Living in a Low-Rate World – the Predictive Impact of Macroeconomic Risk Factors on UK Property Returns

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Bachelor’s Thesis, Finance

Abstract

This thesis analyses the predictive impact of macroeconomic risk factors on UK property stock returns in changing macroeconomic conditions. The monthly return sample from value-weighted index of listed real estate companies and real estate investment trusts (REITs) is from January 1990 to August 2016 and is divided into two sub-sample periods around the turn of 2006 to 2007. Thus, the later sub-sample period includes financial stress events such as the global financial crisis and the European debt crisis. A standard multifactor asset pricing model with seven pre-specified macroeconomic variables is used to test the risk factor impact on future property returns, and the magnitudes of the impacts between the two sub-samples are then compared. The results indicate that the negative impact of short-term interest rate movements is significant throughout the whole sample period, whereas the positive impact of changes in money supply disappears during the later sub-sample period. The results help investors to further understand the effect of changing macroeconomic conditions on future property income.

Keywords

Property stock returns, Macroeconomics, Financial crisis, Financial risk

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1. Introduction

In the recent years, the real estate investment market has globally been thriving. The global investment turnover in the first half of 2015 was nearly five times above the 2009 low. In addition, the capitalisation rates for prime properties - a common metric when valuing income-producing real estates – has set new lows in increasing number of markets, including London in the United Kingdom, leading to high property valuations (CBRE Research, 2016). Recent macroeconomic conditions have been argued to explain the investment activity increase, as the macroeconomic environment in Europe and in the UK has changed considerably since 2007. After recovering from the financial crisis, the economy was hit by the European debt crisis in 2009, leading to a period of low growth in the European economies. These events have led to various changes in macroeconomic conditions as well as in monetary policy. Firstly, to increase investments, on August 4, 2016 The Bank of England cut the official bank rate to a record low of 0.25% after a period of low interest rates since 2008 (Bank of England, 2016). Figure 1 displays the official bank rate movements from January 1990 to August 2016. Secondly, the annual average and volatility of net foreign direct investments in the UK have increased from $-21 billion and $52 billion in 1990-2006 to $33 billion and $108 billion in 2007-2015, respectively, meaning the UK ranked 10th worldwide in terms of receipt of foreign direct investment in 2015 (Oxford Economics, 2016; Financial Times, 2016).

The above-mentioned examples of macroeconomic changes are expected to be linked to the overall stock market development. Therefore, as real estate is a significant asset in the UK economy and comprises a large amount of market development, changes in macroeconomic conditions may have significant explanatory power for future property income as well. The impact of various macroeconomic variables on stock market returns has globally been well identified. Studies by Fama (1981), Chen et al. (1986) and Chen (1991) have found a strong connection between the US stock market returns and macroeconomic fundamentals, such as GDP, interest rates, industrial production and inflation. In the real estate literature, studies by McCue and Kling (1994), Brooks and Tsolacos (1999) and Liow et al. (2006), among others, have found that the same macroeconomic forces constantly drive also real estate returns.

However, the real estate literature lacks recent empirical knowledge concerning this topic especially in the UK. According to the author’s knowledge, all the related studies using UK market data have been carried out before the start of the global financial crisis. Additionally, a study by Ito (2013) using Japanese data is the only study which has tested the changes in macroeconomic variable influence on property returns between before and after the start of the financial crisis periods. Thus, it is in the
interest of this study to bring updated knowledge of the relationship between property returns and changed macroeconomic conditions.

The primary objective of this study is to investigate whether different macroeconomic risk factors have predictive impact on UK property stock returns, which are represented by the value-weighted performance of listed real estate companies and real estate investment trusts (REITs). Furthermore, the total sample period from January 1990 to August 2016 is divided into two sub-samples around the turn of 2006 to 2007 to compare whether the magnitudes of the predictive influences on property returns are significantly different between the periods before and after the start of the financial crisis. A standard multifactor asset pricing model with seven pre-specified macroeconomic variables, namely the growth in GDP, the growth in industrial production, the unexpected inflation, the short-term interest rate, the interest rate term structure, the change in money supply and the change in exchange rate, is used to test the macroeconomic impact on property returns.

The results indicate that of the seven macroeconomic variables, short-term interest rate movements have had significant, negative impact on future property returns throughout the whole
sample period, whereas changes in money supply have had positive impact during the earlier sub-sample period. However, the evidence of money supply influence disappears during the later sub-sample period. Overall, the results imply that identifying macroeconomic factors that predict property returns remains a hard task. Still, even if interest rates have declined to historically lows, their explanatory power has remained significant during the recent years as well.

The rest of the study proceeds as follows. Section 2 presents the theoretical background of finance and real estate studies concerning macroeconomic variable influences on returns as well as the hypotheses for this study. Section 3 presents the sample and data characteristics of the property and stock market returns followed by a description of the seven pre-specified macroeconomic variables. Section 4 introduces the research methodology employed in this study. Section 5 presents the empirical results and finally, Section 6 concludes and gives suggestions for further research.

2. Theoretical background and hypotheses

2.1 Predictive power of macroeconomic risk factors to stock and bond market returns

The line of research concerning the relationship between the macroeconomy and real estate returns have originated from substantive empirical work made in finance literature, which have tried to identify systematic effects of economic variables on stock and bond returns. Beginning with the early work by Fama (1981), much research has placed weight on identifying exogenous risk factors that determine excess returns through time. The relevant economic fundamentals have been well documented using Ross’ (1976) arbitrage pricing theory (APT), and several studies have found a significant connection between stock market returns and macroeconomic fundamentals. Chen et al. (1986) find significant evidence that the industrial production as well as changes in interest rate risk premium and term structure explain expected stock returns. Chen (1986) concludes that the interest rate default and term structure, the one-month Treasury bill rate, the industrial production growth rate and the dividend-price ratio are important determinants of future stock prices. More recently, Patro et al. (2002) estimate a time-varying two-factor asset pricing model and find that several factors, including imports, exports, inflation, market capitalisation dividend yields and price-to-book ratios, are useful predictors of world stock market risk.
2.2 Real estate as an investment class

From the standpoint of this study, real estate is treated as an investment class. In principle, there are two ways to invest in real estates: either directly or indirectly, i.e., privately or publicly. Direct real estate investments are referred to as investing in unsecuritised real estate assets, whereas in the centre of this study are indirect real estate investments, which mean purchasing shares of a company holding a real estate (Morawski et al., 2008). The most typical listed real estate investment companies are real estate investment trusts (REITs) and real estate operating companies (REOCs), of which value-weighted performance characterises this study. In general, REIT is a company that owns or finances income-producing real estate and pays out all of its taxable income as dividends to shareholders (NAREIT, 2016). REOCs are considered similar to REITs, but whereas REITs are regulated by taxation and allowable activities, REOCs are considered as normal equity investments with no special regulations (Niskanen and Falkenbach, 2012).

2.3. Related real estate literature in the US and Asian markets

In the real estate literature, most empirical work concerning macroeconomic risk factors and property returns has been executed using US data. Chan et al. (1990) use a five-factor arbitrage pricing model with pre-specified macroeconomic variables to explain excess equity real estate investment trust (REIT) returns. They conclude that interest rate risk and term structure as well as unexpected inflation consistently affect both real estate and general stock market returns, whereas changes in industrial production and realized inflation did not receive empirical support. Using the VAR methodology and excluding overall stock market movements of real estate return series, McCue and Kling (1994) find that the macroeconomy explains nearly 60% of the real estate return series and that the nominal interest rates explain the greatest percentage of the series. Industrial production and a measure of investment, the McGraw Hill Construction Contract Index, explained only little of the return series. Mueller and Pauley (1995) use a linear regression model to analyse REIT price movements during past interest rate movement cycles. Their results indicate that REIT prices have a lower correlation with interest rate shifts than with shifts in the overall stock market. Ling and Naranjo (1997) employ non-linear multivariate regression techniques and find significant evidence that the growth rate in consumption, the real Treasury bill rate, the interest rate term structure and unexpected inflation are consistently priced in time-varying commercial real estate returns.

There have also been a few studies linking real estate returns and macroeconomy in Asian markets. So far, only Ito (2013) has investigated the impact of changing macroeconomic conditions on
property returns by dividing the sample period into before and after the start of the financial crisis periods. He tests the impact of contemporaneous stock market and interest rate movements on the Tokyo Stock Exchange REIT Index and finds more positive impact of stock price and more negative impact of interest rate changes on REIT prices during after the start of the financial crisis period. Liow et al. (2003) investigate the linkages between interest rate risk and traded property stock returns in Singapore using Iterated Non-linear Seeming Unrelated Regression (ITNLSUR) technique and find systematic interest rate risk priced in property stocks. In addition, Liow et al. (2006) analyse the relationship between expected risk premium on property stocks and macroeconomic risk factors in four major markets, namely Singapore, Hong Kong, Japan and the UK. They employ a three-step estimation strategy (principal component analysis, CARCH (1,1) and GMM) to model the macroeconomic risk factors and relate them to the first and second moments on property stock excess returns. Their findings imply that GDP growth, industrial production growth, unexpected inflation, respective interest rate, changes in money supply and changes in exchange rate all relate to the expected excess property returns, but the sign and significance of the impacts vary between the studied markets.

2.4. Related real estate literature in the UK market

In Great Britain, the relationship between the macroeconomy and real estate returns has attracted significantly less research interest. Lizieri and Satchell (1997) employ Granger causality tests to identify that in the short-term, the stock market leads the real estate market but in the long-term, positive real estate returns may indicate negative future stock market returns. Using similar methodology as McCue and Kling (1994), Brooks and Tsolacos (1999) do not find any strongly suggestive evidence of macroeconomic variables that affect the variation of property return series. However, they find some evidence that the interest rate term spread and unexpected inflation have contemporaneous effect on property returns.

2.5. Hypotheses

In efficient capital markets, security prices should fully reflect available information in a rapid and unbiased fashion and there should not exist any macroeconomic indicators of the future investment performance of a security. (Basu, 1977) Therefore, the initial hypothesis of this study is that any macroeconomic variable should not predict future excess property returns.
However, earlier research has mainly concluded that macroeconomic risk factors have significant explanatory power to excess property returns. Still, the significance level and the predictability of different risk factors have varied between the empirical studies. Most of the earlier studies, including Liow et al. (2003) and McCue and Kling (1994), generally support that especially interest rate movements explain expected real estate returns. Thus, consistent with these studies, it could be expected to find evidence that interest rates, among possibly other macroeconomic variables, have predictive power to UK property returns. As another objective of this study is to compare the magnitudes of the variable influences between before and after the start of the financial crisis periods, the expectation can be extended to relate to the changed macroeconomic conditions in the recent years. As the interest rates in mature economies have declined to record-low levels and the real estate investment activity has increased, it is interesting to see if the influence level of interest rates or other variables has changed during the recent years. Ito (2013) concludes that the contemporaneous explanatory power of interest rates and stock market has increased in Japan during the after the start of the financial crisis period; this study extends Ito’s study to test, whether the predictive influence of macroeconomic variables has changed within changing macroeconomic conditions.

3. Sample and data characteristics

3.1. Property and stock market returns

The monthly total return indices as well as all the other data sets used in this study come from Datastream International. The market proxy for the property returns studied is the FTSE EPRA/NAREIT UK Index, which tracks the performance of real estate companies and REITs listed on the London Stock Exchange. The index is available from December, 1989 and is calculated with the base date set as December 31, 1999. The overall stock market movements are represented by the FTSE All-Share Index, which tracks the performance of eligible companies listed on the London Stock Exchange’s main market, capturing 98% of the UK’s market capitalisation. This index is available from July, 1962 and is calculated with the base date set as April 10, 1962.

The total sample period is limited by the availability of property returns data and runs from January 1990 to August 2016, a total of 320 observations. Construction of the macroeconomic variables, e.g. growth rate in GDP, uses observations up to 13 months prior to the test period. Since most of the previous real estate studies investigate the variation in property returns using monthly data
and many macroeconomic variables are only available in monthly frequency, it is recommendable to conduct this study using monthly returns. The total sample is divided into two sub-samples around the turn of 2006 to 2007, as the FTSE EPRA/NAREIT UK Index hit the record high of 3,981.64 on January 3, 2007. Therefore, the first sub-sample runs from January 1990 to December 2006 and the second sub-sample runs from January 2007 to August 2016. Figure 2 displays daily property index as well as stock market index movements over the total sample period.

**FIGURE 2**

Daily property and stock market portfolio index movements

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Notes: Total sample period is from January 1, 1990 to August 31, 2016. The figure is calculated with the base value of 100 set for both indexes on January 1, 1990. The property portfolio is represented by the FTSE EPRA/NAREIT UK Index and the stock market portfolio is represented by the FTSE All-Share Index. Source: Datastream International.

Monthly returns on the property and stock market indices are computed as log-returns and expressed as excess of risk-free interest rate. The three-month Treasury bill yield acts as a proxy of risk-free interest rate. Therefore, the excess return series on property index is
\[ ER_{FEUTDKL, t} = \log_e \left( \frac{FEUTDKL_t}{FEUTDKL_{t-1}} - R_{f,t} \right), \] (1)

where \( ER_{FEUTDKL} \) is the excess return on FTSE EPRA/NAREIT UK Total Return Index in month \( t \), \( FEUTDKL \) is the value of the index in month \( t \) and \( R_{f,t} \) is the monthly return on three-month Treasury bill in month \( t \). Similarly, the excess return series on stock market index is

\[ ER_{FTALLSH, t} = \log_e \left( \frac{FTALLSH_t}{FTALLSH_{t-1}} - R_{f,t} \right), \] (2)

where \( ER_{FTALLSH} \) is the excess return on FTSE All-Share Total Return Index in month \( t \) and \( FTALLSH_t \) is the value of the index in month \( t \).

Table 1 presents the descriptive statistics of the monthly excess returns on the property stock portfolio over the two sub-sample periods. The statistics include mean, standard deviation, maximum and minimum, measures for skewness and excess kurtosis, the Jarque-Bera (JB) normality test statistics and the Ljung-Box Q statistics for 6, 12, 18 and 24 lags. The statistics imply that the average monthly excess return is lower in the later sub-sample period, whereas volatility in the same period is higher. Excess returns are negatively skewed in both sub-samples, while excess kurtosis greater than 3 is found in the later sub-sample. Based on the Jarque-Bera statistics, the hypothesis of a normal distribution is

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>Descriptive statistics of the monthly excess property returns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.003</td>
</tr>
<tr>
<td>Std. deviation</td>
<td>0.053</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.144</td>
</tr>
<tr>
<td>Minimum</td>
<td>-0.146</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.303</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>-0.003</td>
</tr>
<tr>
<td>Jarque-Bera</td>
<td>3.25</td>
</tr>
<tr>
<td>Ljung-Box Q statistics</td>
<td></td>
</tr>
<tr>
<td>Q(6)</td>
<td>15.81**</td>
</tr>
<tr>
<td>Q(12)</td>
<td>24.72**</td>
</tr>
<tr>
<td>Q(18)</td>
<td>28.41*</td>
</tr>
<tr>
<td>Q(24)</td>
<td>34.78*</td>
</tr>
</tbody>
</table>

Notes: ***, ** and * indicate two-tailed significances at the 1%, 5% and 10% levels, respectively.
rejected in the later but not in the earlier sample. Finally, the Ljung-Box Q statistics indicate that the null hypothesis of uncorrelated excess returns is rejected at five or ten percent level in both sub-samples, as conditional heteroscedasticity exists over all tested lag periods.

A statistical procedure known as orthogonalisation, used in previous real estate studies of Brooks and Tsolacos (1999), Lizieri and Satchell (1997) and McCue and Kling (1994), was also used to control the contemporaneous effect of overall stock market returns on real estate returns, producing a series that mimics real estate return series. The excess returns on the monthly FTSE EPRA/NAREIT UK Total Return Index were regressed on the excess returns on the FTSE All-Share Total Return Index, saving the residuals. The mathematical explanation for the regression is

$$ER_{FEUTDKL, t} = \alpha + \beta ER_{FTALLSH, t} + \epsilon_t,$$  \hspace{1cm} (3)

where $\epsilon_t$ is the residual variation of the equity market; hereafter, PROPRES.

These residuals, denoted PROPRES, represent the extra-market covariance and are assumed to be attributed to a second underlying factor, the real estate industry effect (McCue and Kling, 1994). Results in Brooks and Tsolacos (2000) show that this contemporaneous regression is adequate to separate out that part of real estate returns that are linearly and contemporaneously related to movements in the general stock market. This is an important additional procedure, as the purpose of this study is to model the macroeconomic impact on real estate returns, not on the overall stock market returns. Table 2 presents the regression results. As can be seen, contemporaneous stock market return movements have statistically highly significant influence on real estate returns.

### TABLE 2

Summary of the regression employed to estimate the real estate industry effect

<table>
<thead>
<tr>
<th></th>
<th>Constant</th>
<th>$ER_{FTALLSH}$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ER_{FEUTDKL}$</td>
<td>-0.002</td>
<td>0.881</td>
<td>0.39</td>
</tr>
<tr>
<td></td>
<td>(-0.73)</td>
<td>(14.23)***</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Sample period is from January, 1990 to August, 2016. Values in parenthesis are t-statistics. *** *, and * indicate two-tailed significances at 1%, 5% and 10% level, respectively. The $ER_{FEUTDKL}$ is the excess property portfolio return, while the $ER_{FTALLSH}$ is the excess stock market portfolio return.
3.2. Macroeconomic risk factors

The set of pre-specified macroeconomic variables included in this study is based on previous real estate studies, which have identified the key economic and financial variables affecting stock market and property returns. Important to note is that this set of variables does not capture all economic risk impacting the excess property returns, but it does include macroeconomic variables that are generally considered as important variables that affect excess stock market and property returns. The chosen macroeconomic variables are also special in a way that they are “exogenous”, as they all come from outside the actual property stock market. In addition, these variables have often been included in previous studies of similar nature. (Liow et al. 2006) The chosen macroeconomic factors and the justifications for their inclusion in this study are briefly provided below.

*Growth rate in gross domestic product (GDGP)*

GDP is a measure of the market value of all currently produced final goods and services and is thus an aggregate value of all the industries in the economy. As real estate generates a significant portion of the UK’s economy, the economic growth should reflect the market conditions and could thus have predictive power to property stock returns (Liow et al., 2006). The variable GDPG is the growth rate in the UK GDP. As data of the UK GDP are only available on quarterly frequency, the monthly growth rate is expressed as the growth rate of the last observable variable. Important to note is that due to this estimation there exists some inaccuracy compared to the real monthly GDP growth, but this estimation must be accepted to capture the state of the GDP in monthly level.

*Growth rate in industrial production (INDPG)*

Industrial production is a measure of output of the industrial sector of the economy and thus, similarly to GDP, indicates economic growth. Chen (1986) and Fama (1981) identify positive impact of industrial production growth on US stock returns. The variable INDPG is the growth rate in the UK Index of Production (IoP), which measures the volume of production at base year prices for the manufacturing, mining and quarrying, energy supply, and water and waste management industries (Office for National Statistics, 2016).

*Unexpected inflation (UINFL)*

Inflation is generally separated into two parts, which are the expected inflation rate and the unexpected inflation. Ferson and Harvey (1991) argue that unexpected inflation is likely to be a source of economic risk and thus, the risk premium will be added to the expected property returns. The unexpected inflation
is defined as the difference between the actual and the expected rate of inflation. Similarly to Brown and Matysiak (2000), I regress the monthly realized inflation on the previous month’s realized inflation and use the residual as a measurement of unexpected inflation. The realized monthly inflation is the change in the UK Consumer Price Index, which is a measure of consumer price inflation produced to international standards and in line with European regulations (Office for National Statistics, 2016).

*Short-term interest rate (SIR)*

The interest rate is a macroeconomic variable that tends to fluctuate with economic conditions. In general, lower interest rates should help investments and reduce loan expenses and therefore increase expected returns. Earlier studies, including Liow et al. (2006) and McCue and Kling (1994), have mainly concluded that real estate returns are sensitive to interest rate movements. Respective three-month UK Treasury bill yields are used as a proxy of interest rate movements.

*Interest rate term structure (INTRTS)*

As real estate investments are typically financed with long-term debt, the movements in interest rate term structure could explain the profitability of the investments. In addition, especially recently real estates are often seen as alternative investment class for long-term debt, and therefore changes in term spread might explain investment activity and future property returns. The results in Brooks and Tsolacos (1999) indicate that term structure has explanatory power for the property market. The interest rate term structure is taken to be the difference between the 20-year UK government bond yield and three-month UK Treasury bill yield.

*Growth in money supply (M2G)*

Money supply is a macroeconomic factor that significantly affects the other economic variables, and thus may have an influence on property returns. The positive impact on variables such as GDP could lead to positive impact on property returns, whereas the prospective impact on inflation uncertainty could lead to negative impact on property returns. (Liow et al., 2006) Money supply is represented by M2, a broad measure of money in an economy. The variable M2G is the change in the UK M2.

*Changes in exchange rate, UK£ to SDR currency basket (XCHG)*

Exchange rate is an important measure in the foreign trade: an appreciation of local currency relative to foreign currency is expected to decrease exports and thus affect the economic growth. As the foreign investments in the UK have had an increasing trend, exchange rate could have increasing explanatory power to expected property returns. UK£ is compared to the IMF’s Special Drawing Right (SDR)
currency basket. SDR is an international reserve asset, created by the IMF in 1969 to supplement its member countries’ official reserves. The value of the SDR is based on a basket of five major currencies – the US dollar, euro, the Chinese renminbi, the Japanese yen and the UK pound sterling. (IMF, 2016) The changes in exchange rate are measured as local currency to the SDR currency basket.

All the data series, except interest rates and exchange rates, were first logged. Following McCue and Kling (1994) and Brooks and Tsolacos (1999), all macroeconomic variables are required to be stationary in order to carry out joint significance tests of the impact on excess property returns. Therefore, all the variables were subjected to augmented Dickey Fuller tests. Strong evidence is found that the log of the UK GDP, the log of the UK Index of Production, the log of the M2 and the exchange rate of UK£ to SDR currency basket contain a stochastic trend, implying that they are not stationary. Thus, these variables were 12th differenced to exclude any potential seasonal frequencies. All the other macroeconomic variables, namely the interest rates, led to rejection of the null hypothesis of a unit root, which means that the respective level values of these rates were used in the subsequent analysis.

The mathematical explanations for the macroeconomic variables are as follows. The variables GDPG, INDPG and M2G are

\[ Variable_t = \log(e^{Index_t}) - \log(e^{Index_{t-12}}), \]  

(4)

where \( Variable_t \) is GDPG, INDPG or M2G in month \( t \), respectively, and \( Index_t \) is the value of the GDP, the UK Index of Production or the M2 in month \( t \), respectively. The variable UINFL is the residual of the regression

\[ INFL_t = \alpha + \beta INFL_{t-1} + \epsilon_t, \]  

(5)

where \( INFL_t \) is the realized inflation in month \( t \), which is calculated as

\[ INFL_t = \log(e^{CPI_t}) - \log(e^{CPI_{t-12}}), \]  

(6)

where \( CPI_t \) is the UK Consumer Price Index in month \( t \). The variable SIR is

\[ R_{3\text{-month UK Treasury bill}, t}. \]  

(7)
where $R_{3\text{-month UK Treasury bill}, t}$ is the three-month UK Treasury bill yield in month $t$. The variable INTRTS is

$$INTRTS_t = R_{20\text{-year UK government bond}, t} - R_{3\text{-month UK Treasury bill}, t} \quad (8)$$

where $R_{20\text{-year UK government bond}, t}$ is the 20-year UK government bond yield in month $t$ and $R_{3\text{-month UK Treasury bill}, t}$ is the three-month Treasury bill yield in month $t$. Finally, the variable XCHG is

$$XCHG = Exchange\ rate_t - Exchange\ rate_{t-12}, \quad (9)$$

where $Exchange\ rate_t$ is the exchange rate between UK£ to SDR currency basket in month $t$.

Table 3 presents the descriptive statistics of the chosen macroeconomic variables over the two sub-sample periods. As can be seen, there are some changes in macroeconomic conditions between the sub-sample periods. The growth rate in both the GDP and the industrial production has decelerated during the later sub-sample period; in addition, their volatility is higher during the same period due to the financial stress events. The short-term interest rates are significantly lower while the interest rate term structure is higher in the later sub-sample period. Money supply has slowed down a little, while the exchange rate has varied more during the later sub-sample period.

There exist some notable differences in degrees of skewness and kurtosis between the sub-sample periods. Namely, the growth in GDP displays much more negative degree of skewness in the later sub-sample period, whereas the unexpected inflation has much higher degree of excess kurtosis in the earlier sub-sample period. Based on the Jarque-Bera statistics, the hypothesis of normal distribution is rejected for most of the time series. Finally, the Ljung-Box Q statistics display high degree of conditional heteroscedasticity in all time series, as the statistics mainly reject the null hypothesis of uncorrelated variables at one percent significance level.

Table 4 reports the Spearman correlation results of the macroeconomic variables. The results indicate that most of the variables are significantly related. This is usual, as the macroeconomic factors tend to affect each other in changing economic conditions. However, it must be accepted that the subsequent analysis of the variables may be subject to some collinearity problems caused by the correlations.
### TABLE 3
Descriptive statistics of the macroeconomic variables

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Max.</th>
<th>Min.</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Jarque-Bera</th>
<th>Ljung-Box Q statistics</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Q(6)</td>
</tr>
<tr>
<td><strong>Jan, 1990 - Dec, 2006</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDPG</td>
<td>0.004</td>
<td>0.001</td>
<td>0.008</td>
<td>0.002</td>
<td>1.133</td>
<td>2.342</td>
<td>35.03***</td>
<td>572.10***</td>
</tr>
<tr>
<td>INDPG</td>
<td>0.006</td>
<td>0.022</td>
<td>0.063</td>
<td>-0.057</td>
<td>-0.030</td>
<td>0.419</td>
<td>1.52</td>
<td>641.48***</td>
</tr>
<tr>
<td>UINFL</td>
<td>0.000</td>
<td>0.003</td>
<td>0.017</td>
<td>-0.021</td>
<td>-0.607</td>
<td>15.737</td>
<td>50.24***</td>
<td>3.75</td>
</tr>
<tr>
<td>SIR</td>
<td>0.064</td>
<td>0.027</td>
<td>0.146</td>
<td>0.033</td>
<td>1.715</td>
<td>2.292</td>
<td>52.26***</td>
<td>995.48***</td>
</tr>
<tr>
<td>INTRTS</td>
<td>0.003</td>
<td>0.017</td>
<td>0.038</td>
<td>-0.048</td>
<td>-0.236</td>
<td>0.011</td>
<td>2.07</td>
<td>901.80***</td>
</tr>
<tr>
<td>M2G</td>
<td>0.075</td>
<td>0.021</td>
<td>0.122</td>
<td>0.029</td>
<td>-0.046</td>
<td>-0.840</td>
<td>14.85***</td>
<td>736.56***</td>
</tr>
<tr>
<td>XCHG</td>
<td>0.001</td>
<td>0.054</td>
<td>0.192</td>
<td>-0.123</td>
<td>0.836</td>
<td>2.119</td>
<td>25.85***</td>
<td>603.67***</td>
</tr>
<tr>
<td><strong>Jan, 2007 - Aug, 2016</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDPG</td>
<td>0.002</td>
<td>0.002</td>
<td>0.004</td>
<td>-0.003</td>
<td>-1.705</td>
<td>2.508</td>
<td>29.07***</td>
<td>451.12***</td>
</tr>
<tr>
<td>INDPG</td>
<td>-0.009</td>
<td>0.037</td>
<td>0.055</td>
<td>-0.120</td>
<td>-1.324</td>
<td>1.588</td>
<td>22.98***</td>
<td>403.12***</td>
</tr>
<tr>
<td>UINFL</td>
<td>0.000</td>
<td>0.003</td>
<td>0.010</td>
<td>-0.010</td>
<td>0.128</td>
<td>0.552</td>
<td>1.95</td>
<td>12.05*</td>
</tr>
<tr>
<td>SIR</td>
<td>0.014</td>
<td>0.019</td>
<td>0.059</td>
<td>-0.001</td>
<td>1.548</td>
<td>0.503</td>
<td>23.60***</td>
<td>559.91***</td>
</tr>
<tr>
<td>INTRTS</td>
<td>0.022</td>
<td>0.015</td>
<td>0.041</td>
<td>-0.011</td>
<td>-0.896</td>
<td>-0.332</td>
<td>11.52**</td>
<td>530.38***</td>
</tr>
<tr>
<td>M2G</td>
<td>0.052</td>
<td>0.017</td>
<td>0.092</td>
<td>0.021</td>
<td>0.302</td>
<td>-0.391</td>
<td>2.74</td>
<td>374.16***</td>
</tr>
<tr>
<td>XCHG</td>
<td>0.017</td>
<td>0.071</td>
<td>0.268</td>
<td>-0.090</td>
<td>1.486</td>
<td>2.371</td>
<td>28.47***</td>
<td>335.05***</td>
</tr>
</tbody>
</table>

Notes: ***, ** and * indicate two-tailed significances at 1%, 5% and 10% level, respectively. GDPG = growth in gross domestic product, INDPG = growth in UK Index of Production, UINFL = unexpected inflation, SIR = short-term interest rate, INTRTS = interest rate term spread, M2G = change in money supply and XCHG = change in exchange rate.
**TABLE 4**
Spearman correlation matrix of the macroeconomic variables

<table>
<thead>
<tr>
<th></th>
<th>GDPG</th>
<th>INDPG</th>
<th>UINFL</th>
<th>SIR</th>
<th>INTRTS</th>
<th>M2G</th>
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<tr>
<td>Jan, 1990 - Dec, 2006</td>
<td></td>
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<tr>
<td>INDPG</td>
<td>0.047</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>UINFL</td>
<td>0.106</td>
<td>-0.013</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIR</td>
<td>0.145**</td>
<td>0.112</td>
<td>0.003</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRTS</td>
<td>-0.147**</td>
<td>0.311***</td>
<td>-0.094</td>
<td>-0.413***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M2G</td>
<td>0.140**</td>
<td>-0.437***</td>
<td>0.128*</td>
<td>-0.276***</td>
<td>-0.122*</td>
<td></td>
</tr>
<tr>
<td>XCHG</td>
<td>-0.154***</td>
<td>0.056</td>
<td>0.069</td>
<td>0.036</td>
<td>0.114</td>
<td>0.089</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>GDPG</th>
<th>INDPG</th>
<th>UINFL</th>
<th>SIR</th>
<th>INTRTS</th>
<th>M2G</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDPG</td>
<td>0.334***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UINFL</td>
<td>0.082</td>
<td>0.058</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIR</td>
<td>0.164*</td>
<td>-0.039</td>
<td>0.169*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTRTS</td>
<td>-0.452***</td>
<td>-0.032</td>
<td>-0.035</td>
<td>-0.291***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M2G</td>
<td>0.620***</td>
<td>0.158*</td>
<td>0.252***</td>
<td>0.317***</td>
<td>-0.552***</td>
<td></td>
</tr>
<tr>
<td>XCHG</td>
<td>0.486***</td>
<td>-0.325***</td>
<td>-0.010</td>
<td>0.115</td>
<td>0.067</td>
<td>-0.294**</td>
</tr>
</tbody>
</table>

Notes: ***, ** and * indicate two-tailed significance at 1%, 5% and 10% level, respectively.

### 4. Research methodology

This study uses standard multifactor asset pricing model to analyse the relationship between property returns and macroeconomic factors. The model assumes that there are several sources of economic risk, which predict real estate returns, and is consistent with the popular linear asset pricing models, such as the arbitrage pricing model (Ross, 1976). In the model, the property returns are represented by the excess property stock returns as well as by the estimated real estate industry effect.

Ordinary Least Square (OLS) is used to estimate the equation (10), which explains the impact of seven pre-specified macroeconomic variables on excess property returns. Lag period of one was used in the independent variables to test the predictive power of the variables. The basis for the chosen one-month lag is that the independent variables use observations up to 13 months prior to the return series, implying that longer lag period than one would not any more reflect recent changes in the macroeconomy. Following Ito (2013), serial correlation and heteroscedasticity of $e_t$ are adjusted by using the Newey-West estimator, first introduced by Newey and West (1987), with lag period of 12.
\[ ER_{FEUTDKL,t} = \alpha + \beta_{GDP}GDP_{t-1} + \beta_{INDP}INDP_{t-1} + \beta_{UINFL}UINFL_{t-1} + \beta_{SIR}SIR_{t-1} + \beta_{INTRTS}INTRTS_{t-1} + \beta_{M2G}M2G_{t-1} + \beta_{XCHG}XCHG_{t-1} + \epsilon_t, \]  

(10)

where \( ER_{FEUTDKL} \) is the excess FTSE EPRA/NAREIT UK Total Return Index return, \( GDP \) is the growth in GDP, \( INDP \) is the growth in the UK Index of Production, \( UINFL \) is the unexpected inflation, \( SIR \) is the three-month Treasury bill yield, \( INTRTS \) is the term spread between the 20-year government bond yield and three-month Treasury bill yield, \( M2G \) is the change in M2 and \( XCHG \) is the change in exchange rate between UK£ and the SDR currency basket.

To control the effect of contemporaneous stock market movements, OLS is used to estimate the equation (11). This equation uses the estimated real estate industry effect, namely the residuals of the regression of the excess FTSE EPRA/NAREIT UK Total Return Index returns on the excess FTSE All-Share Total Return Index returns, denoted \( PROPRES \), as dependent variable and the same independent variables as in the equation (10). Similarly to the equation (10), lag period of one was used in the independent variables, and the Newey-West estimator with lag period of 12 was used to adjust serial correlation and heteroscedasticity of \( \epsilon_t \).

\[ PROPRES_t = \alpha + \beta_{GDP}GDP_{t-1} + \beta_{INDP}INDP_{t-1} + \beta_{UINFL}UINFL_{t-1} + \beta_{SIR}SIR_{t-1} + \beta_{INTRTS}INTRTS_{t-1} + \beta_{M2G}M2G_{t-1} + \beta_{XCHG}XCHG_{t-1} + \epsilon_t, \]  

(11)

where \( PROPRES \) is the estimated real estate industry effect.

**5. Results**

**5.1. Results of the OLS regression analysis**

Table 5 shows the results of the OLS regression analysis on both sub-sample periods. Overall, the results do not show many statistically significant macroeconomic variable loadings and are mainly consistent between the impacts on the excess returns, denoted \( ER_{FEUTDKL} \), and on the real estate industry effect, denoted \( PROPRES \). The analysis reveals statistically significant evidence at one or five percent level that the movements in short-term interest rate tend to have negative impact on future property returns during both sub-sample periods. In addition, some evidence is found that the increase in money supply tends to have positive effect on property returns during the first sub-sample period. Concerning the other macroeconomic variables, the analysis does not show any significant evidence that the growth in GDP, growth in industrial production, unexpected inflation, interest rate term structure or changes in
exchange rate would have predictive impact on property returns. All these findings are consistent between the impact on excess returns and on the industry effect.

A comparison of the sub-sample periods indicates that the predictive power of short-term interest rates has remained significant also during the recent macroeconomic shifts, and the impact level has possibly even increased after the start of the financial crisis, as the variable loading is higher with both dependent variables, the excess return and the industry effect. The evidence of the positive predictive impact of changes in money supply is significant at five or ten percent level during the earlier period, but the evidence disappears during the after the start of the financial crisis period.

5.2. Discussion and further analysis

Because of common finance theory, the findings of the analysis are mainly not surprising. The initial hypothesis was that the pre-specified macroeconomic variables should not have explanatory power to future property returns. The results mostly agree that the excess property returns are hard to be explained by these pre-specified variables. The findings are consistent with Brooks and Tsolacos (1999), who concluded that identifying correct factors that determine excess property returns over time is not clear.

The significance of short-term interest rate changes is consistent with many previous real estate studies, including Liow et al. (2003) and McCue and Kling (1994). In the basis of the results, it is possible that the impact level has even increased during the later sub-sample period. However, the change in impact level must be further empirically tested before making strong assumptions based on the results. In the context of explaining property returns, short-term interest rates can be seen as strong indicators of the future state of economy. Based on the results, when interest rates decline, property stocks face positive impact with one month lag; this is consistent with the purpose of monetary policy to achieve investments and gain economic growth by helping debt service and increasing lending.

Liow et al. (2006) find some evidence of positive money supply increase impact on expected property returns in Japan. The background for the positive impact disappearance in the results might be because of the overall monetary policy changes in the UK. On average, the money supply growth has been lower during the later sub-sample period than during the earlier sub-sample period. In addition, as the low interest rates have been in the centre of discussion regarding monetary policy during the recent years, the impact level of money supply might have decreased as a result. However, as the impact during the earlier period is significant only in five or ten percent level, also this impact must be further researched before making strong assumptions.
Results of the OLS regression analysis

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ER(_{FEUTDKL})</td>
<td>PROPRES</td>
</tr>
<tr>
<td>(\alpha)</td>
<td>0.000</td>
<td>-0.005</td>
</tr>
<tr>
<td></td>
<td>(-0.03)</td>
<td>(-0.36)</td>
</tr>
<tr>
<td>(\beta_{GDPG})</td>
<td>0.552</td>
<td>4.278</td>
</tr>
<tr>
<td></td>
<td>(0.13)</td>
<td>(1.11)</td>
</tr>
<tr>
<td>(\beta_{INDPG})</td>
<td>0.066</td>
<td>-0.060</td>
</tr>
<tr>
<td></td>
<td>(0.29)</td>
<td>(-0.37)</td>
</tr>
<tr>
<td>(\beta_{UINFL})</td>
<td>-0.903</td>
<td>-1.179</td>
</tr>
<tr>
<td></td>
<td>(-0.88)</td>
<td>(-1.20)</td>
</tr>
<tr>
<td>(\beta_{SIR})</td>
<td>-0.388</td>
<td>-0.465</td>
</tr>
<tr>
<td></td>
<td>(-1.99)**</td>
<td>(-2.78)**</td>
</tr>
<tr>
<td>(\beta_{INTRTS})</td>
<td>0.296</td>
<td>0.123</td>
</tr>
<tr>
<td></td>
<td>(1.12)</td>
<td>(0.49)</td>
</tr>
<tr>
<td>(\beta_{M2G})</td>
<td>0.325</td>
<td>0.246</td>
</tr>
<tr>
<td></td>
<td>(1.94)*</td>
<td>(1.96)**</td>
</tr>
<tr>
<td>(\beta_{XCHG})</td>
<td>0.053</td>
<td>0.073</td>
</tr>
<tr>
<td></td>
<td>(0.87)</td>
<td>(1.54)</td>
</tr>
<tr>
<td>(R^2)</td>
<td>0.09</td>
<td>0.11</td>
</tr>
<tr>
<td>Adj. (R^2)</td>
<td>0.06</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Notes: Values in the parenthesis are t-statistics. ***, ** and * indicate two-tailed significances at 1%, 5% and 10% levels, respectively. Serial correlation and heteroscedasticity of error terms are adjusted by the method of Newey and West (1987). ER\(_{FEUTDKL}\) = excess FTSE/EPRA NAREIT UK Total Return Index return, PROPRES = estimated real estate industry effect, GDPG = growth in gross domestic product, INDPG = growth in the UK Index of Production, UINFL = unexpected inflation, SIR = short-term interest rate, INTRTS = interest rate term spread, M2G = change in money supply and XCHG = change in exchange rate.

### 6. Conclusion

In this thesis, the predictive impact of seven different macroeconomic risk factors on UK property returns is analysed using a standard multifactor asset pricing model. These factors include the growth in GDP, the growth in industrial production, the unexpected inflation, the short-term interest rate, the interest rate term structure, the change in money supply and the change in exchange rate. In addition,
the total sample period from January 1990 to August 2016 is divided into two sub-sample periods around the turn of 2006 to 2007. This separation is done to divide the total sample into before and after the start of the financial crisis periods and to compare the magnitudes of the variable predictive power within the changed macroeconomic conditions.

The results are not strongly suggestive of any significant changes in the macroeconomic predictability between periods before and after the start of the financial crisis. The results indicate that the predictive impact of short-term interest rate movements on property returns has remained significant throughout the whole sample period. In addition, some evidence is found that the change in money supply has had positive effect on future property returns prior to the financial crisis period; however, this evidence disappears during the later sub-sample period. Concerning the other macroeconomic variables, any significant explanatory power to property returns is not found.

The findings are mainly consistent with Brooks and Tsolacos (1999), who conclude that UK real estate returns are hard to predict based on the information contained in macroeconomic variables. As the existing real estate literature has provided conflicting results of the effects originating from the same macroeconomic variables used in this study, it can be stated that the findings are not in the opposite direction with the earlier studies. The conflicting results of earlier studies might be caused by the use of different methodologies, different return series or different sample periods. However, an important aspect of this study is the recent knowledge of macroeconomic impact on property returns; even though the macroeconomic conditions have changed after the financial crisis, short-term interest rates still seem to lead the property stock market. This finding helps investors to further understand the risk-return relationship in real estate markets.

This study makes use of seven macroeconomic risk factors by employing a standard multifactor asset pricing model. The study could be extended with the use of different econometric techniques, such as non-linear regression models or vector autoregressive models, or by the use of other pre-specified macroeconomic variables, such as unemployment rate and consumption. In addition, further areas of research could include investigating whether the predictability of returns could enable investors to earn excess trading profits in real estate markets.
References


