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Real Estate Return in Hong Kong and Its Determinants: A Dynamic Gordon Growth Model Analysis

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We apply the dynamic Gordon growth model to the Hong Kong real estate market to analyze quarterly data on four kinds of real estate—housing, office, retail, and factory properties—from 1999 to 2020. We find that factories have the highest total returns among the four types of real estate, and also a larger Sharpe ratio. The total returns of these four kinds of real estate are highly correlated. The results of an autoregressive distributed lag model show that the gross domestic product growth rate is the key determinant of real estate returns, while changes in foreign direct investment also influence housing and retail returns. The expected value of the risk-free rate is the key factor that determines the rent-price ratio. The decline in the risk-free rate in Hong Kong is the main reason that the real estate price-rent ratio has increased from 20 to 40 in the last twenty years. Our research represents an early contribution that compares the performance of housing and commercial real estate at the city level, with both types of real estate having similar determinants. Finally, we find that the fall in risk-free interest rates worsens housing affordability in Hong Kong.

Keywords

Real Estate Return, Dynamic Gordon Model, Commercial Real Estate, Housing Premium, ARDL Model, Hong Kong

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1. Introduction

The long-term upward trend of the housing price in Hong Kong and its ever-declining rent-price ratio have caused extensive concern among investors and researchers. At 2020 prices, it would take a skilled service worker 20 years to pay for a 60 square meter flat near the city center, which makes Hong Kong the most unaffordable city in the world in that period of time; however, in 2010, it would have taken this worker only 12 years (UBS, 2020). High housing prices have a direct negative effect on living conditions, and the average living space per person amounts to only 14 square meters, which is lower than that in most global cities (UBS, 2017). Apart from high housing prices relative to income, the rent-price ratio in Hong Kong is one of the lowest among global cities: it takes 38 years of rent to pay the price of a flat, which suggests that there might be a bubble in real estate prices.

There have been some studies on Hong Kong real estate prices and returns in past years. Early research on the Hong Kong housing market points to the decreasing interest rate and rising inflation as causes of the increase in Hong Kong housing prices in the 1990s (Tse, 1996). Recent research shows that there were several bubbles in the 2000s, with housing prices being relatively high in 2004 and 2008 (Yiu et al., 2013). Real estate prices have continued to rise in the last ten years, and both residential and commercial real estate show a bell shape in the rent-price ratio. It is necessary to take a deeper look into this market to determine what is happening.

This research aims to determine the driving factors behind the rapid increase in real estate prices. We apply a dynamic Gordon model to four kinds of real estate markets in Hong Kong: housing, office, retail and factory properties. Analyzing quarterly data for 1999 to 2020, we find that commercial real estate has higher returns than housing, that the gross domestic product (GDP) growth rate is the most important determinant of real estate returns, that changes in foreign direct investment (FDI) have a positive influence on housing and retail returns, and that the decline in the risk-free rate in Hong Kong is the main reason that the price-rent ratio has increased from 20 to 40 in the last twenty years. The contribution of this paper is based on its use of more recent data; we also derive policy recommendations in alignment with our findings. To the best of our knowledge, this is an early study that applies a dynamic Gordon model to commercial real estate analysis. This paper also adds to commercial real estate return research.

This paper is organized as follow. In the next section, we review the literature on real estate returns and the Hong Kong real estate market separately. In Section 3, we give a detailed introduction to the Gordon dynamic growth model, and discuss how we identify the determinants of real estate returns with an autoregressive distributed lag (ARDL) model. In Section 4, we present the data source, statistical description and preliminary test. In Section 5, we give the results. Finally, we offer the discussion and conclusion.

2. Literature Review

2.1 Research on Real Estate Return

This research study on real estate returns focuses on three topics, and we discuss each one separately in the following.

2.1.1 Real Estate Return Measures at the Asset Level

Micro-level real estate data have been used to calculate direct real estate returns. In Europe, Chambers et al. (2019) analyze property-level financial data for the institutional real estate portfolios of four large Oxbridge colleges over the period of 1901–1983 and find that real estate, housing in particular, is a less profitable investment in the long run than previously thought. Cvijanović and Spaenjers (2020) analyze all house and apartment transactions in Paris for the period of 1992–2016 and find that "out-of-country" buyers buy houses at higher prices and resell at substantially lower prices than local investors, and the causal effect of out-of-country demand shocks on property prices is positive but small. Eichholtz et al. (2020) estimate the total rate of return on housing investments based on 120,658 manually collected archival observations of prices, rents, taxes and costs for individual houses in Paris from 1809 to 1942, and Amsterdam from 1900 to 1979. They find that annualized real total returns, the net of costs and taxes, are 4.2% for Paris and 5.0% for Amsterdam and that the yield at purchase is an important determinant of total holding period returns. In Australia, Melser and Hill (2018) analyze large data sets of home prices and rents for Sydney from 2002 to 2016 with flexible smoothing spline hedonic models and find that Sydney homes have both higher returns than shares and much lower risk on average, which give them a far superior Sharpe ratio. In regard to commercial real estate, Peng (2015) analyzes the property-level risk and returns of 14,115 properties for 1977 to 2012 and finds that a cross-sectional approach provides more accurate estimates under reasonable market conditions. Sagi (2020) analyzes property-level commercial real estate returns and finds that even after accounting for all cash flow-relevant events, commercial real estate idiosyncratic return means and variances do not scale with the holding period.

2.1.2 Risk-Return Relationship of Real Estate Assets.

Lorenz and Trück (2008) apply the capital asset pricing model (CAPM) and factor models to five different kinds of real estate in five European countries and find that there are large differences across different countries in the risk-return relationship. The Dutch market gives the highest compensation for risk taken by investors, while returns in Germany are the worst during the research period. At the regional level, Cannon et al. (2006) find a positive relation between housing returns and volatility in 115 metropolitan statistical area (MSA) housing markets in the United States (US), with returns rising 2.48% annually for a 10% total rise in volatility over the sample period. Asymmetric risk in real estate investments has also been measured in previous studies (Cheng, 2005).

2.1.3 Identification of Real Estate Return Determinants.

In the United Kingdom (UK), Kohlert (2010) uses a vector error-correction model (VECM) and finds long-run equilibrium relationships among office market total returns and macroeconomic variables, such as GDP. Lizieri et al. (2012) apply a regime-switching threshold autoregressive (TAR) model to the London office market and find that equity returns and GDP growth can capture the risks of downturns in real estate. In Australia, results have indicated that traditionally established long-term drivers, including real GDP, office stock, and vacancy and net absorption rates, are still relevant. Mintah et al. (2020) find that apart from economic variables such as real GDP, office stock, and vacancy and net absorption rates, cross-border real estate investments impact the performance of the direct commercial office property market in Australia. In South Africa, Akinsomi et al. (2018) find that GDP, and unemployment and interest rates are effective variables in explaining total commercial returns. The value of commercial real estate has also been measured in previous studies. Wheaton et al. (2009) find that inflation-adjusted commercial office property values are 30% lower in 1999 than 1899 in Manhattan.

Apart from the research on the three topics above, there are also two other issues directly relevant to real estate returns: the inflation-hedging ability of real estate (Hoesli et al., 2008) and real estate portfolio diversification (Addae-Dapaah et al., 2002). Real estate investment trust (REIT) returns (Lizieri et al., 2007), land returns (Jadevicius et al., 2018) and real estate equities (Milcheva, 2020) have also received attention from researchers.

2.2 Research on the Hong Kong Real Estate Market

There has been much research on the Hong Kong real estate market that cover most parts of the real estate market. Research has focused on real estate market features including the real estate cycle (Wang et al., 2000), real estate volatility (Wang and Hartzell, 2021), housing supply (Leung et al., 2020), price discovery process (Schwann and Chau, 2003; Chau et al., 2001) and transaction costs (Walters, 2002). Some special issues in the Hong Kong real estate market have also been examined in previous research, including comprehensive development areas (Raymond, 2001) and forward sales (Wong et al., 2006).

The connection between the real estate market and the economic environment has also been examined, as have the impact of property prices on stock prices (Tse, 2001) and the linkages between direct and indirect property performances (Newell and Chau, 1996). One special characteristic of the Hong Kong real estate market is its connection with mainland China. The economic growth of China has a direct influence on the commercial real estate market in Hong Kong (Leung and Tang, 2015), and the influence of Chinese outward real estate investment (Li et al., 2020) and the Guangzhou–Shenzhen–Hong Kong Express Rail Link (Bao and Mok, 2020) on the Hong Kong real estate market has also been examined in recent studies. In regard to commercial real estate, excess returns (Chau and Brown, 1997), retail rents (Tay et al., 1999; Ooi et al., 2007) and office vacancy rates (Chau and Wong, 2016) have also received attention from researchers.

In regard to the real estate price and returns in Hong Kong, at the asset level, housing attributes (Choy et al., 2012) and local characteristics, such as feng shui (Choy et al., 2007), have been proven to have an important influence on housing prices. Quantile regression estimates have also been applied to model housing prices at the micro level (Mak et al., 2009). At the city level, a real estate index was built in early research (Chau et al., 2005), and an autoregressive moving average (ARMA) model has been applied to forecast real estate prices (Raymond, 1997). Investor sentiment (Lam and Hui, 2018) and political factors (He et al., 1998; Chau, 1997) have been proven to influence real estate prices and returns.

As this review section shows, there is limited research that models residential and commercial real estate returns at the city level. In this paper, we apply a dynamic Gordon growth model to the Hong Kong real estate market. We measure the returns of housing and commercial real estate and identify their determinants. Our research adds information on developments in this market in recent days.

3. Method

The dynamic Gordon model ties the worth of an asset to the expected value of the future payoff stream that is accrued to the asset, and has been widely used in the literature on finance (Campbell and Shiller, 1988) and exchange rates (Engel and West, 2005).

In the real estate market, Campbell et al. (2009) apply a dynamic Gordon growth model to the US housing market at the national and city levels. They find that housing premia are forecastable, which largely account for rent-price ratio volatility at the national and local levels, and that covariances among the real interest rate, rent growth and housing premia dampen fluctuations in rent-price ratios. Lai and Van Order (2017) apply this model to the US housing market and find that the long-run housing prices in different cities are largely explained by the same fundamentals. Kim and Lim (2016) analyze data on housing prices and rents in South Korea from 1987 to 2013 and find that housing prices from 2007 to 2014 are driven by classic self-fulfilling-expectation bubble dynamics. Liu et al. (2017) apply this model to the four largest cities in China. Compared to expected returns or expected rent growth rates, rational bubbles contribute more directly to fluctuations to the price-rent ratio. To the best of our knowledge, this model has not been applied to research on the Hong Kong real estate market. We provide detailed information on the model in the following.

The investment returns of real estate in one period are calculated as follows:

$$(P_{t+1} + R_{t+1})/P_t \tag{1}$$

where P is the real estate price and R is real estate rents. We rewrite the model by using a log-linear approximation to obtain the following:

$$log(R_t\ /P_t) \equiv r_t - p_t \tag{2}$$

Following Campbell and Davis (2009), we obtain Eq. 3, which shows that the log value of the rent-price ratio at date t is equal to the expected net present value of all future real estate return rates and real estate rent growth rates.

$$\begin{aligned} r_t - p_t &= k + E_t\left[\sum_{j=0}^{\infty} \rho^j\, \tau_{t+1+j} - \sum_{j=0}^{\infty} \rho^j\, \Delta r_{t+1+j}\right] \\ \rho &= (1 + e^{\underline{r-p}})^{-1} \\ k &= (1-\rho)^{-1}\left[ln\,(\rho)\ + (1-\rho)\ln\left(\frac{1}{\rho} - 1\right)\right] \end{aligned} \tag{3}$$

In Eq. 3, τ is the log of real estate investment returns, r is the log of real estate rents, ρ is a discount factor related to the average of rent-price ratio, written as $e^{\underline{r-p}}$ in Eq. 3 (please see Campbell et al. 2009), and k is a constant. We define φ as real estate returns and i as the real risk-free interest rate. We obtain the investment premium π for that period, which is calculated with Eq. 4.

$$\pi_t = \varphi_t - i_t \tag{4}$$

Then, the log rent-price ratio is the sum of three components related to the expected present value of future real risk-free interest rates, housing premia, and rent growth.

$$r_t - p_t = k + E_t \sum_{j=0}^{\infty} \rho^j i_{t+j+1} + E_t \sum_{j=0}^{\infty} \rho^j \pi_{t+j+1} - E_t \sum_{j=0}^{\infty} \rho^j \Delta r_{t+j+1} \quad (5)$$

or

$$r_t - p_t = k + \tau_t + \varphi_t - \omega_t \quad (6)$$

In Eq. 6, τ_t, φ_t, and ω_t represent investor expectations of the present value of interest rates, premia and rent growth.

$$\tau_t = E_t \sum_{j=0}^{\infty} \rho^j i_{t+1+j}$$
$$\varphi_t = E_t \sum_{j=0}^{\infty} \rho^j \pi_{t+1+j} \quad (7)$$
$$\omega_t = E_t \sum_{j=0}^{\infty} \rho^j \Delta r_{t+1+j}$$

Eq. 6 is the dynamic version of the classic Gordon growth model developed by Campbell and Shiller (1988), who apply the model to analyze the stock market.

Next, we determine how we implement the dynamic Gordon growth model.

First, we calculate the total return in each period as follows:

$$r_t = (P_t + R_t - P_{t-1})/P_{t-1} \quad (8)$$

We use the Sharpe ratio to evaluate the performance of real estate as follows:

$$S_p = \frac{\overline{r}_p - \overline{r}_f}{\sigma_p} \quad (9)$$

where $\overline{r}_p$ is real estate returns, $\overline{r}_f$ is the risk-free interest rate, and σ_p is the variance of the real estate returns. The Sharpe ratio shows the expected amount of returns that can be obtained for each unit of risk. A higher Sharpe ratio indicates better portfolio performance.

We obtain investment premia π based on Eq. 4, and choose the 10-year government bond rate as the real risk-free interest rate, which is i.

$$\pi_t = r_t - i_t \quad (10)$$

We use an ARDL model to identify real estate return determinants; this model allows us to introduce lags of both the dependent and explanatory variables as regressors, and has also been used to forecast real estate returns in previous research (Mintah et al., 2020). A similar model has also been applied to the US and Chinese housing markets (Lai and Van Order, 2018). As the ARDL model requires all variables to be stationary, we use the first-order difference value of the economic variables in the model.

$$\varphi_t = \alpha_0 + \sum_{i=1}^{n} \beta_{0i}\, \varphi_{t-1} + \sum_{i=1}^{n} \beta_{1i}\, \Delta Bond_t + \sum_{i=1}^{n} \beta_{2i}\, \Delta GDP_t + \sum_{i=1}^{n} \beta_{3i}\, \Delta FDI_t + \mu_t \tag{11}$$

Eq. 10 shows that real estate returns are determined by their lagged value and changes in the government bond rate, GDP and FDI. Campbell et al. (2009) choose risk-free rate, income growth, unemployment rate and population growth as independent variables to forecast housing premia and rent growth. We run the model with unemployment rate and population growth and find that these two variables do not have much influence on real estate returns. Previous research has shown that GDP is a key variable in determining commercial real estate returns (Kohlert, 2010). Apart from GDP, FDI has also been taken into consideration for commercial real estate analysis in previous research (Ke and White, 2009; White and Ke, 2014), so we add this variable to the model as well.

Eq. 6 shows that the real estate rent-price ratio is determined by the expected value of the interest rate, investment premia and rent growth. We use a first-order vector autoregression model (VAR) model to determine why the rent-price ratio declines in these years.

$$Ratio_t = \alpha Ratio_{t-1} + \beta_4 \tau_{t-1} + \beta_5 \varphi_{t-1} + \beta_6 \omega_{t-1} \tag{12}$$

where the ratio is the rent-price ratio of each real estate property. Eq. 11 is very close to the cap rate estimation model of Chervachidze and Wheaton (2013).

Finally, we determine how we obtain the expected values of risk-free interest rates τ_t, investment premia φ_t and rent growth ω_t. In brief, we estimate the forecasting equation for each kind of return, and take the forecasted value as the expected value.

We use the ARMA model to forecast the risk-free rate (10-year government bond yield). The ARDL model is applied to forecast risk premia and rent growth, as there is a close connection among risk-free interest rates τ_t, investment premia φ_t and rent growth ω_t (Campbell et al., 2009). We also add two other variables to the forecast model.

$$i_t = \alpha_1 + \sum_{i=1}^{p} \emptyset_i \, i_{t-i} + \sum_{j=1}^{q} \theta_j \, \varepsilon_{t-j} + \varepsilon_t \tag{13}$$

where α_1 is a constant term, $\emptyset_i$ is the autoregressive coefficient, and θ_j is the moving average coefficient. i_{t-i} is the risk-free returns in a former period, and ε_t is the error term at time *t*. *p* and *q* are the results of the autoregressive and moving average models, respectively.

$$\pi_t = \alpha_2 + \sum_{i=1}^{n} \beta_{7i} \, \pi_{t-1} + \sum_{i=1}^{n} \beta_{8i} \, \omega_t + \sum_{i=1}^{n} \beta_{9i} \, \Delta i_t + \sum_{i=1}^{n} \beta_{10i} \, \Delta GDP_t + \sum_{i=1}^{n} \beta_{11i} \, \Delta FDI_t + \mu_t \tag{14}$$

$$\omega_t = \alpha_3 + \sum_{i=1}^{n} \beta_{12i} \, \omega_{t-1} + \sum_{i=1}^{n} \beta_{13i} \, \pi_t + \sum_{i=1}^{n} \beta_{14i} \, \Delta i_t + \sum_{i=1}^{n} \beta_{15i} \, \Delta GDP_t + \sum_{i=1}^{n} \beta_{16i} \, \Delta FDI_t + \mu_t \tag{15}$$

4. Data

4.1 Data Sources and Descriptive Statistics

In this research, we analyze quarterly data on Hong Kong real estate prices and other economic indicators from 1999Q1 to 2020Q3, with 87 observations for each variable. We consider four kinds of real estate assets in our research: housing, office, retail and factory properties. We calculate the rent-price ratio and the logarithm of these variables to obtain the Ratio-Housing, Ratio-Office, Ratio-Retail, Ratio-Factories indicators.

We obtain real estate price and rent data from the Hong Kong Rating and Valuation Department website[1]. The seasonally adjusted GDP growth rate (GDP) and log FDI data (FDI) are from the Hong Kong statistical office website[2], and 10-year government bond yields of the Hong Kong government (Bond) are from the Hong Kong Monetary Authority website[3].

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[1] https://www.rvd.gov.hk/mobile/en/index.html

[2] https://www.censtatd.gov.hk/home/

[3] https://www.hkma.gov.hk/eng

Table 1 Descriptive Statistics of the Data

	Mean	Median	Max.	Min.	Std. Dev.	Obs.
BOND	3.2486	2.5351	7.6877	0.5239	1.9360	87
GDP	0.8023	0.9000	6.1000	-5.5000	1.5250	87
FDI	2.1463	2.0550	2.8870	1.4800	0.4433	87
Ratio-Housing	1.3057	1.3227	1.7536	0.7791	0.3007	87
Ratio-Office	1.5081	1.4649	2.1558	1.0493	0.3370	87
Ratio-Retail	1.2568	1.2288	2.0230	0.7187	0.4717	87
Ratio-Factories	1.6360	1.5824	2.5688	0.9320	0.6060	87

4.2 Preliminary Test

To analyze the time series of these variables, we use the augmented Dickey-Fuller (ADF) test to determine if the real estate price series are stationary. The results appear in Table 2. The table shows that the GDP growth rate (GDP) and the rate of return on the four kinds of real estate are stationary and that the government bond rate and FDI data are not stationary but their first-order difference variables are stationary. Thus, we use DBond and DFDI in the ARDL model.

Table 2 Results of ADF Test

	t-Statistic	Prob.		*t*-Statistic	Prob.
Return-Housing	-5.6286	0.0000			
Return-Office	-4.8222	0.0001			
Return-Retail	-4.7629	0.0002			
Return-Factories	-4.0954	0.0017			
Bond	-1.5822	0.4873	DBond	-8.0135	0.0000
GDP	-7.2621	0.0000			
FDI	-0.7782	0.8200	DFDI	-3.1051	0.0300

5. Results

5.1 Real Estate Returns and Determinants

We estimate the total returns and Sharpe ratio of the four kinds of real estate according to Eqs. 8 and 9. The results show that factories have the highest returns among these four kinds of real estate, with average quarterly returns of 4.08%, and also have the largest Sharpe ratio. Research on the securitized real estate market shows similar results; industrial REITs in Japan have a higher return Sharpe ratio than housing, office, and retail properties (Lin et al., 2019). However, unlike Japanese REITs, housing returns in Hong Kong are lower than those on office and retail properties, perhaps because investors choose more profitable rental housing when building a REIT portfolio (Aveline-Dubach, 2020). Table 4 gives the correlations across the different real estate types. The table shows that the returns of these four kinds of real estate are highly correlated, which suggests that they might be influenced by similar factors. We identify their determinants in the following.

Table 3 Quarterly Returns of Four Kinds of Real Estate in Hong Kong

		Housing	Office	Retail	Factory
Total Return	Mean	2.6243	3.1671	3.0144	4.0783
	Std. Dev.	4.6387	6.4092	4.7866	5.0626
Investment Premium	Mean	1.8238	2.3665	2.2139	3.2777
	Std. Dev	4.7929	6.4565	4.8345	5.1124
Rent Growth	Mean	0.7264	0.9931	0.6562	0.8023
	Std. Dev.	3.2638	3.3419	2.0820	2.4092
Sharpe Ratio		0.3932	0.3692	0.4625	0.6474

Table 4 Return Correlations Across Different Real Estate Types in Hong Kong

	Return-Housing	Return-Office	Return-Retail	Return-Factories
Return-Housing	1.0000			
Return-Office	0.8088	1.0000		
Return-Retail	0.7887	0.8230	1.0000	
Return-Factories	0.7279	0.7730	0.7908	1.0000

We estimate Eq. 11 to evaluate what factors determine real estate returns. We give the actual and forecast real estate returns in Figure 1, which shows that our model captures the trend of real estate returns well. Table 5 shows that all real estate returns have a certain degree of autocorrelation and that changes in the government bond rate have little influence on real estate returns. The GDP growth rate is an important factor that determines the returns of housing, office and factory properties. While retail returns are influenced by FDI changes, this variable also has a positive influence on housing returns. The results show that residential and commercial real estate have similar determinants, the total returns of office and factory properties are mainly influenced by the GDP growth rate, and retail returns are influenced by FDI changes, while housing returns are determined by both the GDP and FDI growth rates. Our research results align with findings in previous research that GDP is of vital importance to real estate returns (Kohlert, 2010; Akinsomi et al., 2018). Previous research shows that FDI in real estate does not cause property price appreciations in Organisation for Economic Co-operation and Development (OECD) countries (Gholipour et al., 2014). However, we find that FDI changes have a direct influence on housing and retail returns in Hong Kong.

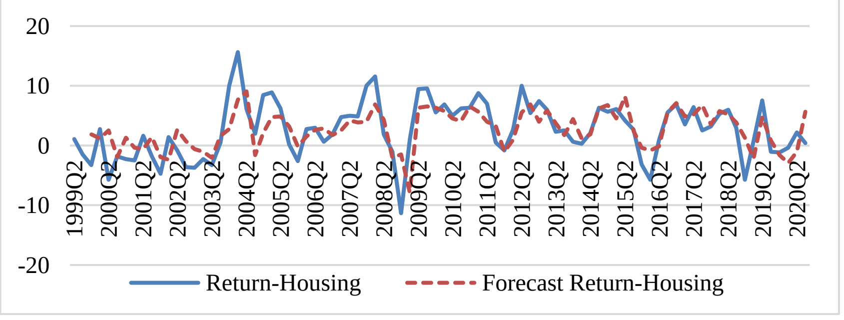
Table 5 Real Estate Return Determinants in Hong Kong

	Return-Housing	Return-Office	Return-Retail	Return-Factories
Return(-1)	0.5426***	0.4154***	0.7845***	0.5953***
Return(-2)	-0.2769***		-0.2906*	
D(Bond)	-0.2057	0.2257	0.5206	1.2693
GDP	0.5918***	1.0789***	0.047	0.5365***
GDP(-1)	-0.443**	-0.76**		-0.3861
DFDF	0.1196	-0.1554	-0.1601	-0.019
DFDI(-1)	0.3646***		0.3733***	
C	-0.8028	0.3624	1.7582	1.6541
@TREND	0.0362**	0.0168	-0.0146	-0.0062
Adjusted R^2	0.4089	0.3814	0.4314	0.5198
AIC	5.4949	6.1629	5.5155	5.3999
SC	5.7553	6.3641	5.747	5.6011
Selected Model	ARDL(2,0,1,1)	ARDL(1,0,1,0)	ARDL(2,0,0,1)	ARDL(1,0,1,0)
Observations	84	85	84	85

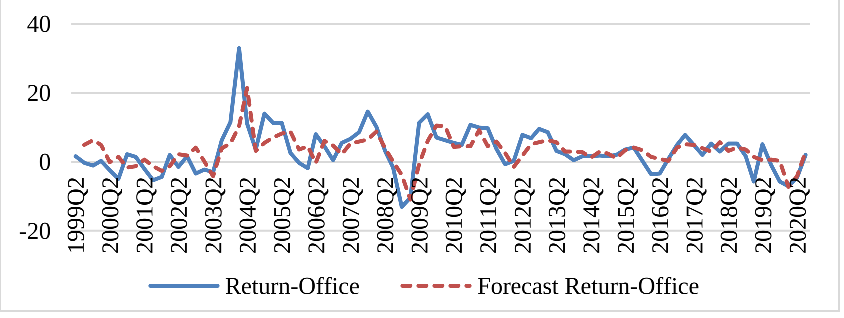
Notes: *, ** and *** indicate significance at the 10%, 5% and 1% levels; AIC denotes Akaike information criterion; and SC denotes Schwartz criterion

Figure 1 Real Estate Returns and Forecast Values in Hong Kong

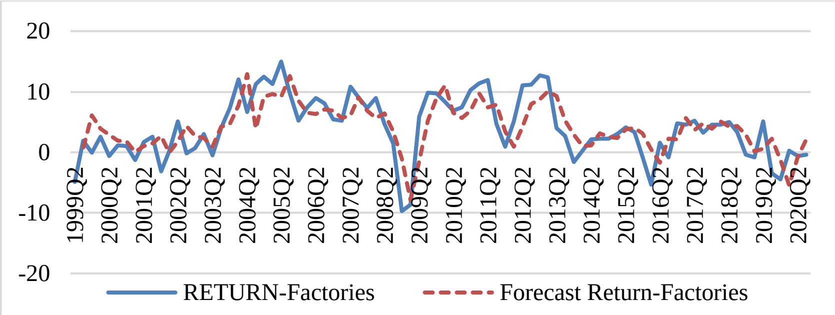
Panel A: Housing



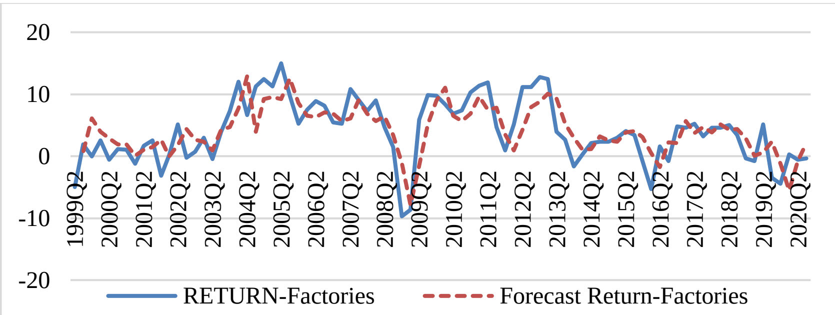
Panel B: Office



Panel C: Retail



Panel D: Factories



We further analyze the determinants of three different kinds of real estate returns: the risk-free rate, premia and rent growth. In the appendix, we present the estimation results of Eqs. 13, 14 and 15. It turns out that the risk-free rate (10-year government bond rate) follows an AR(4) process, and the adjusted R^2 is 0.956. We use the forecast value of the risk-free rate, real estate premia and rent growth as the expected values of these three kinds of real estate returns in Eq. 7. The stationarity test of each variable is also given in the appendix.

Table 9 shows that housing and factory rents have a positive influence on premia. Table 10 shows that housing and factory premia also directly influence rents. This connection between premia and rents has also been proven in the US housing market (Campbell et al., 2009). Our research suggests that there is an integration of premia and rents on factory properties. In regard to office premia and rents, the GDP growth rate is the key variable. Research on London shows that GDP growth can capture the risk of downturns in the office market (Lizieri et al., 2012). Our research shows that GDP growth is of vital importance to both office rents and premia.

5.2 Changes in the Rent-Price Ratio

In the appendix, we present the cointegration test results for real estate returns and expected risk-free rates, real estate premia, and rent growth. In all of the real estate markets, at least one cointegration relationship exists at the 0.05 level. We estimate Eq. 12 to determine why the rent-price ratio of real estate has continued to decline in the last 20 years. Table 16 shows that the expected value of the risk-free rate is the key factor that determines the rent-price ratio. Previous research on the US housing market shows that the real interest rate is the key variable that determines rent-price ratio changes (Lai and Van Order, 2017). Our research further supports this finding. Figure 2 shows the real estate rent-price ratio and 10-year government bond rate over the last 20 years.

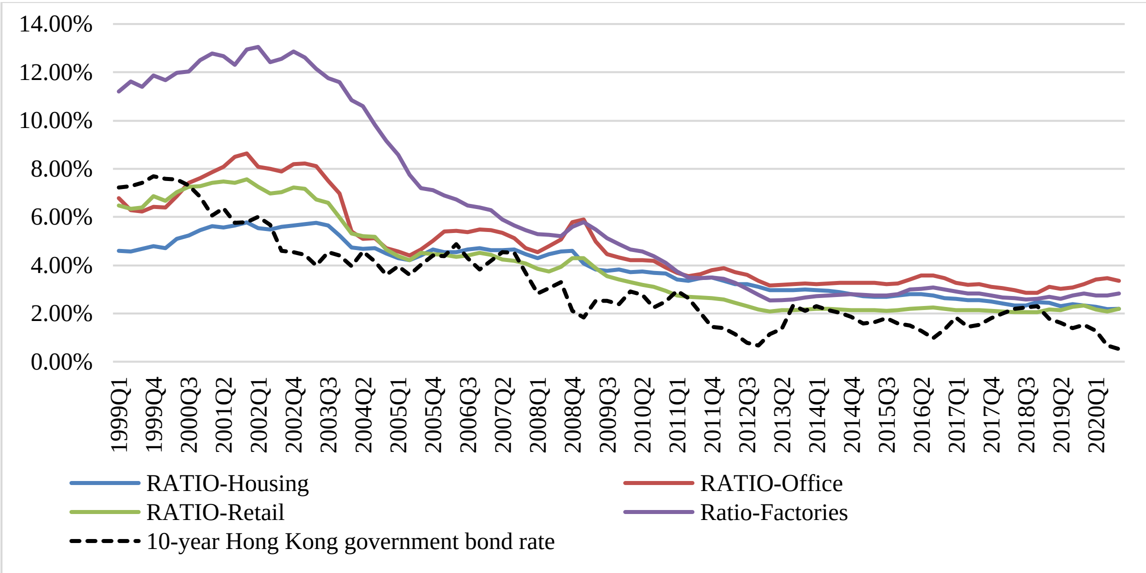
Research on the Amsterdam rent market shows that housing rents are highly influenced by economic activity (Eichholtz et al., 2012). Our research also finds that the real estate rent growth rate is very close to the GDP growth rate. Table 4 shows that the average quarterly growth rate of housing is 0.762%, which is very close to the GDP growth rate of 0.802%; however, declines in the risk-free rate cause an increase in housing valuations, so housing prices keep increasing. In regard to commercial real estate, the story is very similar, and we believe that the decline in the risk-free rate in Hong Kong is the main reason that the real estate price-rent ratio has increased from 20 to 40 in the last twenty years.

Table 6 Results of VAR model

	RATIO-Housing	RATIO-Office	RATIO-Retail	RATIO-Factories
RATIO(-1)	0.9460	0.8723	0.8873	0.9169
	[46.5488]	[24.6457]	[43.0302]	[65.4779]
FRISKFREE(-1)	0.0574	0.0957	0.1061	0.0863
	[4.2628]	[3.8117]	[5.1781]	[5.1781]
FPREMIA(-1)	0.0028	-0.0032	0.0040	0.0003
	[1.7917]	[-2.3299]	[2.0444]	[0.2417]
FRENT(-1)	-0.0002	0.0036	-0.0107	-0.0101
	[-0.0807]	[1.4114]	[-2.7164]	[-3.6842]
C	0.0098	0.1104	0.0390	0.0558
	[0.5007]	[2.8788]	[3.0080]	[4.2433]
Adjusted R^2	0.9902	0.9785	0.9946	0.9975
Log-Likelihood	175.7257	134.8138	165.6735	177.5300
AIC	-4.1139	-3.1280	-3.8717	-4.1573
SC	-3.9682	-2.9823	-3.7259	-4.0116
Observations	83	83	83	83

Notes: *t*-statistics in []; AIC denotes Akaike information criterion, and SC denotes Schwartz criterion

Figure 2 Real Estate Rent-Price Ratio and Government Bond Rate in Hong Kong



6. Conclusion and Discussion

We apply a dynamic Gordon growth model to the Hong Kong real estate market in this paper and analyze quarterly data on four kinds of real estate—housing, office, retail, and factory properties—for 1999 to 2020. Our main findings are as follows.

(1) Factories have the highest total returns among the four kinds of real estate; average quarterly returns are 4.08%, and the Sharpe ratio is larger than those of the other real estate types. Average quarterly housing returns are 2.62%. The total returns of these four kinds of real estate are highly correlated.

(2) The results of the ARDL model show that all real estate returns have a certain degree of autocorrelation, and government bond rate changes have little influence on real estate returns. The GDP growth rate is the key variable that determines real estate returns, while FDI changes also influence housing and retail returns.

(3) The expected value of the risk-free rate is the key factor that determines the rent-price ratio. The increase in the real estate rent rate is very close to the GDP growth rate, and the decline in the risk-free rate has caused an increase in the valuation of housing, so housing prices keep increasing.

Our results show that the decline in the risk-free rate in Hong Kong is the main reason that the real estate price-rent ratio has increased from 20 to 40 in the last twenty years. Our research shows that housing prices in Hong Kong are highly influenced by the ever-declining government bond rate. Wetzstein (2017) points out that global housing affordability crises after the global financial crisis have often been triggered by cheap credit. Our research shows how this mechanism works: namely, a decline in the risk-free rate in global cities may increase the valuation of housing, and rising housing prices further increase housing costs. There are two questions to be answered in the coming days. First, will housing prices adjust when the interest rate increases? Second, what can we do now to improve the housing conditions of ordinary people in Hong Kong?

We believe that the housing market will adjust to risk-free rate changes in the future; however, this may not improve the affordability of housing directly. As a small open economy, Hong Kong uses a linked exchange system, and the Hong Kong dollar exchange rate remains stable within a band of HK$7.75–7.85 to one US dollar, so the Hong Kong government rate is also heavily influenced by the US Treasury bill rate. This might cause some difficulty in the adjustment of the risk-free rate for the housing market. In regard to housing conditions, the mass supply of affordable housing could be an option; however, the strict urban planning system makes it difficult to increase housing beyond a certain amount. The price of newly supplied housing may also be too high for ordinary people, so decentralization might be an alternative choice, to encourage some people to move to mainland China. In this way, housing demand may be reduced, and the housing conditions for remaining residents might be improved.

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Appendices

Appendix A Fisk-Free Rate Forecasted Model

Variable	Coefficient	t-Statistic	Prob.
C	0.8931	1.7581	0.0825
AR(1)	1.1045	10.0271	0.0000
AR(2)	-0.3137	-2.0237	0.0463
AR(3)	0.4167	2.7171	0.0081
AR(4)	-0.2203	-2.0991	0.0389
SIGMASQ	0.0097	6.3143	0.0000
Adjusted R-squared	0.9556	AIC	-1.6148
Log likelihood	76.2448	SC	-1.4448

Notes: AIC denotes Akaike information criterion and SC denotes Schwartz criterion

Appendix B Stationary Test of Real Estate Return and Premia

	t-Statistic	Prob.
Premia-Housing	-5.3774	0.0000
Premia-Office	-4.7798	0.0002
Premia-Retail	-4.7229	0.0002
Premia-Factories	-4.1083	0.0016
Rent-Housing	-6.0676	0.0000
Rent-Office	-4.2628	0.0010
Rent-Retail	-4.6162	0.0003
Premia-Factories	-4.7002	0.0002

Appendix C Results of Real Estate Premia Estimations

	Premia-Housing	Premia-Office	Premia-Retail	Premia-Factories
Premia(-1)	0.3379***	0.4133***	0.6353***	0.4803***
Premia(-2)			-0.2643*	
D(Riskfree)	-2.2459	3.9787	0.6547	3.089
Rent	0.8454***	0.2099	0.5156*	0.5528***
Rent(-1)	-0.6292***			
GDP	0.4223	1.6722***	0.3797	0.8182**
GDP(-1)		0.6489*		
GDP(-2)		0.234		
GDP(-3)		-1.4692**		
DFDF	0.0776	-0.1954	-0.2326*	-0.0927
DFDI(-1)	0.2857***			
C	-1.503	0.1414	1.4759	1.5083
@TREND	0.0377***	0.0169	-0.0078	-0.0143
Adjusted R^2	0.5786	0.5194	0.4359	0.6024
AIC	5.2161	5.9629	5.5233	5.2223
SC	5.4747	6.2522	5.7549	5.4235
Selected Model	ARDL(1,0, 1,0, 1)	ARDL(1,0,0,3,0)	ARDL(2,0,0,0,0)	ARDL(1,0,0,0,0)
Observations	85	84	84	85

Notes: **, ** and *** indicate significance at the 10%, 5% and 1% level; AIC denotes Akaike information criterion; and SC denotes Schwartz criterion

Appendix D Results of Real Estate Rent Estimations

	Rent-Housing	Rent-Office	Rent-Retail	Rent-Factories
Rent(-1)	0.4560***	0.6386***	0.2044**	0.3260***
Rent(-2)				
D(Riskfree)	0.7363	0.7169	-0.8229	0.8483
Premia	0.2438***	0.0831**	0.0305	0.1298***
Premia(-1)	0.2486***		0.1161***	
Premia(-2)	-0.1767***			
GDP	0.3359**	0.251	0.4954***	0.3756***
GDP(-1)		0.7537***	0.3985***	0.3924***
DFDI	0.0276	0.0300	0.0402	0.0141
DFDI(-1)				
C	-0.4665	-1.2481**	-1.4397***	-1.9012***
@TREND	-0.0002	0.0152*	0.0201***	0.0332***
Adjusted R^2	0.7584	0.7882	0.652	0.6565
AIC	3.9041	3.7275	3.3522	3.5782
SC	4.1645	3.9574	3.6109	3.8081
Selected Model	ARDL(1,0, 2,0,0)	ARDL(1,0,0, 1,0)	ARDL(1,0, 1, 1,0)	ARDL(1,0,0, 1,0)
Observations	84	85	85	85

Notes: *, ** and *** indicate significance at the 10%, 5% and 1% levels; AIC denotes Akaike information criterion; and SC denotes Schwartz criterion

Appendix E Cointegration Test Results of Real Estate Return and Expected Risk-free Rate, Real Estate Premia, and Rent Growth

	Housing	Office	Retail	Factories
None *	129.1177***	134.1167***	191.0053***	127.5024***
At most 1 *	67.6189***	34.3242**	59.1755***	45.1356***
At most 2 *	22.953***	15.0955*	28.9334***	22.1298***
At most 3	0.5172	3.0364*	3.158*	3.8220*
Number of cointegrating equation(s) at 5% level	3	2	3	3

Note: *, ** and *** indicate significance at the 10%, 5% and 1% levels.