The Interest Rate Spread and Real Estate Returns
---- Evidence from Hong Kong

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Abstract

There is a great deal of research has focused on the links between real estate market returns and macroeconomic factors such as interest rates, inflation rates, and gross domestic production. Though the interest and inflation rates' influences on real estate and other asset prices had been discovered and investigated in previous literature, no study has formally addressed the effects of interest rate spread, which is related to both interest rate and expected inflation. This study constructed an alternative real estate pricing model based on Gordon Growth Model and identifies the rental income, interest rate, interest rate spread and expected rental income growth as the fundamental drivers that systematically affect real estate returns. The empirical investigation is conducted in commercial real estate sector, which is known as the income-producing property sector. The findings of a consistently significant risk premium on interest rate spread has vital indication for the vast previous literature that has examined the real estate returns, because it suggests that prior findings of significant abnormal returns that based on observed inflation rate have ignored the investors' expected inflation and are potentially biased by an omitted variables problem. The empirical results of this study have important contributions on asset pricing that involves the predictability of real estate returns based on macroeconomic factors.

Keywords: asset's price, interest rate spread, expected rental growth rate, DCF, cost of capital, Gordon Growth Model

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INTRODUCTION

The real estate market is an important part of both the nation's economy and the investors' portfolios. And there is a great deal of work focusing on the relationship between real estate market and macroeconomic events, such as the fluctuations in interest rates, inflation rates, and industrial production. Among those macroeconomic factors, the interest rate is the most volatile one and thus is regarded as a vital source of risk for the asset investments. However, there's surprisingly little research being performed on the impact of interest rate effects on the real estate asset pricing. Most of the existed ones are focused on the interest rate sensitivity of the securitized real estate return while few are investigating the co-movements of real estate asset price and the interest rate. Several pieces of work has been talking about the real estate return and interest rate, however most of them were focused on the interest rate sensitivity of real estate by considering interest rate as one of the risk factors in the multi-factor pricing models. Among them, few of empirical studies concerning the term structure of interest rate, except Ling and Naranjo(1997) and Sing(2004)'s work. However they had not explained why the interest rate spread had explanatory power on the price movements of real estate asset yet.

The existed asset pricing theories in finance area, i.e. CAPM and APT, are mainly for valuing the equity which is frequently traded. The common point of both theories is the concerns of risk factors and beta. As the transaction needs to be frequent enough for estimating the beta while the selection of risk factors is not easy, neither theory is capable for the long-term holding asset, such as the property. Contrary to CAPM and APT, the DCF model, which discounts the future income into the present value of the asset, is more capable for pricing the long-term holding asset with transaction cost (i.e. the real estate asset). As the asset is held based on its income-producing feature, the income and the cost for holding it become the key factor to explain the asset's value. For real estate asset, the income refers to the rental income while the cost of capital should be market driven, expected rate of return that the market requires to commit capital to the property. Through the cost of capital, the property price is connected with the expected rate of return, which is usually equal to the government bond yield (interest rate). Thus in this paper, the interest rate is directly related to the property price movement instead of being one of the macroeconomic dynamics.

This study aims at exploring how the term structure of interest rate explains the property price change. In Xu and Yiu(2009)'s earlier work, we constructed a simple model to demonstrate the property price change in the context of its discounted future income and interest rate. Notwithstanding its simplicity, the expected earnings growth model makes it possible to explain the relationship between real estate and capital markets in a mathematically logical method that provided a first view of the issues involved. This study is in some ways an application to the model. The expected earnings growth model, based on DCF model and Gordon Growth Model, for real estate asset pricing is employed in this paper. Thus the price of the real estate asset is expressed by the present rental income and interest rate, the expected growth of future rental incomes and interest rate spread. This paper extends the existed findings of the relationship between the term structure of interest rate and the price of real estate asset by investigating the investors' expectations on both future interest rate and earnings of the real estate asset. The empirical work is induced in Hong Kong commercial real estate market, which is regarded as one of the most prosperous ones. As the multi-co-linearity of the price and rental indices movements of the property, the regression tests are conducted through two steps. Firstly, we estimate the rental changes based on office rental dynamics model from previous literature; and then the estimated rental movement is put into the commercial real estate return model as one of the fundamental factors.

This paper is organized into six sections. Section 1 provides the motivation and objectives of the study. Section 2 reviews the real estate literature on interest rate sensitivity and term structure. Section 3 describes the conceptual framework, which is mainly based on Discounted Cash Flow (DCF) model and Gordon Growth Model (GGM). The empirical methodologies, which include data analysis, testable hypotheses, and two-stage least square regression models, are explained in Section 4. The empirical results of the interest yields spread that explain the price movements of direct real estate asset are discussed in Section 5. Section 6 concludes the paper with highlights of the implications of the empirical findings.

LITERATURE REVIEW

Interest Rate Risk

The interest rate is volatile with both economic and financial market movements, thus it represents an important source of risk for the asset investment. One of the traditional streams of traditional interest rate research had focused on its effects on the inflation rate. Fisher(1930)'s pointed the one-period nominal interest rate is the equilibrium real return plus the expected inflation rate under the condition of perfect foresight and well-functioning capital market. Several studies supported Fisher's proposition and extensively tested the relationship between interest rate and inflation. Among them, some are focused on the investigation of the interest rate determinants and combine the Fisherian analysis with their model, thus confirm the relationship between interest rate and the inflation rate posited in Fisher(1930)'s research. For instance, Feldstein and Eckstein(1970) constructed a model of interest rate determinants by integrating Keynes's liquidity preference theory with Fisher's theory of interest. Both Yohe and Karnosky(1969), Sargent(1969) and Anderson and Carlson(1970) incorporated the Fisherian distributed lag measure of expected inflation in their work to investigate the determinants of the interest rate. Yohe and Karnosky(1969) focused on the change in expected inflation while Sargent(1969) and Anderson and Carlson(1970) constructed a loan-able funds model to confirm Fisher's views about the interest rates. Though different price variables were modified in different studies, similar findings were concluded.

Contrary to the Fisherian view, the Gibson's Paradox proposed that there is a positive relationship between the nominal interest rate and the level of commodity prices, rather than its rate of change (inflation rate). The proposition was probably first noticed by Tooke(1844) and was named by Keynes(1930). It was called a "Paradox" because the absence of theoretical reason to explain the indication found by the data and the reasons which expect there should be no relationship between level interest rate and price level. Nonetheless, several explanations had been advanced for the *positive correlation*. Keynes(1930) explained the relationship in the context of the demand of loans. By generalizing Keynes's explanation, Sargent(1973) empirically found that the positive correlation of interest rate and price is caused by the changes of the aggregate supply and demand. Similar empirical literature had been produced to make the proposition replete with empirical evidences. Harley(1977) found evidence in Great Britain during the period from 1873 to 1913 to confirm the positive relationship between interest rate and prices through the expected inflation. Shiller and Siegel(1977) even claimed that they had rejected Fisher's hypothesis by finding the correlation between interest rates and prices persisting for almost a quarter of a millennium. They related this correlation to the governments' characteristic behavior during the World War I and the unanticipated inflation. Also Friedman and Schwartz(1982) presented empirical evidence that interest rates can positively affect the expected inflation during sub period. During 1980s, the research on the informative features of interest rate did not stop. Sims(1980)'s study might be the provocation on this topic. He found that M1 money stock could explain 37% of the future variance of industrial production at a horizon of 48 month through VAR system. There is another interesting findings in Sims(1980)'s work that when commercial paper rate was added to the VAR model, almost all predictive power of M1 for output was *absorbed* by the interest rate. Litterman and Weiss(1985) gained similar results with Sims while the commercial paper was replaced by the Treasury bill. On one hand, both Sims(1980) and Litterman and Weiss(1985) concluded that the predictive power of monetary stock was weaker and can be instead by the interest rate. On the other hand, some other researchers (i.e. McCallum(1983) and Bernanke and Blinder(1989)) argued that the interest rate might be a better indicator than money stock about the future real economy, but it cannot be evidence to against the predictive power of monetary policy because the interest rate is most closely associated with the policy.

Besides, the research of the interest rate's effects also spread to the stock markets. The first try might be Schumpeter(1912)'s work on the linkage between stock market and macro-economic variables. Then Merton(1973) not only deduced an inter-temporal capital asset pricing model, but also suggested that the market interest rates may act as one of the instrumental variables, which would explain the shifts of future investment opportunity. During the recent decades, numbers of researchers explored further on this issue (i.e. Fama(1981), Poterba and Summers(1988), Hamao(1988), Fama(1990), Chen(1991), MacDonald and Power(1991), Thornton(1993), Kaneko and Lee(1995), Cheung and Ng(1998), Darrat and Dickens(1999) and so on). In both Chan et al.(1985) and Chen et al.(1986)'s investigations, the interest rate was studied as one of the observable variables at the macro level for equity pricing. Sweeney and Warga(1986) empirically found that the interest rate was priced as the risk premium of its changes in stock market, especially significant for those firms in utility industries. Also Choi et al.(1992), Turtle et al.(1994), Song(1994) and Elyasiani and Mansur(1998) concluded that interest risk is one of the priced variable for the stocks. Not only the developed market but also the emerging market (for example, Mookherjee and Yu(1997) and Maysami and Koh(2000) for Singapore, Kwon and Shin(1999) for South Korea, Ibrahim(1999) for Malaysia, Charkravarty(2005) for India, Saleem(2007) and Ihsan *et al.*(2007) for Pakistani) had been investigated on the linkage between interest rate and the stock return/price. The findings are consistent on the issue that the interest rate risk is priced on stock's price, or say the interest rate has some impact on the stock's return.

As one of the asset investment instruments, the real estate had been investigated in the context of the interest rate influence as well. The previous work on this area is not large scale or diversified. Most of them are focused primarily on the interest rate sensitivity of real estate. In the research, the sensitivity is usually measured by the beta coefficient of the interest rate and estimated by the regression function of ex post real estate returns/prices on several explanatory macroeconomic variables (including interest rate). For instance, Liu and Mei(1992) investigated the predictability of the equity REIT's return by taking interest rate as one of the sources of time-varying risk premiums based on a multifactor latent variable model. Similar works had been done and confirmed the hypothesis that the interest rate change was one of the risk factor for real estate investment and the pricing of the real estate asset contained the premium from its movements. Also there are some papers focused on the relationship between REIT's return/price and movements of interest rate. Though the previous findings are conflicting, the interest rate's impacts on REIT's return/price are confirmed. For instance, Chen and Tzang(1988) found that equity REITs were not sensitive to interest rates while mortgage REITs are sensitive to it by investigating a small sample of both REITs during period of 1973—1979 and 1980—1985. In Bharati and Gupta(1992)'s work, the interest rate was regarded as one of the financial market variables to predict the future returns of mix asset (stock, bond, real estate) allocation model. As the active strategy was found to outperform the passive one, they concluded that some capital market factors affect real estate returns. Further Gyourko and Keim(1993)'s study reveal that the correlation between equity REITs and long-term interest rates were 0.43 during 1978—1990. Mueller and Pauley(1995) extended the previous work by analyzing the movement of REIT price during a whole interest rate cycle to clear the air. They found that during the rising interest rate period the relationship between REIT price and interest rate is low and negative while the prices of both REITs and real estate behaved like bond during the falling interest rate period. Therefore, the investigations on the relationship between interest rate and real estate prices are not consistent yet. And the mixed previous conclusions are the provocations for us to explore on this issue further.

Term Structure of Interest Rate

The term structure of interest rate had been playing a central role ---- both theoretically and practically in the economy. Before the research on term structure, there's a stream of studies concerning on the duration of interest rate. Macaulay(1938) explored the risk exposure of interest rate by proposing the duration as a more meaningful measure of life than its term to maturity first. Similar analyses and confirmed results were investigated by Hicks(1939) and Samuelson(1945). Hicks(1939) found that the duration was the elasticity of the financial instrument with respect to the discount factor. Later Samuelson(1945) rediscovered that the financial institutions could profit by the greater average disbursement time period of when the interest rate increased.

In line with the findings that level of interest rates was important for forecasting the economy, there are a number of papers concerning the information contained in the term structure of the interest about the future economy, real interest rate, inflation rate and the fiscal policy. Fama(1984) found that the forward Treasury bill rates could predict the correct direction of short-term rates movements through the investigation of one- to six-month T-bill rates during the period of 1959 to 1982. Mankiw and Miron(1986) used three- to six-month rates to find consistent results and attribute the predictive power to the forecast able seasonal pattern of the interest rates. Hardouvelis(1988) explored this issue across several monetary regimes and the predictive power of the term structure had increased significantly after October 1979. Stock and Watson(1989) compared a wide variety of possible leading indicators of the real economy and found the term structure of interest rates played as a vital factor. To interpret the forecasting ability of term structure of interest rate, Shiller et al.(1983) constructed a linearized model of the term structure of interest rates and concluded that the expectation theory of term structure is acceptable with proper measures of time-varying risk premiums to be introduced. Campbell(1987) and Chen(1991) argued that the term premium of interest rates had forecasting power of the market excess return by predicting the macro economy. Laurent(1988) examined the relationship between the growth in real GNP and the lags of the spread of 20-year bond rate to the federal funds rate without finding significant relationship. Estrella and Hardouvelis(1991) and Hardouvelis(1994) explored the predictive power of the term structure of interest rates on the real economy and found that the spread had more power than the short-term interest rate on forecasting the changes of future economy. In general, the yield curve tends to perform quite well in comparisons with other leading indicators, including the traditional leading indexes and their components, and other variables with potential predictive power. Indicators such as stock prices and interest rates may have similar performance to the yield curve at some horizons, but none seem to dominate the yield curve as a predictor. For instance, Dueker(1997) and Dotsey(1998) compared the yield curve with a few other variables as a leading indicator of recessions, and find generally supportive statistical evidence. Stock and Watson(2003) examined a large number of competing indicators in forecasts of output growth and find that all of them fall short of ideal properties, but that within these limitations the term structure “comes closest” to achieving those goals. During the recent decades, the predictive power of term structure of interest rate had been understood even better. Some important stylized facts have been captured based on several financially coherent models. Most of the models employed the unobserved or latent risk factors which is difficult to interpret (see Dai and Singleton(2003) for the review of literature on the constructions of those models). Later, another strand of the research is concerning a lot on the connections between latent risk factors driving the term structure dynamics and the observed macro-economic variables (i.e. Ang and Piazzesi(2003), Rudebusch and Wu(2003), Hordahl et al.(2003) and so on). Similar empirical works are plenty without divaricating findings.

The relationship between stock return/price and the term structure of interest rate also attracted lots of attentions in the previous literature. Campbell(1987) argued that both the prediction of excess return in the term structure and stock would employ same variables by deducing a simultaneous analysis of the returns of T-bills, bonds and stocks. He found the evidence to support the predictive power of term structure on excess returns of the US stocks. Campbell and Viceira(2005) further argued that the long-horizon investors’ expected excess return on long-term returns are correlated to each other. They used a return dynamics model to explore the predictability of asset returns by the commonly-used return-forecasting variables including yield spreads, interest rates, and dividend yields, and then found that all the variables had considerable effects on the portfolio allocation among T-bills, stocks and bonds based on the correlations they issued. Kothari *et al.*(2006) investigate the term structure of interest rate as one of the discount-rate proxies and found strong evidence to support correlation between the earnings growth of stock and all proxy variables they employed.

The previous works about the forecasting ability of term structure on the real estate return/price are limited with mixed findings. For instance, Chan *et al.*(1990) found that the term structure has impacts on the real estate returns while Liu and Mei(1992) did not find such evidence to support that view. To clear the air, Ling and Naranjo(1997) concluded that the term structure could be important during specific periods. Later the relative literature explored this issue in the context of the integration of capital and real estate markets. Ling and Naranjo(1999) regressed the risk premiums and several macro-economic factors which included growth of GNP, CPI and the term structure of the interest rate, and found the significant correlation between REITs return and the term structure so as to provide evidence of the market integration between REIT and stock markets. However no evidence was found from direct real estate market, which is consistent with the findings of Liu *et al.*(1990)'s work years before. Besides REITs, it can barely find the factors from direct real estate market which is linked to the term structure of interest rate. This paper is going to explore the linkage between direct real estate market and the term structure of interest rate through a simple but useful model.

THE THEORETICAL MODEL

The discounted cash flow (DCF) analysis provides a framework for thinking about the determinants of asset's value. The DCF analysis states that the present value of the asset equals to the sum of all its expected future earnings. Considering the time value of the money, DCF model employ the discount rate to discount the future earnings to the respective present value of the earnings. Thus the present value of the asset can be expressed as followed:

$$P = \sum_{t=0}^{n} \frac{R_t}{(1+I)^t} \qquad (1)$$

Where P refers to the present value of the asset, R is the future earnings of the asset at time t and I presents the required rate of return, which is usually regarded as the discounted rate. Though DCF model has rationality in considering the time value of the money into the valuation of the asset, the earnings at time t is not reasonable to be assumed as the spot earnings at the beginning time. Therefore Gordon(1959) constructed Gordon Growth Model (GGM), further assuming that the earnings are expected to grow at a constant rate during the holding period, which can be expressed as followed:

$$P = \sum_{t=0}^{n} \frac{R_0(1+g)^t}{(1+I)^t} \qquad (2)$$

Where g is the constant expected earnings growth of the asset. There are two important assumptions for the construction of GGM: (1) it assumes that the asset has income with current value of R_0 and the income is expected to grow at a constant rate g; (2) it also assumes that the discount rate of money remains constant at I, which is equal to the cost of capital for the asset.

When estimating the price or value of certain asset with concerns of the time value of money, a practitioner may encounter a problem about how to settle that time value. In DCF model, GGM and MGM, the time value of money is proxied by discount rate, which is also known as the cost of capital for the asset. Looking from the angle of the investor, the cost of capital for the asset is equal to the return they require (or say expect) from the asset. To the minimum level, it should be the return of risk-free investment, which is usually equal to the government bond yield rate. Therefore the time value of the money in those models should be named as required return rate, which is determined by the risk-free return rate.

As mentioned above, we can barely find a model taking the growth of required return rate into accounted when estimating the price of certain asset. Comparing the assumptions of constant or inconstant growth rate of asset's income, the change of required return rate has been ignored for long time. However the time value of money, or say the cost of capital for certain asset, changed over time. As the required return rate is based on the risk-free return rate, it would change with it. In this way, the growth of required return rate should be concerned as well when evaluate certain asset.

In this study, we are focus on the research of mature asset. So the first assumption is same with GGM on the constant expected growth of asset's income; while the second assumption is novel that the required return rate of asset is expected to grow with a constant rate. Therefore based on GGM, the price of certain asset can be calculated with the formula as followed:

$$P = \frac{R_0}{(1+I)} + \frac{R_0 \times (1+g)}{(1+I+G)^2} + \frac{R_0 \times (1+g)^2}{(1+I+2\times G)^3} + \Lambda + \frac{R_0 \times (1+g)^{t-1}}{(1+I+(t-1)\times G)^t} \qquad (3)$$

where g and G represent the expected growth of asset's income and the growth of required return rate of asset respectively.

The formula (3) includes both the expected income growth and the required return of the asset. It seems closer to practice. Based on this new model, with the known data series of asset's price, income, require return rate and its growth, the expected growth of asset's income can be calculated in time-series format.

The selection of required return rate is fundamental to this model. In most valuation model, it would be discount rate. Though the discount rate of each country can be gained from the public statistics information from the government, it is not applicable for the valuations of all assets, especially those long-lived ones. Actually, in Wong *et al.*(2008)'s study, the discount rate for long-live asset is derived by examining the mix of lease tenure of land property and their transactions. Wong *et al.*(2008)'s approach also implies that there is spread, which reflects the investors' expectations, existing in rents differences of the varied lease tenures. However because of the limitation of the data availability, the method is not applicable in this paper.

In this way, the required rate of return, also the discount rate in this paper would be proxied by the risk-free rate in the market, which is usually the treasury security market. Though the variable G (the growth of the required return rate) is not directly collectable from the market, it can be calculated from the available Treasury security market data. To be more specific, from the market, we can get the spread of the Treasury bill yield between t-year and 1-year. With the assumption of constant growth of the rate, the spread and the growth are defined as followed:

$$S_t = I_t - I \qquad (4)$$

$$G = I_2 - I \qquad (5)$$

Combining formula (4) and (5), we can get:

$$G = \frac{I_t - I}{t-1} = \frac{S_t}{t-1} \qquad (6)$$

Where S_t represents the spread between t-year and 1-year T-bill yields.

By putting formula (6) into formula (3), we can get:

$$P = \frac{R_0}{(1+I)} + \frac{R_0 \times (1+g)}{(1+I+\frac{S_t}{t-1})^2} + \frac{R_0 \times (1+g)^2}{(1+I+2\times\frac{S_t}{t-1})^3} + \Lambda + \frac{R_0 \times (1+g)^{t-1}}{(1+I+(t-1)\times\frac{S_t}{t-1})^t} \qquad (7)$$

Where P, R_0 and g refer to the price, income and expected income growth of the asset while I and S_t represent the 1-year T-bill yield and the spread between t-year and 1-year T-bill yield.

Given the data of transaction price and earning of the asset and the data of 1-year, t-year T-bill yield, the expected earnings growth of asset during the holding period of t years can be calculated. In this study, we have also done the simulations based on this model to find out the relationship between real estate return and changes of each variable clearly. The detailed simulation procedure and results shown in the Appendix 2 helps to observe the relationship between real estate returns and all other variables in the model clearly.

The detailed model construction process are explained in Xu and Yiu(2009)'s previous work. Based on this model, we hope to investigate how the investors' expectation on inflation would affect the property price on the direct real estate market. The empirical work is induced in Hong Kong, where the real estate market is regarded as the one of the most blossom ones.

EMPIRICAL METHODOLOGY

Empirical Research Design:

In the real world, the commercial real estate is usually expected to be hold for around 50 years and the interest rate spread is the difference between 10-year and 1-year government bond yield rates. Thus the equation (7) should be expressed as

$$P = \frac{R_0}{(1+I)} + \frac{R_0 \times (1+g)}{(1+I+\frac{S_{10}}{9})^2} + \frac{R_0 \times (1+g)^2}{(1+I+2\times\frac{S_{10}}{9})^3} + \Lambda + \frac{R_0 \times (1+g)^{t-1}}{(1+I+(t-1)\times\frac{S_{10}}{9})^t} + \Lambda + \frac{R_0 \times (1+g)^{49}}{(1+I+49\times\frac{S_{10}}{9})^{50}} \qquad (8)$$

As for the multi-co-linearity between movements of price and rental of the office property, the empirical study in this paper will be conducted through several steps. First we followed the previous literature to model the office property's rental movements.

$$\Delta \ln R_{0t} = \beta_0 + \beta_1 \times \Delta(I_t - INF_t) + \beta_2 \times GDP_t + \beta_3 \times \Delta GDP_t + \beta_4 \times \Delta UNE_t + \phi_t \quad (9)$$

Secondly, with the beta estimated from empirical time-varied variables, we can further estimate the expected property rental based on equation (9).

In the last step, the estimated expected property rental will be put into the empirical model based on the expected rental income growth model derived in section 3.

$$\Delta \ln P_t = \alpha_0 + \alpha_1 \times \Delta \ln R_{0t} + \alpha_2 \times \Delta g_t + \alpha_3 \times \Delta S_t + \alpha_4 \times \Delta I_t + \varepsilon_t \qquad (10)$$

Where INF and GDP refers to the percentage change of CPI and the General Domestic Products.

As GDP data is published only quarterly, all other date series are on quarter basis as well then. The detailed variable description is shown in Table 1 while the empirical results are exhibited in Table 4 & 5.

Testable Hypothesis

Based on the expected rental growth model in equation (8), the hypotheses of the explanatory ability of the term structure of interest rates for the property price movements can be tested by using least square method. To be more specific, the null (H_0) and the competing (H_1) hypotheses are interpreted as followed:

H_0: the property price changes are significantly related to the term structure of interest rates;

H_1: the property price changes cannot be found related to the term structure of interest rates.

If the null hypothesis is not rejected, then the risk of term structure of interest rates is confirmed to be priced during the property valuation process. Therefore the spread can be regarded as another macro-level indicator of the property price.

Data

Our primary data source is the Rating and Valuation Department (RVD) and Hong Kong Monetary Authority (HKMA) in Hong Kong. Monthly data of both real estate and financial market can be gained from their statistics report. The appendix provides a detailed description of all the variables and their construction.

In our study, the expected earnings growth of property is derived based on the model we constructed earlier. And the capitalization rate and the spot return rate of property is accessed from the RVD monthly statistics. The risk premium is the required unlevered return on equity minus the yield to maturity on 10-year exchange fund note yield which can be gained from RVD and HKMA respectively. And the risk free return rate is the 10-year exchange fund note yield, gained from HKMA statistics. The investigation period is from January 1999 to March 2009. Table 1 describes the dependent and independent variables in this study. And Table 2 shows the summary of the statistics of the variables, including means, standard deviations, minimums, maxims, and serial correlations of levels and changes for capitalization rates, expected earnings growth, real earnings growth, required return rate and risk-free return rate of the property. The unit roots tests of each series are shown in Table 3.

ANALYSIS OF RESULTS

The structural equations of the empirical model are estimated with least square method by using Eviews Quantitative Micro Software Package. We use this regression analysis in this paper because the dependent variable (natural logarithm of property price index)'s error terms are correlated with the one of the independent variables (natural logarithm of property rental index). With the feedback loops in the model, the problem of the co-movement of both property price and rental can be resolved. The hypothesis tests of the relationship between property price change and the time-varying explaining variables are performed in this paper. The empirical results are exhibited in Table 4 & 5 and the interpretations are as followed:

As the movement of property rental is the Endogenous Variables to explain the property price change, we need to use the least square method to test the structural equations in this study. In the equations, the GDP (both level and differenced), property price, real interest rate and the unemployment rate are employed as the instrument variables. From the empirical results summarized in Table 4, there is evidence to confirm that the term structure of interest rate can explain the property return. The detailed information of the tests results are exhibited in Table 5. The results reveal the negative relationship between interest rate spread and the real estate returns. All four property sectors' returns are confirmed to drop 65.40%, 87.23%, 64.14% and 24.60% respectively when the interest rate spread rises 1%. This is consistent with the findings in previous literature where the spread is used to be the proxy of the interest rate.

CONCLUSIONS AND IMPLICATIONS

A great deal of empirical evidences indicates that macro-economic variables including the interest rate spread act as a proxy for systematic risk factors that are priced, ex ante, in the stock market. Although some previous research such as Ling and Naranjo(1997) suggest that those systematic risk factors are likely to be rewarded in real estate markets, no study has theoretically confirmed this hypothesis.

The purpose of this paper is to find out the fundamental macroeconomic drivers that systematically influence the real estate returns. The novelty lies in the theoretical model, which is used here to find out the linkage between real estate returns and all other variables. To overcome some of the econometric problems encountered in this research, we conduct the empirical test with several steps. With the estimated rental index movements, we test the relationship between real estate returns and the macroeconomic variables. The robustness of the study is tested by the other three real estate sectors in Hong Kong.

The findings are consistent with previous work on the relationship between real estate return and interest rate spread. However, this study investigates and confirms the hypothesis based on a more solid theoretical background. One of the most important contributions of this piece of work is to address the investors' expectations, both on future inflation and asset earning changes, into the pricing of real estate. Therefore, it is implied that the investors' expectations are not only the econometric forecasts or the survey reports but also can be captured by combining the asset and capital markets. In this way, the results have important implications for dynamic asset allocation and pricing strategies that involve the predictability of real estate returns based on macroeconomic data.

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Tables and Figures

Table 1: Data Descriptions

Table 1: Descriptions of the Variables in the Empirical Model

Categories	**Unit of measure**	**Descriptions**
Dependent Variable		
P_t	percentage	return of capital change
Independent Variables		
R_{0t}	percentage	return of rental change
g_t	percentage	the derived expected earnings growth of the property
I_t	percentage	the yield rate of one-year exchange

		fund notes
S_t	percentage	the yield spread between one-year and ten-year exchange fund notes
INF_t	percentage	the percentage change of the CPI composite
GDP_t	million HKD	level data of GDP

*Remarks: the expected earnings growth of property is derived based on the model we constructed earlier. And the capitalization rate and the spot return rate of property is accessed from the RVD monthly statistics. The risk premium is the required unlevered return on equity minus the yield to maturity on 10-year exchange fund note yield which can be gained from RVD and HKMA respectively. And the risk free return rate is the 10-year exchange fund note yield, gained from HKMA statistics. The investigation period is from January 1999 to March 2009.

Table 2: Descriptive Statistics Summary

variables	Mean	Median	Maximum	Minimum	Std. Dev.	Sum	Sum Sq. Dev.	Observations
LNP_IND	0.0047	0.0053	0.0547	-0.0514	0.0210	0.1918	0.0177	41
LNP_OFFA	0.0031	-0.0014	0.1151	-0.0982	0.0329	0.1259	0.0434	41
LNP_RES	0.0003	-0.0013	0.0592	-0.0504	0.0203	0.0110	0.0166	41
LNP_RET	0.0037	0.0000	0.0529	-0.0363	0.0194	0.1515	0.0150	41
LNR_IND	-0.0011	0.0012	0.0455	-0.0310	0.0139	-0.0451	0.0078	41
LNR_OFFA	0.0021	0.0047	0.0365	-0.0364	0.0173	0.0845	0.0120	41
LNR_RES	-0.0008	-0.0003	0.0242	-0.0635	0.0144	-0.0311	0.0083	41
LNR_RET	0.0003	0.0023	0.0142	-0.0155	0.0078	0.0138	0.0024	41
EG_IND	-0.0038	-0.0040	0.0002	-0.0074	0.0023	-0.1567	0.0002	41
EG_OFFA	0.0021	0.0018	0.0058	-0.0007	0.0016	0.0848	0.0001	41
EG_RES	0.0032	0.0031	0.0056	0.0008	0.0013	0.1310	0.0001	41
EG_RET	0.0010	0.0010	0.0026	-0.0006	0.0009	0.0397	0.0000	41
SPREAD	0.0015	0.0013	0.0032	0.0002	0.0010	0.0625	0.0000	41
INT_1YEAR	0.0025	0.0022	0.0055	0.0003	0.0016	0.1039	0.0001	41
INF	-0.0003	-0.0003	0.0077	-0.0070	0.0028	-0.0133	0.0003	41
GDP	346766	334627	448047	287670	40988	14217403	67200000000	41
UNE	0.0562	0.0540	0.0850	0.0330	0.0140	2.3030	0.0079	41

Table 3: the Stationality of the variables:

The stationality of each variable was tested through Augmented Dickey-Fuller Unit Root Test. The results are shown as followed:

	t-statistics		p-value	
	level	1^{st} differenced	level	1^{st} differenced
Price (office)	-3.77	-8.95	0.01	0.00
Price (residential)	-6.02	-9.59	0.00	0.00
Price (retail)	-9.70	-9.65	0.00	0.00
Price (industrial property)	-9.14	-12.57	0.00	0.00

rent (office)	-3.00	-7.30	0.04	0.00
rent (residential)	-4.14	-13.70	0.00	0.00
rent (retail)	-5.78	-10.49	0.00	0.00
rent (industrial property)	-10.75	-12.40	0.00	0.00
expected rental growth (office)	-2.04	-10.74	0.26	0.00
expected rental growth (residential)	-2.12	-10.42	0.23	0.00
expected rental growth (retail)	-2.66	-10.05	0.08	0.00
expected rental growth (industrial)	-0.95	-12.05	0.77	0.00
interest rate (1 year)	-1.38	-4.47	0.58	0.00
interest rate spread	-1.54	-4.82	0.50	0.00

Table 4: Summary of the Empirical Results of the regression model for the Property Return Movements

sector	expected earnings growth	Interest Rate	Interest Rate Spread	Spot Rental
office	34.15^{***}	-25.43^{***}	-65.40^{***}	0.90^{***}
residential	39.76^{***}	-40.08^{***}	-87.23^{***}	0.70^{***}
retail	30.76^{***}	-35.43^{***}	-64.14^{***}	0.88^{**}
industrial	28.60^{**}	-18.03^{**}	-24.60^{**}	0.73^{*}

Notes: *,**,*** is significance at 10%,5% and 1% level respectively.

Table 5: the Detailed Empirical Results of the Regression Model for the Commercial Property Return Movements

1. Office

Dependent Variable: LNP_OFFA
Method: Least Squares
Sample (adjusted): 1999Q2 2009Q1
Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000473	0.003082	0.153360	0.8790
E_R_OFFA	0.900524	0.237747	3.787745	0.0006
D(SPREAD)	-65.40196	14.87692	-4.396205	0.0001
D(EG_OFFA)	34.15376	4.305939	7.931780	0.0000
D(INT_1YEAR)	-25.43315	8.776327	-2.897926	0.0064

R-squared	0.735260	Mean dependent var	0.003373
Adjusted R-squared	0.705004	S.D. dependent var	0.033291
S.E. of regression	0.018082	Akaike info criterion	-5.071366
Sum squared resid	0.011443	Schwarz criterion	-4.860256
Log likelihood	106.4273	Hannan-Quinn criter.	-4.995035
F-statistic	24.30127	Durbin-Watson stat	1.926586
Prob(F-statistic)	0.000000		

2. Residential

Dependent Variable: LNP_RES
Method: Least Squares
Sample (adjusted): 1999Q2 2009Q1
Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.005399	0.002933	-1.840894	0.0741
E_R_RES	0.699175	0.246775	2.833253	0.0076
D(SPREAD)	-87.23421	19.16299	-4.552224	0.0001
D(EG_RES)	39.75542	7.280250	5.460722	0.0000
D(INT_1YEAR)	-40.07696	9.489325	-4.223373	0.0002

R-squared	0.546030	Mean dependent var	0.000509
Adjusted R-squared	0.494147	S.D. dependent var	0.020544
S.E. of regression	0.014612	Akaike info criterion	-5.497489
Sum squared resid	0.007473	Schwarz criterion	-5.286379
Log likelihood	114.9498	Hannan-Quinn criter.	-5.421158
F-statistic	10.52438	Durbin-Watson stat	2.232851
Prob(F-statistic)	0.000011		

3. Retail

Dependent Variable: LNP_RET
Method: Least Squares
Sample (adjusted): 1999Q2 2009Q1
Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000964	0.002367	0.407204	0.6863
E_R_RET	0.881151	0.430410	2.047235	0.0482
D(SPREAD)	-64.14111	13.23164	-4.847556	0.0000
D(EG_RET)	30.75942	5.352774	5.746445	0.0000
D(INT_1YEAR)	-35.42706	7.855878	-4.509625	0.0001

R-squared	0.533902	Mean dependent var	0.003944
Adjusted R-squared	0.480634	S.D. dependent var	0.019543
S.E. of regression	0.014084	Akaike info criterion	-5.571090
Sum squared resid	0.006943	Schwarz criterion	-5.359980
Log likelihood	116.4218	Hannan-Quinn criter.	-5.494759
F-statistic	10.02288	Durbin-Watson stat	2.484138
Prob(F-statistic)	0.000016		

4. Industrial

Dependent Variable: LNP_IND				
Method: Least Squares				
Sample (adjusted): 1999Q2 2009Q1				
Included observations: 40 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001981	0.002767	0.716040	0.4787
E_R_IND	0.730419	0.375662	1.944351	0.0599
D(SPREAD)	-24.60047	10.34725	-2.377489	0.0230
D(EG_IND)	28.59992	6.081512	4.702764	0.0000
D(INT_1YEAR)	-18.03375	8.788106	-2.052063	0.0477
R-squared	0.519019	Mean dependent var		0.005194
Adjusted R-squared	0.464050	S.D. dependent var		0.021041
S.E. of regression	0.015404	Akaike info criterion		-5.391913
Sum squared resid	0.008305	Schwarz criterion		-5.180804
Log likelihood	112.8383	Hannan-Quinn criter.		-5.315583
F-statistic	9.441996	Durbin-Watson stat		2.103365
Prob(F-statistic)	0.000028			

Figure 1: the interest rate and the spread

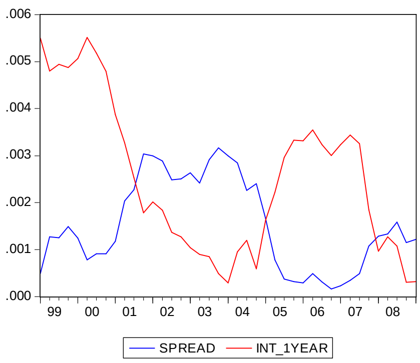
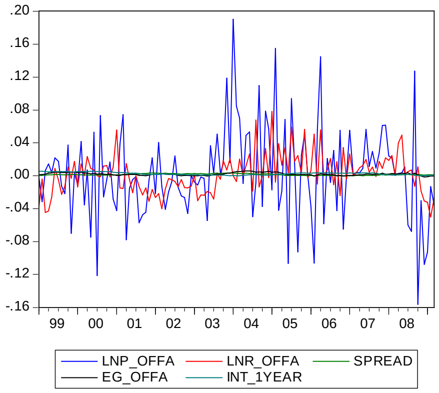
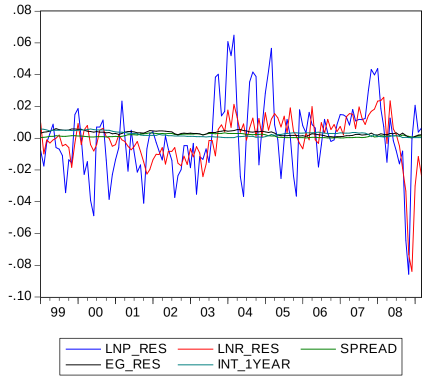


Figure 2: the co-movements of property price and other variables:

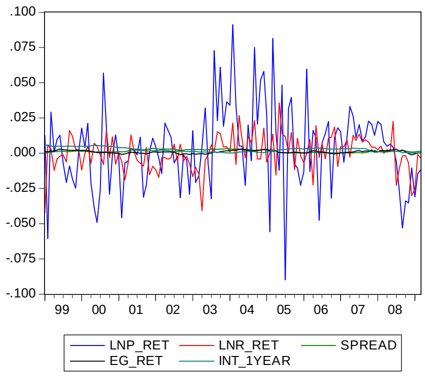
1. Office



2. Residential



3. Retail



4. Industrial

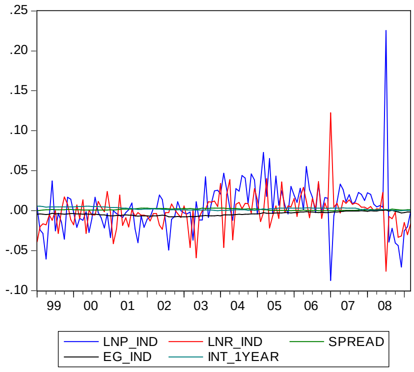
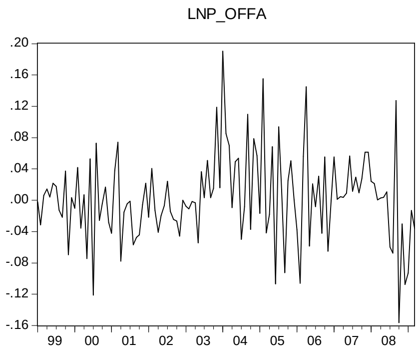
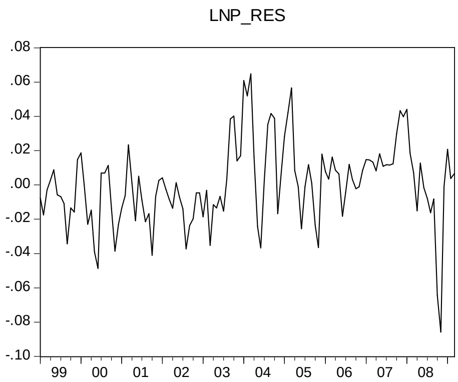


Figure 3: the movements of property price return

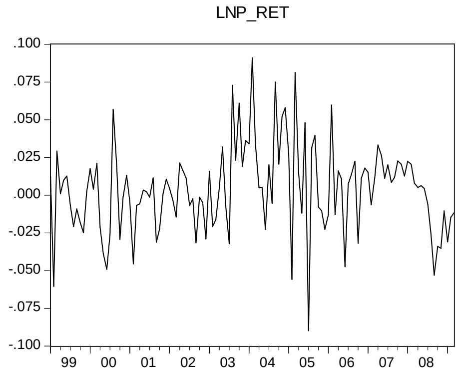
1. Office



2. Residential



3. Retail



4. Industrial

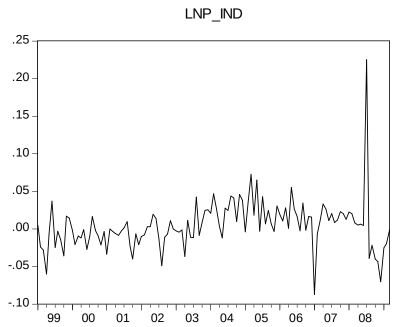
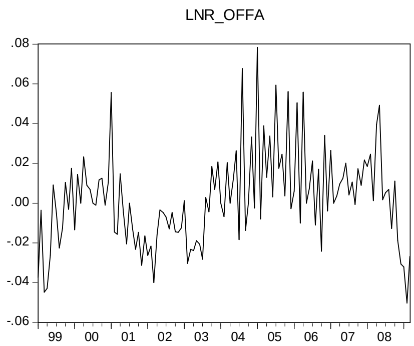
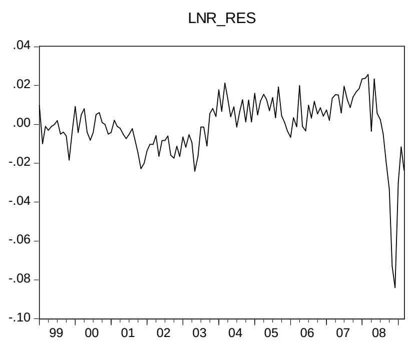


Figure 4: the movements of property rent changes

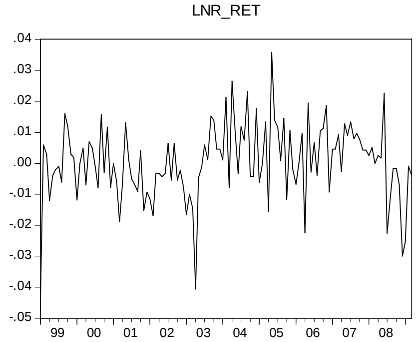
1. Office



2. Residential



3. Retail



4. industrial

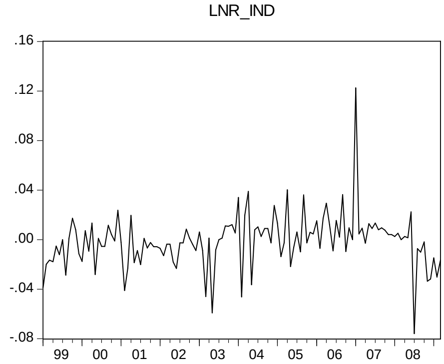


Figure 5: the movements of interest rate spread

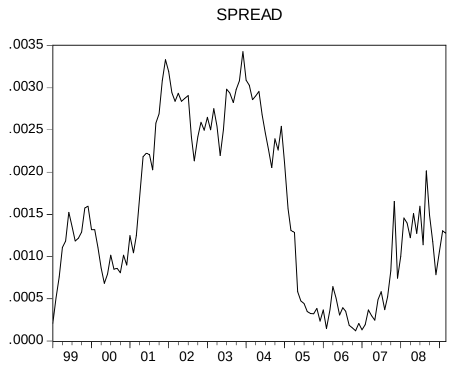
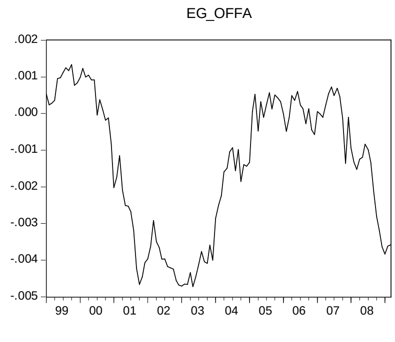
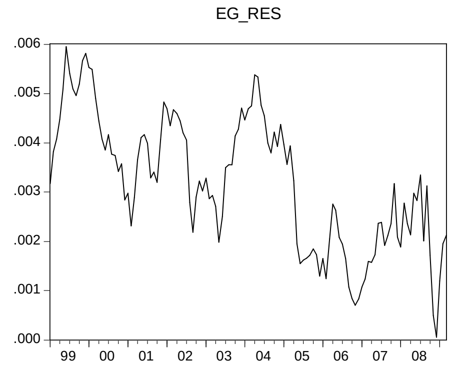


Figure 6: the movements of investors' expected rental income growth

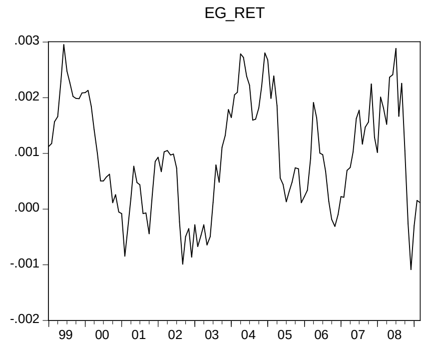
1. office



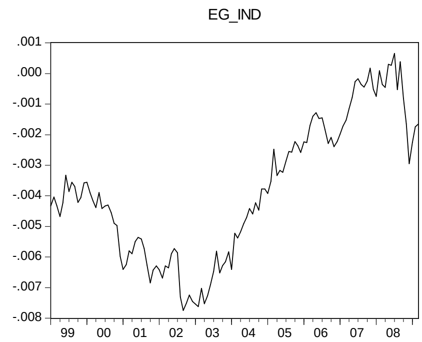
2. residential



3. retail



4. industrial



Appendix:

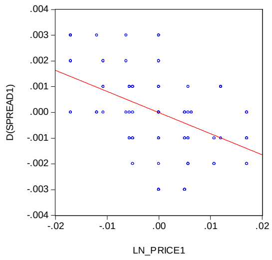
A.1. the Simulations of the Expected Earnings Growth Model for Real Estate Assets

1. Real estate returns v.s. interest rate spread

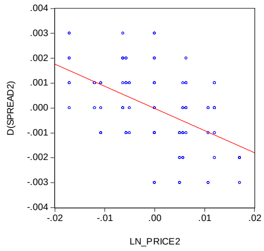
We run 6 times of the simulation with constant values of other variables and changing value of interest rate spread. The correlations between real estate return and differenced interest rate spread are shown as followed with scattered plot graph respectively:

Simulation	1st	2nd	3rd	4th	5th	6th
Correlation	-0.4614	-0.5074	-0.4191	-0.5292	-0.4470	-0.4739

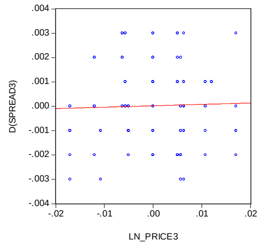
Graph 1: 1st simulation



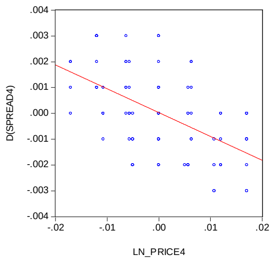
Graph 2: 2nd simulation



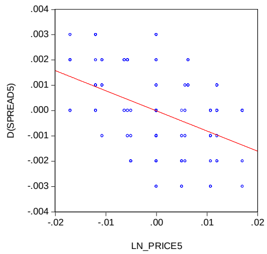
Graph 3: 3rd simulation



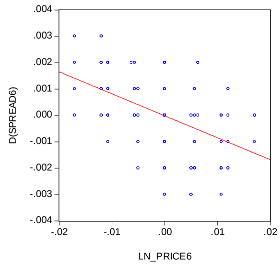
Graph 4: 4th simulation



Graph 5: 5th simulation



Graph 6: 6th simulation

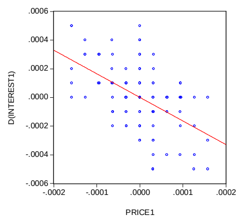


2. Real estate returns v.s. interest rate

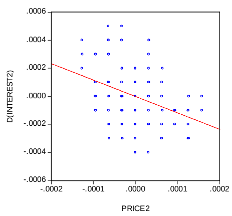
We run 6 times of the simulation with constant values of other variables and changing value of interest rate. The correlations between real estate return and differenced interest rate are shown as followed with scattered plot graph respectively:

Simulation	1st	2nd	3rd	4th	5th	6th
Correlation	-0.5205	-0.3650	-0.4321	-0.5603	-0.5650	-0.4887

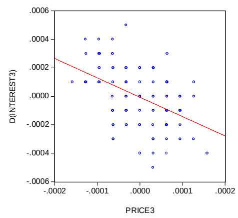
Graph 1: 1st simulation



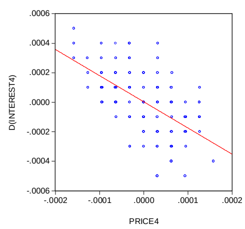
Graph 2: 2nd simulation



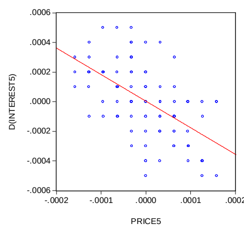
Graph 3: 3rd simulation



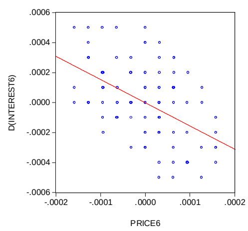
Graph 4: 4th simulation



Graph 5: 5th simulation



Graph 6: 6th simulation



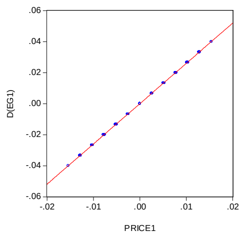
3. Real estate returns v.s. derived earnings growth of real estate asset

We run 6 times of the simulation with constant values of other variables and changing value of derived earnings growth of real estate asset. The correlations between real estate return and differenced interest rate are shown as followed with scattered plot graph respectively:

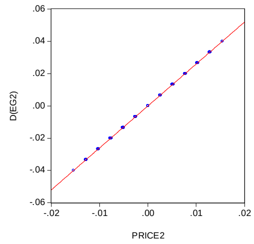
Simulation	1st	2nd	3rd	4th	5th	6th

Correlation	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999

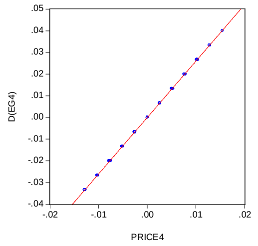
Graph 1: 1st simulation



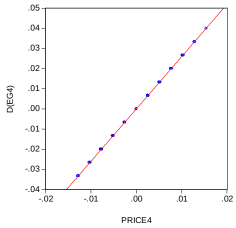
Graph 2: 2nd simulation



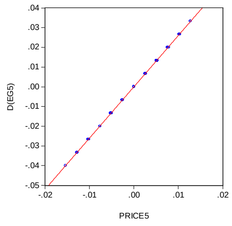
Graph 3: 3rd simulation



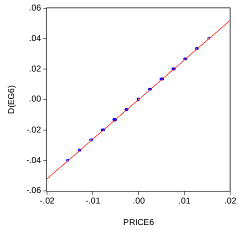
Graph 4: 4th simulation



Graph 5: 5th simulation



Graph 6: 6th simulation

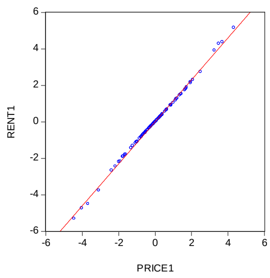


4. Real estate returns v.s. its spot rental income

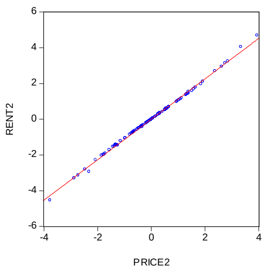
We run 6 times of the simulation with constant values of other variables and changing value of spot rental income of real estate asset. The correlations between real estate return and differenced interest rate are shown as followed with scattered plot graph respectively:

Simulation	1st	2nd	3rd	4th	5th	6th
Correlation	0.9987	0.9987	0.9995	0.9985	0.9987	0.9989

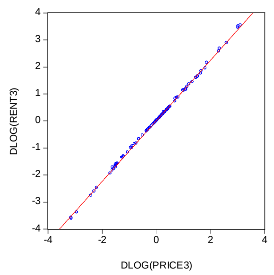
Graph 1: 1st simulation



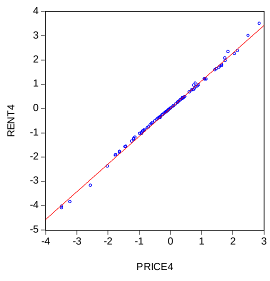
Graph 2: 2nd simulation



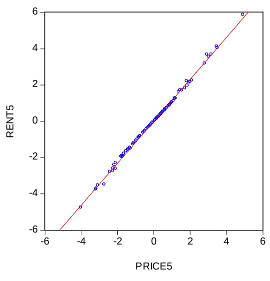
Graph 3: 3rd simulation



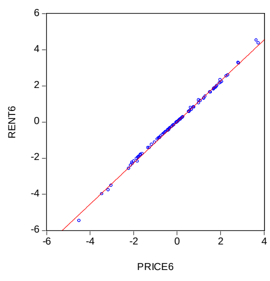
Graph 4: 4th simulation



Graph 5: 5th simulation



Graph 6: 6th simulation



A.2. Previous theoretical and empirical work on Real Estate Rent Dynamics

It's been at the heart of the real estate literature to explore the rent dynamics ever since 1950s when Blank and

Winnick(1953) modeled the residential rent changes as a function of vacancy rate. Shilling *et al.*(1987) applied this model to explain the office rent changes in the United States. Also both Wheaton(1987) and Wheaton and Torto(1988) estimated the model for the aggregate office property market in US. For the research in European market, Hendershott *et al.*(2002) and Brounen and Jennen(2009) modeled the office rents and examined an international panel of cities with economic data.

In the previous theoretical research on rent dynamics, the influences are mainly divided into demand and supply aspects. Usually the supply side is proxied by the stock and vacancy rate while the supply side is usually proxied by several economic factors, including GDP or industrial production, employment rate, interest rate and inflation rate. Thus the research has become two streams with different focus dynamics. Considering the economic drivers (demand side) only, the previous findings acknowledged that the macroeconomic factors, such as GDP (both level and differenced), inflation rate, interest rate and employment rate would influence the real estate rent changes (see Giussani *et al.*(1992)). In line with the previous study on rent dynamics from demand side, this paper also estimates the rent changes with the acknowledged macroeconomic variables.

A.3. Estimation of Rent Changes

According to the previous study, we estimate the real estate rent changes based on following equation:

$$\Delta \ln R_{0t} = \beta_0 + \beta_1 \times \Delta(I_t - INF_t) + \beta_2 \times GDP_t + \beta_3 \times \Delta GDP_t + \beta_4 \times \Delta UNE_t + \phi_t \quad (9)$$

Based on the data from 1st quarter, 1999 to 1st quarter 2009, we get the beta for rent changes estimation as followed in Table 6:

Table 6: Estimates of rent dynamics beta

Property sector	Constant	GDP	d(GDP)	d(UNE)	d(INT-INF)
Office	-0.032842	0.000000101**	-0.0000000752	-2.616805***	-0.112462
Residential	-0.006856	0.0000000166	-0.0000000704	-2.287231***	0.933575
Retail	-0.002993	0.00000000916	0.0000000674	-0.973431***	-0.096567
Industrial	-0.01413	0.000000038	-0.000000017	-1.365563***	-0.422221

Note: estimates of rent dynamics beta are obtained by estimating each of the property sector equations based on equation (9) as followed using least square method.

$$R_{0t} = \beta_0 + \beta_1 \times (I_t - INF_t) + \beta_2 \times GDP_t + \beta_3 \times \Delta GDP_t + \beta_4 \times UNE_t + \phi_t$$

Where ***(I_t-INF_t)*** refers to the 1st differenced value of the real interest rate, ***(GDP_t)***and ***(GDP_t)***represent the level and 1st differenced value of GDP and the ***(UNE_t)***refers to the 1st differenced value of the unemployment rate.

*, **, *** are 10, 5, and 1% significance levels, heteroscedastic-consistent (robust-White) standard errors are in parentheses.

With the estimated beta values, we further estimate the rent changes ***(R_{0t})*** without error. Thus the multi-co-linearity between rent and price movements can be eliminated and the newly estimated rent changes series are used in the empirical test for the relationship between property return and macroeconomic factors.