIMA (1, 1, 0) model is large, positive, and very significant. The positive sign implies that appreciations (depreciations) are followed by further price increases (decreases), and the coefficient on the lag implies that over the sample period a 1 percent increase (decrease) in real property prices was typically followed by a 0.6 percent increase (decrease) a quarter later. The positive sign also suggests the possibility that the market may be subject to speculative bubbles. Third, the residuals provides a measure of the "excess" price changes and an indication of outliers (Figure 4). The 95 percent confidence intervals around the residuals are stable and contain almost all residuals. The majority of the actual deviations for both ARIMA models appear to lie within ±5 percent of the "trend" values. Fourth, the price movements during the latest cycle over 1997–1998 were larger than ±5

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[14]During this step, the models that generated numerical singularities were first set aside. This did not diminish the admissible set of models in any substantive manner. The remaining admissible models were then ordered according to Schwartz Information Criterion.

Table 3. Hong Kong SAR Property Prices Changes 1/
Sample period: 1980-1998

Mean: 0.0039
Standard deviation: 0.065

Autocorrelation function and statistics

Lag	Autocorrelation function				Partial autocorrelation function		
	r	SE-r	t statistics -r		p	SE-p	t statistics -p
1	0.61	0.12	5.2		0.60	0.10	6.0
2	0.41	0.16	2.6		0.03	0.14	0.2
3	0.24	0.17	1.4		-0.01	0.14	-0.1
4	-0.03	0.17	-0.2		-0.26	0.14	-1.9
5	-0.27	0.17	-1.5		-0.23	0.15	-1.5
6	-0.27	0.18	-1.5		0.06	0.15	0.4
7	-0.05	0.19	-0.3		0.32	0.15	2.1
8	-0.07	0.19	-0.4		-0.12	0.15	-0.8

Schwartz information criteria for ARIMA (p,q)

		q				
		0	1	2	3	4
p	0	-5.479	-5.788	-5.780	-5.899	-5.879
	1	-5.892	-5.835	-5.779	-5.871	-5.840
	2	-5.835	-5.784	-5.728	-5.941	-5.774
	3	-5.779	-5.723	-5.818	-5.824	-5.759
	4	-5.774	-5.740	-5.648	-5.804	-5.727

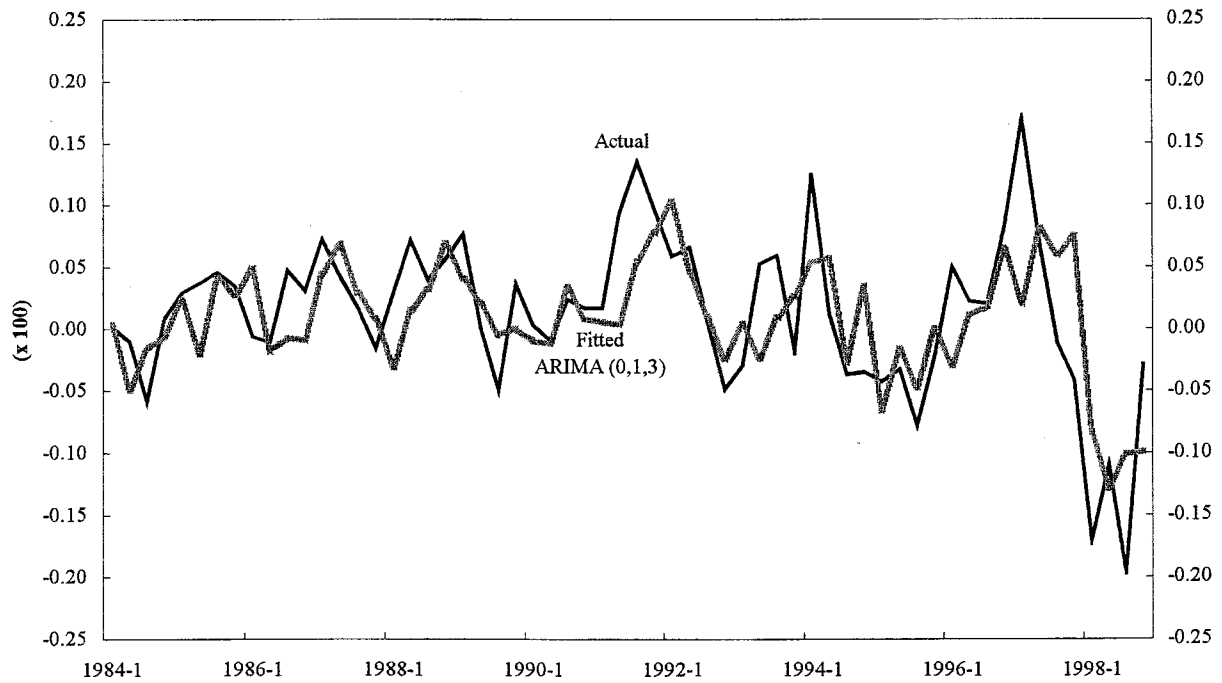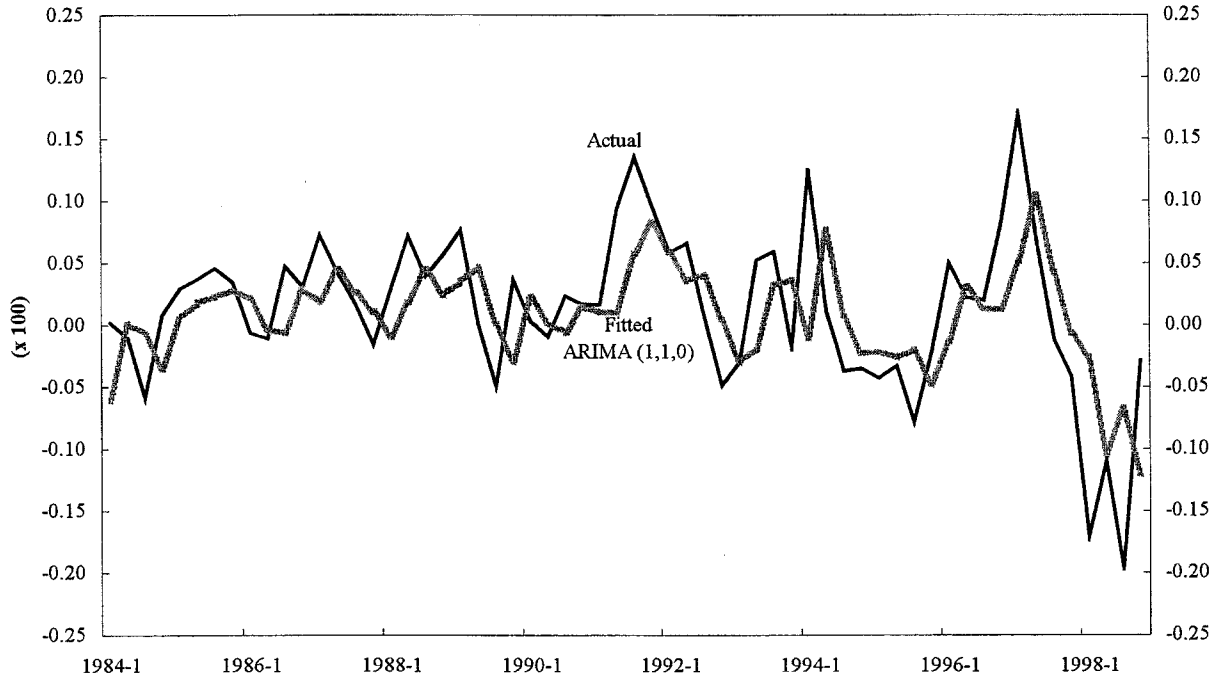Sources: HKSAR authorities, and Fund staff estimates.

1/ Log differences.

Table 4. Hong Kong SAR: ARIMA models of real property prices
Sample period: 1980 to 1998

ARIMA (1,1, 0) Model

Variable	Coefficient	Std.Error	t-value	t-prob	Partial R^2
Constant	0.0001	0.006	0.03	0.98	0.00
a_1	0.61	0.09	6.63	0.00	0.38

$R^2 = 0.40$ $\quad$ $F(1,73) = 49.50\ [0.00]$ $\quad$ $\sigma = 0.05$ $\quad$ $DW = 1.98$
RSS = 0.18 for 2 variables and 75 observations

Information Criteria: SC = –5.89; HQ = –5.93; FPE = 0.003

ARCH 4 F(4, 65)	= 2.14 [0.09]
Normality $\chi^2(2)$	= 4.00 [0.14]
AR 1–5 F(5, 68)	= 1.64 [0.16]
Xi^2 F(2,70)	= 1.63 [0.20]
Xi*Xj F(2,70)	= 1.62 [0.20]

ARIMA (0,1, 3) Model

Variable	Coefficient	Std.Error	t-value	t-prob	Partial R^2
Constant	0.003	0.014	0.18	0.85	0.00
θ_1	0.47	0.10	4.33	0.00	0.21
θ_2	0.33	0.08	4.10	0.00	0.19
θ_3	0.73	0.12	6.26	0.00	0.36

$R^2 = 0.47$ $\quad$ $F(3,71) = 21.19\ [0.00]$ $\quad$ $\sigma = 0.05$ $\quad$ $DW = 1.80$
RSS = 0.16 for 4 variables and 75 observations

Information Criteria: SC = –5.899; HQ = –5.97; FPE = 0.002

|	
ARCH 4 F(4, 63)	= 3.06 [0.02] *
Normality $\chi^2(2)$	= 3.02 [0.22]
AR 1–5 F(5, 66)	= 1.90 [0.11]
Xi^2 F(6, 64)	= 1.64 [0.15]
Xi*Xj F(9, 61)	= 0.90 [0.31]

Sources: HKSAR authorities; and staff estimates.

Figure 3. ARIMA Models of Hong Kong SAR Real Property Prices
Quarterly percent change, 1984-98

Sources: HKSAR authorities; and Fund staff estimates.

Figure 4. ARIMA Models of Hong Kong SAR Real Property Prices
Estimated Residuals, 1984-98
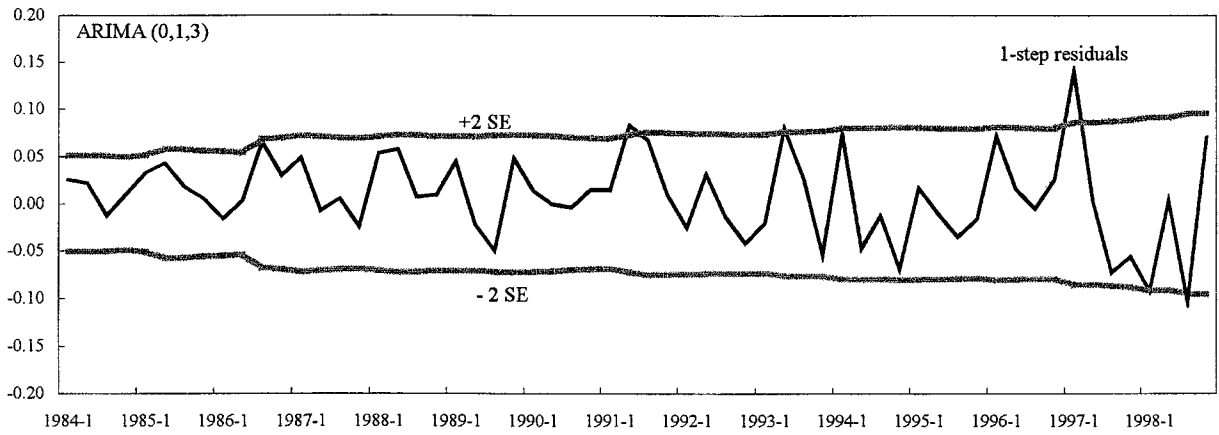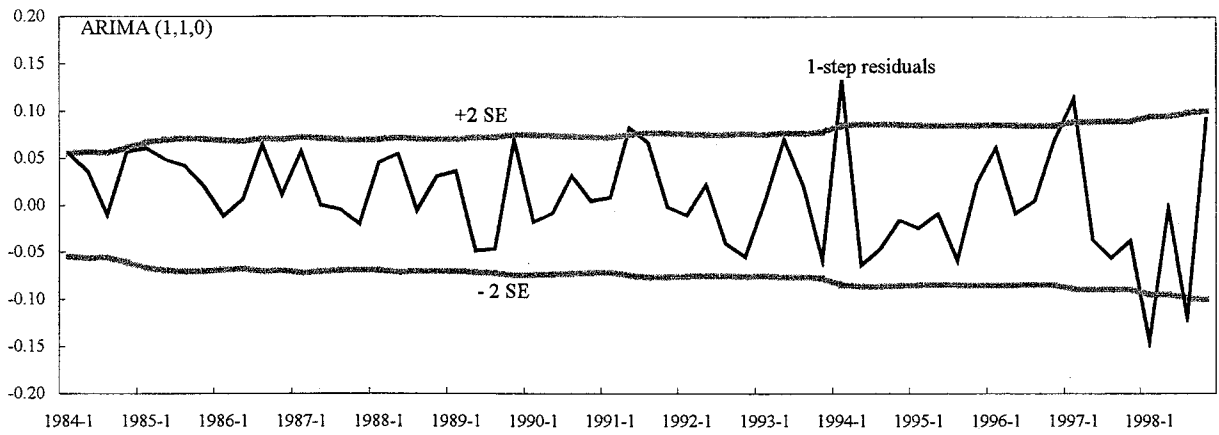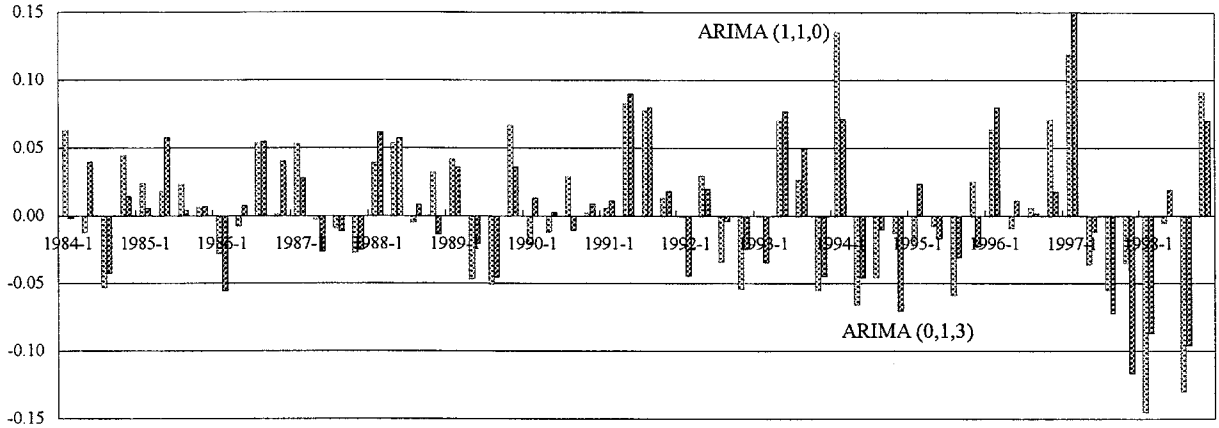
Sources: HKSAR authorities; and Fund staff estimates.

percent "norm", both during the upswing and the downswing. At the peak of the upswing in the first quarter of 1997, real property prices were 10–15 percent higher than trend; at the maximal level of the trough during the first quarter of 1998, property prices were again 10–15 percent below trend values. The recovery may already have started in the fourth quarter of 1998.

C. A Speculative Bubbles Model of Property Prices

Elaborating on the discounted present value model, Abraham and Henderschott (1996) propose a model and test for speculative bubbles in which equilibrium property prices are determined by "fundamentals" and a bubble term so that:

$$drppi_t = drppi_t^* + u_t$$

where the error term u_t is used to capture the dynamic adjustment. The growth rate $drppi_t^*$ can be modeled as a function of the growth rate of real rental prices, income, population, real construction costs, the level of real interest rates, and other variables:

$$drppi_t^* = a_0 + a_1 RINT_t + a_2 drrisa_t + a_3 dpcrgdp_t + ... + \text{lagged variables}$$

The functional form of the "error term" can be further specified as a sum of a bubble "builder", a bubble "burster", and a random variable:

$$u_t = \lambda_0 + \lambda_1 drppi_{t-1} + \lambda_2 (rppi_{t-1}^* - rppi_{t-1}) + \epsilon_t$$

With $\lambda_1 > 0$, the lagged growth of real property prices acts to perpetuate this growth thus generating a bubble; with $\lambda_2 > 0$, the second term captures the tendency of the bubble to burst when the actual price level $rppi_{t-1}$ exceeds the equilibrium level $rppi_t^*$. Real property price growth can then be expressed as:

$$drppi_t = (a_0 + \lambda_0) + a_1 RINT_t + a_2 drrisa_t + a_3 dpcrgdp_t + ... + \lambda_1 drppi_{t-1} + \lambda_2 (rppi_{t-1}^* - rppi_{t-1}) + \epsilon_t$$

An estimated model for Hong Kong property prices along these lines is reported in Table 5.[15] The model has a number of interesting properties.

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[15]Estimating this equation requires an estimate of rppi*. Furthermore, this estimate needs to be consistent with drppi* and the parameter estimates of a $_i$. This issue is resolved as follows: (i) estimate the equation *without* the λ_2 term; (ii) construct a first-pass estimate of rppi* by cumulating drppi* over time using the parameter estimates from (i); (iii) calibrate the rppi* series assuming that actual property prices were in equilibrium during a particular time period; (iv) reestimate drppi, *including* the λ_2; (v) reiterate (i)–(iv) until the a $_i$ parameter estimates stabilize (which typically happens after a few iterations) which implies

(continued...)

- **First**, the absence of volume changes in the number of apartments and, more interestingly, of the real construction cost index as explanatory variables in the estimated equation, is striking. This absence appears to confirm the relative importance of demand side factors in explaining short-term property price movements. While further analysis is required, this may also be taken as supporting the conjecture that government policy and the structure of the real estate industry may be more important as determinants of property price *levels* rather than of price *changes*.

- **Second**, the estimated model performs reasonably well in explaining variations in property price changes, and somewhat better than the ARIMA models. The "exogenous" variables explain around 65 percent of the variation in property price movements (50–60 percent in Abraham and Henderschott), and the diagnostic statistics do not indicate any misspecification (see Figure 5).

- **Third**, the longest lag on the explanatory variable is two quarters, suggesting a relatively quick passthrough from the explanatory variables to property prices.

- **Fourth**, parameter coefficients of the explanatory variable are of the expected sign and are highly significant. Real property price changes are contemporaneously positively related to real rental price changes, real per capita GDP growth, and the real effective exchange rate, and negatively to the real interest rate. The dependence of property prices on rental prices is reassuring. Also, not surprisingly, given the importance of non-wage incomes, a broader measure such as real per capita GDP growth performs better as a scale variable. The presence of the real effective exchange rate and the real interest rate in the estimated equation reflect the high degree of openness of the HKSAR economy, and the close relationship between a key sector of the economy and global market conditions. Given the linked exchange rate system and the open capital account, domestic interest rates typically move with US interest rates, and transmit international monetary conditions to the domestic economy through this channel. A real effective exchange rate appreciation generates pressures for a decrease in nontraded goods prices, and increases *real* residential property prices with a lag of two quarters.

The data suggest that the HKSAR property price movements may have a tendency for speculative bubbles. The estimated bubble builder and burster parameters are significant. Furthermore, the bubble builder parameter (0.3) is within the range reported in Abraham and Henderschott for US cities (0.5 for coastal US cities and 0.2 for the remainder of the

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[15](...continued)
stability in drppi* and rppi*. The estimated equation is reported under the calibration that the property market was in equilibrium in the first quarter of 1990, which appears to be a reasonable assumption considering the relative stability in drppi* during that time period.

Table 5. Hong Kong SAR: A "Speculative Bubbles" model of real property prices

Sample period: 1980 to 1998

Variable	Coefficient	Std.Error	t-value	t-prob	Part R^2
Constant	0.007	0.007	0.90	0.37	0.01
RINT	−0.005	0.002	−2.59	0.01	0.10
drrisa	1.18	0.21	5.69	0.00	0.34
$drrisa_{t-1}$	−0.67	0.20	−3.30	0.00	0.15
$drersa_{t-2}$	0.64	0.24	2.66	0.01	0.10
dpcrgdpsa	0.41	0.25	1.60	0.12	0.04
λ_1	0.31	0.12	2.54	0.01	0.09
λ_2	0.05	0.03	1.79	0.08	0.05

$R^2 = 0.66$ $\qquad$ $F(7, 64) = 17.67 [0.00]$ $\qquad$ $\sigma = 0.04$ $\qquad$ DW = 2.01
RSS = 0.10 for 8 variables and 72 observations

Information Criteria: SC = −6.26; HQ = −6.25; FPE = 0.002

AR 1–5 F(5, 59) $\qquad$ = $\qquad$ 0.81 [0.55]
ARCH 4 F(4, 56) $\qquad$ = $\qquad$ 1.94 [0.12]
Normality $\chi^2(2)$ $\qquad$ = $\qquad$ 2.72 [0.26]
Xi^2 F(35, 28) $\qquad$ = $\qquad$ 2.00 [0.04] *
Xi*Xj F(35, 28) $\qquad$ = $\qquad$ 1.27 [0.26]
RESET F(1, 63) $\qquad$ = $\qquad$ 2.09 [0.15]

Sources: HKSAR authorities; and staff estimates.

Figure 5. A "Speculative Bubbles" Model of Hong Kong SAR Property Prices, 1982-98
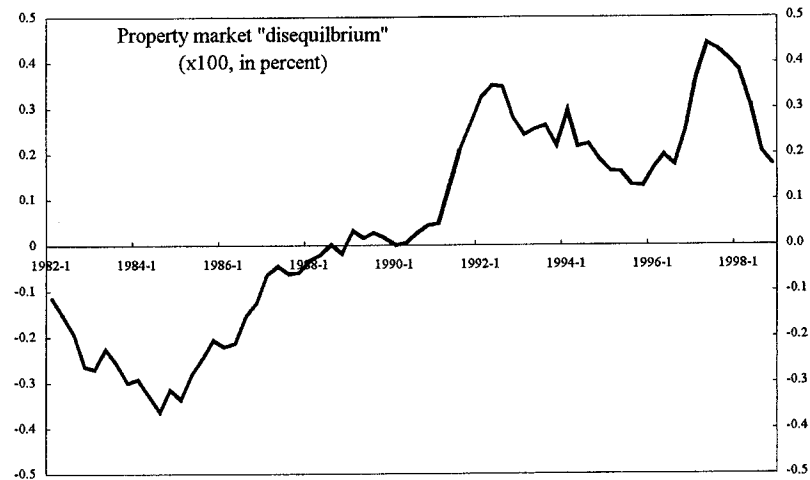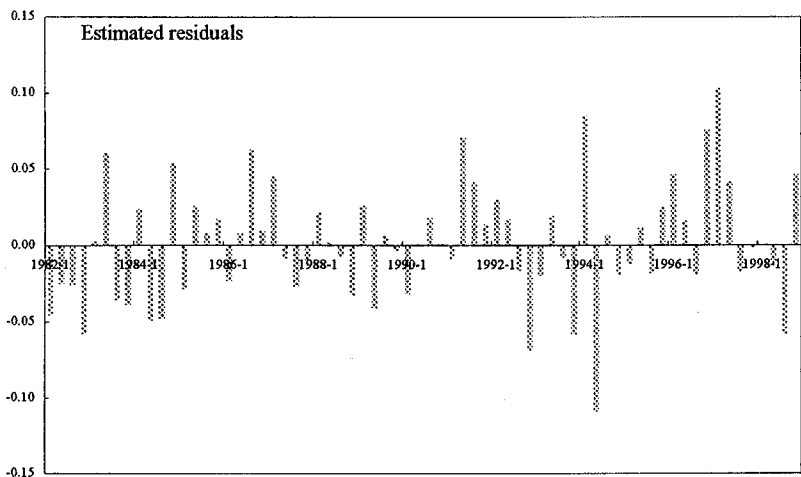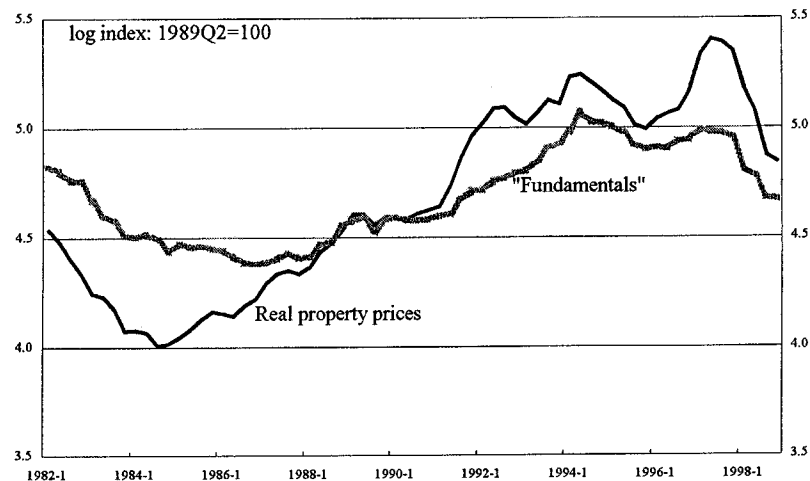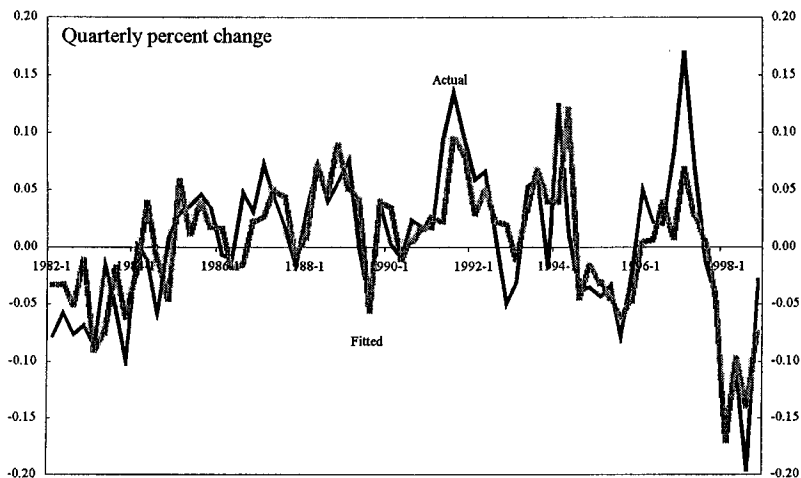
Sources: HKSAR authorities; and Fund staff estimates.

country; 0.4 for the pooled data); so is the bubble burster parameter (0.05) (0.1 for coastal US cities and 0 for the remainder of the country; 0.05 for the pooled data in Abraham and Henderschott). This suggests that the propagation of appreciations and depreciations in the HKSAR property market is similar to the US cities, and property cycles in HKSAR are roughly of the same duration.

The estimated model provides measures of the deviation of actual property price changes from "trend" values. The speculative bubbles model predicts roughly similar orders of magnitude of the deviation of actual property price changes from "trend" values as the ARIMA models. In particular, during the latest cycle, at the peak the "excess" upswing was about 10 percent; at the trough, the "excess" swing was about 5 percent. The question of the *level* of the property prices from equilibrium values has attracted even greater attention than the price changes. Numerous market observers have offered estimates of the "overvaluation" and "undervaluation" of the property price, ostensibly compared to levels they assume to be determined by "fundamentals". The estimated model provides a measure of such deviations over the sample period through the estimated series (rppi–rppi*). On the assumption that property prices were broadly in equilibrium during the early 1990's, during the latest upswing which peaked in second quarter of 1997, property prices may have been 40–45 percent above levels suggested by developments in "fundamentals." This estimate is broadly consistent with market perceptions at that time.

V. CONCLUDING REMARKS

This paper examined developments in residential property prices in Hong Kong SAR over 1980–98. Using ARIMA models and the framework of the efficient markets hypothesis, the paper provided measures of the deviations of the actual price changes from "trend." In particular, for the latest cycle in property prices during 1996–98, the estimated models suggest "excess" up and down swings of 10–15 percent and 5–10 percent, respectively. The actual price changes are well-explained by the estimated models.

The estimated models do not reject the notion that the HKSAR property market may be subject to speculative bubbles. There appears to be considerable inertia in property price movements, reflected in the large impact of lagged price changes on current changes in the ARIMA models. This hypothesis is confirmed by the "speculative bubbles" model where the "bubble" parameters are significant and comparable to those estimated for the housing markets in US metropolitan cities. Also, the propagation of appreciations and depreciations in the HKSAR property market appears to be similar to the U.S. cities.

The "speculative bubbles" model indicates that short-run property price changes are closely associated with rental price changes, per capita GDP growth, and movements in the effective exchange rate and interest rate, while housing volume and construction cost variables are relatively unimportant. While future research is required, this may suggest that

government land policy and the structure of the real estate industry have a limited impact on price changes over time (although they may affect the price level). These determinants of property prices are in keeping with important structural features of the HKSAR economy, including the linked exchange rate system, its liberal trade regime, and the open financial account.

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