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Testing Commercial Real Estate Factors

Supervisor: Prof. Dr. Roland Füss

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Samuel de Montmollin
Student ID: 13-613-534
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Abstract

I test a set of 21 candidate risk factors on the returns of privately owned commercial real estate in the US from 1978 to 2018. I use a bottom-up sequential approach to build a linear model which keeps the risk factors that are important in explaining the cross-section of returns. The results I find suggest that the most important risk factor is the real estate market risk premium as it is the candidate which most reduced the mispricing error in the iterations of the approach I use. I do not find concrete evidence of another important risk factor. In a second part, I attempt to get a deeper understanding of the real estate market risk premium. I find that the change in unemployment rate significantly explain the variation of it.

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Index of Abbreviations

AMEX	American Stock Exchange
CAPEX	Capital Expenditure
CAPM	Capital Asset Pricing Model
CBSA	Core Based Statistical Area
CEI	Change in Expected Inflation
CFU	Change in Financial Uncertainty
CMA	Conservative Minus Aggressive
CMS	Change in Money Supply
CMU	Change in Macroeconomic Uncertainty
COP	Change in Oil Price
CPI	Consumer Price Index
CSP	Change in Credit Spread
CUI	Change in Unexpected Inflation
CUR	Change in Unemployment Rate
ECO	Economic PCA Factor
FRED	Federal Reserve Economic Data
GDP	Growth Domestic Product
GRS	Gibbons, Ross and Shanken
HML	High Minus Low
LASSO	Least Absolute Shrinkage and Selection Operator
LIQ	Liquidity Risk Factor
MKT	Market Risk Factor
MOM	Momentum Risk Factor
MV	Market Value
NCREIF	National Council of Real Estate Investment Fiduciaries
NOI	Net Operating Income
NPI	NCREIF Property Index
NYSE	New York Stock Exchange
PCA	Principal Component Analysis
PEC	Personal Consumption Expenditure
PRI	Price PCA Factor
RCG	Relative Change in GDP
REIT	Real Estate Investment Trust
REM	Real Estate Market Risk Factor
RMW	Robust Minus Weak
SMB	Small Minus Big
TSP	Change in Term Spread

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1. Introduction

There have been over 400 risk factors published in financial journals that explained equity risk premiums (Harvey & Liu, 2019a). Recent literature suggests that many of them are likely false as they have been subject of data mining (Harvey & Liu, 2019b, Welch & Goyal, 2008). By using a sequential approach and controlling for multiple testing, Harvey & Liu (2019b) find only 3 important risk factors for US stock market returns. Similar trends are observed in the UK's (Fletcher, 2019) and Australian's (Hoang et al., 2019) stock markets.

Although smaller, financial literature has also explored which risk factors explain the cross-section of privately owned commercial real estate. For example, Ling and Naranjo (1997) find a linear macroeconomic four-factor model with the consumption, interest rate, term spread and unanticipated inflation as the risk factors. More recently, Peng (2016) tests the most popular financial risk factors and finds evidence of a relationship between the credit spread, term spread, liquidity (Pastor and Stambaugh, 2003), stock market risk premium, size and value factors (Fama & French 1993) and the commercial real estate returns. In total, I find in the published literature fourteen risk factors which have been linked to commercial real estate returns.

In this paper, I test the risk factors of privately owned commercial real estate in the USA by using the sequential approach developed by Harvey and Liu (2019b). This testing framework is a bottom-up approach, meaning that it starts from the hypothesis that no risk factors are significant. At every step, the framework adds a risk factor to the baseline hypothesis if it is significant. The measure I use to determine which risk factors contributes the most to explaining the cross-section of returns is determined by the pricing error. More precisely, it is the risk factor which reduces the most the intercept of the regression between the baseline and the augmented model scaled by the standard error of the baseline model. The significance of this measure is drawn from a simulation where the iterations are bootstrapped from the historical data. Furthermore, to control for the data mining bias, a multiple test is calculated at each step of the testing framework.

I compute the commercial real estate returns from a dataset provided by the National Council of Real Estate Investment Fiduciaries (NCREIF). It contains quarterly data from Q1 1978 to Q4 2018 and is segmented by property type which include apartment, office, industrial and retail. I test twenty-one candidate risk factors which are chosen because they have already been tested for commercial real estate or because they a prevalent risk factor in other fields of empirical asset pricing. Two factors, the real estate quality and size, which are found in the commercial real estate literature (Peng, 2019) are not tested in this thesis due to the unavailability of the data. I perform the test on the full dataset, on a subset from 2009 to 2018 to control for the incompleteness stemming from the full dataset and on a subset from 2008 to 2018 including the financial crisis of 2008.

I find strong empirical evidence suggesting that the real estate market risk premium significantly helps explain the cross-section of commercial real estate returns. Indeed, when looking at the commercial real estate market as a whole, I find the real estate market premium to be significant in all variation of the testing framework and I find little evidence supporting any of the other thirteen risk factors stemming from the academic literature. If I look at the property types separately, I find varying results depending on which dataset I use. For all property types from 2009 to 2018, the real estate market risk premium is the lone significant risk factor. However, with the full dataset from 1978 to 2018, I find that the momentum factor is significant for the apartment property type and that the relative change in the growth domestic product (GDP) is significant for the office property type. For the industrial property type, I find no evidence of a significant risk factor from 1978 to 2018. Overall, the results I find strongly suggests the existence of a real estate risk premium which is in line with past findings (Mai and Lee, 1994).

In the second part of this paper I also perform a least absolute shrinkage and selection operator (LASSO) regression to determine the drivers of the real estate risk premium. I attempt to find macroeconomic and financial variable to explain the variations in the risk premium. I find that the change in unemployment rate is the lone significant driver of the real estate risk premium. As it is not a risk factor tested in academic literature, I fail to link, in a meaningful way, any of the stock market risk factors and macroeconomic risk factors to the cross-section of asset returns in commercial real estate. An explanation for the lack of evidence supporting stock market and macroeconomic risk factors is the strong performance of the real estate market risk premium in the tests. Indeed, as the testing framework includes a multiple test, a risk factor which strongly contributes to the explanation of the cross-section of returns sets the bar higher for any other risk factor to be significant.

The implication of the results I find are twofold. First, as suggested by Mai and Lee (1994), investors should consider adding a diversified holding of private real estate to capture the real estate market risk premium. Second, as the only significant risk factor which is constantly significant across the different time periods tested and across the property types, with some exception[1], is the real estate market risk premium, my paper joins the growing body of research which suggests that only a few risk factors significantly explain risk premiums (Harvey and Liu, 2019b).

This paper is organised as follows, Section 2 is a review of the literature relevant to the topic and outlines the risk factors which have been linked to commercial real estate returns. Section 3 discusses the data. Section 4 describe the methodology used. Section 5 presents and discusses the empirical results. Section 6 investigates the drivers of the real estate market risk premium. Finally, Section 7 concludes.

2. Literature Review

2.1. Risk factors

Risk factors stem from financial research trying to explain variations in the cross-section of asset returns. The first finding of risk factor can be traced to the discovery of the market risk premium with the capital asset pricing model (CAPM) (Sharpe, 1966). Later papers described the empirical limitations of the CAPM and suggested the existence of other variables with predictive power over asset returns (e.g. Black, Jensen & Scholes, 1972). For stocks, two anomalies were discovered and are still relevant today. First, the size anomaly by which stocks of companies with low market equity have on average higher returns than stock of companies with high market equity (Banz, 1981). Second, the value anomaly by which stocks with high book-to-market equity ratios have on average higher returns than stocks with low book-to-market ratios (Fama & French, 1992).

These findings led to the formalization of factor models. Fama and French (1993) calculate the difference of monthly returns of a portfolio of small stocks minus a portfolio and big stocks (*SMB*) and the difference of monthly returns of a portfolio of stocks with high book-to-market ratios minus a portfolio of stocks with low book-to-market ratios (*HML*). Then, by using time-series regressions of the monthly returns on the market risk premium, the HML and SMB returns, the authors find significant factor loadings (betas) for all three. Thus, they conclude that the size and value factors significantly improve the CAPM in explaining the cross-section of asset returns. In a later paper, Fama and French (2015) add two factors to their original model:

[1] The case of the industrial property type from 1978 to 2018 is an example in which I do not find any significant risk factors.

profitability and investment. The former is proxied by the difference of monthly returns between a portfolio of robust stock (high profitability) and a portfolio of weak stock (low profitability) (*RMW*). The latter is proxied by the difference of monthly returns between a portfolio of conservative stock (low investment) and a portfolio of aggressive stocks (high investment) (*CMA*). The average pricing error of the five-factor model is 0.10% per month compared to 0.13% for the three-factor model and thus is a significant improvement of the explanatory power of the model (Fama & French, 2015).

Another popular risk factor found in the academic literature is the momentum factor. Jegadeesh and Titman (1993) find that stocks with higher past short-term returns on average outperform stocks with lower past short-term returns. Carhart (1997) extends the Fama and French (1993) three-factor model with a fourth factor, the momentum, which captures the anomaly found by Jegadeesh and Titman (1993). He finds that the extra factor substantially improves Fama and French's (1993) three-factor model by capturing a significant portion of the missed cross-sectional variation and therefore improves the explanatory power of the model (Carhart, 1997).

The risk factors discussed so far can be classified as fundamental risk factors as there explain anomalies in the returns and risks of assets. On the other hand, macroeconomic risk factors test whether an asset's financial performance is affected by the innovations in macroeconomic variables (Chen, Roll & Ross, 1986). In this case, the factor loadings measure the sensitivity of an asset to the macroeconomic risk. Using the Fama and Macbeth (1973) procedure, Chen, Roll and Ross (1986) find that the spread between long and short interest rates, the expected and unexpected inflation, industrial production and the credit spread have a significant impact on the pricing of assets in the stock market. They also find that change in oil prices is not a priced risk factor in the stock market. Interestingly, the authors find that the market risk premium has a non-significant impact on pricing when macroeconomic variables are accounted for.

Most of the academic literature focuses on explaining the equity risk premiums. However, some studies have been made on risk factors in commercial real estate and publicly traded real estate.

2.2 Risk Factors in Commercial Real Estate

Due to the scarce availability of observations of market value, most studies for privately owned real estate use aggregated data at fund or index level or use appraisal based data. Furthermore, commercial real estate is a non-traded asset which presents an econometric hurdle (Peng, 2016). By using fund data from 1972 to 1983, Brueggeman, Chen and Thihodeau (1983) find, in a CAPM framework, that real estate returns are positively and significantly correlated with the inflation rate but have an insignificant market beta. However, Geltner (1989) finds a positive sensitivity to national consumption using the appraisal-based indices Frank Russel Company and Prudential Property Investment Separate Account. With appraisal values of 403 properties from 1973 to 1983, Hartzell, Hekman and Miles (1986) find no significant correlation with equity returns, a significant and negative correlation with bond returns and a positively significant correlation with inflation. Goetzmann and Ibbotson (1990) find a positive relation to interest rates and no relation to stock returns with appraisal-based returns. Mei and Lee (1994), use the Russell-NCREIF appraisal based index and find that the presence of a real estate market factor which suggests that an investor needs exposure to real estate to earn this market premium. In a study from 1978 to 1994, Ling and Naranjo (1997) analyse the “unsmoothed” NCREIF appraisal-based returns to test economic risk factors. They find negative coefficients the term spread, unanticipated inflation and real T-bill rate and a positive coefficient for the consumption growth. In a later paper, Ling and Naranjo (1999) find that commercial real estate returns are not integrated with the stock market. However, they find that both the commercial real estate returns and the stock market returns are, at least partially, explained by the growth rate in real per capita consumption.

More recently, Peng (2016) uses a cross-sectional approach for estimating factor loadings with a sample of 14,115 properties from 1977 to 2012. This approach considers each investment as a realization of returns and thus uses the variation between the investments to estimate the factor loadings. He finds positive loadings for the stock market, the size, the liquidity and the credit spread factors and negative loadings for the book-to-market and the term spread factors. In further studies, Peng (2019) finds that the quality (net operating income per square foot) and the deal size of property are related to real estate’s returns. Indeed, properties tend to have higher abnormal returns when the quality is higher, and the deal size is lower. Peng and Zhang (2018) analyse the systematic risk of about 6 million repeat sales properties in the USA between 2000 and 2015 to find that pricier houses tend to have lower stock market betas. This result holds before and after the financial crisis of 2007-08.

Studies on publicly traded real estate, Real Estate Investment Trusts (REIT), provide some evidence of risk factors in commercial real estate. Although REITs do not behave in the same way than privately owned real estate (e.g. Anderson, Clayton, MacKinnon, & Sharma, 2005), some studies merit to be highlighted. Using factor models, Li (2016) finds that REITs returns are related to their own volatility and to the covariance with the Fama-French factors suggesting that REITs are compensated for risks associated with the general stock market. Further, Bond and Xue (2017) show that the investment and profitability factors are predictive of REIT returns, Chui, Titman and Wei (2003) find a momentum effect for REITs and Bond, Karolyi and Sanders (2003), find that country-specific factors have strong explanatory power worldwide.

The risk factors of commercial real estate returns are summarized in **table 1**.

2.3 Testing Risk Factors

Fama and MacBeth (1973) developed an empirical test for risk factors. The test is designed as a two-pass regression. First, the beta coefficients are estimated for each stock in the sample through a time-series regression. Second, a cross-sectional regression acts as a test equation in which the excess returns are regressed on the beta coefficients found in the first pass. If the factor is true, a few predictions can be made. For example, in a CAPM framework, the intercept of the second pass regression should not be significantly different from zero and the coefficient of the betas should be the market risk premium. Other assumptions include the linearity of the relationship (if the beta squared are included in the second pass, the coefficient should be 0) and other factors should not have significant explanatory power (in a CAPM framework). Roll (1977) provides some critic of this method suggesting that the grouping of assets done through Fama and Macbeth's (1973) approach (assets are usually put into portfolios) reduces the power of the regression test.

Gibbons, Ross and Shanken (1989) provide another framework to test risk factors by means of a test statistic (GRS). GRS tests the hypothesis that all alphas (the intercepts) are equal to zero. In short, it is a test performed after the first pass of the Fama and Macbeth (1973) approach as it uses the residual matrix from the time-series regressions. There are several issues with the GRS stemming from the use of a large cross-section of assets relative to the time dimension which this paper features as the observations are quarterly. Indeed, the GRS statistics is unusually large when the cross-sectional dimension is large, which means that the test would reject most factor models (Harvey and Liu, 2019b). Furthermore, the big cross-section of asset leads to difficulties in the estimation of the residual covariance matrix (Harvey and Liu, 2019b). Therefore, this paper will focus on a set of test statistics proposed by Harvey and Liu (2019b) that are inspired by the GRS statistics but not as dependent on the residual covariance matrix. An added benefit from the use of Harvey and Liu (2019b) test statistics is the augmented economic interpretability as the GRS test statistics imply short positions for certain assets which in the case of commercial real estate is unrealistic.

In explaining the cross-section of expected returns for equities, the academic literature has accumulated many factors. Harvey, Liu and Zhu (2016) find a total of 316 factors discovered by academia while Harvey and Liu (2019a) find over 400. It is highly likely that not all of them are true risk factors. Indeed, Welch and Goyal (2008) find that most models fail at predicting equity premium both in-sample and out-of-sample suggesting that, at the time, most models were unstable and spurious. Furthermore, Mclean and Pontiff (2016) find, by using an out-of-sample approach that investors learn about the mispricing from academia and thus the anomaly becomes priced in the asset and disappears. Although not as many risk factors have been discovered in the commercial real estate literature, the above papers show that the review of all factors in a multiple testing framework is needed.

Another aspect that may have led to finding falsely significant risk factors is the methodology used. For example, Lewellen, Nagel and Shanken (2010) show that many documented factors are spurious as the use of the cross-sectional R-Squared and pricing error as test statistics may be misleading. Harvey, Liu and Zhu (2016) argue for the use of higher statistical significance cut-offs from a t-statistic exceeding 2 to a t-statistic exceeding 3 (p-value of 0.27%) as the cost of data mining has significantly decreased and that the "easy" factors to discover have already been discovered meaning the rate of discovery should decrease. Their paper concludes that many discovered factors are likely false. Furthermore, data dredging (or data snooping, p-hacking), the process of testing patterns until one is significant (knowingly or unknowingly), increases the risk of finding false positives. Hou, Xue and Zhand (2018) find, through a replication study, that many discovered anomalies have been data dredged.

In the light of the recent literature concerning risk factors in equity markets, it is important that this paper addresses multiply testing, variable selection and test dependence in the context of regression models. This paper will focus on the testing framework proposed by Harvey and Liu (2019b) as it simultaneously addresses the issues discussed above.

Table 1**: Commercial Real Estate Risk Factors in Academic Literature**

This table presents a summary of the risk factors found in privately traded commercial real estate. There are three types of risk factors: macroeconomic which are economic indices, financial which are built from return series and real estate which represent factors derived from the characteristics of a property.

Risk Factor	Type	Date	Authors	Paper
Inflation Rate	Macroeconomic	1984	Brueggeman, Chen & Thihodeau	Real Estate Investment Funds: Performance and Portfolio Considerations
		1986	Hartzell, Hekman & Miles	Diversification Categories in Investment Real Estate
Consumption	Macroeconomic	1989	Geltner	Estimating Real Estate's Systematic Risk from Aggregate Level Appraisal-Based Returns
		1997	Ling & Naranjo	Economic Risk Factors and Commercial Real Estate Returns
		1999	Ling & Naranjo	The Integration of Commercial Real Estate Markets and Stock Markets
Bond returns	Financial	1986	Hartzell, Hekman & Miles	Diversification Categories in Investment Real Estate
Interest Rates	Macroeconomic	1990	Goetzmann & Ibbotson	The Performance of Real Estate as an Asset Class
		1997	Ling & Naranjo	Economic Risk Factors and Commercial Real Estate Returns
Real Estate Market Risk Premium	Real Estate	1994	Mei & Lee	Is There a Real Estate Factor Premium?
Term Spread	Macroeconomic	1997	Ling & Naranjo	Economic Risk Factors and Commercial Real Estate Returns
		2016	Peng	The risk and return of commercial real estate: A property level analysis
Unanticipated Inflation	Macroeconomic	1997	Ling & Naranjo	Economic Risk Factors and Commercial Real Estate Returns
Stock market risk premium	Financial	2016	Peng	The risk and return of commercial real estate: A property level analysis
Size (stock market)	Financial	2016	Peng	The risk and return of commercial real estate: A property level analysis
Liquidity	Financial	2016	Peng	The risk and return of commercial real estate: A property level analysis
Credit Spread	Macroeconomic	2016	Peng	The risk and return of commercial real estate: A property level analysis
Value (stock market)	Financial	2016	Peng	The risk and return of commercial real estate: A property level analysis
Quality (real estate)	Real Estate	2019	Peng	Quality, Deal Size and Investment Returns of Commercial Real Estate
Size (real estate)	Real Estate	2019	Peng	Quality, Deal Size and Investment Returns of Commercial Real Estate

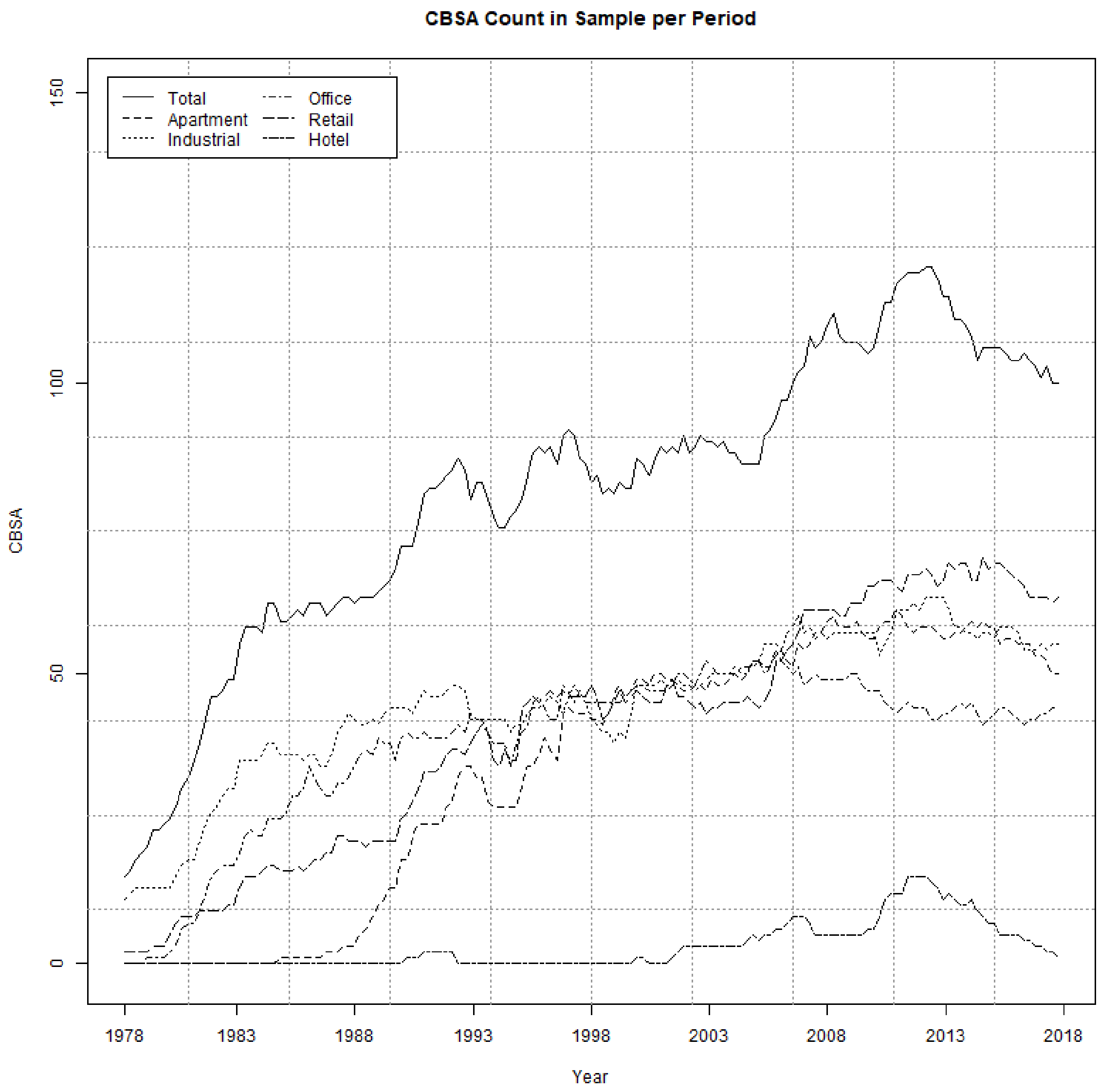
3. Data

3.1 Commercial Real Estate Returns

The commercial real estate data I use in this paper is provided by the NCREIF which is a not-for-profit association that collects, processes and distributes commercial real estate information. The database I use contains quarterly data from Q1 1978 to Q4 2018. It is split in Core Based Statistical Areas (CBSA). A CBSA is one or more counties with an urbanized area of at least 10’000 people. The USA has 147 CBSA in total. From each CBSA, the information contained in the database is the period, the total Net Operating Income (NOI) of all properties in the CBSA in the sample at the given period, the total Capital Expenditure (CAPEX) of all properties in the CBSA in the sample at the given period, the total Market Value (MV) of all properties in the CBSA in the sample at the given period, the average income and capital return of all the sample properties in the CBSA at the given period, and the number of properties in the sample of a given CBSA and period. The database is split by property type including apartment, office, industrial, retail and hotel. All variables are on an unlevered basis.

The data is incomplete, meaning that for every period and for every CBSA there is not necessarily an observation. This is due to the nature of the NCREIF database as it includes the properties owned or managed by its members. The dataset I use requires that at least 3 properties be in the sample for a CBSA at a specific period. **Figure 1** shows the number of CBSA in the sample at each period for all properties type and for the aggregation of all property types. An important observation to make is that the data is unbalanced as the number of CBSA in the sample increase with time. This means that the results obtained from a regression using the entire dataset may be biased as the observations in the early years are too few. To control for this bias, I will also run the analysis on a balanced dataset which goes from 2009 to 2018. Extending it further than that would significantly reduce the cross-section of CBSA in the sample. Indeed, even though the number of CBSA seem to only marginally increase from 1998 to 2008 for all property types (expect total), it is not the same ones that are present across the sample. Thus, increasing the time dimension by 10 years would result in a loss in the cross-section of 25%. Based on tests, taking a 9 year sample seems to be the optimal trade-off as it satisfies the minimum requirement to run the algorithm of 36 observations (Harvey & Liu, 2019b).

Figure 1: **CBSA Count**
This graph shows the count of CBSA included in the sample at each period and for every property type. The data covers the range from 1978 to 2018 and is provided by NCREIF.



Another observation from **figure 1** is the very low number of observations for the hotel property type. Including it would not make sense as the results would not be reliable. Hence, I do not include hotels in this paper. The dataset only starts in 1984 for the apartment property type and in 1979 for the office property type giving the samples a total of 136 and 159 time periods respectively instead of 163 for the others. The dataset containing all the property types has an extra period (164) as the property type datasets do not have observations for Q4 of 2018. In the analysis with the balanced dataset, the 36 observations are from Q4 2009 to Q3 2018 for all cases including the aggregated one.

For the testing, I examine the excess total return of commercial real estate. I use the one month US Treasury Bill as the risk-free rate. **Table 2** contains the descriptive statistics of the returns by property type and for the entire dataset.

Table 2: **Descriptive Statistics (full dataset)**

This table presents basic descriptive statistics for the real estate excess total returns used in this research. It includes the entire NCREIF dataset from 1978 to 2018. It is sorted by property type with the first row "Total" being all the property types combined. The summary statistics are computed on the average returns of all the CBSA at every period.

Panel A: Summary Statistics

	N	Mean	St. Dev.	Min	Max
Total	164	1.09%	1.76%	-7.27%	4.46%
Apartment	136	1.18%	2.09%	-7.71%	5.78%
Industrial	163	1.16%	1.89%	-7.39%	6.37%
Office	159	0.71%	2.27%	-7.70%	6.01%
Retail	163	1.22%	1.98%	-7.41%	5.87%

Panel B: Correlation Matrix

	Total	Apartment	Industrial	Office	Retail
Total	1				
Apartment	0.86	1			
Industrial	0.95	0.81	1		
Office	0.89	0.79	0.89	1	
Retail	0.88	0.71	0.78	0.72	1

From 1978 to 2018 the average quarterly excess returns for commercial real estate are situated between 0.71% (office) and 1.22% (retail) with the standard deviation varying between 1.89% (industrial) and 2.27% (office). The returns of all property types are strongly correlated with each other with coefficients above 0.78 except for Retail-Apartment and Retail-Office where the coefficients are 0.71 and 0.72 respectively. Therefore, the expectation should be to find little variation in the significant risk factors between the property types. However, some variation should still be expected as I analyse the CBSAs individual returns and not the property types as whole.

Table 3 presents the descriptive statistics for the balanced dataset going from 2009 to 2018. The correlation is still quite high between the property types average excess returns except for the Industrial-Apartment (0.49) and Industrial-Retail (0.57) combinations. The average excess returns are higher across the board due to the risk-free rate being much lower and the standard deviation is lower. The downside of the use of a balanced dataset is the reduction in the cross-section's size as demonstrated by the CBSA column which shows the dimension of the cross-section for every property type. The purpose of the balanced dataset is to control for a potential bias arising from the unbalanced dataset used in the analysis performed with the whole NCREIF dataset.

Table 3: **Descriptive Statistics (balanced dataset)**

This table presents basic descriptive statistics for the real estate excess total returns used in this research. It includes a balanced dataset from 2008 to 2018 extracted from the NCREIF dataset. It is sorted by property type with the first row "Total" being all the property types combined. The summary statistics are computed on the average returns of all the CBSA at every period.

Panel A: Summary Statistics

	CBSA	N	Mean	St. Dev.	Min	Max
Total	83	36	2.31%	1.00%	-1.82%	3.96%
Apartment	42	36	2.60%	1.40%	-1.88%	6.11%
Industrial	45	36	2.59%	1.12%	-2.78%	3.80%
Office	37	36	1.86%	1.16%	-3.75%	3.12%
Retail	48	36	2.37%	1.16%	-0.97%	4.31%

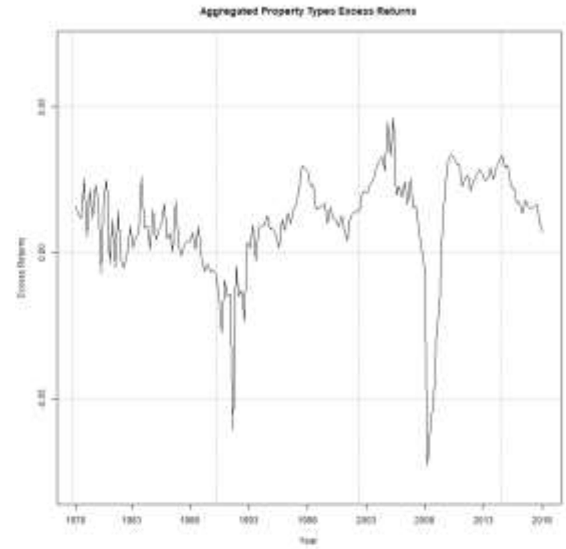
Panel B: Correlation Matrix

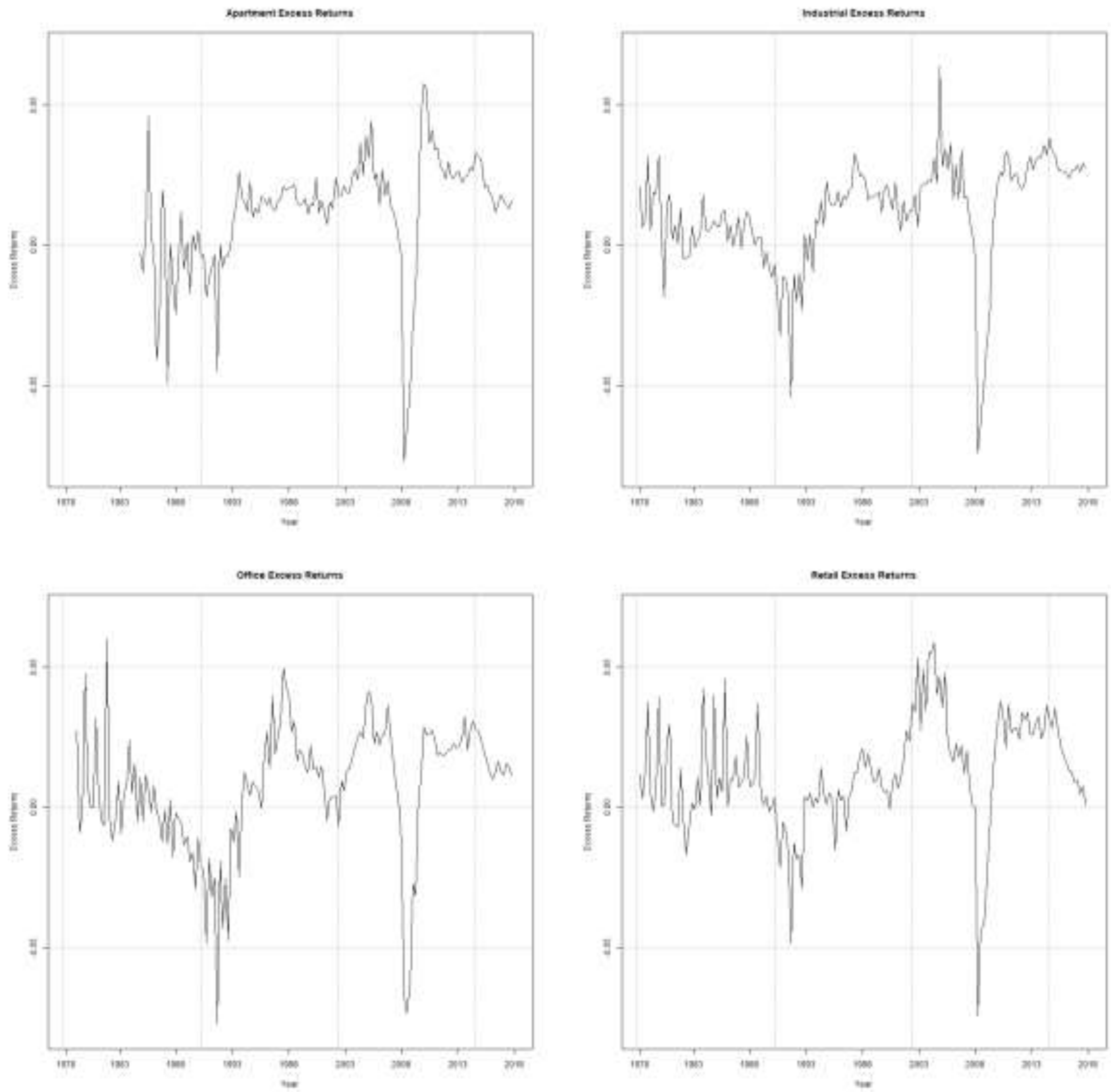
	Total	Apartment	Industrial	Office	Retail
Total	1				
Apartment	0.87	1			
Industrial	0.78	0.49	1		
Office	0.94	0.74	0.87	1	
Retail	0.91	0.77	0.57	0.81	1

In **Figure 2**, the excess returns of every property type are plotted. In general, all property types and their aggregation show similar trends in their excess returns time-series. More specifically, all of them show a structural break with the financial crisis of 2008. Both these observations are in line with the high linear correlation measured in **Table 2**. Moreover, there is enough heterogeneity among the property types to except different results. For example, the ten-year period between 1983 and 1993 the apartment property type is more volatile than the other property type.

Figure 2: **Excess Returns**

These graphs show the excess returns from each property type. The data covers the range from 1978 to 2018 and is provided by NCREIF.





3.2 Candidate Risk Factors

The analysis in this paper includes a total of twenty-one risk factors. The selection is made based on the commercial real estate literature and the availability of high quality data. The method used in this paper requires the candidate risk factors to be complete across the period of the analysis (1978 to 2018). In this section, I will discuss how I retrieve these risk factors and their relevance to this paper's topic.

The first factors are from the Fama and French five-factor model (Fama & French, 2015). This model includes the stock market risk factor (*MKT*), the *SMB* factor, the *HML* factor, the *RMW* factor and the *CMA* factor. These factors have been discussed in the literature review. In short, they result from long-short strategy where the assets are sorted on their properties. For example, the *HML* factor is computed from the difference in returns from a portfolio with assets with high book-to-market ratios and low book-to-market ratios. The data for these risk factors are available from Professor French's website and are estimated with data from all stocks traded on the New York Stock Exchange (NYSE), the American Stock Exchange (AMEX) and the NASDAQ (CRSP share code 10 and 11). The methodology used to estimate the risk factors is from Fama and French (1993) and Fama and French (2015). I compute the quarterly returns from the monthly data. Although, the five factors are mostly used in the asset pricing literature for publicly traded equity, they have also been tested for commercial real estate (Peng, 2016) which is why they are included in this paper.

Two bond market risk factors are included in the analysis, namely the change in the term spread (*TSP*) and the change in the credit spread (*CSP*). The change in term spread is calculated as the difference between the 10 year treasury annual yield and the 1 year treasury annual yield. The spread is expressed in first order difference and the data is retrieved from the Federal Reserve Economic Data (FRED). Peng (2016) suggests that the term spread is linked to commercial real estate valuations. Therefore, the change in term spread (first order difference) should be linked to the returns of commercial real estate. Furthermore, Fama and French (1989) argue that the term spread is high when business cycles are low and low when business cycles peak, and Plazzi, Torous and Valkanov (2008) demonstrate that business cycles have a direct effect on real estate prices as, for example, a downturn in the economy would impact vacation and lease rates which would lower the returns of commercial real estate. The link between the term spread and the values of commercial real estate suggest a strong link between the changes in the term spread and the returns of commercial real estate, which is why this risk factor is added in this analysis.

The change in credit spread is calculated as the difference between the annual yield of BAA rated corporate bonds and the annual yield of AAA rated corporate bonds. The spread is expressed in first order difference and the data is retrieved from FRED. Some theoretical links exist between the returns in commercial real estate and the changes in the credit spread. For example, the availability of credit is linked to commercial real estate values (Chervachidze & Wheaton, 2011) which could suggest a negative loading on the credit risk factor. Furthermore, an increase in the credit spread may decrease the availability of debt financing which directly impacts the demand for commercial real estate (Plazzi, Torous & Valkanov, 2008). The theoretical link between the returns of commercial real estate and the credit spread was tested by Peng (2016) and therefore is included in this paper.

The next risk factor is the liquidity factor (*LIQ*) from Pastor and Stambaugh (2003). The data is obtained from Professor Stambaugh's website. The returns of the risk factor are estimated using data from stocks traded on the NYSE and the AMEX (CRSP share code 10 and 11). The returns represent the innovations in aggregate liquidity and are constructed through the temporary prices changes accompanying order flow (Pastor & Stambaugh, 2003). The methodology used to estimate the risk factors returns in this paper is the same as in Pastor and Stambaugh (2003). This factor is included as the risk of time varying market liquidity in the stock market on commercial real estate returns has been found to have a positive loading (Peng, 2016).

I include a real estate market risk factor (*REM*) which is the excess returns of the overall theoretical commercial real estate market portfolio. I estimate these returns with the NCREIF Property Index (NPI) which is an index compromised of properties acquired on behalf of tax-exempt institutions and held in a fiduciary environment in the USA. It includes properties from across the country with an average property count of 3'533 proprieties through the sample period. It is the aggregate of the data used for the real estate data and thus includes all property types. The prominence of the market return in the academic literature on public equity motivates the inclusion of a similar measure for real estate. Mei and Lee (1994) find that the real estate factor exists and suggest that mutual fund manager should include some real estate in their portfolio to gain exposure to this risk factor. Thus, the inclusion of this factor is important to better understand the risk factors in commercial real estate.

To control if a momentum anomaly exists in commercial real estate returns, I also include a momentum risk factor (*MOM*). I estimate the returns of the momentum premium using Carhart (1997) methodology. I sort the CBSA into two size groups using the average market value and I also sort them into two momentum groups using the returns of last period. The sorting is performed twice a year in quarters one and three. The sorting results in two size groups (small and big) and into two momentum groups (up and down). The intersects of the groups yields four other groups: small and up, big and up, small and down, and big and down. The returns on these groups in each quarter are calculated as the value-weighted mean returns of the CBSA returns in the group. The estimated return of the momentum risk factor is the average of the returns on the small and up group and the big and up group minus the average of the returns on the small and down group and the big and down group. As the sorting is performed twice a year, the groups are frequently rebalanced and thus do not include the same CBSAs over the time period of this analysis.

The next factors in this analysis are seven macroeconomic risk factors. First, I include the relative quarterly change in the USA's GDP (*RCG*). I calculate the first order difference of the GDP with data from FRED. In equity premium returns, GDP has been linked to significant risk factors. For example, Vassalou (2003), finds that news related to future GDP growth helps explain the cross-section of asset returns as well as the SMB and HML factors. In commercial real estate, to my knowledge, no studies analyse growth production as a risk factor. Given the predominance of production-related factors in models such as in Chen, Roll and Ross (1986) for public stocks, it would be interesting to get a deeper understanding of its impact in commercial real estate.

Second and third, I include the changes in expected inflation (*CEI*) and in unexpected inflation (*CUI*). To calculate both, I start with the Consumer Price Index (CPI) that I retrieve from FRED. The CPI gives a reliable measure of the general inflation in the USA. The next step is to separate what is expected from what is unexpected. To achieve this, I follow the methodology from Wei (2010) where the expected inflation is estimated with a time-series regression. The equation Wei (2010) proposes is the following:

$$\pi_t = c_0 + c_1\pi_{t-1} + c_2\pi_{t-6} + c_3\pi_{t-7} + c_4\pi_{t-9} + c_5\pi_{t-11} + c_6\mu_{t-1} + c_7\mu_{t-11} + \epsilon_t \qquad (1)$$

Where π_t is the CPI inflation rate at time t and μ_t is the unemployment rate at time t. The expected inflation is the fitted value of the regression and the unexpected inflation is the residuals of the regression. The model is selected by Wei (2010) as it offers the lowest Akaike's Information Criterion of all combinations. Previous studies for commercial real estate found a positive loading for the expected inflation risk factor (Hartzell, Hekman & Miles, 1986) and a negative one for the unexpected inflation risk factor (Ling & Naranjo, 1997).

Fourth, I include the changes in the personal consumption expenditure (*PEC*). To estimate the time-series for this factor, I retrieve the data in gross terms from FRED and compute the relative change. This risk factor has been well documented in asset pricing literature both for equities (e.g. Lettau & Ludvigson, 2001 & Ferson, Nallareddy & Xie, 2013) and for commercial real estate where it has been found to be significant (Ling & Naranjo, 1997).

Fifth, I include the changes in unemployment rate (*CUR*). I retrieve the rates from FRED and calculate the relative changes. In theory, the significance of unemployment as a risk factor for commercial real estate should be linked to the PEC risk factor as unemployment has a direct effect on consumption. However, I believe it is still relevant to test the unemployment risk factor as the correlation is not perfect with PEC (see **table 5**). As The methodology I use in this paper controls for multiple testing, I am not constraint by the number of risk factors I test. Therefore, there is no drawback of adding extra and arguably unnecessary risk factors.

Sixth, I include the changes in money supply (*CMS*). As with the PEC and the CUR, I retrieve the data from FRED and calculate the relative changes. I use the M2 Money Stock supply, which include a broader set of financial assets than the M1 Money Stock. I do this as it is the one used by Chan, Foresti and Lang (1996) when they empirically test money growth as a risk factor for public stock returns. To the best of my knowledge, no papers test this risk factor for commercial real estate.

Seventh and final macroeconomic risk factor, I include the changes in oil prices (*COP*). I use the WTI crude oil prices retrieved from FRED as it is the best estimate of oil prices in the USA[2]. I calculate the relative changes of the gross prices to estimate the time-series for this factor. To the best of my knowledge, no studies examine the significance of the changes in oil risk factor on commercial real estate returns. For global equity markets, Ferson and Harvey (1994) find the change in oil price to be a significant risk factor. I include the risk factor in this paper as it is it readily available and to provide a first analysis in its impact in commercial real estate.

Finally, two measures of uncertainty are included: macroeconomic uncertainty (*CMU*) and financial uncertainty (*CFU*). Macroeconomic uncertainty measures "*the common volatility*

[2] WTI is the oil price index used for a majority of oil derivatives trade in USA's markets. For a global analysis I would have considered using the Brent crude oil prices or the Dubai crude oil prices.

in the unforecastable component of a large number of economic indicators" (Jurado, Ludvingston & Ng, 2015). It is obtained by removing the forecastable component of the volatility conditional to the available information and by taking only the common unforecastable element across many economic time-series. Financial uncertainty measures the same unforecastable common volatility but uses time-series from portfolios from different industries (e.g. steel, toys, etc.) and from portfolios built from Fama/French factors (Ludvingston, Ma & Ng, 2019). Both uncertainty indices are retrieved from Professor Ludvingston's website. I calculate the relative changes from the available data. Macroeconomic uncertainty has been tested as a risk factor in equity markets and found as a significant risk factor (Bali, Brown & Tang, 2016). For commercial real estate, a significant result for uncertainty measures could suggest that commercial real estate has safe haven properties as a positive factor loading would mean that returns increase with uncertainty.

Table 4 summarizes the risk factor data going from 1978 to 2018. As with the real estate data, the time-series are on a quarterly basis. The risk factors can be separated into two categories: the financial risk factors which represent the returns of a zero investment long-short portfolio or, in the case of the liquidity factor, the innovations in aggregate liquidity, and the macroeconomic risk factors which are the relative change of economic indicators. The financial risk factors include the five Fama/French factors, the liquidity factor, the real estate market premium and momentum factor. The remaining factors are macroeconomic risk factors. The correlation matrix of these time-series is found in **Table 5**. They are no clusters of risk factors as none appear to be strongly correlated to others. Indeed, the biggest coefficients are the PEC-RCG (0.54), CUR-RCG (-0.63) and COP-CUI (0.62) which are not high enough to be clustered together. The methodology used tests the risk factors independently in the first run and therefore multicollinearity issues are absent. In the later stages, multicollinearity issues only arise when two highly correlated factors are tested together. I do not find any of the highlighted relation to be the best performing model. Furthermore, the level at which the risk factors are correlated in the dataset covering the period from 1978 to 2018 is lower than the threshold normally used in studies for multicollinearity issues (Yoo et al., 2014).

Table 4: **Descriptive Statistics (Factors 1978-2018)**

This table presents basic descriptive statistics for the quarterly risk factor data used in this research. It includes data from 1978 to 2018 extracted from various resources. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Summary Statistics

	N	Mean	St. Dev.	Min	Max
MKT	164	1.97%	8.19%	-24.38%	20.67%
SMB	164	0.48%	4.77%	-10.83%	12.10%
HML	164	0.77%	5.97%	-17.14%	26.20%
RMW	164	1.07%	4.47%	-14.31%	26.58%
CMA	164	0.82%	3.97%	-7.95%	20.03%
CSP	164	0%	0.81%	-5.17%	3.75%
TSP	164	0%	0.55%	-2.73%	2.81%
LIQ	164	1.29%	6.40%	-19.80%	23.76%
REM	164	1.14%	2.01%	-8.51%	4.70%
MOM	164	1.13%	1.62%	-5.00%	6.90%
RCG	164	2.74%	3.00%	-8.40%	16.40%
CEI	164	-0.01%	0.38%	-2.08%	1.17%
CUI	164	0%	0.42%	-2.62%	1.54%
PEC	164	1.45%	0.80%	-2.45%	4.15%
CUR	164	-0.28%	5.17%	-9.96%	19.76%
CMS	164	1.49%	0.83%	-0.38%	5.67%
COP	164	1.26%	16.84%	-67.16%	83.96%
CMU	164	0.01%	1.93%	-5.22%	7.98%
CFU	164	0.06%	1.77%	-5.79%	5.27%

Table 5: **Pearson Correlation – Risk Factors (1978-2018)**

Pearson coefficients of correlation between the risk factors. The risk factors are quarterly time-series from 1978 to 2018. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

	MKT	SMB	HML	RMW	CMA	CSP	TSP	LIQ	REM	MOM	RCG	CEI	CUI	PEC	CUR	CMS	COP	CMU	CFU
MKT	1																		
SMB	0.38	1																	
HML	-0.29	0.02	1																
RMW	-0.39	-0.23	0.2	1															
CMA	-0.37	-0.02	0.74	0.21	1														
CSP	0.21	0.15	0.17	-0.12	0.04	1													
TSP	-0.05	-0.19	-0.06	0.02	-0.06	0.13	1												
LIQ	0.03	0.02	0	-0.06	-0.01	0.13	-0.02	1											
REM	0.08	-0.03	0.02	-0.06	-0.04	0.07	0.23	0.11	1										
MOM	-0.12	-0.08	0.07	0.19	0.08	-0.16	-0.08	-0.03	-0.12	1									
RCG	0.13	-0.01	-0.02	-0.05	-0.07	0.25	0.35	0.20	0.27	0.06	1								
CEI	-0.04	-0.06	0.03	-0.14	-0.02	0.21	0.13	0.27	0.11	-0.1	0.26	1							
CUI	0.08	0.07	0.03	-0.11	-0.03	0.34	0.09	0.26	0.1	-0.29	0.25	0.45	1						
PEC	0.09	0.14	0.09	-0.14	0.04	0.29	0.23	0.17	0.24	-0.03	**0.54**	0.27	0.34	1					
CUR	-0.14	0.1	-0.06	0.07	0.05	-0.3	-0.38	0.07	-0.48	0.04	**-0.63**	-0.12	-0.15	-0.36	1				
CMS	-0.15	0.07	-0.07	0.11	0.05	-0.16	-0.18	-0.09	0.07	0.08	-0.18	-0.2	-0.15	0.03	0.23	1			
COP	-0.02	-0.05	0.05	-0.11	0.07	0.21	-0.06	0.27	0.09	-0.2	0.12	0.4	**0.62**	0.2	-0.05	-0.19	1		
CMU	-0.28	-0.21	-0.02	0.05	0	-0.34	0.17	-0.13	0.23	-0.08	-0.07	0.06	0.09	0.07	0.06	0.05	-0.04	1	
CFU	-0.34	-0.29	-0.07	0.17	-0.01	-0.15	0.11	0	0.07	0.02	0.05	0.07	0.02	0.03	0	0.02	-0.01	0.45	1

The risk factor data is also summarized for the period from 2009 to 2018, which are the dates used in the analysis with the balanced panel of real estate returns and is presented in **Table 6**. The correlation matrix for this data is shown in **Table 7**. The only high correlation observed is the oil price risk factor and the unexpected inflation risk factor. This relation is expected as shocks in oil prices have a significant impact on inflation and are usually unexpected. This relation does not create a multicollinearity issue as the level at which the two risk factors are correlated falls under the threshold regularly used (Yoo et al., 2014). Furthermore, the only scenario in which a potential multicollinearity issue would arise is if one of the factors is the chosen factor in the first run of the algorithm. In this study, I do not find either factor to be the best performing risk factor in a one-factor model or in a multi-factor model.

Table 6: **Descriptive Statistics (Factors 2009-2018)**

This table presents basic descriptive statistics for the quarterly risk factor data used in this research. It includes data from 2009 to 2018 extracted from various resources. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Summary Statistics

	N	Mean	St. Dev.	Min	Max
MKT	36	3.55%	6.07%	-15.18%	13.10%
SMB	36	0.18%	3.50%	-8.11%	6.65%
HML	36	-0.62%	4.43%	-7.55%	16.83%
RMW	36	0.50%	2.90%	-3.32%	7.66%
CMA	36	0.02%	2.57%	-3.88%	5.11%
CSP	36	0.05%	0.51%	-1.05%	1.25%
TSP	36	0.08%	0.31%	-0.75%	0.76%
LIQ	36	-0.27%	5.17%	-9.55%	10.28%
REM	36	2.41%	1.17%	-2.09%	4.60%
MOM	36	0.64%	1.16%	-2.72%	4.17%
RCG	36	2.36%	1.56%	-1.10%	5.50%
CEI	36	0.02%	0.28%	-0.59%	0.68%
CUI	36	-0.06%	0.30%	-0.77%	0.51%
PEC	36	0.99%	0.37%	0.15%	1.79%
CUR	36	-2.71%	2.88%	-9.30%	1.98%
CMS	36	1.46%	0.72%	0.10%	4.63%
COP	36	0.27%	14.18%	-39.36%	28.23%
CMU	36	-0.34%	1.36%	-2.91%	4.12%
CFU	36	-0.10%	1.66%	-3.27%	3.94%

Table 7: **Pearson Correlation – Risk Factors (2009-2018)**

Pearson coefficients of correlation between the risk factors for the balanced dataset. The risk factors are quarterly time-series from 2009 to 2018. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

	MKT	SMB	HML	RMW	CMA	CSP	TSP	LIQ	REM	MOM	RCG	CEI	CUI	PEC	CUR	CMS	COP	CMU	CFU
MKT	1																		
SMB	0.39	1																	
HML	0.15	0.22	1																
RMW	-0.42	-0.6	-0.2	1															
CMA	0.24	0.3	0.62	-0.17	1														
CSP	0.17	0.15	0.3	-0.13	0.17	1													
TSP	-0.3	-0.31	-0.37	0.42	-0.11	-0.37	1												
LIQ	0.27	0.34	-0.08	-0.27	0.11	-0.1	-0.02	1											
REM	-0.11	0.04	-0.06	-0.11	0.1	-0.3	0.15	-0.02	1										
MOM	-0.02	-0.04	-0.05	0.05	-0.21	0.02	0.1	-0.35	0.29	1									
RCG	0.25	0.02	-0.24	0.19	-0.21	-0.05	0.12	0.2	-0.2	0.05	1								
CEI	0.17	0.13	0.07	-0.1	0.02	0.25	-0.41	0.22	-0.1	0.12	0.12	1							
CUI	0.23	0.05	0.11	-0.13	-0.03	0.27	-0.16	0.17	-0.14	0	-0.2	0.21	1						
PEC	0.12	-0.08	-0.02	0.02	-0.12	0.21	-0.14	0.09	-0.01	0.39	0.32	0.28	0.07	1					
CUR	-0.15	0.2	-0.02	-0.06	0.09	0.29	0.18	0.14	-0.1	-0.08	-0.35	-0.04	0.14	-0.27	1				
CMS	-0.48	-0.32	-0.08	0.34	-0.05	-0.06	0.36	-0.4	0.37	0.1	-0.38	-0.1	0.05	-0.08	0.1	1			
COP	0.39	0.23	0.31	-0.29	0.16	0.34	-0.38	0.25	-0.21	-0.03	0.09	**0.62**	0.57	0.29	-0.02	-0.25	1		
CMU	-0.08	-0.08	0.06	0.03	0	-0.22	0.05	-0.17	0.27	0.26	0	-0.26	-0.28	0.12	-0.28	0.18	-0.5	1	
CFU	-0.56	-0.37	-0.26	0.29	-0.43	-0.27	0.2	-0.22	-0.05	0.23	0.04	-0.15	-0.2	0.12	0	0.1	-0.27	0.24	1

4. Methodology

4.1 Test Statistic

A linear factor model implies the following relation for expected excess returns:

$$E(r_i) = \sum_{k=1}^{K} \beta_{ik}\gamma_k \qquad (2)$$

Where r_i is the excess return of asset i, K is the number of factors in the model, β_{ik} is the beta (sensitivity) of asset i on risk factor k, γ_k is the risk premium of factor k.

Equation (2) can be extended to a time-series regression model:

$$r_{it} = \alpha_i + \sum_{k=1}^{K} \beta_{ik} x_{kt} + \varepsilon_{it} \; for \; i = 1, \ldots, N \qquad (3)$$

Where r_{it} is the excess return of asset i at time t, α_i is the pricing error of asset i, K is the number of factors in the model, β_{ik} is the beta (sensitivity) of asset i on risk factor k, x_{kt} is the return of factor k at time t and ε_{it} is the random error term at time t. Importantly, two relation must hold namely E(ε_{it}) = 0 and E($\varepsilon_{it}r_{it}$) = 0 for all factors.

In the procedure outlined in Fama and Macbeth (1973), the betas from equation (3) would then be regressed through a cross-sectional equation:

$$r_{it} = \lambda_{i0} + \sum_{k=1}^{K} \lambda_{kt}\beta_{ik} + \varepsilon_{it} \qquad (4)$$

Where some assumption should hold if k is a true risk factor namely that $\lambda_{i0} = 0$ and $\overline{\lambda_k} = \gamma_k$. The GRS test statistic can also be computed from equation (3). Indeed, if the factor model is well specified, equation (2) implies the null hypothesis

$$H_0: \alpha_i = 0 \; for \; i = 1, \ldots, N \qquad (5)$$

The GRS test is thus given by

$$GRS = [(T - N - K)/N]\alpha'\Sigma^{-1}\alpha/(1 + Sh^2(f)) \qquad (6)$$

Where T is the number of periods, N is the number of assets, K is the number of risk factors. α is a (N,1) vector of the N α_i's given in equation (3). Σ is the residual covariance matrix of dimensions (N,N) from equation (3) estimated with maximum likelihood. $Sh^2(f)$ is the maximum squared Sharpe (1964) performance of the K factors. In essence, this test compares the maximum squared Sharpe performance attainable by K factors to the maximum squared Sharpe performance attainable by N+K assets as Gibbons, Ross and Shanken (1989) show that the

$\alpha'\Sigma^{-1}\alpha$ can be rewritten as $Sh_{max}^2 - Sh^2(f)$ where Sh_{max}^2 is the maximum performance of the N + K assets.

The issues Harvey and Liu (2019b) point out concerning the GRS test is that when N > T the inverse of the residual covariance matrix does not exist. It restricts the cross-section of asset that can be used. As my analysis relies on many CBSAs but few time dimension observations (quarterly data), it may not be suitable to use the GRS test. Furthermore, the authors state that the GRS test is often rejected, meaning it must be used as a comparative tool which it is not designed to do. Therefore, instead of using the procedures described above, the analysis in this paper will focus on a sequential approach to build the model. This approach only includes factors that significantly reduce the pricing error and are thus useful. An added benefit of this approach is that it does not require the model to be specified in advance. Indeed, GRS is used to test models against each other, but the bootstrapping approach used in this paper starts from the premise that no factors are significant and only includes them if they significantly improve the model. This approach allows to test a wide variety of risk factors.

Before detailing the testing procedure, the test statistics will be discussed. The test statistic should measure the difference in explanatory power of the cross-section of expected returns between the baseline model and the augmented model with an additional risk factor. It should be economically significant (substantial increase in the explanation of the cross-section) and statistically significant. Harvey and Liu (2019b) propose an equally weighted scaled intercept which is the difference in the intercept from the baseline model and the augmented model scaled by the cross-section of standard errors for regression intercepts under the baseline model. The key assumption of the test statistic is that if the augmented model is better than the baseline model, then its absolute cross-sectionally averaged intercept should be smaller than the one of the baseline model. Indeed, if the augmented model is the true model than its intercept should be zero, which is always smaller than the absolute value of the baseline model. Formally the test statistic is given by:

$$SI_{ew}^m = \left(\frac{1}{N}\sum_{i=1}^N|\alpha_i^+|/s_i - \frac{1}{N}\sum_{i=1}^N|\alpha_i|/s_i\right) / \frac{1}{N}\sum_{i=1}^N|\alpha_i|/s_i \tag{7}$$

Where SI means “scaled intercept”, “m” means mean and “ew” means equally weighted. Let N be the number of assets, α_i^+ the cross-section regression intercept of the augmented model for asset i, α_i the cross-section regression intercept of the baseline model of asset i and s_i the cross-section of the standard error for regression intercepts under the baseline model. The interpretation of equation (6) goes as follow: if SI_{ew}^m is negative then the augmented model is superior to the baseline model. To test the significance of the superiority of the augmented model, the improvement is evaluated against the empirical distribution generated from the bootstrapped simulation. In this case, the null hypothesis is that the risk factor added in the augmented model does not improve the explanatory power of the model.

The test statistic in equation (7) is not robust to extreme observations. Therefore, it is wise to consider a second statistic to control for extreme observations in the cross-section and improve the robustness of the analysis. Harvey and Liu (2019b) propose the scaled median absolute intercept which calculates, as its names suggests, the difference in the medians of the adjusted scaled intercepts. That is:

$$SI_{ew}^{med} = \left(med(\{|\alpha_i^+|/s_i\}_{i=1}^N) - med(\{|\alpha_i|/s_i\}_{i=1}^N)\right) / med(\{|\alpha_i|/s_i\}_{i=1}^N) \quad (8)$$

Where $med(\cdot)$ is the median of the distribution in parenthesis and SI_{ew}^{med} means the scaled median absolute intercept. Equation (8) is the same as equation (7) but takes the median instead of the mean. Results are expected to be similar except in cases where extreme value of $\{|\alpha_i^+|/s_i\}$ and $\{|\alpha_i|/s_i\}$ can be observed.

Contrary to the widely used in practice GRS test which tests the cross-section of $|\alpha_i^+|$ to determine whether the augmented model is true, the approach of equation (7) and (8) tests whether the additional factor in the augmented model significantly improve the baseline model which under the null hypothesis is true (Harvey & Liu, 2019b). The information gained about the significance of the single factor is therefore greater as SI_{ew}^{m} and SI_{ew}^{med} measures the contribution of the added factor rather than testing the entire model. The test statistics proposed by Harvey and Liu (2019b) are well suited for testing commercial real estate factors as the literature has not developed a reference model such as the Fama and French 3-factors model (Fama & French, 1993) or the Fama and French 5-factors model (Fama & French, 2015) for stocks. This means that there is not a benchmark with which the GRS test can be compared to. Therefore, testing the incremental contribution of a wide range of potential risk factors to the baseline model appears to be the optimal approach. Moreover, in some cases in my analysis, the cross-sectional dimension will be larger than the time-series dimension which makes the GRS not usable.

Another aspect worthy of discussion is the use of scaled intercepts instead of using the intercepts outright. Indeed, they are three reasons why it is more suitable to consider the scaled intercepts. First, the heterogeneity in the volatility of the return time-series are considered with the outright intercepts (Harvey & Liu, 2019b). Indeed, for two assets that generate the same regression intercept, the degree of mispricing by the model should be higher for the asset that is less noisy. This means, with the scaled intercept, the weight assigned to the different assets varies with its volatility – the more volatile the asset the lower its assigned weight will be. Second, the scaled intercept can be interpreted as the information ratio (Treynor & Black, 1973) which is better measures the economic significance of an investment strategy[3] (Harvey & Liu, 2019b). Third, it is in line with literature on bootstrap hypothesis testing (Hall & Wilson, 1991).

4.2 Sequential Approach

As previously mentioned, the analysis made in this paper will rely on a sequential approach as outlined in Harvey and Liu (2019b). In contrast to the Fama and Macbeth (1973) approach, the method used relies on a panel regression model. I will not use a predefined model. Therefore, the baseline model does not include any risk factors. It can be written as:

$$r_{it} = \alpha_i + \varepsilon_{it} \; for \; i = 1,\dots,N \qquad (9)$$

Where r_{it} is the excess return of asset i at time t, α_i is the pricing error of asset i and ε_{it} is the random error term at time t. Equation (9) is effectively the same as equation (3) without the risk factors time-series and their respective loadings. Starting from equation (9) an algorithm will be followed to determine if the addition of a risk factor to the model significantly improve the cross-section explanation and it will also determine which risk factors does so the most (out of the candidate factors). After running through the algorithm once, two outcomes are thus possible. First, the addition of any of the candidate risk factors does not significantly improve the explanatory power of the model on the cross-section of expected returns. Therefore, the algorithm is stopped, and the baseline model is concluded to be the best performing model. Second, a risk factor is added to the model as it significantly improves the explanatory power of the model on the cross-section of expected returns. The selected risk factor is the one which reduces the absolute scaled intercept the most. Then, the baseline model is a one-factor model with the selected factor from the algorithm:

$$r_{it} = \alpha_i + \beta_{i1} x_{t1} + \varepsilon_{it} \; for \; i = 1,\dots,N \qquad (10)$$

Where β_{i1} is the factor loading (beta) of pre-selected risk factor 1 of asset i and x_{t1} is the return of factor 1 at time t. With this new baseline model, the algorithm is run again until none of the candidate factors can significantly improve the model's explanatory power.

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[3] In this case the strategy is a long position in the test asset and a short position in the benchmark index (see: Treynor & Black, 1973).

The algorithm follows four steps:

Step 1: Calculate the test statistics

The data is organized into three matrices. First, the matrix of excess returns R which is of dimensions N x M with N being the total number of periods and M being the total number of assets. Second, the matrix of pre-selected risk factors X which is of dimensions N x X with X being the number of pre-selected factors[4]. Third, the matrix of candidate risk factors K which is of dimensions N x K.

The purpose of the first step is to obtain the original test statistic defined in equation (7) and (8). Later the simulation will define the significance of the results obtained in this step. As a reminder, the null hypothesis is that the augmented model does not significantly improve the baseline model and therefore, the baseline model is the true model. To obtain the inputs for the two test statistics, the baseline and the augmented model need to be regressed as per equation (3), (9) or (10) depending on the number of risk factors pre-selected. Therefore, I run a panel regression for the baseline model and for all the augmented models (one for each candidate risk factor). After each regression, I extract the inputs for the calculation of the two risk factors and obtain two vectors Υ^{m} and Υ^{med} of length K with the SI_{ew}^{m} and SI_{ew}^{med} of each candidate risk factor.

Step 2: Orthogonalize the candidate risk factors

In the second step I orthogonalize the candidate factors on the pre-selected factors to capture the incremental contribution of the candidate factor. I do this so that the orthogonalize factors do not impact the cross-section of expected returns. After being orthogonalize, the candidate factors lose their cross-section's explanatory power but maintain their role in explaining the time-series. If I maintained the candidate factors in their original form, they may or may not line up with the cross-section of expected return and generate a spurious relation – generate a large time-series regression R-Squared but contribute little to explaining the cross-section of expected returns. By proceeding to the orthogonalization, I solve this issue as demonstrated below.

For example, take the baseline model to be a one factor model and the augmented model to be a two factors models. The regression equation for the baseline model for a given asset i:

[4] During the first pass this matrix is empty

$$r_{it} = \alpha_i + b_{i1}x_{t1} + \varepsilon_{it} \qquad (11)$$

And the augmented model

$$r_{it} = \alpha_i^* + b_{i1}^* x_{t1} + b_{i2}^* x_{t2} + \varepsilon_{it}^* \qquad (12)$$

Where * denotes the augmented model. As discussed with the test statistic, if the candidate factor x_{t2} helps improve the explanatory power of the cross-section of the model then α_i^* should be closer to 0 than α_i. The goal of this step is to remove the incremental impact of the additional factor on the cross-section of expected returns and maintain its time-series properties. Therefore, we can create a pseudo factor by adjusting the original such that $\alpha_i = \alpha_i^*$. To achieve this, I regress x_{t2} onto x_{t1}:

$$x_{t2} = \alpha + \beta x_{t1} + e_t \qquad (13)$$

And I define x_{t2}^* as

$$x_{t2}^* = x_{t2} - \alpha = \beta x_{t1} + e_t \qquad (14)$$

If we replace x_{t2} by x_{t2}^* in equation (12) it can be shown that $\alpha_i = \alpha_i^*$:

$$r_{it} = \alpha_i^* + b_{i1}^* x_{t1} + b_{i2}^*(\beta x_{t1} + e_t) + \varepsilon_{it}^* = \alpha_i^* + (b_{i1}^* + b_{i2}^*\beta)x_{t1} + b_{i2}^* e_t + \varepsilon_{it}^* \quad (15)$$

The term $b_{i2}^* e_t + \varepsilon_{it}^*$ can be considered as the residual of a regression equation as both e_t and ε_{it}^* are orthogonal to x_{t1} and a vector of ones. Therefore, we can compare equation (15) and (11) and obtain $\alpha_i = \alpha_i^*$ and $b_{i1}^* + b_{i2}^*\beta = b_{i1}$.

With this transformation, the adjusted factor x_{t2}^* is absorbed by x_{t1} and has no incremental impact on the cross-section of expected returns while maintaining all of the time-series properties of the original factor x_{t2}. The transformation of the candidate risk factors sets up the simulation that takes place in the next step to generate the distribution of pricing error.

Step 3: Bootstrap the data and generate a pricing error distribution

The aim of this step is to generate pricing error distributions for each candidate risk factor. Through these distributions, I will compute the single test which will act as an indicator of the significance of the incremental contribution of a given risk factor and the multiple test which will indicate whether one of the candidate factor in general can significantly improve the baseline model. More generally, the multiple test controls for data mining as any given candidate risk factors is tested against the entire set of candidates. Therefore, multiple testing minimizes the likelihood of finding a false positive.

The simulation is performed through a bootstrap of the data meaning that a new data set is built by randomly sampling with replacement of the existing data. The bootstrap is performed through the time dimension giving new distributions for the CBSA's, the pre-selected risk factors and the candidate risk factors returns series.

To illustrate this step let us take the same example as in step 2 where the baseline model is a one factor model and the augmented model is a two factor model. Further, I will take the example of a 7 periods time index. I define the original time index as:

$$T = [t_1 = 1, t_2 = 2, t_3 = 3, t_4 = 4, t_5 = 5, t_6 = 6, t_7 = 7] \tag{16}$$

One possible bootstrap could be:

$$T^b = [t_1^b = 5, t_2^b = 7, t_3^b = 3, t_4^b = 7, t_5^b = 1, t_6^b = 4, t_7^b = 4] \tag{17}$$

Where b denotes that the sample is bootstrapped. What is important to note from (17), is that some periods can be repeated (7 and 4) and some can be missing (2 and 6). Further the same period can be repeated consecutively (t_6^b and t_7^b). With this sampling, I obtain a new dataset as illustrated in the following diagram:

$$[Y \quad X \quad K] = \begin{bmatrix} y_1 & x_1 & k*_1 \\ y_2 & x_2 & k_2 \\ y_3 & x_3 & k_3 \\ y_4 & x_4 & k_4 \\ y_5 & x_5 & k_5 \\ y_6 & x_6 & k_6 \\ y_7 & x_7 & k_7 \end{bmatrix} \rightarrow \begin{bmatrix} y_5 & x_5 & k_5 \\ y_7 & x_7 & k_7 \\ y_3 & x_3 & k_3 \\ y_7 & x_7 & k_7 \\ y_1 & x_1 & k_1 \\ y_4 & x_4 & k_4 \\ y_4 & x_4 & k_4 \end{bmatrix} = [Y^b \quad X^b \quad K^b] \tag{18}$$

Where Y is the vector of returns for a CBSA from the original sample, X is the vector of returns of the pre-selected risk factor from the original sample, K is the vector of returns of the candidate risk factor from the original sample and the superscript b denotes the vectors after the bootstrap.

With the bootstrap data, a panel regression is run for each candidate factors. With these regressions, I extract the necessary inputs to calculate the test statistics SI_{ew}^{m} and SI_{ew}^{med} as in equations (7) and (8) and organise them in two matrices $\Upsilon^{m,b}$ and $\Upsilon^{med,b}$ of dimension K x B where B is the number of simulations. According to Harvey and Liu (2019b), 10'000 simulations is conservative enough to yield accurate results. In my analysis I find that 1’000 iterations yield accurate results[5] but use Harvey and Liu (2019b) recommendation to be conservative.

Step 4: Interpret the results and set up new iteration

The final step consists of reading the results, determining whether the augmented model is significantly better than the baseline model and, if appropriate, setting up the next iteration of the algorithm. As previously mentioned, there are two types of significance tests calculated, the single test which determines if a single candidate risk factor can significantly improve the baseline model and a multiple test which determines whether at least one of the candidate variables can improve the baseline model. I calculate a p-value for both and use a 5% significance cut-off point.

For the single test p-value I compare Υ^{m} and Υ^{med} to $\Upsilon^{m,b}$ and $\Upsilon^{med,b}$. For each risk factor, the result is the frequency at which each bootstrap result is inferior to the original regression results. That is for each row of the vectors Υ^{m} and Υ^{med} I compare with its respective row of $\Upsilon^{m,b}$ and $\Upsilon^{med,b}$ and calculate at which frequency the values found in the B iterations of the simulaton are inferior to the value in the vectors. The interpretation of the number is straight forward, if it is below the 5% threshold then the result is statistically significative. This means, for a risk factor with a p-value small than 5%, that the augmented model featuring it outperforms the baseline model.

For the multiple test p-value I compare Υ^{m} and Υ^{med} to $\Upsilon^{m,b}_{MIN}$ and $\Upsilon^{med,b}_{MIN}$. $\Upsilon^{m,b}_{MIN}$ and $\Upsilon^{med,b}_{MIN}$ are vectors of length B where the minimum test statistic is taken in each column. I then compare min(Υ^{m}) and min(Υ^{med}) to $\Upsilon^{m,b}_{MIN}$ and $\Upsilon^{med,b}_{MIN}$ respectively where min($\cdot$) is the row of the vector with the highest value. Then, I compute the frequency at which the observations in $\Upsilon^{m,b}_{MIN}$ and $\Upsilon^{med,b}_{MIN}$ are inferior to min(Υ^{m}) and min(Υ^{med}). If the result is below the 5% threshold then at least one of the candidate factors significantly improve the baseline model. The purpose of the multiple test is to control for data snooping bias. Indeed, as I do not restrict the number of candidate risk factors some may prove to be significant by chance (Foster, Smith & Whaley, 1997). The bootstrap approach yields an empirical distribution of the min SI^{m}_{ew} and SI^{med}_{ew} under the joint null hypothesis that none of the candidate risk factors significantly improves the model.

[5] In this sense, accurate results mean that they were no significant differences when the algorithm was run with 1’000 or 10’000 iterations.

It is different from the one generated in the single test and thus provides a control for multiple hypothesis testing (Harvey & Liu, 2019b).

For the interpretation of the results, I will first look at the multiple test p-value. If it is above the 5% threshold, then I conclude that the baseline model is true and that none of the augmented models can significantly improve upon it. On the other hand, if it is below the threshold, I add the risk factors which reduces the scaled intercept the most. That is, I chose the risk factor with the lowest SI_{ew}^{m} and SI_{ew}^{med}. I control for the significance of this risk factor with its single test p-value. If it is below a 5% threshold then it is selected, if not, then I select the next risk factor with the lowest SI_{ew}^{m} and SI_{ew}^{med} and proceed to the same control. Finally, I add the selected risk factor to the baseline model and run the algorithm again with all the other candidate risk factors.

5. Empirical Results

5.1 Results from 1978 to 2018

The results for the unbalanced panel of data with all property types aggregated are shown in **table 8**. The first takeaway from these results is that only the REM is a significant factor with both the mean and the median scaled intercepts. Other factors pass the single test in the first run (MKT, HML, RCG, PEC) but do not decrease the scaled intercept as much as REM. On the second run, the multiple test is failed both in the mean and the median approaches and therefore the test is stopped. Interestingly, the median approach has a much lower multiple test p-value than the mean approach and has some factors that pass the single test (SMB, CMA, MOM, CUI, CMU, CFU). This suggests that the true model might be REM + MOM as MOM has the lowest measure of SI_{ew}^{med} in the second pass although the significance threshold is not entirely passed. I run a third pass of the model with the baseline being REM + MOM and no additional factors are significant (**appendix A**). In this setting the true model is thus a one-factor model with the real estate market risk premium being the lone significant factor. It reduces the scaled intercept by 77.2% from the baseline hypothesis that no factors are significant.

When looked at separately, the picture is different for each property type under the same time period. The results are shown in **table 9** for the apartment property type, **table 10** for the industrial property type, **table 11** for the office property type and **table 12** for the retail property type. For the apartment property type, I find the best performing model to be a one-factor model with MOM as the significant risk factor. In the first run, the REM, RCG CMS are also significant risk factors but they do not perform as well as the MOM risk factor (CMU and MKT are also significant, but they increase the scaled intercept from the baseline model). For the industrial property type, I find no significant risk factors as the multiple test p-value is 13.1% for the mean scaled intercept and 15.3% for the median scaled intercept. This means that none of the candidate factors I propose to explain the cross-section of industrial real estate returns are significant. For the office property type, in a single-factor model, I find the RCG risk factor to be significant with the MKT, LIQ and CMS also passing both the single and multiple tests. When I run the algorithm in a two factor setting, no additional risk factors are significant. For the retail property type as with the aggregated case, the best performing model I find is a one-factor model with the REM being the significant risk factor.

To draw comparison to the risk factors found in literature and summarized in **table 1**, it appears that many of the risk factors fail to be significant when tested in this framework. The inflation rate, term spread, unanticipated inflation, size, credit spread, and value are not significant in any of the property types even on a single test level. This is expected as in Harvey and Liu (2019), many popular US stock market risk factors fail with this testing framework. Indeed, the authors test 14 risk factors and find only the market risk premium, the size (SMB) and the value (HML) factors to have significant explanatory power over the cross-section of returns. Furthermore, by performing the same test on the UK stock returns, Fletcher (2019) finds that only the market risk premium and the CMA to be significant out of a set of 13 candidates. One of the methodology's purposes is to reduce the number of risk factors found in literature to determine which ones are important.

Table 8: **Aggregated Property Types from 1978-2018 (Unbalanced Dataset)**

This table presents the results for the aggregated property types with an unbalanced dataset from 1978 to 2018. A CBSA needs to have at least 36 consecutive quarterly observation to be considered. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Baseline is no factor						
		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5^{th}-percentile	p-value
MKT	-0.037	-0.037	0.050	-0.024	-0.042	0.087
SMB	0.023	-0.063	0.635	0.029	-0.078	0.685
HML	-0.041	-0.049	0.066	-0.051	-0.058	0.060
RMW	0.064	-0.041	0.839	0.052	-0.046	0.787
CMA	-0.007	-0.056	0.283	-0.003	-0.069	0.371
CSP	0.000	-0.018	0.210	0.000	-0.019	0.203
TSP	0.090	-0.042	0.555	0.059	-0.042	0.420
LIQ	-0.058	-0.100	0.135	-0.045	-0.111	0.185
REM	-0.772	-0.409	0.000	-0.811	-0.427	0.000
MOM	0.084	-0.149	0.767	0.071	-0.158	0.725
RCG	-0.602	0.026	0.000	-0.637	0.027	0.000
CEI	0.016	-0.041	0.466	0.001	-0.046	0.312
CUI	0.021	-0.030	0.395	0.010	-0.032	0.325
PEC	-0.414	0.193	0.000	-0.453	0.190	0.000
CUR	0.283	0.024	0.450	0.253	0.022	0.403
CMS	0.442	-0.047	0.979	0.434	-0.050	0.974
COP	-0.051	-0.091	0.135	-0.032	-0.092	0.202
CMU	0.019	-0.029	0.481	0.011	-0.033	0.416
CFU	0.018	-0.030	0.541	0.017	-0.035	0.511
		Multiple test			Multiple test	
		-0.409	0		-0.427	0.019

Panel B: Baseline is **REM**						
		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5^{th}-percentile	p-value
MKT	0.000	-0.070	0.330	-0.011	-0.078	0.224
SMB	0.010	-0.067	0.535	-0.182	-0.081	0.011
HML	0.004	-0.074	0.446	0.014	-0.085	0.538
RMW	0.026	-0.067	0.712	-0.018	-0.072	0.196
CMA	0.015	-0.063	0.678	-0.141	-0.077	0.015
CSP	-0.014	-0.051	0.162	0.017	-0.052	0.411
TSP	0.041	-0.185	0.705	-0.043	-0.196	0.327
LIQ	0.016	-0.147	0.701	-0.073	-0.164	0.170
REM						
MOM	-0.024	-0.222	0.466	-0.219	-0.239	0.063
RCG	0.073	-0.056	0.360	-0.064	-0.057	0.043
CEI	-0.010	-0.069	0.226	-0.018	-0.076	0.186
CUI	-0.023	-0.060	0.137	-0.108	-0.063	0.019
PEC	0.454	0.131	0.327	0.426	0.128	0.289
CUR	0.173	-0.200	0.698	0.181	-0.207	0.700
CMS	0.635	-0.060	0.978	0.618	-0.065	0.973
COP	0.013	-0.145	0.570	0.051	-0.149	0.694
CMU	0.008	-0.095	0.550	-0.111	-0.107	0.047
CFU	0.012	-0.041	0.526	-0.049	-0.049	0.048
		Multiple test			Multiple test	
		-0.294	0.959		-0.331	0.182

Table 9: **Apartment Property Type from 1978-2018 (Unbalanced Dataset)**

This table presents the results for the apartment property type with an unbalanced dataset from 1978 to 2018. A CBSA needs to have at least 36 consecutive quarterly observation to be considered. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Baseline is no factor						
		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5th-percentile	p-value
MKT	0.082	-0.068	0.757	0.055	-0.090	0.658
SMB	0.038	-0.058	0.703	0.018	-0.083	0.556
HML	-0.051	-0.120	0.178	-0.062	-0.151	0.178
RMW	0.013	-0.097	0.857	0.032	-0.126	0.854
CMA	-0.040	-0.078	0.127	-0.032	-0.102	0.179
CSP	0.222	-0.017	0.501	0.192	-0.020	0.429
TSP	0.146	-0.082	0.560	0.146	-0.093	0.513
LIQ	-0.032	-0.062	0.125	0.017	-0.082	0.655
REM	-0.356	0.035	0.000	-0.410	0.035	0.000
MOM	-0.511	-0.212	0.000	-0.547	-0.259	0.000
RCG	-0.482	-0.125	0.000	-0.545	-0.144	0.000
CEI	-0.038	-0.129	0.236	-0.045	-0.158	0.219
CUI	-0.049	-0.346	0.427	-0.043	-0.413	0.450
PEC	0.743	0.003	0.820	0.541	0.000	0.679
CUR	0.199	-0.044	0.422	0.198	-0.046	0.408
CMS	-0.317	0.006	0.000	-0.413	-0.012	0.001
COP	-0.001	-0.151	0.539	0.000	-0.194	0.534
CMU	0.341	0.000	0.506	0.337	-0.001	0.473
CFU	0.216	0.005	0.476	0.182	-0.001	0.407
		Multiple test			Multiple test	
		-0.355	0.004		-0.442	0.015

Panel B: Baseline is **MOM**						
		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5th-percentile	p-value
MKT	-0.003	-0.087	0.352	0.006	-0.119	0.492
SMB	-0.012	-0.079	0.260	-0.053	-0.116	0.133
HML	0.003	-0.147	0.562	-0.019	-0.198	0.377
RMW	-0.044	-0.072	0.098	-0.029	-0.106	0.203
CMA	-0.002	-0.105	0.472	0.006	-0.143	0.570
CSP	0.500	-0.164	0.896	0.511	-0.198	0.860
TSP	0.186	-0.051	0.523	0.297	-0.069	0.627
LIQ	-0.002	-0.070	0.392	-0.009	-0.104	0.323
REM	0.309	0.037	0.209	0.410	0.037	0.282
MOM						
RCG	0.681	-0.204	0.927	1.174	-0.247	0.933
CEI	-0.037	-0.202	0.355	0.014	-0.252	0.562
CUI	0.099	-0.483	0.908	0.044	-0.584	0.842
PEC	2.911	-0.011	0.941	2.974	-0.016	0.937
CUR	0.389	-0.070	0.641	0.630	-0.077	0.737
CMS	0.846	-0.035	0.924	0.932	-0.059	0.913
COP	-0.019	-0.250	0.555	-0.035	-0.328	0.493
CMU	0.999	-0.003	0.834	1.523	-0.007	0.868
CFU	0.310	-0.026	0.657	0.619	-0.042	0.800
		Multiple test			Multiple test	
		-0.486	0.900		-0.589	0.899

Table 10: **Industrial Property Type from 1978-2018 (Unbalanced Dataset)**

This table presents the results for the industrial property type with an unbalanced dataset from 1978 to 2018. A CBSA needs to have at least 36 consecutive quarterly observation to be considered. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Baseline is no factor						
		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5th-percentile	p-value
MKT	0.077	-0.071	0.968	-0.039	-0.135	0.235
SMB	0.006	-0.134	0.767	0.006	-0.198	0.685
HML	0.055	-0.031	0.859	0.040	-0.097	0.654
RMW	-0.054	-0.068	0.084	-0.287	-0.181	0.010
CMA	0.039	-0.042	0.891	-0.039	-0.118	0.202
CSP	0.008	-0.041	0.671	-0.041	-0.133	0.223
TSP	0.076	-0.034	0.732	0.093	-0.107	0.721
LIQ	0.011	-0.033	0.700	-0.138	-0.117	0.036
REM	0.003	0.379	0.000	-0.011	0.309	0.006
MOM	-0.158	-0.194	0.096	-0.103	-0.287	0.297
RCG	0.065	-0.073	0.951	0.111	-0.168	0.897
CEI	0.050	-0.027	0.737	0.059	-0.111	0.754
CUI	0.008	-0.031	0.558	0.022	-0.086	0.668
PEC	1.886	-0.070	0.997	1.599	-0.263	0.995
CUR	0.029	-0.065	0.552	0.047	-0.167	0.615
CMS	1.072	-0.046	0.997	0.515	-0.210	0.988
COP	0.005	-0.049	0.578	0.020	-0.147	0.661
CMU	0.190	0.046	0.576	-0.013	-0.103	0.148
CFU	0.042	-0.041	0.754	-0.011	-0.130	0.363
		Multiple test			Multiple test	
		-0.205	0.131		-0.371	0.153

Table 11: **Office Property Type from 1978-2018 (Unbalanced Dataset)**

This table presents the results for the office property type with an unbalanced dataset from 1978 to 2018. A CBSA needs to have at least 36 consecutive quarterly observation to be considered. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Baseline is no factor						
		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5^{th}-percentile	p-value
MKT	-0.065	-0.047	0.024	-0.103	-0.072	0.024
SMB	0.018	-0.076	0.844	0.013	-0.111	0.744
HML	-0.023	-0.037	0.104	0.033	-0.055	0.804
RMW	0.065	-0.040	0.985	0.017	-0.060	0.774
CMA	0.017	-0.034	0.805	0.122	-0.061	0.974
CSP	0.013	-0.023	0.456	0.035	-0.046	0.577
TSP	0.016	-0.077	0.685	-0.012	-0.143	0.378
LIQ	-0.116	-0.056	0.006	-0.110	-0.077	0.023
REM	0.180	-0.262	0.624	0.138	-0.277	0.563
MOM	0.120	-0.060	0.973	0.151	-0.099	0.943
RCG	-0.440	-0.099	0.000	-0.632	-0.126	0.000
CEI	0.000	-0.038	0.393	0.001	-0.066	0.453
CUI	-0.008	-0.085	0.329	-0.003	-0.131	0.436
PEC	-0.016	-0.025	0.072	-0.154	-0.062	0.008
CUR	-0.138	-0.205	0.144	-0.112	-0.258	0.245
CMS	-0.055	-0.028	0.011	-0.159	-0.056	0.008
COP	-0.008	-0.030	0.176	-0.012	-0.051	0.191
CMU	0.106	-0.014	0.614	0.106	-0.029	0.597
CFU	-0.004	-0.053	0.297	-0.006	-0.075	0.294
		Multiple test			Multiple test	
		-0.281	0.001		-0.344	0.001

Panel B: Baseline is **RCG**						
		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5^{th}-percentile	p-value
MKT	-0.027	-0.119	0.351	-0.051	-0.177	0.303
SMB	-0.016	-0.100	0.377	-0.109	-0.143	0.086
HML	0.052	-0.048	0.904	0.132	-0.080	0.953
RMW	0.021	-0.064	0.880	0.118	-0.100	0.975
CMA	0.214	-0.059	0.998	0.346	-0.107	0.995
CSP	-0.020	-0.143	0.290	-0.030	-0.222	0.292
TSP	-0.088	-0.373	0.450	-0.198	-0.497	0.360
LIQ	0.001	-0.188	0.831	0.015	-0.263	0.816
REM	0.734	-0.694	1.000	1.043	-0.773	0.997
MOM	1.073	-0.125	1.000	1.528	-0.202	1.000
RCG						
CEI	-0.054	-0.176	0.297	-0.367	-0.253	0.013
CUI	-0.037	-0.122	0.229	-0.343	-0.191	0.008
PEC	0.663	-0.393	0.997	1.139	-0.511	0.995
CUR	1.009	-0.641	0.969	1.907	-0.750	0.981
CMS	2.160	-0.045	1.000	1.813	-0.133	0.999
COP	-0.018	-0.094	0.299	-0.113	-0.142	0.080
CMU	0.027	-0.014	0.194	-0.028	-0.049	0.070
CFU	0.000	-0.107	0.560	0.001	-0.159	0.566
		Multiple test			Multiple test	
		-0.709	0.975		-0.800	0.822

Table 12: **Retail Property Type from 1978-2018 (Unbalanced Dataset)**

This table presents the results for the retail property type with an unbalanced dataset from 1978 to 2018. A CBSA needs to have at least 36 consecutive quarterly observation to be considered. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Baseline is no factor

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5th-percentile	p-value
MKT	0.044	-0.091	0.952	0.057	-0.142	0.905
SMB	-0.005	-0.059	0.341	-0.011	-0.119	0.330
HML	0.015	-0.045	0.689	0.012	-0.086	0.614
RMW	0.083	-0.074	0.912	0.170	-0.126	0.922
CMA	-0.049	-0.077	0.116	-0.079	-0.121	0.106
CSP	0.000	-0.052	0.477	0.001	-0.099	0.491
TSP	0.024	-0.024	0.558	0.023	-0.066	0.550
LIQ	-0.057	-0.080	0.098	-0.018	-0.129	0.360
REM	-0.463	0.113	0.000	-0.498	0.082	0.000
MOM	-0.168	-0.251	0.218	-0.203	-0.401	0.306
RCG	-0.309	-0.166	0.002	-0.386	-0.271	0.012
CEI	-0.007	-0.134	0.493	-0.067	-0.205	0.233
CUI	0.032	-0.079	0.661	-0.057	-0.177	0.217
PEC	0.095	-0.036	0.864	-0.053	-0.090	0.119
CUR	-0.005	-0.078	0.313	-0.004	-0.134	0.394
CMS	0.148	0.016	0.333	-0.172	-0.007	0.004
COP	0.008	-0.030	0.439	0.013	-0.080	0.521
CMU	0.003	-0.059	0.541	-0.003	-0.103	0.417
CFU	0.009	-0.072	0.683	0.048	-0.139	0.792
		Multiple test			Multiple test	
		-0.265	0		-0.425	0.019

Panel B: Baseline is **REM**

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5th-percentile	p-value
MKT	0.102	-0.090	0.980	0.017	-0.153	0.695
SMB	0.012	-0.071	0.654	-0.002	-0.139	0.435
HML	0.023	-0.053	0.749	0.109	-0.101	0.910
RMW	0.045	-0.097	0.819	-0.031	-0.152	0.265
CMA	0.020	-0.077	0.761	0.102	-0.128	0.903
CSP	0.002	-0.048	0.410	-0.021	-0.110	0.240
TSP	-0.005	-0.111	0.536	-0.147	-0.175	0.071
LIQ	-0.002	-0.110	0.610	-0.096	-0.174	0.159
REM						
MOM	0.268	-0.218	0.998	0.325	-0.357	0.986
RCG	0.501	-0.247	0.999	0.169	-0.378	0.938
CEI	0.002	-0.109	0.639	-0.023	-0.177	0.364
CUI	0.030	-0.069	0.780	0.110	-0.138	0.906
PEC	1.254	-0.073	1.000	0.973	-0.146	1.000
CUR	0.036	-0.259	0.917	0.033	-0.390	0.827
CMS	0.675	-0.035	0.977	0.248	-0.066	0.647
COP	0.007	-0.045	0.538	0.081	-0.099	0.859
CMU	0.023	-0.125	0.891	-0.088	-0.205	0.205
CFU	0.003	-0.071	0.535	0.013	-0.151	0.592
		Multiple test			Multiple test	
		-0.296	0.999		-0.468	0.750

Interestingly, for every property type, all the models found are one-factor models which is less than the three-factor model Harvey and Liu (2019b) and the two-factor model Fletcher (2019) find for the US and UK stock markets. The explanation for this is the stronger impact on the scaled intercept from the first factor for commercial real estate returns compared to stock market returns. For example, REM reduces the mean scaled intercept by 77.2% (**table 8**) in the analysis with all property types aggregated and the first factor (MKT) in Harvey and Liu's (2019) framework offers a reduction in the mean scaled intercept of 19.2%. The higher explanatory power of the first factor in commercial real estate returns makes it harder for additional factors to be significant as the baseline model becomes a strong hypothesis. This is demonstrated by the extreme shifts in the multiple test's p-value between the first and the second run of the algorithm. Indeed, in the mean approach, for the aggregated case, the multiple test's p-value goes from 0 to 0.959 in the aggregated property type case. Similar jumps are seen for the apartment, office, and retail cases as well.

5.2 Results from 2009 to 2018

The analysis performed with the balanced panel of data from 2009 to 2018 offers different results. As a reminder, I perform this analysis as the full dataset is incomplete, meaning that every CBSA does not necessarily have an observation in every period. With the balanced dataset I reduce the time dimension and the cross-sectional dimension so as to have a dataset where every CBSA has an observation in every period. Furthermore, the period selected corresponds exactly to the period after the structural break observed in the returns due to the financial crisis. This is interesting as it would give insights into any potential fundamental change of the drivers of the returns of commercial real estate resulting from the financial crisis. Indeed, the significance and correlation of risk factors can differ depending on the period selected (Welch and Goyal, 2008). The results of the analysis are shown in **table 13** for the aggregated property type case**,** **table 14** for the apartment property type, **table 15** for the industrial property type, **table 16** for the office property type and **table 17** for the retail property type.

For all four property types and for the aggregation of all property types, the resulting model from the algorithm is a one-factor model with REM being the long significant risk factor. Additionally, the CMS factor is significant in all cases, but its impact on the scaled intercept is not as important as the one of the REM factor. Therefore, compared to the risk factors found in academic literature, I only find strong evidence supporting Mei and Lee's (1994) real estate risk premium. A comparison to the results obtained with the full dataset gives insights into any potential shift in the significant risk factors over time or any potential bias due to the unbalanced panel of data. The aggregation of all property types and the retail property type results do not change from the initial analysis as both datasets yield that REM is the best performing risk factor.

However, the three other property types have different results with both datasets. The apartment property type's final model changes from a one-factor model with MOM to a one-factor model with REM. Although MOM is still significant in the first run of the algorithm with the balanced dataset, it is outperformed by REM. For the industrial property type, it seems that the shorter time dimension allows for the risk factors to pass the multiple test and thus REM becomes a significant factor. More interestingly, the office property type's best performing risk factor in the first set of results (RCG) is not significant in the second set of results. This is due to the bias of the unbalanced data as the first result could have been driven by the earlier, less populous, time periods and a potential shift in the correlation structure of the risk factor due to the different time period used (Welch & Goyal, 2008). As the result with the balanced dataset is drastically different to the initial result, there is not enough evidence to conclude that it is likely that the true model for the office property type is a one-factor model with RCG being the significant factor.

Table 13: **Aggregated Property Types from 2009-2018 (Balanced Dataset)**

Note: This table presents the results for the aggregated property types with a balanced dataset from 2009 to 2018. All CBSA have 36 consecutive quarterly observation. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Baseline is no factor

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5^{th}-percentile	p-value
MKT	0.024	-0.025	1.000	0.021	-0.035	0.986
SMB	0.000	-0.020	0.499	0.006	-0.029	0.779
HML	-0.003	-0.013	0.195	-0.007	-0.020	0.182
RMW	0.010	-0.028	0.799	0.008	-0.033	0.727
CMA	0.000	-0.017	0.561	-0.001	-0.027	0.456
CSP	0.013	-0.036	0.729	0.031	-0.044	0.857
TSP	-0.014	-0.031	0.136	-0.017	-0.039	0.128
LIQ	-0.001	-0.020	0.410	0.003	-0.029	0.636
REM	-0.748	-0.101	0.000	-0.798	-0.101	0.000
MOM	-0.079	-0.031	0.002	-0.065	-0.034	0.012
RCG	0.139	-0.031	0.999	0.172	-0.032	0.999
CEI	0.003	-0.023	0.726	0.008	-0.032	0.824
CUI	-0.010	-0.027	0.154	0.009	-0.034	0.734
PEC	-0.032	-0.018	0.018	-0.015	-0.028	0.114
CUR	-0.039	-0.017	0.010	-0.022	-0.021	0.050
CMS	-0.326	-0.031	0.000	-0.307	-0.039	0.000
COP	0.002	-0.032	0.604	0.004	-0.037	0.702
CMU	0.031	-0.026	0.857	0.035	-0.033	0.882
CFU	-0.001	-0.022	0.452	0.004	-0.031	0.713
		Multiple test			Multiple test	
		-0.117	0		-0.123	0

Panel B: Baseline is **REM**

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5^{th}-percentile	p-value
MKT	0.041	-0.077	0.979	0.006	-0.088	0.737
SMB	-0.001	-0.057	0.455	-0.002	-0.065	0.425
HML	-0.001	-0.047	0.416	0.001	-0.055	0.485
RMW	-0.001	-0.108	0.527	-0.049	-0.122	0.180
CMA	-0.016	-0.094	0.343	-0.010	-0.106	0.429
CSP	0.057	-0.244	0.990	0.092	-0.271	0.993
TSP	0.003	-0.110	0.771	0.012	-0.121	0.831
LIQ	0.001	-0.075	0.529	0.002	-0.084	0.549
REM						
MOM	0.003	-0.230	0.724	0.009	-0.250	0.733
RCG	0.072	-0.178	0.990	0.066	-0.191	0.981
CEI	0.005	-0.087	0.756	0.040	-0.100	0.931
CUI	-0.003	-0.133	0.577	-0.030	-0.149	0.340
PEC	0.128	-0.056	0.993	0.215	-0.069	0.997
CUR	0.000	-0.108	0.621	-0.025	-0.118	0.321
CMS	0.090	-0.363	0.999	0.094	-0.407	0.998
COP	-0.010	-0.176	0.761	-0.046	-0.194	0.466
CMU	0.051	-0.234	0.987	-0.009	-0.256	0.781
CFU	-0.004	-0.069	0.425	0.000	-0.082	0.550
		Multiple test			Multiple test	
		-0.393	1		-0.444	0.979

Table 14: **Apartment Property Type from 2009-2018 (Balanced Dataset)**

Note: This table presents the results for the apartment property type with a balanced dataset from 2009 to 2018. All CBSA have 36 consecutive quarterly observation. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Baseline is no factor						
		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5th-percentile	p-value
MKT	0.014	-0.051	0.990	0.001	-0.057	0.768
SMB	-0.002	-0.033	0.406	-0.001	-0.037	0.472
HML	-0.006	-0.017	0.157	-0.002	-0.022	0.294
RMW	0.007	-0.026	0.731	0.006	-0.031	0.669
CMA	0.001	-0.038	0.556	0.001	-0.043	0.560
CSP	0.012	-0.039	0.725	0.019	-0.045	0.782
TSP	-0.022	-0.045	0.133	-0.036	-0.051	0.090
LIQ	0.003	-0.039	0.673	0.003	-0.044	0.637
REM	-0.730	-0.130	0.000	-0.837	-0.143	0.000
MOM	-0.068	-0.035	0.007	-0.072	-0.042	0.010
RCG	0.096	-0.025	0.999	0.079	-0.031	0.994
CEI	0.001	-0.013	0.537	0.002	-0.021	0.613
CUI	-0.009	-0.031	0.212	-0.010	-0.036	0.227
PEC	-0.058	-0.016	0.002	-0.033	-0.023	0.021
CUR	-0.002	-0.020	0.320	-0.021	-0.026	0.073
CMS	-0.239	-0.030	0.000	-0.256	-0.039	0.000
COP	0.001	-0.027	0.640	0.001	-0.033	0.616
CMU	0.009	-0.027	0.774	0.005	-0.033	0.667
CFU	-0.003	-0.039	0.469	-0.003	-0.046	0.440
		Multiple test			Multiple test	
		-0.134	0		-0.148	0

Panel B: Baseline is **REM**						
		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5th-percentile	p-value
MKT	0.054	-0.092	0.962	0.234	-0.109	1.000
SMB	0.000	-0.073	0.547	-0.013	-0.079	0.322
HML	-0.001	-0.066	0.509	-0.006	-0.078	0.404
RMW	-0.021	-0.093	0.261	-0.018	-0.104	0.302
CMA	-0.009	-0.122	0.529	0.020	-0.135	0.832
CSP	0.036	-0.235	0.980	0.229	-0.253	1.000
TSP	0.003	-0.143	0.789	0.021	-0.160	0.898
LIQ	0.001	-0.085	0.540	0.003	-0.095	0.564
REM						
MOM	0.001	-0.227	0.754	-0.012	-0.249	0.655
RCG	0.073	-0.122	0.992	0.128	-0.139	0.996
CEI	-0.008	-0.046	0.280	0.079	-0.064	0.986
CUI	0.006	-0.115	0.709	-0.025	-0.133	0.335
PEC	0.103	-0.043	0.990	0.330	-0.053	1.000
CUR	0.068	-0.072	0.969	0.208	-0.084	0.999
CMS	0.142	-0.242	0.996	0.048	-0.279	0.976
COP	0.047	-0.110	0.983	0.142	-0.132	0.999
CMU	0.105	-0.153	0.978	0.503	-0.174	1.000
CFU	-0.004	-0.076	0.442	-0.010	-0.086	0.364
		Multiple test			Multiple test	
		-0.310	0.999		-0.354	0.997

Table 15: **Industrial Property Type from 2009-2018 (Balanced Dataset)**

Note: This table presents the results for the industrial property type with a balanced dataset from 2009 to 2018. All CBSA have 36 consecutive quarterly observation. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Baseline is no factor

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5^{th}-percentile	p-value
MKT	0.037	-0.021	0.985	0.048	-0.037	0.987
SMB	0.002	-0.021	0.693	0.000	-0.032	0.567
HML	-0.002	-0.016	0.306	-0.002	-0.028	0.351
RMW	0.008	-0.031	0.746	0.014	-0.038	0.811
CMA	0.000	-0.022	0.467	0.001	-0.030	0.563
CSP	0.014	-0.036	0.715	0.011	-0.039	0.699
TSP	-0.013	-0.024	0.121	-0.008	-0.034	0.257
LIQ	-0.004	-0.024	0.252	0.006	-0.031	0.663
REM	-0.606	-0.055	0.000	-0.666	-0.081	0.000
MOM	-0.126	-0.042	0.000	-0.111	-0.051	0.003
RCG	0.127	-0.031	0.998	0.183	-0.041	0.999
CEI	0.004	-0.033	0.797	0.000	-0.037	0.552
CUI	-0.014	-0.023	0.095	0.016	-0.031	0.812
PEC	-0.194	-0.027	0.000	-0.150	-0.035	0.001
CUR	-0.076	-0.020	0.001	-0.099	-0.028	0.000
CMS	-0.296	-0.033	0.000	-0.348	-0.048	0.000
COP	0.002	-0.037	0.584	0.000	-0.041	0.542
CMU	0.049	-0.039	0.855	0.046	-0.039	0.854
CFU	0.005	-0.020	0.500	-0.004	-0.031	0.306
		Multiple test			Multiple test	
		-0.078	0		-0.099	0

Panel B: Baseline is **REM**

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5^{th}-percentile	p-value
MKT	0.043	-0.075	0.980	0.018	-0.102	0.839
SMB	-0.001	-0.042	0.422	-0.004	-0.063	0.410
HML	0.000	-0.049	0.540	-0.007	-0.067	0.370
RMW	0.005	-0.109	0.636	0.029	-0.123	0.815
CMA	-0.029	-0.034	0.064	-0.121	-0.051	0.005
CSP	0.095	-0.243	0.996	0.052	-0.269	0.974
TSP	0.000	-0.085	0.745	-0.015	-0.107	0.423
LIQ	-0.002	-0.072	0.428	-0.006	-0.084	0.390
REM						
MOM	0.014	-0.299	0.941	0.020	-0.322	0.924
RCG	0.116	-0.149	0.998	0.136	-0.165	0.998
CEI	0.007	-0.090	0.859	-0.038	-0.099	0.214
CUI	0.008	-0.109	0.743	-0.004	-0.119	0.480
PEC	-0.175	-0.058	0.003	-0.114	-0.069	0.016
CUR	-0.068	-0.094	0.094	-0.249	-0.108	0.004
CMS	-0.030	-0.323	0.880	-0.099	-0.363	0.610
COP	0.032	-0.136	0.987	-0.041	-0.150	0.389
CMU	0.236	-0.264	0.999	0.270	-0.277	0.999
CFU	-0.009	-0.040	0.212	-0.032	-0.053	0.108
		Multiple test			Multiple test	
		-0.378	0.493		-0.426	0.310

Table 16: **Office Property Type from 2009-2018 (Balanced Dataset)**

Note: This table presents the results for the office property type with a balanced dataset from 2009 to 2018. All CBSA have 36 consecutive quarterly observation. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Baseline is no factor						
		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5^{th}-percentile	p-value
MKT	0.050	-0.031	0.999	0.067	-0.051	0.983
SMB	0.002	-0.026	0.618	-0.012	-0.043	0.219
HML	-0.006	-0.014	0.152	-0.029	-0.028	0.045
RMW	0.017	-0.049	0.808	0.011	-0.057	0.708
CMA	0.000	-0.023	0.490	-0.001	-0.043	0.450
CSP	0.019	-0.049	0.701	0.028	-0.065	0.733
TSP	-0.017	-0.037	0.142	-0.016	-0.051	0.220
LIQ	-0.006	-0.039	0.256	-0.005	-0.045	0.316
REM	-0.600	-0.101	0.000	-0.702	-0.117	0.000
MOM	-0.127	-0.045	0.001	-0.156	-0.055	0.001
RCG	0.175	-0.047	0.999	0.109	-0.058	0.988
CEI	0.005	-0.037	0.762	-0.006	-0.056	0.384
CUI	-0.028	-0.041	0.087	-0.024	-0.052	0.145
PEC	-0.091	-0.031	0.004	-0.119	-0.045	0.003
CUR	-0.100	-0.031	0.002	-0.131	-0.042	0.002
CMS	-0.378	-0.043	0.000	-0.486	-0.054	0.000
COP	0.003	-0.050	0.582	0.000	-0.065	0.556
CMU	0.058	-0.051	0.854	-0.011	-0.067	0.303
CFU	0.003	-0.024	0.500	0.007	-0.039	0.594
		Multiple test			Multiple test	
		-0.115	0		-0.143	0

Panel B: Baseline is **REM**						
		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5^{th}-percentile	p-value
MKT	0.085	-0.090	0.999	0.185	-0.132	0.998
SMB	0.001	-0.050	0.482	-0.014	-0.080	0.283
HML	0.000	-0.058	0.501	-0.004	-0.084	0.431
RMW	-0.004	-0.148	0.500	0.024	-0.181	0.774
CMA	0.006	-0.050	0.615	-0.003	-0.080	0.389
CSP	-0.015	-0.301	0.865	-0.101	-0.366	0.516
TSP	0.001	-0.115	0.758	-0.011	-0.148	0.507
LIQ	0.000	-0.102	0.483	-0.012	-0.125	0.358
REM						
MOM	-0.002	-0.305	0.745	-0.016	-0.356	0.706
RCG	0.150	-0.181	0.998	0.399	-0.225	1.000
CEI	0.020	-0.104	0.908	0.071	-0.129	0.946
CUI	0.000	-0.169	0.670	0.000	-0.202	0.666
PEC	0.274	-0.062	1.000	0.123	-0.088	0.976
CUR	0.073	-0.134	0.951	0.229	-0.165	0.992
CMS	0.017	-0.347	0.987	-0.031	-0.416	0.873
COP	0.044	-0.174	0.984	-0.016	-0.209	0.654
CMU	0.032	-0.299	0.973	-0.031	-0.352	0.751
CFU	-0.002	-0.045	0.296	-0.008	-0.071	0.288
		Multiple test			Multiple test	
		-0.401	0.999		-0.458	0.877

Table 17: **Retail Property Type from 2009-2018 (Balanced Dataset)**

Note: This table presents the results for the retail property type with a balanced dataset from 2009 to 2018. All CBSA have 36 consecutive quarterly observation. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Baseline is no factor						
		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5^{th}-percentile	p-value
MKT	0.011	-0.029	0.994	0.041	-0.042	0.998
SMB	0.000	-0.019	0.463	-0.006	-0.030	0.250
HML	0.003	-0.009	0.530	0.011	-0.020	0.731
RMW	0.012	-0.029	0.847	0.023	-0.035	0.887
CMA	0.001	-0.031	0.557	0.001	-0.044	0.580
CSP	0.008	-0.031	0.722	-0.010	-0.038	0.232
TSP	-0.009	-0.031	0.230	-0.010	-0.044	0.265
LIQ	-0.001	-0.024	0.408	-0.004	-0.036	0.354
REM	-0.741	-0.106	0.000	-0.777	-0.121	0.000
MOM	-0.016	-0.019	0.066	0.005	-0.030	0.566
RCG	0.199	-0.044	1.000	0.273	-0.060	1.000
CEI	0.004	-0.030	0.753	0.000	-0.038	0.567
CUI	-0.007	-0.022	0.206	-0.025	-0.033	0.086
PEC	0.216	-0.029	1.000	0.323	-0.039	1.000
CUR	-0.010	-0.019	0.114	0.057	-0.030	0.989
CMS	-0.373	-0.037	0.000	-0.294	-0.055	0.000
COP	0.002	-0.036	0.593	0.001	-0.048	0.550
CMU	0.025	-0.027	0.851	0.010	-0.032	0.713
CFU	-0.005	-0.033	0.354	-0.013	-0.042	0.238
		Multiple test			Multiple test	
		-0.108	0		-0.126	0

Panel B: Baseline is **REM**						
		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5^{th}-percentile	p-value
MKT	-0.062	-0.057	0.042	-0.070	-0.085	0.074
SMB	-0.002	-0.043	0.407	-0.007	-0.059	0.334
HML	0.002	-0.037	0.514	0.004	-0.053	0.540
RMW	0.056	-0.096	0.957	0.070	-0.109	0.944
CMA	0.027	-0.103	0.909	0.088	-0.121	0.979
CSP	-0.063	-0.177	0.365	-0.159	-0.207	0.108
TSP	-0.008	-0.092	0.504	-0.002	-0.120	0.619
LIQ	0.000	-0.063	0.544	-0.001	-0.081	0.479
REM						
MOM	-0.009	-0.137	0.478	-0.021	-0.165	0.412
RCG	0.336	-0.169	1.000	0.390	-0.201	1.000
CEI	-0.004	-0.090	0.556	-0.013	-0.110	0.454
CUI	-0.006	-0.087	0.456	-0.030	-0.114	0.302
PEC	0.645	-0.065	1.000	0.777	-0.082	1.000
CUR	0.086	-0.073	0.993	0.161	-0.086	0.998
CMS	0.140	-0.293	1.000	0.158	-0.336	1.000
COP	-0.032	-0.143	0.502	-0.142	-0.175	0.097
CMU	0.021	-0.178	0.959	0.097	-0.203	0.990
CFU	0.006	-0.070	0.757	0.013	-0.085	0.776
		Multiple test			Multiple test	
		-0.310	0.944		-0.360	0.580

5.3 Illiquidity Adjustment

Commercial real estate assets are infrequently traded. This means that its exposure to risk factors may not be direct. To account for this illiquidity, it is also necessary to test the returns of the test assets on lagged risk factors. In this testing framework, I include up to four lags (1 year) per risk factor and test the baseline hypothesis against all of them simultaneously. As the testing framework accounts for multiple testing, this approach is robust for data mining meaning I will not find falsely significant risk factor because of the high number of candidates. I perform the lagged risk factor analysis both on the unbalanced dataset from 1978 to 2018 and the balanced dataset from 2009 to 2018. The results are summarized in **appendix B** with the unbalanced dataset analysis in **tables 1B to 5B** and analysis with the balanced dataset in **tables 6B to 10B**. I chose to only report the multiple test p-value in the final pass of the test for presentation purposes as the number of risk factors is very high with the lags.

With the unbalanced dataset, the results differ from the initial set of results in **tables 8 through 12** except for the industrial property type where the multiple test is still failed and for the aggregation of property types where REM is still the lone risk factor to result from the algorithm. For the apartment and the office property types, the resulting model is a one-factor model with RCG lagged 4 times which corresponds to the change in GDP from the previous year. To compare with the initial set of results, the apartment property type shifts from MOM to RCG while the office property type's best performing risk factor remains the same as the non-lagged version of RCG is the best performing risk factor in the initial analysis. Finally, for the retail property type, where the best performing model in the first set of results is a one-factor model with REM as the significant risk factor, RCG lagged 3 times is the best performing risk factor in a one-factor model. These results suggest that illiquidity in the commercial real estate market may impact the testing of risk factors as for the apartment, office and retail property type the results change. However, as with the initial set of results, the dataset used may be biased due to its incompleteness. Therefore, to validate the hypothesis of the role of illiquidity it is important to also look at the case with the balanced dataset.

The liquidity adjusted analysis on the balanced dataset results in the same conclusion as the initial analysis on the balanced dataset for all property types except the office one. Indeed, the office property type's best performing model is a one-factor model with the REM lagged once as the lone risk factor. However, this risk factor only slightly outperforms the non-lagged REM as its mean scaled intercept is 2.5% better. Therefore, the liquidity adjusted analysis only marginal changes the conclusions drawn in the initial analysis on the balanced dataset. Contrary to the analysis on the unbalanced dataset, it does not support the hypothesis of a significant impact of the illiquidity in the commercial real estate market on the testing of its risk factors.

The liquidity adjustment provides robustness to the claim of the existence and significance of a real estate market risk premium as, with the balanced dataset, the risk factor remains the best performing across all property types despite the addition of the lags. With the period extended with the case from 1978 to 2018, the apartment, office and retail property type show evidence for a lagged effect of RCG. The RCG risk factor is still significant when controlling for the incompleteness bias in the balanced dataset but is outperformed by REM. Therefore, the results point towards a lagged RCG risk factor but not in combination with REM as evidenced by the very high multiple test in the second pass with the balanced dataset for all property types.

5.4 Including the financial crisis

The balanced panel reduces the time dimension of the dataset. Importantly, the financial crisis of 2008 is not included. The structural break in the data the crisis created drove some risk factor to behave similarly and led to high linear correlation measures. The summary statistics and the correlation table of the risk factor dataset going from 2008 to 2018 and thus including the financial crisis as shown in **appendix C**. Two clusters are observed in the correlation table: an economic condition cluster including risk factors REM, PEC, CUR and RCG and a price cluster including risk factors COP, CEI and CUI. The first cluster can be defiened as the economic condition cluster as it includes the change in GDP, consumption and unemployment rate which are three important economic measures and the second as the price cluster as it includes both measures of inflation and the change in crude oil price which is indicative of prices. To analyse the significance of the explanatory power these risk factors have on the cross-section of commercial real estate returns, the multicollinearity issues have to be dealt with. Therefore, I perform a principal component analysis on the two clusters and find that two new risk factors, an economic condition one (ECO) and a price one (PRI). In both cases, most of the variance is explained with the first principal component (81% for ECO and 99.93% for PRI) therefore the first column of the rotated data from the two PCA's performed becomes the ECO and PRI risk factors. The scree plots of the two PCA are shown in **table 1D** of **appendix D**. The summary statistics and the correlation table with the other risk factors of the ECO and PRI risk factors are shown in **table 2D**. There are no potential multicollinearity issues to highlight the two new risk factors.

The **tables 3D to 7D** show the results of the analysis performed with the dataset from 2008 to 2018 for every property type and with the two risk factors stemming from the PCA. Their performance in explaining the cross-section of commercial real estate returns is poor. Indeed, in all five cases, ECO and PRI fail to reduce the scaled intercept. This result is surprising for the ECO risk factor as its components (REM, PEC, CUR and RCG) performed well in the other analysis. A potential explanation for the poor performance of the ECO risk factor is its higher dispersion to the REM, PEC and RCG risk factors. Indeed, the ECO risk factor has a standard deviation of 6.72% while the REM, PEC and RCG risk factors respectively have standard deviations of 2.79%, 2.54% and 0.70%. The higher standard deviation of the ECO risk factor makes it less fit to explain the cross-section of returns. The results for the PRI risk factors are not surprising as its components are not the best performing risk factor in any of the testing performed in this paper.

I also run the test on the same dataset but with the original factors (excluding ECO and PRI but including REM, RCG, PEC, CUR, COP, CEI and CUI). The results are shown in **tables 8D to 12D**. In a one-factor model for the apartment, industrial, retail and aggregated property types, REM is the best performing risk factors when the analysis is run without the ECO and PRI risk factors. In a one-factor model for the office property type, RCG is the best performing risk factors when the analysis is run without the ECO and PRI risk factors as it outperforms REM in the median approach (performs equally in the mean approach). Although, I cannot draw conclusions on any two-factor models as multicollinearity would become an issue not resolved, the results I found with the extended time dimension are similar to the ones found in the initial balanced dataset analysis.

Overall, the findings from the analysis including the financial crisis of 2008 while controlling for the incompleteness bias stemming from the NCREIF dataset are in line with the findings from the balanced dataset from 2009 to 2018. The only differing conclusion is for the office property type where RCG slightly outperforms REM in the median approach.

6. Real Estate Market Risk Premium Drivers

6.1 Methodology

For two out of the five cases (including the aggregation of property types) with the unbalanced dataset and all five cases with the balanced dataset, the best performing model is a one-factor model with REM as the best performing risk factor. Of the risk factors I found in academic literature and listed in **table 1**, REM is the only risk factor for which I found strong evidence. One way to find further common ground between the existing literature and my findings is to look at the drivers of REM. By performing a LASSO regression, I can identify if any and which of the other factors drive the real estate market premium. In this case, REM can be interpreted as the aggregation of external factors impacting the commercial real estate returns.

As mentioned above, the method I use to determine the drivers of the real estate risk premium is the LASSO regression which consists of a regression in which the absolute size of the regression coefficients are penalized (Tibshirani, 1996). The penalty is set by constraining the sum of the absolute value of the estimates and leads to a situation where some regression coefficients are zero. The variables with coefficients not equal to zero are selected as explanatory variables. Formally, the LASSO regression is a minimization equation and its objective function for a linear regression is defined as:

$$\min_{\beta_0 \beta_j} \left[\frac{1}{2N} \sum_{i=1}^{n} (y_i - \beta_0 - \sum_j^k \beta_j x_{ij})^2 + \lambda \|\beta\|_1 \right] \tag{19}$$

Where $\lambda \geq 0$ is a complexity parameter, β_j are the regression coefficients, y_i is the dependant variable, x_{ij} are the independent variables. $\|\beta\|_1$ means that the function makes use of L1 regularization technique. The minimization problem yields the estimates $\widehat{\beta_0}$ and $\widehat{\beta_j}$. The parameter λ is predefined and controls the amount of shrinkage that is performed on the estimates.

Before solving the optimization problem in (19) the parameter λ must be defined. I define this parameter by performing a cross-validation. I run the optimization problem (19) k-fold + 1 times, the first to define the λ sequence and the remainder to compute the fit with each of the folds omitted (Friedman, Hastie & Tibshirani, 2008). The k-fold splits the dataset into equal-sized sub dataset. I set the number of folds for this analysis at 10. The outcome of the procedure yields an error curve from which a value of lambda can be selected. The results of the cross-validation are random as the folds are selected randomly. To minimize the randomness, I run the cross-validation 10’000 times and average the error curves and select the value for λ where the error is the smallest.

6.2 Results

The first step of the LASSO regression is identifying the optimal value for λ. This value is computed by calculating the average mean-squared error curve from the iterations of the cross-validation and taking the value of λ where the average mean-squared error is the smallest. The curve of the average mean-squared error for every value of λ is shown in **figure 1E** in **appendix E**. This exercise yields the optimal value of λ at 0.008068. Next, the LASSO regression is performed, and the results are shown in **table 1E**. The main takeaway from this regression is that, after applying the regularization, the only risk factor to drive the real estate risk premium is CUR. Running an OLS regression with REM as the dependant variable and CUR as the independent variable shows that CUR explains 23.2% of the variance of REM. The results of the OLS regression are shown in **table 18**. This result means that CUR is probably a driver of REM given its significance level, and that none of the other candidate risk factors are drivers of REM for the period from 1978 to 2018. As CUR is not a risk factor found in the academic literature, the LASSO regression fails to link REM to any of the risk factors outlined in **table 1** outside of itself.

The absence of evidence supporting the stock market risk factors can be attributed to the commercial real estate market and the stock market’s segmentation. Indeed, there is overwhelming support in academic literature of the two markets not being integrated (e.g. Liu et al., 1990; Wilson et al., 1996; Ling and Naranjo, 1999). This explains why the cross-section of returns of commercial real estate are not explained by the same risk factors as for the stock market. Therefore, an investor should expect a reduction in risk when adding privately owned real estate to a stock portfolio (Wilson et al., 1996; Lin and Lin, 2011). For the period from 2009 to 2018, this conclusion holds for all property type meaning that they should all offer investors a potential risk reduction.

The explanation for the lack of evidence supporting the macroeconomic risk factors found in the academic literature can be linked to REM outperforming them in the tests. Indeed, if I exclude REM and the risk factors which are not present in **table 1,** the only significant risk factor in both the mean and the median approach is PEC for the aggregated case from 1978 to 2018 (**table 8**). This result shows two things. First, it highlights the importance of multiple testing to find the most important risk factors as individually some of the macroeconomic risk factors are significant (for example RCG, PEC pass the single test in the first run of the aggregated property type from 1978 to 2018 case). Second, it shows that REM outperforms the previously found macroeconomic risk factors. Therefore, when commercial real estate market excess returns are controlled for, the macroeconomic risk factors are not important. Moreover, the LASSO regression results show that REM is not an aggregation of the effects of the macroeconomic risk factors. Therefore, the results I find suggest that the macroeconomic risk factors previously found in academic literature are not important in explaining the cross-section of commercial real estate returns.

Table 18: **Real Estate Market Risk Premium OLS Regression**

The table shows the results of the OLS regression where REM, the real estate market excess risk premium, is the dependent variable and CUR, the change in unemployment rate, is the independent variable. Both coefficients are significative with p-values below 0.01.

	Dependent variable:
	REM
	(1)
CUR	-0.19*
	(0)
Constant	0.11*
	(0)
Observations	162
R^2	0.23

Note: * = p<0.01

7. Conclusion

In this paper, I contribute to the existing literature on risk factors in the commercial real estate market by using quarterly data of privately owned properties in the US from 1978 to 2018. I test the cross-section of the returns from this data with popular risk factors found in the commercial real estate and the stock market academic literatures. To perform the test, I employ a recent testing framework developed by Harvey and Liu (2019b) where the significance of the risk factors is drawn from a bootstrap of the historical data and the model is built from a sequential approach. For commercial real estate as a whole, I find that the real estate market risk premium is the lone significant risk factor. This result is robust as the scaled intercept is reduced both in the mean and in the median approach for both the 1978 to 2018 and the 2009 to 2018 time periods.

I also test the candidate risk factors with the dataset split by property type. In this context, the results are not as clear as for commercial real estate as a whole. With the balanced dataset from 2009 to 2018, I find that the real estate market premium is the best performing risk factor for every property type both in the mean and in the median approach. However, with the dataset from 1978 to 2018, I find different results for the apartment (momentum factor), industrial (no significant factors) and office (GDP factor) property types. As the results are different between the two analysis, the conclusions I draw for every property type are not as robust as with the aggregated case.

Harvey and Liu's (2019b) approach builds a model where only the risk factors which significantly improve the scaled pricing error after controlling for multiple testing are included. This approach has led to smaller factor models such as Fletcher (2019) finding a two-factor model out of 13, previously found significant, candidate risk factors and Harvey and Liu (2019b) finding a three-factor model from 14 candidate risk factors. For commercial real estate, I find a similar picture as I find little evidence supporting the 14 risk factors outlined in **table 1**. The lone risk factor for which I find significant evidence is the real estate market premium. In this sense, my paper joins the growing body of research which suggests that only a few important risk factors are essential for explaining the cross-section of asset returns. Harvey and Liu (2019a) state that many risk factors are false. My results substantiate their claim with the example of commercial real estate.

As I only find strong evidence for the real estate market risk premium, I perform a LASSO regression in order to derive the drivers of this risk factor. After the regularization, I find that the only driver from the candidates I proposed is the change in unemployment rate. This result does not allow me to draw comparisons with the existing literature as the unemployment rate has also not been tested as a risk factor. Overall, the lack of evidence for the macroeconomic risk factors can be linked to its underperformance compared to REM as some of them are significant on an individual level.

My research does have some limitations. For one, the data I use is incomplete. Indeed, for the case from 1978 to 2018, the panel of data is unbalanced and for the case from 2009 to 2018 some CBSA are not included. This is due to the nature of collecting data for commercial real estate as it is by nature privately owned which makes it less readily available. Further research could focus on the returns of publicly traded real estate such as REIT’s where data is more available. Another area of research which could yield fruitful results is to look at possible risk factors stemming from the characteristics of the properties such as the size or the age.

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Appendix

Appendix A: Third Pass Aggregated Property Types

Table 1A: **Aggregated Property Types from 1978-2018 3rd Pass**

Note: This table presents the results for the 3rd pass of the aggregated property types with an unbalanced dataset from 1978 to 2018. A CBSA needs to have at least 36 consecutive quarterly observation to be considered. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Baseline is **REM + MOM**

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5^{th}-percentile	p-value
MKT	0.007	-0.068	0.359	-0.030	-0.079	0.131
SMB	0.053	-0.075	0.811	0.082	-0.084	0.875
HML	0.018	-0.118	0.601	-0.021	-0.137	0.253
RMW	0.030	-0.048	0.591	-0.093	-0.060	0.022
CMA	0.037	-0.088	0.803	0.011	-0.112	0.619
CSP	0.034	-0.083	0.515	0.066	-0.095	0.610
TSP	0.036	-0.174	0.599	-0.123	-0.188	0.118
LIQ	0.091	-0.143	0.899	0.211	-0.160	0.969
REM						
MOM						
RCG	0.099	-0.167	0.593	0.159	-0.175	0.669
CEI	0.002	-0.082	0.384	0.002	-0.090	0.379
CUI	0.010	-0.133	0.381	-0.009	-0.146	0.283
PEC	0.551	0.111	0.489	0.864	0.115	0.690
CUR	0.256	-0.243	0.783	0.628	-0.254	0.900
CMS	0.677	-0.066	0.981	1.083	-0.079	0.985
COP	0.079	-0.094	0.739	-0.071	-0.109	0.081
CMU	0.069	-0.112	0.772	0.134	-0.120	0.859
CFU	0.043	-0.060	0.751	-0.002	-0.076	0.340
		Multiple test			Multiple test	
		-0.61	0.987		-0.656	0.546

Appendix B: Illiquidity Adjustment (Lagged Models)

Table 1B: **Aggregated Property Types from 1978-2018 (Unbalanced Dataset – Liquidity Adjusted)**

Note: This table presents the results for the aggregated property types with an unbalanced dataset from 1978 to 2018. The risk factors are included in their contemporaneous and in their lags. A CBSA needs to have at least 36 consecutive quarterly observation to be considered. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty. Only the multiple test in the second pass of the algorithm is presented as its results is above the threshold.

Panel A: Baseline is no factor

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5th-percentile	p-value
MKT (4 lags)	-0.077	-0.088	0.061	-0.064	-0.090	0.081
SMB (4 lags)	-0.087	-0.216	0.296	-0.095	-0.242	0.295
HML (4 lags)	-0.020	-0.052	0.166	-0.047	-0.064	0.087
RMW (4 lags)	0.099	-0.076	0.854	0.088	-0.081	0.801
CMA (4 lags)	-0.044	-0.109	0.245	-0.035	-0.125	0.310
CSP (4 lags)	0.002	-0.169	0.488	0.001	-0.187	0.484
TSP (4 lags)	0.123	-0.002	0.565	0.100	-0.003	0.467
LIQ (4 lags)	0.024	-0.049	0.586	0.026	-0.058	0.591
REM (4 lags)	-0.166	-0.181	0.060	-0.175	-0.200	0.066
MOM (4 lags)	0.164	-0.070	0.979	0.170	-0.081	0.977
RCG (4 lags)	-0.381	0.040	0.000	-0.420	0.038	0.000
CEI (4 lags)	0.000	-0.032	0.322	0.000	-0.040	0.343
CUI (4 lags)	0.004	-0.034	0.412	-0.006	-0.042	0.223
PEC (4 lags)	-0.383	-0.053	0.001	-0.416	-0.050	0.001
CUR (4 lags)	0.221	0.063	0.450	0.200	0.067	0.367
CMS (4 lags)	0.678	-0.063	0.987	0.782	-0.074	0.986
COP (4 lags)	-0.011	-0.043	0.235	-0.029	-0.051	0.131
CMU (4 lags)	-0.064	-0.250	0.482	-0.047	-0.272	0.540
CFU (4 lags)	-0.098	-0.282	0.402	-0.088	-0.296	0.451
MKT (3 lags)	-0.018	-0.017	0.047	-0.011	-0.016	0.060
SMB (3 lags)	-0.011	-0.091	0.426	-0.018	-0.098	0.337
HML (3 lags)	-0.006	-0.040	0.248	-0.018	-0.051	0.176
RMW (3 lags)	0.149	-0.025	0.857	0.146	-0.024	0.823
CMA (3 lags)	-0.026	-0.085	0.279	-0.022	-0.107	0.364
CSP (3 lags)	0.015	-0.108	0.494	0.005	-0.126	0.453
TSP (3 lags)	0.142	0.004	0.557	0.126	0.001	0.491
LIQ (3 lags)	0.000	-0.030	0.292	0.013	-0.038	0.481
REM (3 lags)	-0.354	-0.256	0.021	-0.356	-0.267	0.025
MOM (3 lags)	0.194	-0.079	0.979	0.190	-0.087	0.975
RCG (3 lags)	-0.514	0.061	0.000	-0.535	0.061	0.000
CEI (3 lags)	0.007	-0.030	0.459	-0.006	-0.035	0.191
CUI (3 lags)	0.010	-0.032	0.437	-0.002	-0.038	0.249
PEC (3 lags)	-0.663	0.135	0.000	-0.774	0.146	0.000
CUR (3 lags)	0.218	0.038	0.424	0.200	0.040	0.361
CMS (3 lags)	0.762	-0.043	0.987	0.860	-0.049	0.987
COP (3 lags)	-0.016	-0.046	0.167	-0.008	-0.048	0.228
CMU (3 lags)	-0.076	-0.204	0.383	-0.083	-0.225	0.360
CFU (3 lags)	-0.087	-0.247	0.395	-0.090	-0.263	0.384
MKT (2 lags)	-0.045	-0.037	0.039	-0.055	-0.040	0.034
SMB (2 lags)	0.052	-0.033	0.636	0.055	-0.039	0.613
HML (2 lags)	-0.010	-0.044	0.215	0.003	-0.049	0.469
RMW (2 lags)	0.091	-0.034	0.829	0.080	-0.033	0.766
CMA (2 lags)	-0.012	-0.054	0.275	0.006	-0.063	0.651

CSP (2 lags)	-0.003	-0.068	0.396	-0.004	-0.076	0.376
TSP (2 lags)	0.098	-0.010	0.542	0.108	-0.010	0.557
LIQ (2 lags)	-0.027	-0.104	0.269	-0.077	-0.117	0.107
REM (2 lags)	-0.560	-0.332	0.007	-0.564	-0.344	0.011
MOM (2 lags)	0.191	-0.134	0.974	0.209	-0.150	0.975
RCG (2 lags)	-0.536	0.053	0.000	-0.543	0.051	0.000
CEI (2 lags)	-0.001	-0.046	0.329	-0.001	-0.050	0.332
CUI (2 lags)	0.021	-0.032	0.430	0.024	-0.034	0.430
PEC (2 lags)	-0.659	0.135	0.000	-0.699	0.135	0.000
CUR (2 lags)	0.271	0.033	0.450	0.264	0.033	0.423
CMS (2 lags)	0.566	-0.033	0.981	0.591	-0.037	0.979
COP (2 lags)	-0.030	-0.053	0.105	-0.050	-0.058	0.062
CMU (2 lags)	-0.075	-0.162	0.288	-0.079	-0.179	0.276
CFU (2 lags)	-0.035	-0.146	0.345	-0.037	-0.158	0.335
MKT (1 lag)	-0.052	-0.042	0.039	-0.068	-0.046	0.027
SMB (1 lag)	0.037	-0.066	0.630	-0.018	-0.080	0.194
HML (1 lag)	0.005	-0.040	0.427	-0.020	-0.048	0.134
RMW (1 lag)	0.070	-0.038	0.815	0.074	-0.043	0.798
CMA (1 lag)	0.033	-0.038	0.675	0.017	-0.045	0.526
CSP (1 lag)	-0.011	-0.043	0.228	-0.015	-0.051	0.192
TSP (1 lag)	0.083	-0.038	0.551	0.062	-0.040	0.449
LIQ (1 lag)	-0.111	-0.157	0.103	-0.105	-0.172	0.127
REM (1 lag)	-0.719	-0.372	0.000	-0.772	-0.394	0.001
MOM (1 lag)	0.161	-0.109	0.958	0.173	-0.122	0.954
RCG (1 lag)	-0.695	0.082	0.000	-0.751	0.077	0.000
CEI (1 lag)	0.000	-0.055	0.337	0.000	-0.060	0.346
CUI (1 lag)	0.028	-0.030	0.452	0.025	-0.034	0.426
PEC (1 lag)	-0.443	0.174	0.000	-0.467	0.193	0.000
CUR (1 lag)	0.289	0.041	0.446	0.268	0.043	0.395
CMS (1 lag)	0.636	-0.030	0.982	0.687	-0.035	0.979
COP (1 lag)	-0.050	-0.076	0.103	-0.047	-0.084	0.117
CMU (1 lag)	-0.017	-0.062	0.214	-0.012	-0.069	0.253
CFU (1 lag)	-0.018	-0.090	0.283	-0.019	-0.096	0.271
MKT (no lags)	-0.037	-0.034	0.043	-0.024	-0.039	0.082
SMB (no lags)	0.023	-0.064	0.613	0.029	-0.080	0.676
HML (no lags)	-0.041	-0.047	0.062	-0.051	-0.050	0.049
RMW (no lags)	0.064	-0.041	0.853	0.052	-0.045	0.800
CMA (no lags)	-0.007	-0.055	0.279	-0.003	-0.062	0.370
CSP (no lags)	0.000	-0.019	0.221	0.000	-0.019	0.214
TSP (no lags)	0.090	-0.058	0.616	0.059	-0.059	0.483
LIQ (no lags)	-0.058	-0.102	0.134	-0.045	-0.109	0.179
REM (no lags)	-0.772	-0.412	0.000	-0.811	-0.431	0.000
MOM (no lags)	0.084	-0.176	0.761	0.071	-0.184	0.728
RCG (no lags)	-0.602	0.018	0.000	-0.637	0.017	0.000
CEI (no lags)	0.016	-0.047	0.458	0.001	-0.048	0.306
CUI (no lags)	0.021	-0.027	0.406	0.010	-0.029	0.335
PEC (no lags)	-0.414	0.191	0.000	-0.453	0.188	0.000
CUR (no lags)	0.283	0.031	0.445	0.253	0.032	0.400
CMS (no lags)	0.442	-0.045	0.976	0.434	-0.050	0.971
COP (no lags)	-0.051	-0.084	0.126	-0.032	-0.081	0.196
CMU (no lags)	0.019	-0.030	0.490	0.011	-0.032	0.414
CFU (no lags)	0.018	-0.031	0.571	0.017	-0.038	0.527
		Multiple test			Multiple test	
		-0.458	0		-0.494	0
Panel B: Baseline is **REM (no lags)**						
		Multiple test			Multiple test	
		-0.704	0.985		-0.774	0.961

Table 2B: **Apartment Property Type from 1978-2018 (Unbalanced Dataset – Liquidity Adjusted)**

This table presents the results for the apartment property type with an unbalanced dataset from 1978 to 2018. The risk factors are included in their contemporaneous and in their lags. A CBSA needs to have at least 36 consecutive quarterly observation to be considered. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty. Only the multiple test in the second pass of the algorithm is presented as its results is above the threshold.

Panel A: Baseline is no factor

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5th-percentile	p-value
MKT (4 lags)	-0.051	-0.049	0.043	-0.075	-0.064	0.036
SMB (4 lags)	-0.010	-0.122	0.431	0.010	-0.184	0.619
HML (4 lags)	-0.011	-0.060	0.242	-0.001	-0.080	0.359
RMW (4 lags)	0.077	-0.058	0.825	0.048	-0.080	0.706
CMA (4 lags)	-0.002	-0.102	0.441	0.020	-0.148	0.692
CSP (4 lags)	0.114	-0.030	0.506	0.133	-0.037	0.542
TSP (4 lags)	0.163	-0.158	0.543	0.150	-0.179	0.523
LIQ (4 lags)	-0.041	-0.051	0.067	-0.043	-0.075	0.084
REM (4 lags)	-0.251	-0.077	0.008	-0.283	-0.084	0.01
MOM (4 lags)	-0.356	-0.245	0.005	-0.388	-0.274	0.007
RCG (4 lags)	-0.596	-0.237	0.000	-0.677	-0.263	0
CEI (4 lags)	0.011	-0.088	0.525	0.009	-0.105	0.5
CUI (4 lags)	-0.011	-0.086	0.299	-0.024	-0.108	0.242
PEC (4 lags)	-0.507	-0.027	0.000	-0.599	-0.038	0
CUR (4 lags)	0.172	-0.060	0.469	0.162	-0.083	0.426
CMS (4 lags)	0.168	-0.115	0.856	0.065	-0.161	0.711
COP (4 lags)	-0.005	-0.037	0.210	0.003	-0.059	0.41
CMU (4 lags)	0.155	-0.017	0.533	0.139	-0.027	0.48
CFU (4 lags)	0.222	0.002	0.503	0.216	-0.006	0.466
MKT (3 lags)	-0.071	-0.059	0.040	-0.081	-0.064	0.035
SMB (3 lags)	0.027	-0.091	0.705	0.011	-0.116	0.564
HML (3 lags)	-0.041	-0.073	0.137	-0.011	-0.093	0.301
RMW (3 lags)	0.096	-0.072	0.842	0.100	-0.084	0.82
CMA (3 lags)	-0.002	-0.075	0.395	0.020	-0.125	0.683
CSP (3 lags)	0.083	-0.038	0.526	0.061	-0.051	0.465
TSP (3 lags)	0.112	-0.219	0.545	0.121	-0.259	0.555
LIQ (3 lags)	-0.078	-0.086	0.065	-0.082	-0.103	0.082
REM (3 lags)	-0.157	0.001	0.008	-0.169	-0.003	0.011
MOM (3 lags)	0.190	-0.076	0.874	0.178	-0.106	0.814
RCG (3 lags)	-0.515	-0.209	0.000	-0.542	-0.244	0
CEI (3 lags)	0.011	-0.036	0.373	0.012	-0.067	0.39
CUI (3 lags)	0.024	-0.059	0.497	0.029	-0.073	0.513
PEC (3 lags)	-0.280	-0.025	0.000	-0.304	-0.041	0.004
CUR (3 lags)	0.296	-0.010	0.452	0.258	-0.007	0.393
CMS (3 lags)	0.355	-0.136	0.921	0.430	-0.210	0.924
COP (3 lags)	-0.034	-0.073	0.137	-0.049	-0.108	0.128
CMU (3 lags)	0.066	-0.035	0.517	0.081	-0.053	0.537
CFU (3 lags)	0.083	-0.036	0.515	0.087	-0.044	0.496
MKT (2 lags)	-0.151	-0.119	0.023	-0.204	-0.140	0.022
SMB (2 lags)	-0.003	-0.059	0.351	0.011	-0.096	0.613
HML (2 lags)	-0.067	-0.121	0.160	-0.027	-0.147	0.329
RMW (2 lags)	0.074	-0.105	0.851	0.066	-0.119	0.784
CMA (2 lags)	-0.007	-0.052	0.293	0.019	-0.061	0.698
CSP (2 lags)	-0.005	-0.075	0.304	-0.007	-0.095	0.299
TSP (2 lags)	0.144	-0.122	0.581	0.140	-0.135	0.518

LIQ (2 lags)	-0.117	-0.108	0.038	-0.122	-0.145	0.063
REM (2 lags)	-0.175	0.019	0.002	-0.186	0.021	0.006
MOM (2 lags)	0.174	-0.099	0.784	0.243	-0.102	0.79
RCG (2 lags)	-0.559	-0.154	0.000	-0.643	-0.166	0
CEI (2 lags)	0.031	-0.035	0.443	0.048	-0.062	0.489
CUI (2 lags)	0.058	-0.056	0.541	0.067	-0.072	0.546
PEC (2 lags)	0.132	0.001	0.248	0.109	-0.002	0.223
CUR (2 lags)	0.344	-0.003	0.473	0.327	0.001	0.432
CMS (2 lags)	0.549	-0.199	0.933	0.666	-0.307	0.933
COP (2 lags)	-0.027	-0.059	0.110	-0.034	-0.066	0.114
CMU (2 lags)	-0.001	-0.044	0.240	0.000	-0.051	0.253
CFU (2 lags)	-0.006	-0.064	0.234	-0.003	-0.070	0.279
MKT (1 lag)	-0.048	-0.055	0.056	-0.092	-0.079	0.037
SMB (1 lag)	0.001	-0.071	0.505	0.001	-0.107	0.501
HML (1 lag)	-0.116	-0.160	0.119	-0.078	-0.183	0.214
RMW (1 lag)	0.031	-0.059	0.760	0.071	-0.078	0.818
CMA (1 lag)	-0.033	-0.069	0.139	0.027	-0.080	0.668
CSP (1 lag)	-0.009	-0.042	0.175	-0.010	-0.054	0.148
TSP (1 lag)	0.188	-0.092	0.567	0.167	-0.103	0.51
LIQ (1 lag)	-0.152	-0.147	0.040	-0.113	-0.169	0.102
REM (1 lag)	-0.128	0.084	0.003	-0.138	0.081	0.004
MOM (1 lag)	0.296	-0.052	0.854	0.245	-0.077	0.801
RCG (1 lag)	-0.527	-0.132	0.000	-0.551	-0.152	0
CEI (1 lag)	0.033	-0.035	0.398	0.024	-0.058	0.371
CUI (1 lag)	0.061	-0.083	0.568	0.071	-0.103	0.585
PEC (1 lag)	0.178	0.000	0.317	0.172	0.000	0.32
CUR (1 lag)	0.357	0.014	0.465	0.359	0.013	0.437
CMS (1 lag)	0.172	-0.137	0.790	0.250	-0.200	0.857
COP (1 lag)	-0.023	-0.044	0.098	-0.021	-0.065	0.123
CMU (1 lag)	0.121	-0.058	0.573	0.078	-0.069	0.473
CFU (1 lag)	0.122	-0.041	0.558	0.077	-0.051	0.451
MKT (no lags)	0.082	-0.061	0.765	0.055	-0.086	0.665
SMB (no lags)	0.038	-0.048	0.705	0.018	-0.074	0.546
HML (no lags)	-0.051	-0.115	0.184	-0.062	-0.153	0.173
RMW (no lags)	0.013	-0.100	0.861	0.032	-0.135	0.844
CMA (no lags)	-0.040	-0.079	0.111	-0.032	-0.105	0.188
CSP (no lags)	0.221	-0.010	0.503	0.192	-0.012	0.43
TSP (no lags)	0.146	-0.133	0.620	0.145	-0.137	0.569
LIQ (no lags)	-0.032	-0.061	0.126	0.017	-0.070	0.612
REM (no lags)	-0.356	0.010	0.000	-0.410	0.012	0
MOM (no lags)	-0.511	-0.200	0.000	-0.547	-0.233	0.001
RCG (no lags)	-0.482	-0.160	0.000	-0.545	-0.186	0
CEI (no lags)	-0.038	-0.117	0.230	-0.044	-0.144	0.218
CUI (no lags)	-0.049	-0.318	0.406	-0.043	-0.375	0.423
PEC (no lags)	0.743	-0.037	0.837	0.541	-0.043	0.726
CUR (no lags)	0.199	-0.060	0.460	0.198	-0.061	0.44
CMS (no lags)	-0.317	0.004	0.001	-0.413	-0.014	0.001
COP (no lags)	-0.001	-0.154	0.501	0.000	-0.207	0.496
CMU (no lags)	0.340	-0.024	0.547	0.337	-0.027	0.518
CFU (no lags)	0.216	-0.008	0.521	0.182	-0.013	0.457
		Multiple test			Multiple test	
		-0.468	0		-0.510	0
Panel B: Baseline is **RCG (4 lags)**						
		Multiple test			Multiple test	
		-0.698	0.986		-0.772	0.971

Table 3B: **Industrial Property Type from 1978-2018 (Unbalanced Dataset – Liquidity Adjusted)**

Note: This table presents the results for the industrial property type with an unbalanced dataset from 1978 to 2018. The risk factors are included in their contemporaneous and in their lags. A CBSA needs to have at least 36 consecutive quarterly observation to be considered. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty. Only the multiple test in the second pass of the algorithm is presented as its results is above the threshold.

Panel A: Baseline is no factor

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5^{th}-percentile	p-value
MKT (4 lags)	0.058	-0.059	0.962	0.002	-0.131	0.542
SMB (4 lags)	0.012	-0.096	0.781	0.007	-0.181	0.621
HML (4 lags)	0.009	-0.030	0.697	-0.065	-0.098	0.093
RMW (4 lags)	0.102	-0.029	0.979	0.364	-0.102	0.983
CMA (4 lags)	-0.024	-0.045	0.129	-0.120	-0.111	0.039
CSP (4 lags)	0.000	-0.020	0.375	0.000	-0.095	0.488
TSP (4 lags)	0.010	-0.027	0.563	-0.016	-0.119	0.300
LIQ (4 lags)	0.046	-0.035	0.868	-0.028	-0.106	0.222
REM (4 lags)	0.028	0.114	0.012	-0.049	-0.073	0.062
MOM (4 lags)	0.099	-0.041	0.961	-0.076	-0.128	0.119
RCG (4 lags)	0.165	-0.058	0.987	0.340	-0.157	0.984
CEI (4 lags)	-0.006	-0.032	0.245	-0.002	-0.115	0.446
CUI (4 lags)	0.028	-0.031	0.764	0.027	-0.109	0.662
PEC (4 lags)	1.380	-0.058	0.993	1.253	-0.306	0.989
CUR (4 lags)	0.022	-0.048	0.503	-0.006	-0.160	0.425
CMS (4 lags)	0.571	-0.069	0.993	0.168	-0.224	0.782
COP (4 lags)	0.020	-0.045	0.810	-0.005	-0.127	0.437
CMU (4 lags)	0.013	-0.035	0.531	0.018	-0.110	0.603
CFU (4 lags)	0.004	-0.044	0.635	-0.006	-0.121	0.416
MKT (3 lags)	-0.003	-0.064	0.451	0.029	-0.126	0.762
SMB (3 lags)	0.000	-0.047	0.425	0.001	-0.158	0.505
HML (3 lags)	0.008	-0.057	0.691	0.027	-0.136	0.728
RMW (3 lags)	0.155	-0.021	0.971	0.163	-0.107	0.887
CMA (3 lags)	-0.039	-0.056	0.088	-0.044	-0.163	0.252
CSP (3 lags)	-0.001	-0.030	0.333	0.002	-0.128	0.520
TSP (3 lags)	0.028	-0.026	0.561	0.054	-0.108	0.691
LIQ (3 lags)	0.105	-0.087	0.965	0.078	-0.154	0.820
REM (3 lags)	0.010	0.054	0.021	0.010	-0.138	0.157
MOM (3 lags)	0.200	-0.050	0.985	0.300	-0.138	0.961
RCG (3 lags)	0.133	-0.047	0.983	0.048	-0.154	0.775
CEI (3 lags)	0.028	-0.035	0.685	0.026	-0.115	0.642
CUI (3 lags)	-0.017	-0.109	0.383	-0.032	-0.195	0.335
PEC (3 lags)	1.350	-0.063	0.993	1.186	-0.278	0.979
CUR (3 lags)	0.019	-0.039	0.508	-0.003	-0.167	0.373
CMS (3 lags)	1.470	-0.092	0.993	1.643	-0.313	0.993
COP (3 lags)	0.002	-0.043	0.539	-0.001	-0.121	0.418
CMU (3 lags)	0.040	-0.042	0.636	0.078	-0.126	0.736
CFU (3 lags)	-0.001	-0.053	0.511	0.003	-0.127	0.602
MKT (2 lags)	-0.038	-0.043	0.063	0.014	-0.088	0.620
SMB (2 lags)	-0.001	-0.033	0.352	-0.020	-0.120	0.291
HML (2 lags)	0.008	-0.027	0.637	-0.133	-0.124	0.044
RMW (2 lags)	0.033	-0.062	0.911	0.082	-0.153	0.854
CMA (2 lags)	0.021	-0.022	0.740	-0.147	-0.099	0.022
CSP (2 lags)	0.000	-0.040	0.482	0.011	-0.115	0.612
TSP (2 lags)	-0.014	-0.052	0.215	-0.013	-0.155	0.362

LIQ (2 lags)	0.086	-0.061	0.974	0.207	-0.161	0.972
REM (2 lags)	0.010	0.017	0.045	-0.086	-0.185	0.122
MOM (2 lags)	0.013	-0.100	0.825	0.105	-0.190	0.914
RCG (2 lags)	0.009	-0.067	0.750	-0.060	-0.163	0.194
CEI (2 lags)	0.008	-0.027	0.578	-0.001	-0.108	0.429
CUI (2 lags)	0.001	-0.056	0.549	-0.005	-0.115	0.417
PEC (2 lags)	1.140	-0.076	0.993	1.127	-0.324	0.987
CUR (2 lags)	0.017	-0.045	0.499	0.048	-0.157	0.639
CMS (2 lags)	1.100	-0.045	0.993	0.738	-0.196	0.983
COP (2 lags)	-0.001	-0.025	0.297	-0.004	-0.090	0.344
CMU (2 lags)	0.007	-0.061	0.638	0.025	-0.181	0.674
CFU (2 lags)	-0.012	-0.062	0.334	-0.008	-0.156	0.465
MKT (1 lag)	-0.021	-0.032	0.091	-0.086	-0.093	0.057
SMB (1 lag)	0.001	-0.073	0.622	-0.001	-0.163	0.547
HML (1 lag)	0.071	-0.033	0.893	0.011	-0.149	0.555
RMW (1 lag)	-0.003	-0.037	0.338	0.220	-0.112	0.957
CMA (1 lag)	-0.030	-0.060	0.135	-0.172	-0.154	0.043
CSP (1 lag)	-0.007	-0.054	0.317	-0.001	-0.144	0.500
TSP (1 lag)	0.003	-0.027	0.483	-0.021	-0.115	0.292
LIQ (1 lag)	0.005	-0.042	0.590	-0.100	-0.140	0.087
REM (1 lag)	-0.008	0.140	0.004	-0.070	-0.126	0.064
MOM (1 lag)	0.257	-0.061	0.990	0.300	-0.151	0.945
RCG (1 lag)	0.114	-0.036	0.965	0.013	-0.161	0.623
CEI (1 lag)	0.004	-0.043	0.610	-0.009	-0.122	0.370
CUI (1 lag)	0.000	-0.025	0.409	0.001	-0.089	0.492
PEC (1 lag)	0.974	-0.148	0.992	1.263	-0.446	0.992
CUR (1 lag)	0.017	-0.048	0.432	0.035	-0.182	0.589
CMS (1 lag)	1.110	-0.045	0.993	0.871	-0.210	0.990
COP (1 lag)	0.002	-0.038	0.334	0.003	-0.099	0.397
CMU (1 lag)	0.028	-0.058	0.586	0.009	-0.204	0.499
CFU (1 lag)	0.025	-0.048	0.648	-0.003	-0.110	0.397
MKT (no lags)	0.077	-0.073	0.967	-0.039	-0.136	0.202
SMB (no lags)	0.006	-0.126	0.745	0.006	-0.189	0.674
HML (no lags)	0.055	-0.028	0.854	0.040	-0.093	0.643
RMW (no lags)	-0.054	-0.059	0.060	-0.287	-0.170	0.012
CMA (no lags)	0.039	-0.037	0.891	-0.039	-0.113	0.190
CSP (no lags)	0.008	-0.045	0.665	-0.041	-0.131	0.230
TSP (no lags)	0.076	-0.037	0.741	0.093	-0.107	0.731
LIQ (no lags)	0.011	-0.031	0.708	-0.138	-0.120	0.034
REM (no lags)	0.003	0.384	0.000	-0.011	0.329	0.003
MOM (no lags)	-0.158	-0.184	0.079	-0.103	-0.269	0.271
RCG (no lags)	0.065	-0.082	0.942	0.111	-0.180	0.888
CEI (no lags)	0.050	-0.027	0.747	0.059	-0.113	0.767
CUI (no lags)	0.008	-0.039	0.606	0.022	-0.081	0.665
PEC (no lags)	1.890	-0.063	0.993	1.599	-0.251	0.987
CUR (no lags)	0.029	-0.065	0.564	0.047	-0.156	0.602
CMS (no lags)	1.070	-0.043	0.993	0.515	-0.208	0.981
COP (no lags)	0.005	-0.042	0.549	0.020	-0.130	0.620
CMU (no lags)	0.190	0.038	0.597	-0.013	-0.109	0.158
CFU (no lags)	0.042	-0.042	0.765	-0.011	-0.125	0.351
		Multiple test			Multiple test	
		-0.241	0.192		-0.509	0.493

Table 4B: **Office Property Type from 1978-2018 (Unbalanced Dataset – Liquidity Adjusted)**

Note: This table presents the results for the office property type with an unbalanced dataset from 1978 to 2018. The risk factors are included in their contemporaneous and in their lags. A CBSA needs to have at least 36 consecutive quarterly observation to be considered. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty. Only the multiple test in the second pass of the algorithm is presented as its results is above the threshold.

Panel A: Baseline is no factor

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5th-percentile	p-value
MKT (4 lags)	-0.225	-0.103	0.002	-0.275	-0.136	0.005
SMB (4 lags)	-0.013	-0.033	0.162	-0.004	-0.068	0.347
HML (4 lags)	-0.054	-0.041	0.025	0.038	-0.065	0.831
RMW (4 lags)	0.149	-0.067	0.989	0.142	-0.084	0.962
CMA (4 lags)	-0.011	-0.031	0.157	0.131	-0.065	0.969
CSP (4 lags)	-0.016	-0.093	0.391	-0.012	-0.116	0.384
TSP (4 lags)	0.044	-0.104	0.591	0.084	-0.134	0.704
LIQ (4 lags)	-0.025	-0.037	0.086	-0.023	-0.054	0.145
REM (4 lags)	-0.579	-0.167	0.000	-0.734	-0.174	0.000
MOM (4 lags)	0.266	-0.027	0.999	0.417	-0.087	0.997
RCG (4 lags)	-0.763	-0.079	0.000	-0.720	-0.095	0.000
CEI (4 lags)	0.019	-0.041	0.650	0.029	-0.059	0.651
CUI (4 lags)	-0.010	-0.053	0.270	0.018	-0.061	0.669
PEC (4 lags)	-0.238	-0.031	0.000	-0.134	-0.081	0.016
CUR (4 lags)	-0.062	-0.131	0.229	-0.068	-0.168	0.246
CMS (4 lags)	0.255	-0.028	1.000	0.183	-0.062	0.992
COP (4 lags)	-0.009	-0.018	0.106	-0.008	-0.038	0.196
CMU (4 lags)	-0.089	-0.174	0.263	-0.023	-0.206	0.630
CFU (4 lags)	-0.044	-0.099	0.230	-0.015	-0.132	0.465
MKT (3 lags)	-0.223	-0.089	0.002	-0.233	-0.120	0.009
SMB (3 lags)	0.020	-0.056	0.802	0.018	-0.096	0.711
HML (3 lags)	-0.011	-0.032	0.194	-0.045	-0.055	0.076
RMW (3 lags)	0.141	-0.074	0.997	0.224	-0.101	0.986
CMA (3 lags)	0.018	-0.035	0.805	0.025	-0.059	0.802
CSP (3 lags)	-0.031	-0.074	0.274	-0.007	-0.100	0.490
TSP (3 lags)	0.007	-0.080	0.537	0.005	-0.103	0.509
LIQ (3 lags)	-0.113	-0.066	0.015	-0.056	-0.087	0.095
REM (3 lags)	-0.594	-0.199	0.000	-0.774	-0.225	0.000
MOM (3 lags)	0.348	-0.031	1.000	0.355	-0.082	0.996
RCG (3 lags)	-0.462	-0.134	0.000	-0.588	-0.173	0.000
CEI (3 lags)	-0.001	-0.030	0.376	-0.003	-0.047	0.323
CUI (3 lags)	0.004	-0.047	0.487	0.003	-0.080	0.499
PEC (3 lags)	-0.072	-0.026	0.012	-0.230	-0.054	0.000
CUR (3 lags)	-0.121	-0.185	0.162	-0.108	-0.218	0.234
CMS (3 lags)	-0.028	-0.035	0.077	-0.079	-0.063	0.031
COP (3 lags)	-0.010	-0.022	0.120	-0.005	-0.061	0.294
CMU (3 lags)	-0.063	-0.108	0.184	-0.031	-0.151	0.359
CFU (3 lags)	-0.020	-0.058	0.217	-0.017	-0.091	0.307
MKT (2 lags)	-0.229	-0.092	0.001	-0.147	-0.112	0.027
SMB (2 lags)	-0.006	-0.034	0.287	-0.002	-0.057	0.437
HML (2 lags)	-0.010	-0.034	0.196	-0.067	-0.053	0.028
RMW (2 lags)	0.122	-0.053	0.991	0.159	-0.070	0.981
CMA (2 lags)	0.073	-0.034	0.964	0.044	-0.049	0.858
CSP (2 lags)	-0.024	-0.060	0.247	-0.028	-0.089	0.244
TSP (2 lags)	-0.002	-0.090	0.491	-0.002	-0.112	0.495

LIQ (2 lags)	-0.058	-0.047	0.034	-0.026	-0.063	0.144
REM (2 lags)	-0.408	-0.216	0.000	-0.631	-0.243	0.000
MOM (2 lags)	0.243	-0.025	0.994	0.259	-0.058	0.966
RCG (2 lags)	-0.504	-0.143	0.000	-0.540	-0.169	0.000
CEI (2 lags)	0.009	-0.037	0.579	0.000	-0.062	0.407
CUI (2 lags)	0.022	-0.039	0.623	0.006	-0.061	0.455
PEC (2 lags)	-0.188	-0.020	0.000	-0.414	-0.053	0.000
CUR (2 lags)	-0.153	-0.217	0.176	-0.146	-0.274	0.242
CMS (2 lags)	0.076	-0.032	0.943	-0.051	-0.060	0.065
COP (2 lags)	-0.013	-0.025	0.102	-0.013	-0.041	0.157
CMU (2 lags)	-0.003	-0.058	0.330	0.005	-0.091	0.470
CFU (2 lags)	-0.004	-0.034	0.272	-0.008	-0.057	0.267
MKT (1 lag)	-0.122	-0.052	0.005	-0.054	-0.080	0.096
SMB (1 lag)	0.024	-0.070	0.839	0.051	-0.110	0.876
HML (1 lag)	-0.025	-0.036	0.087	0.052	-0.056	0.841
RMW (1 lag)	0.097	-0.059	0.988	0.137	-0.088	0.975
CMA (1 lag)	0.128	-0.041	0.975	0.224	-0.059	0.982
CSP (1 lag)	-0.013	-0.043	0.219	-0.021	-0.068	0.236
TSP (1 lag)	0.030	-0.081	0.591	0.042	-0.098	0.654
LIQ (1 lag)	-0.142	-0.087	0.013	-0.198	-0.116	0.006
REM (1 lag)	-0.261	-0.229	0.038	-0.369	-0.247	0.014
MOM (1 lag)	0.018	-0.050	0.782	-0.114	-0.094	0.039
RCG (1 lag)	-0.581	-0.163	0.000	-0.646	-0.205	0.000
CEI (1 lag)	0.020	-0.041	0.642	0.031	-0.072	0.658
CUI (1 lag)	0.024	-0.040	0.604	0.039	-0.046	0.649
PEC (1 lag)	-0.157	-0.014	0.000	-0.171	-0.031	0.002
CUR (1 lag)	-0.148	-0.209	0.130	-0.136	-0.239	0.204
CMS (1 lag)	0.116	-0.023	0.960	0.308	-0.052	0.990
COP (1 lag)	-0.004	-0.029	0.231	0.001	-0.040	0.377
CMU (1 lag)	0.055	-0.027	0.630	0.056	-0.053	0.624
CFU (1 lag)	0.005	-0.042	0.521	0.008	-0.061	0.552
MKT (no lags)	-0.065	-0.046	0.020	-0.103	-0.068	0.021
SMB (no lags)	0.018	-0.072	0.828	0.013	-0.092	0.736
HML (no lags)	-0.023	-0.032	0.088	0.033	-0.051	0.789
RMW (no lags)	0.065	-0.033	0.980	0.017	-0.052	0.770
CMA (no lags)	0.017	-0.031	0.820	0.122	-0.061	0.975
CSP (no lags)	0.013	-0.023	0.467	0.035	-0.043	0.605
TSP (no lags)	0.016	-0.101	0.780	-0.012	-0.158	0.417
LIQ (no lags)	-0.116	-0.059	0.005	-0.110	-0.073	0.024
REM (no lags)	0.180	-0.300	0.693	0.138	-0.325	0.632
MOM (no lags)	0.120	-0.040	0.970	0.151	-0.074	0.950
RCG (no lags)	-0.440	-0.125	0.000	-0.632	-0.170	0.000
CEI (no lags)	0.000	-0.043	0.405	0.001	-0.071	0.450
CUI (no lags)	-0.008	-0.077	0.330	-0.003	-0.112	0.428
PEC (no lags)	-0.016	-0.020	0.063	-0.154	-0.044	0.004
CUR (no lags)	-0.138	-0.207	0.183	-0.112	-0.268	0.281
CMS (no lags)	-0.055	-0.033	0.019	-0.159	-0.067	0.009
COP (no lags)	-0.008	-0.030	0.172	-0.012	-0.050	0.199
CMU (no lags)	0.106	-0.020	0.669	0.106	-0.038	0.641
CFU (no lags)	-0.004	-0.071	0.381	-0.006	-0.097	0.356
		Multiple test			Multiple test	
		-0.337	0		-0.402	0
Panel B: Baseline is **RCG (4 lags)**						
		Multiple test			Multiple test	
		-0.702	0.984		-0.812	0.817

Table 5B: **Retail Property Type from 1978-2018 (Unbalanced Dataset – Liquidity Adjusted)**

Note: This table presents the results for the retail property type with an unbalanced dataset from 1978 to 2018. The risk factors are included in their contemporaneous and in their lags. A CBSA needs to have at least 36 consecutive quarterly observation to be considered. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty. Only the multiple test in the second pass of the algorithm is presented as its results is above the threshold.

Panel A: Baseline is no factor

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5th-percentile	p-value
MKT (4 lags)	0.028	-0.080	0.882	0.065	-0.156	0.888
SMB (4 lags)	0.010	-0.051	0.285	0.013	-0.092	0.355
HML (4 lags)	-0.084	-0.125	0.125	-0.207	-0.190	0.041
RMW (4 lags)	-0.091	-0.150	0.165	-0.222	-0.229	0.057
CMA (4 lags)	-0.099	-0.162	0.145	-0.257	-0.233	0.038
CSP (4 lags)	-0.002	-0.074	0.444	-0.014	-0.128	0.364
TSP (4 lags)	-0.004	-0.087	0.496	-0.020	-0.163	0.388
LIQ (4 lags)	-0.150	-0.210	0.129	-0.176	-0.307	0.185
REM (4 lags)	-0.379	0.134	0.000	-0.391	0.072	0.000
MOM (4 lags)	-0.249	-0.180	0.014	-0.382	-0.271	0.017
RCG (4 lags)	-0.400	-0.163	0.001	-0.614	-0.245	0.000
CEI (4 lags)	-0.003	-0.047	0.356	0.004	-0.092	0.595
CUI (4 lags)	-0.039	-0.142	0.340	0.030	-0.192	0.719
PEC (4 lags)	0.260	-0.054	0.998	-0.006	-0.098	0.379
CUR (4 lags)	0.000	-0.087	0.552	0.002	-0.156	0.582
CMS (4 lags)	-0.233	0.011	0.000	-0.478	-0.026	0.000
COP (4 lags)	0.000	-0.072	0.568	0.000	-0.103	0.510
CMU (4 lags)	-0.006	-0.101	0.444	-0.002	-0.187	0.535
CFU (4 lags)	-0.024	-0.157	0.447	-0.075	-0.265	0.327
MKT (3 lags)	0.082	-0.142	0.964	0.112	-0.206	0.940
SMB (3 lags)	0.000	-0.123	0.576	0.000	-0.211	0.586
HML (3 lags)	-0.064	-0.097	0.125	-0.146	-0.162	0.065
RMW (3 lags)	-0.097	-0.177	0.186	-0.248	-0.250	0.052
CMA (3 lags)	-0.079	-0.117	0.118	-0.074	-0.166	0.215
CSP (3 lags)	-0.014	-0.100	0.347	-0.005	-0.164	0.494
TSP (3 lags)	0.011	-0.119	0.622	0.024	-0.204	0.676
LIQ (3 lags)	-0.095	-0.126	0.092	-0.036	-0.183	0.317
REM (3 lags)	-0.225	0.114	0.000	-0.348	0.078	0.000
MOM (3 lags)	-0.374	-0.232	0.002	-0.548	-0.371	0.005
RCG (3 lags)	-0.513	-0.138	0.000	-0.685	-0.241	0.000
CEI (3 lags)	-0.001	-0.055	0.442	-0.001	-0.110	0.436
CUI (3 lags)	-0.005	-0.099	0.454	-0.003	-0.189	0.527
PEC (3 lags)	0.051	-0.088	0.745	-0.284	-0.138	0.004
CUR (3 lags)	-0.002	-0.082	0.431	-0.008	-0.138	0.407
CMS (3 lags)	-0.125	0.013	0.000	-0.152	-0.081	0.020
COP (3 lags)	0.000	-0.054	0.405	-0.001	-0.127	0.438
CMU (3 lags)	-0.003	-0.064	0.431	-0.009	-0.116	0.406
CFU (3 lags)	-0.059	-0.195	0.369	-0.031	-0.303	0.554
MKT (2 lags)	0.048	-0.067	0.967	-0.066	-0.118	0.134
SMB (2 lags)	0.001	-0.072	0.631	0.005	-0.134	0.651
HML (2 lags)	-0.028	-0.063	0.156	0.019	-0.107	0.732
RMW (2 lags)	-0.016	-0.121	0.383	0.043	-0.194	0.818
CMA (2 lags)	-0.101	-0.140	0.126	-0.134	-0.198	0.126
CSP (2 lags)	-0.024	-0.110	0.304	-0.013	-0.187	0.421
TSP (2 lags)	0.015	-0.053	0.630	0.007	-0.106	0.518

LIQ (2 lags)	-0.101	-0.124	0.095	-0.130	-0.170	0.095
REM (2 lags)	-0.284	0.100	0.000	-0.314	0.060	0.000
MOM (2 lags)	-0.301	-0.250	0.020	-0.347	-0.382	0.074
RCG (2 lags)	0.008	-0.063	0.556	-0.115	-0.131	0.063
CEI (2 lags)	0.026	-0.068	0.718	0.027	-0.126	0.693
CUI (2 lags)	0.000	-0.068	0.507	0.034	-0.115	0.805
PEC (2 lags)	0.601	-0.068	0.999	0.364	-0.142	0.991
CUR (2 lags)	-0.002	-0.069	0.459	0.003	-0.128	0.603
CMS (2 lags)	-0.297	0.022	0.000	-0.425	-0.007	0.000
COP (2 lags)	-0.001	-0.031	0.311	-0.002	-0.078	0.354
CMU (2 lags)	0.017	-0.096	0.650	0.010	-0.147	0.591
CFU (2 lags)	-0.020	-0.145	0.396	-0.022	-0.236	0.425
MKT (1 lag)	0.089	-0.087	0.962	0.058	-0.125	0.849
SMB (1 lag)	0.000	-0.065	0.506	-0.001	-0.138	0.517
HML (1 lag)	0.022	-0.042	0.728	0.035	-0.095	0.737
RMW (1 lag)	-0.030	-0.082	0.234	-0.042	-0.140	0.242
CMA (1 lag)	-0.033	-0.075	0.184	-0.029	-0.140	0.322
CSP (1 lag)	0.020	-0.062	0.647	0.035	-0.122	0.722
TSP (1 lag)	0.022	-0.032	0.645	0.017	-0.088	0.566
LIQ (1 lag)	-0.050	-0.072	0.095	0.054	-0.129	0.867
REM (1 lag)	-0.306	0.087	0.000	-0.398	0.051	0.000
MOM (1 lag)	0.006	-0.143	0.569	-0.301	-0.268	0.034
RCG (1 lag)	-0.244	-0.091	0.002	-0.446	-0.166	0.000
CEI (1 lag)	-0.006	-0.100	0.462	-0.010	-0.177	0.459
CUI (1 lag)	0.007	-0.069	0.651	-0.003	-0.127	0.449
PEC (1 lag)	0.155	-0.045	0.984	-0.479	-0.102	0.000
CUR (1 lag)	0.000	-0.062	0.395	0.000	-0.116	0.430
CMS (1 lag)	-0.183	0.016	0.000	-0.366	-0.004	0.000
COP (1 lag)	0.009	-0.039	0.599	0.033	-0.096	0.737
CMU (1 lag)	0.005	-0.106	0.625	0.011	-0.166	0.634
CFU (1 lag)	-0.049	-0.201	0.424	-0.074	-0.338	0.379
MKT (no lags)	0.041	-0.099	0.959	0.034	-0.156	0.860
SMB (no lags)	-0.005	-0.059	0.352	-0.011	-0.125	0.362
HML (no lags)	0.026	-0.052	0.791	0.014	-0.108	0.654
RMW (no lags)	0.096	-0.079	0.924	0.097	-0.132	0.806
CMA (no lags)	-0.047	-0.073	0.104	-0.063	-0.128	0.146
CSP (no lags)	0.000	-0.048	0.476	0.001	-0.103	0.500
TSP (no lags)	0.025	-0.031	0.624	0.025	-0.078	0.608
LIQ (no lags)	-0.055	-0.088	0.120	-0.083	-0.126	0.117
REM (no lags)	-0.453	0.110	0.000	-0.492	0.078	0.000
MOM (no lags)	-0.135	-0.222	0.282	-0.133	-0.383	0.437
RCG (no lags)	-0.260	-0.194	0.012	-0.438	-0.310	0.006
CEI (no lags)	-0.006	-0.122	0.501	-0.065	-0.200	0.241
CUI (no lags)	0.041	-0.064	0.766	-0.085	-0.178	0.157
PEC (no lags)	0.118	-0.029	0.944	-0.133	-0.088	0.021
CUR (no lags)	-0.005	-0.073	0.322	-0.003	-0.138	0.405
CMS (no lags)	0.110	0.016	0.261	-0.257	-0.009	0.000
COP (no lags)	0.008	-0.029	0.425	0.006	-0.095	0.472
CMU (no lags)	0.003	-0.064	0.577	-0.004	-0.123	0.460
CFU (no lags)	0.010	-0.064	0.691	0.050	-0.156	0.809
		Multiple test			Multiple test	
		-0.320	0.004		-0.488	0.009
Panel B: Baseline is **RCG (3 lags)**						
		Multiple test			Multiple test	
		-0.702	0.984		-0.812	0.817

Table 6B: **Aggregated Property Types from 2009-2018 (Balanced Dataset – Liquidity Adjusted)**

Note: This table presents the results for the aggregated property types with a balanced dataset from 2009 to 2018. The risk factors are included in their contemporaneous and in their lags. All CBSA have 36 consecutive quarterly observation. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty. Only the multiple test in the second pass of the algorithm is presented as its results is above the threshold.

Panel A: Baseline is no factor

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5^{th}-percentile	p-value
MKT (4 lags)	-0.083	-0.046	0.005	-0.071	-0.052	0.020
SMB (4 lags)	-0.009	-0.034	0.230	-0.004	-0.039	0.349
HML (4 lags)	0.011	-0.027	0.670	0.021	-0.032	0.740
RMW (4 lags)	0.022	-0.030	0.791	0.021	-0.032	0.783
CMA (4 lags)	-0.002	-0.017	0.292	-0.002	-0.024	0.351
CSP (4 lags)	-0.018	-0.037	0.182	-0.012	-0.043	0.256
TSP (4 lags)	-0.003	-0.020	0.263	-0.004	-0.027	0.307
LIQ (4 lags)	0.023	-0.034	0.767	0.012	-0.042	0.665
REM (4 lags)	-0.105	-0.050	0.008	-0.088	-0.055	0.016
MOM (4 lags)	0.104	-0.054	0.969	0.098	-0.061	0.955
RCG (4 lags)	-0.183	-0.048	0.000	-0.170	-0.052	0.000
CEI (4 lags)	0.005	-0.014	0.384	0.005	-0.015	0.396
CUI (4 lags)	0.031	-0.027	0.746	0.022	-0.034	0.674
PEC (4 lags)	-0.299	-0.038	0.000	-0.280	-0.044	0.000
CUR (4 lags)	-0.037	-0.041	0.060	-0.028	-0.044	0.116
CMS (4 lags)	0.433	-0.064	1.000	0.488	-0.065	1.000
COP (4 lags)	0.008	-0.025	0.575	0.001	-0.029	0.394
CMU (4 lags)	-0.030	-0.032	0.060	-0.034	-0.040	0.062
CFU (4 lags)	-0.009	-0.015	0.110	0.007	-0.027	0.814
MKT (3 lags)	-0.040	-0.026	0.024	-0.034	-0.032	0.045
SMB (3 lags)	-0.003	-0.022	0.316	0.007	-0.026	0.780
HML (3 lags)	0.004	-0.020	0.520	0.000	-0.025	0.421
RMW (3 lags)	0.000	-0.014	0.471	-0.001	-0.023	0.430
CMA (3 lags)	-0.004	-0.033	0.349	0.000	-0.042	0.497
CSP (3 lags)	0.010	-0.028	0.907	0.013	-0.032	0.881
TSP (3 lags)	-0.001	-0.017	0.383	-0.003	-0.024	0.332
LIQ (3 lags)	-0.001	-0.026	0.389	-0.002	-0.032	0.392
REM (3 lags)	-0.192	-0.062	0.003	-0.191	-0.065	0.002
MOM (3 lags)	0.015	-0.017	0.859	0.026	-0.024	0.912
RCG (3 lags)	-0.226	-0.043	0.000	-0.202	-0.046	0.000
CEI (3 lags)	0.019	-0.028	0.733	0.024	-0.028	0.755
CUI (3 lags)	-0.002	-0.030	0.382	-0.004	-0.034	0.348
PEC (3 lags)	-0.333	-0.025	0.000	-0.313	-0.030	0.000
CUR (3 lags)	-0.080	-0.034	0.001	-0.075	-0.038	0.003
CMS (3 lags)	0.139	-0.043	1.000	0.166	-0.048	1.000
COP (3 lags)	0.009	-0.031	0.746	0.017	-0.033	0.830
CMU (3 lags)	0.062	-0.039	0.947	0.058	-0.044	0.932
CFU (3 lags)	0.029	-0.024	0.891	0.037	-0.027	0.923
MKT (2 lags)	0.087	-0.033	0.968	0.089	-0.038	0.961
SMB (2 lags)	0.010	-0.024	0.758	0.017	-0.027	0.809
HML (2 lags)	0.003	-0.029	0.522	0.004	-0.034	0.556
RMW (2 lags)	-0.006	-0.015	0.158	0.004	-0.022	0.648
CMA (2 lags)	-0.003	-0.020	0.293	0.009	-0.028	0.750
CSP (2 lags)	0.049	-0.049	0.904	0.062	-0.050	0.931
TSP (2 lags)	-0.013	-0.034	0.167	-0.012	-0.035	0.192

LIQ (2 lags)	0.003	-0.022	0.769	0.001	-0.027	0.638
REM (2 lags)	-0.345	-0.082	0.000	-0.348	-0.084	0.000
MOM (2 lags)	-0.032	-0.022	0.021	-0.017	-0.025	0.092
RCG (2 lags)	-0.163	-0.039	0.000	-0.179	-0.042	0.000
CEI (2 lags)	-0.002	-0.018	0.337	0.000	-0.023	0.459
CUI (2 lags)	-0.009	-0.044	0.303	-0.011	-0.053	0.292
PEC (2 lags)	-0.210	-0.025	0.000	-0.184	-0.027	0.000
CUR (2 lags)	-0.137	-0.039	0.000	-0.118	-0.041	0.000
CMS (2 lags)	-0.120	-0.019	0.000	-0.099	-0.025	0.000
COP (2 lags)	0.011	-0.038	0.725	0.010	-0.043	0.706
CMU (2 lags)	0.074	-0.043	0.928	0.074	-0.048	0.923
CFU (2 lags)	0.038	-0.031	0.836	0.039	-0.033	0.840
MKT (1 lag)	0.072	-0.034	0.974	0.097	-0.042	0.985
SMB (1 lag)	0.010	-0.030	0.855	0.020	-0.036	0.912
HML (1 lag)	-0.003	-0.034	0.313	-0.003	-0.038	0.316
RMW (1 lag)	-0.003	-0.015	0.230	-0.003	-0.022	0.302
CMA (1 lag)	0.006	-0.024	0.622	0.020	-0.026	0.821
CSP (1 lag)	0.054	-0.039	0.823	0.071	-0.045	0.868
TSP (1 lag)	-0.015	-0.035	0.162	-0.008	-0.043	0.292
LIQ (1 lag)	0.000	-0.022	0.561	-0.003	-0.029	0.386
REM (1 lag)	-0.575	-0.094	0.000	-0.567	-0.094	0.000
MOM (1 lag)	0.001	-0.017	0.572	0.014	-0.023	0.840
RCG (1 lag)	0.026	-0.024	0.998	0.017	-0.032	0.950
CEI (1 lag)	0.000	-0.014	0.457	-0.001	-0.023	0.428
CUI (1 lag)	-0.017	-0.040	0.181	-0.021	-0.046	0.165
PEC (1 lag)	0.188	-0.024	1.000	0.257	-0.035	1.000
CUR (1 lag)	-0.112	-0.036	0.000	-0.108	-0.039	0.001
CMS (1 lag)	-0.259	-0.027	0.000	-0.258	-0.035	0.000
COP (1 lag)	0.001	-0.025	0.634	0.001	-0.033	0.634
CMU (1 lag)	0.066	-0.043	0.907	0.071	-0.046	0.912
CFU (1 lag)	0.016	-0.027	0.778	0.025	-0.034	0.826
MKT (no lags)	0.024	-0.028	0.999	0.021	-0.036	0.981
SMB (no lags)	0.000	-0.021	0.503	0.006	-0.029	0.794
HML (no lags)	-0.003	-0.012	0.188	-0.007	-0.017	0.159
RMW (no lags)	0.010	-0.029	0.801	0.008	-0.035	0.741
CMA (no lags)	0.000	-0.021	0.543	-0.001	-0.029	0.455
CSP (no lags)	0.013	-0.036	0.708	0.031	-0.043	0.865
TSP (no lags)	-0.014	-0.031	0.154	-0.017	-0.037	0.153
LIQ (no lags)	-0.001	-0.024	0.420	0.003	-0.032	0.623
REM (no lags)	-0.748	-0.095	0.000	-0.798	-0.099	0.000
MOM (no lags)	-0.079	-0.034	0.001	-0.065	-0.038	0.009
RCG (no lags)	0.139	-0.032	1.000	0.172	-0.035	1.000
CEI (no lags)	0.003	-0.023	0.742	0.008	-0.029	0.821
CUI (no lags)	-0.010	-0.024	0.151	0.009	-0.033	0.715
PEC (no lags)	-0.032	-0.019	0.018	-0.015	-0.025	0.120
CUR (no lags)	-0.039	-0.019	0.010	-0.022	-0.024	0.060
CMS (no lags)	-0.326	-0.034	0.000	-0.307	-0.040	0.000
COP (no lags)	0.002	-0.032	0.611	0.004	-0.037	0.697
CMU (no lags)	0.031	-0.031	0.855	0.035	-0.034	0.876
CFU (no lags)	-0.001	-0.021	0.453	0.004	-0.031	0.734
		Multiple test			Multiple test	
		-0.120	0		-0.130	0
Panel B: Baseline is **REM (no lags)**						
		Multiple test			Multiple test	
		-0.697	1		-0.775	0.983

Table 7B: **Apartment Property Type from 2009-2018 (Balanced Dataset – Liquidity Adjusted)**

Note: This table presents the results for the apartment property type with a balanced dataset from 2009 to 2018. The risk factors are included in their contemporaneous and in their lags. All CBSA have 36 consecutive quarterly observation. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty. Only the multiple test in the second pass of the algorithm is presented as its results is above the threshold.

Panel A: Baseline is no factor

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5^{th}-percentile	p-value
MKT (4 lags)	-0.099	-0.072	0.018	-0.113	-0.074	0.015
SMB (4 lags)	-0.015	-0.054	0.260	-0.025	-0.057	0.180
HML (4 lags)	0.013	-0.049	0.697	0.023	-0.050	0.761
RMW (4 lags)	0.020	-0.039	0.794	0.031	-0.043	0.841
CMA (4 lags)	-0.005	-0.035	0.331	-0.006	-0.036	0.329
CSP (4 lags)	-0.024	-0.088	0.326	-0.033	-0.090	0.253
TSP (4 lags)	0.002	-0.026	0.629	0.005	-0.032	0.699
LIQ (4 lags)	0.029	-0.049	0.779	0.034	-0.056	0.794
REM (4 lags)	-0.022	-0.035	0.094	-0.059	-0.047	0.037
MOM (4 lags)	0.128	-0.091	0.985	0.128	-0.093	0.976
RCG (4 lags)	-0.159	-0.047	0.001	-0.187	-0.058	0.001
CEI (4 lags)	0.005	-0.015	0.422	0.008	-0.017	0.457
CUI (4 lags)	0.039	-0.059	0.779	0.048	-0.061	0.813
PEC (4 lags)	-0.248	-0.036	0.000	-0.278	-0.043	0.000
CUR (4 lags)	-0.019	-0.027	0.088	-0.022	-0.035	0.101
CMS (4 lags)	0.544	-0.093	1.000	0.538	-0.097	1.000
COP (4 lags)	0.011	-0.038	0.625	0.015	-0.040	0.656
CMU (4 lags)	-0.080	-0.082	0.055	-0.082	-0.087	0.057
CFU (4 lags)	-0.040	-0.044	0.066	-0.040	-0.047	0.068
MKT (3 lags)	-0.073	-0.042	0.010	-0.091	-0.049	0.008
SMB (3 lags)	-0.006	-0.033	0.284	-0.006	-0.035	0.310
HML (3 lags)	0.005	-0.034	0.611	0.007	-0.036	0.628
RMW (3 lags)	-0.004	-0.025	0.292	-0.010	-0.032	0.218
CMA (3 lags)	-0.006	-0.050	0.400	-0.007	-0.053	0.389
CSP (3 lags)	-0.025	-0.040	0.138	-0.042	-0.042	0.054
TSP (3 lags)	0.005	-0.021	0.799	0.012	-0.026	0.873
LIQ (3 lags)	0.000	-0.035	0.529	-0.002	-0.043	0.447
REM (3 lags)	-0.091	-0.045	0.015	-0.101	-0.058	0.016
MOM (3 lags)	0.044	-0.046	0.965	0.047	-0.049	0.960
RCG (3 lags)	-0.208	-0.043	0.000	-0.270	-0.049	0.000
CEI (3 lags)	0.017	-0.020	0.727	0.022	-0.025	0.741
CUI (3 lags)	-0.001	-0.025	0.464	0.000	-0.033	0.519
PEC (3 lags)	-0.309	-0.025	0.000	-0.403	-0.032	0.000
CUR (3 lags)	-0.050	-0.023	0.004	-0.067	-0.031	0.006
CMS (3 lags)	0.344	-0.092	1.000	0.258	-0.096	1.000
COP (3 lags)	0.006	-0.019	0.723	0.007	-0.032	0.718
CMU (3 lags)	0.011	-0.032	0.829	0.022	-0.044	0.881
CFU (3 lags)	0.009	-0.017	0.822	0.009	-0.025	0.774
MKT (2 lags)	0.091	-0.045	0.985	0.084	-0.047	0.972
SMB (2 lags)	0.003	-0.018	0.605	0.007	-0.026	0.668
HML (2 lags)	0.003	-0.036	0.555	0.003	-0.037	0.551
RMW (2 lags)	-0.009	-0.025	0.180	-0.013	-0.029	0.151
CMA (2 lags)	-0.004	-0.030	0.332	-0.003	-0.037	0.418
CSP (2 lags)	0.034	-0.043	0.915	0.042	-0.051	0.918
TSP (2 lags)	-0.012	-0.033	0.186	-0.014	-0.043	0.187

LIQ (2 lags)	0.004	-0.036	0.780	0.006	-0.042	0.779
REM (2 lags)	-0.248	-0.079	0.002	-0.264	-0.094	0.002
MOM (2 lags)	-0.007	-0.029	0.218	-0.017	-0.034	0.143
RCG (2 lags)	-0.165	-0.040	0.000	-0.162	-0.043	0.000
CEI (2 lags)	-0.002	-0.016	0.300	-0.002	-0.019	0.323
CUI (2 lags)	-0.007	-0.046	0.327	-0.011	-0.053	0.301
PEC (2 lags)	-0.083	-0.015	0.000	-0.074	-0.018	0.003
CUR (2 lags)	-0.083	-0.023	0.000	-0.092	-0.029	0.001
CMS (2 lags)	0.054	-0.038	0.998	0.046	-0.041	0.987
COP (2 lags)	0.009	-0.030	0.717	0.013	-0.039	0.737
CMU (2 lags)	0.033	-0.026	0.913	0.040	-0.037	0.909
CFU (2 lags)	0.032	-0.031	0.864	0.042	-0.035	0.890
MKT (1 lag)	0.085	-0.052	0.986	0.116	-0.059	0.997
SMB (1 lag)	0.005	-0.026	0.757	0.004	-0.028	0.708
HML (1 lag)	-0.003	-0.042	0.359	-0.005	-0.050	0.351
RMW (1 lag)	-0.006	-0.020	0.216	-0.007	-0.024	0.221
CMA (1 lag)	0.004	-0.019	0.562	0.010	-0.025	0.682
CSP (1 lag)	0.052	-0.042	0.847	0.068	-0.048	0.882
TSP (1 lag)	-0.020	-0.053	0.174	-0.027	-0.058	0.153
LIQ (1 lag)	0.001	-0.033	0.660	-0.003	-0.040	0.437
REM (1 lag)	-0.507	-0.109	0.000	-0.554	-0.119	0.000
MOM (1 lag)	0.028	-0.025	0.961	0.023	-0.031	0.926
RCG (1 lag)	-0.001	-0.027	0.507	-0.009	-0.034	0.243
CEI (1 lag)	-0.002	-0.012	0.303	-0.002	-0.021	0.370
CUI (1 lag)	-0.014	-0.040	0.203	-0.024	-0.046	0.139
PEC (1 lag)	0.218	-0.024	1.000	0.240	-0.031	1.000
CUR (1 lag)	-0.063	-0.031	0.002	-0.113	-0.039	0.000
CMS (1 lag)	-0.177	-0.030	0.000	-0.226	-0.038	0.000
COP (1 lag)	0.000	-0.016	0.611	0.001	-0.026	0.637
CMU (1 lag)	0.030	-0.026	0.878	0.042	-0.033	0.902
CFU (1 lag)	0.017	-0.034	0.800	0.028	-0.039	0.869
MKT (no lags)	0.014	-0.052	0.992	0.001	-0.060	0.778
SMB (no lags)	-0.002	-0.031	0.437	-0.001	-0.035	0.486
HML (no lags)	-0.006	-0.017	0.166	-0.002	-0.022	0.300
RMW (no lags)	0.007	-0.024	0.756	0.006	-0.032	0.695
CMA (no lags)	0.001	-0.037	0.546	0.001	-0.041	0.563
CSP (no lags)	0.012	-0.040	0.734	0.019	-0.046	0.792
TSP (no lags)	-0.022	-0.043	0.143	-0.036	-0.051	0.091
LIQ (no lags)	0.003	-0.038	0.669	0.003	-0.042	0.630
REM (no lags)	-0.730	-0.135	0.000	-0.837	-0.147	0.000
MOM (no lags)	-0.068	-0.036	0.011	-0.072	-0.043	0.013
RCG (no lags)	0.096	-0.026	1.000	0.079	-0.031	0.998
CEI (no lags)	0.001	-0.012	0.533	0.002	-0.019	0.611
CUI (no lags)	-0.009	-0.031	0.210	-0.010	-0.035	0.224
PEC (no lags)	-0.058	-0.015	0.002	-0.033	-0.021	0.020
CUR (no lags)	-0.002	-0.021	0.329	-0.021	-0.025	0.070
CMS (no lags)	-0.239	-0.030	0.000	-0.256	-0.040	0.000
COP (no lags)	0.001	-0.026	0.656	0.001	-0.034	0.622
CMU (no lags)	0.009	-0.027	0.792	0.005	-0.033	0.662
CFU (no lags)	-0.003	-0.041	0.472	-0.003	-0.048	0.456
		Multiple test			Multiple test	
		-0.167	0		-0.181	0
Panel B: Baseline is **REM (no lags)**						
		Multiple test			Multiple test	
		-0.676	1		-0.751	0.994

Table 8B: **Industrial Property Type from 2009-2018 (Balanced Dataset – Liquidity Adjusted)**

Note: This table presents the results for the industrial property type with a balanced dataset from 2009 to 2018. The risk factors are included in their contemporaneous and in their lags. All CBSA have 36 consecutive quarterly observation. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty. Only the multiple test in the second pass of the algorithm is presented as its results is above the threshold.

Panel A: Baseline is no factor

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5th-percentile	p-value
MKT (4 lags)	-0.068	-0.037	0.006	-0.083	-0.044	0.009
SMB (4 lags)	-0.004	-0.019	0.215	-0.003	-0.027	0.326
HML (4 lags)	0.010	-0.023	0.677	0.002	-0.032	0.516
RMW (4 lags)	0.023	-0.033	0.797	0.017	-0.032	0.733
CMA (4 lags)	0.003	-0.014	0.607	-0.005	-0.027	0.258
CSP (4 lags)	-0.015	-0.027	0.110	-0.011	-0.033	0.211
TSP (4 lags)	-0.007	-0.029	0.217	-0.011	-0.034	0.192
LIQ (4 lags)	0.016	-0.025	0.669	0.027	-0.036	0.753
REM (4 lags)	-0.163	-0.060	0.000	-0.121	-0.056	0.005
MOM (4 lags)	0.067	-0.032	0.919	0.093	-0.049	0.943
RCG (4 lags)	-0.212	-0.050	0.000	-0.197	-0.057	0.000
CEI (4 lags)	0.006	-0.018	0.375	0.005	-0.017	0.366
CUI (4 lags)	0.028	-0.023	0.662	0.021	-0.026	0.575
PEC (4 lags)	-0.364	-0.047	0.000	-0.356	-0.053	0.000
CUR (4 lags)	-0.054	-0.058	0.063	-0.049	-0.055	0.073
CMS (4 lags)	0.366	-0.045	1.000	0.400	-0.057	1.000
COP (4 lags)	0.006	-0.023	0.468	-0.002	-0.027	0.292
CMU (4 lags)	0.005	-0.017	0.648	-0.028	-0.031	0.061
CFU (4 lags)	0.021	-0.013	0.913	-0.002	-0.021	0.340
MKT (3 lags)	-0.029	-0.019	0.026	-0.017	-0.030	0.106
SMB (3 lags)	0.003	-0.017	0.656	-0.002	-0.030	0.422
HML (3 lags)	0.003	-0.020	0.464	0.003	-0.028	0.468
RMW (3 lags)	-0.006	-0.010	0.107	-0.005	-0.024	0.274
CMA (3 lags)	-0.003	-0.027	0.306	-0.002	-0.044	0.395
CSP (3 lags)	0.035	-0.039	0.933	0.016	-0.039	0.796
TSP (3 lags)	-0.011	-0.026	0.184	-0.003	-0.029	0.356
LIQ (3 lags)	-0.003	-0.032	0.332	-0.002	-0.034	0.388
REM (3 lags)	-0.252	-0.062	0.000	-0.214	-0.064	0.000
MOM (3 lags)	-0.022	-0.012	0.010	-0.026	-0.019	0.023
RCG (3 lags)	-0.254	-0.043	0.000	-0.262	-0.046	0.000
CEI (3 lags)	0.023	-0.035	0.756	0.019	-0.035	0.696
CUI (3 lags)	-0.003	-0.031	0.374	-0.001	-0.039	0.422
PEC (3 lags)	-0.431	-0.029	0.000	-0.497	-0.032	0.000
CUR (3 lags)	-0.104	-0.045	0.000	-0.077	-0.044	0.005
CMS (3 lags)	0.018	-0.020	0.941	0.113	-0.039	0.999
COP (3 lags)	0.012	-0.042	0.745	0.003	-0.046	0.616
CMU (3 lags)	0.099	-0.050	0.948	0.106	-0.054	0.957
CFU (3 lags)	0.046	-0.031	0.913	0.010	-0.035	0.652
MKT (2 lags)	0.081	-0.025	0.950	0.073	-0.030	0.936
SMB (2 lags)	0.014	-0.029	0.780	0.005	-0.028	0.600
HML (2 lags)	0.002	-0.024	0.554	0.001	-0.036	0.504
RMW (2 lags)	-0.002	-0.013	0.258	0.007	-0.020	0.724
CMA (2 lags)	0.000	-0.017	0.415	0.000	-0.023	0.455
CSP (2 lags)	0.058	-0.058	0.895	0.045	-0.059	0.846
TSP (2 lags)	-0.015	-0.044	0.173	0.003	-0.045	0.579

LIQ (2 lags)	0.002	-0.014	0.731	-0.016	-0.029	0.137
REM (2 lags)	-0.379	-0.067	0.000	-0.370	-0.080	0.000
MOM (2 lags)	-0.070	-0.033	0.008	-0.079	-0.034	0.006
RCG (2 lags)	-0.163	-0.037	0.000	-0.164	-0.042	0.000
CEI (2 lags)	-0.002	-0.025	0.368	-0.009	-0.034	0.230
CUI (2 lags)	-0.009	-0.043	0.277	-0.010	-0.046	0.274
PEC (2 lags)	-0.356	-0.037	0.000	-0.319	-0.036	0.000
CUR (2 lags)	-0.172	-0.047	0.000	-0.153	-0.051	0.000
CMS (2 lags)	-0.153	-0.017	0.000	-0.114	-0.021	0.000
COP (2 lags)	0.010	-0.042	0.713	0.004	-0.050	0.582
CMU (2 lags)	0.097	-0.050	0.929	0.074	-0.055	0.894
CFU (2 lags)	0.043	-0.029	0.853	0.045	-0.033	0.850
MKT (1 lag)	0.070	-0.024	0.946	0.062	-0.031	0.931
SMB (1 lag)	0.010	-0.033	0.828	0.009	-0.037	0.769
HML (1 lag)	-0.003	-0.037	0.289	-0.005	-0.045	0.295
RMW (1 lag)	-0.001	-0.014	0.341	-0.027	-0.028	0.055
CMA (1 lag)	0.012	-0.040	0.700	0.020	-0.042	0.771
CSP (1 lag)	0.059	-0.034	0.815	0.052	-0.037	0.786
TSP (1 lag)	-0.009	-0.026	0.161	-0.012	-0.044	0.243
LIQ (1 lag)	-0.001	-0.015	0.367	0.000	-0.027	0.487
REM (1 lag)	-0.526	-0.060	0.000	-0.487	-0.083	0.000
MOM (1 lag)	-0.040	-0.019	0.003	-0.038	-0.032	0.025
RCG (1 lag)	-0.020	-0.022	0.061	0.002	-0.032	0.656
CEI (1 lag)	0.000	-0.021	0.655	0.007	-0.035	0.839
CUI (1 lag)	-0.015	-0.037	0.176	-0.013	-0.040	0.217
PEC (1 lag)	-0.020	-0.019	0.047	0.009	-0.032	0.754
CUR (1 lag)	-0.143	-0.047	0.000	-0.115	-0.042	0.001
CMS (1 lag)	-0.245	-0.021	0.000	-0.268	-0.030	0.000
COP (1 lag)	0.000	-0.022	0.703	0.002	-0.035	0.681
CMU (1 lag)	0.084	-0.048	0.900	0.077	-0.053	0.882
CFU (1 lag)	0.021	-0.026	0.785	0.032	-0.033	0.833
MKT (no lags)	0.037	-0.021	0.985	0.048	-0.036	0.984
SMB (no lags)	0.002	-0.021	0.710	0.000	-0.031	0.575
HML (no lags)	-0.002	-0.016	0.301	-0.002	-0.027	0.345
RMW (no lags)	0.008	-0.031	0.767	0.014	-0.040	0.825
CMA (no lags)	0.000	-0.022	0.478	0.001	-0.031	0.576
CSP (no lags)	0.014	-0.037	0.709	0.011	-0.042	0.688
TSP (no lags)	-0.013	-0.023	0.122	-0.008	-0.035	0.256
LIQ (no lags)	-0.004	-0.023	0.260	0.006	-0.033	0.669
REM (no lags)	-0.606	-0.054	0.000	-0.666	-0.080	0.000
MOM (no lags)	-0.126	-0.045	0.001	-0.111	-0.058	0.004
RCG (no lags)	0.127	-0.033	0.999	0.183	-0.044	1.000
CEI (no lags)	0.004	-0.032	0.797	0.000	-0.036	0.554
CUI (no lags)	-0.014	-0.021	0.091	0.016	-0.031	0.817
PEC (no lags)	-0.194	-0.029	0.000	-0.150	-0.035	0.001
CUR (no lags)	-0.076	-0.021	0.002	-0.099	-0.030	0.001
CMS (no lags)	-0.296	-0.032	0.000	-0.348	-0.047	0.000
COP (no lags)	0.002	-0.032	0.585	0.000	-0.035	0.539
CMU (no lags)	0.049	-0.038	0.847	0.046	-0.035	0.842
CFU (no lags)	0.005	-0.021	0.508	-0.004	-0.031	0.305
		Multiple test			Multiple test	
		-0.109	0		-0.128	0
Panel B: Baseline is **REM (no lags)**						
		Multiple test			Multiple test	
		-0.675	0.891		-0.758	0.784

Table 9B: **Office Property Type from 2009-2018 (Balanced Dataset – Liquidity Adjusted)**

Note: This table presents the results for the office property type with a balanced dataset from 2009 to 2018. The risk factors are included in their contemporaneous and in their lags. All CBSA have 36 consecutive quarterly observation. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty. Only the multiple test in the second pass of the algorithm is presented as its results is above the threshold.

Panel A: Baseline is no factor

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5th-percentile	p-value
MKT (4 lags)	-0.113	-0.062	0.006	-0.094	-0.071	0.024
SMB (4 lags)	-0.012	-0.044	0.203	0.004	-0.052	0.616
HML (4 lags)	0.014	-0.034	0.671	-0.011	-0.037	0.213
RMW (4 lags)	0.038	-0.060	0.795	0.011	-0.056	0.612
CMA (4 lags)	0.002	-0.022	0.544	0.005	-0.035	0.584
CSP (4 lags)	-0.027	-0.046	0.117	-0.024	-0.044	0.117
TSP (4 lags)	-0.005	-0.032	0.253	-0.015	-0.047	0.201
LIQ (4 lags)	0.029	-0.046	0.768	-0.013	-0.047	0.209
REM (4 lags)	-0.173	-0.073	0.002	-0.225	-0.084	0.000
MOM (4 lags)	0.136	-0.069	0.956	0.061	-0.074	0.851
RCG (4 lags)	-0.257	-0.062	0.000	-0.274	-0.083	0.000
CEI (4 lags)	0.010	-0.032	0.442	-0.001	-0.031	0.265
CUI (4 lags)	0.047	-0.036	0.757	0.036	-0.040	0.701
PEC (4 lags)	-0.423	-0.050	0.000	-0.496	-0.066	0.000
CUR (4 lags)	-0.057	-0.067	0.063	-0.090	-0.090	0.051
CMS (4 lags)	0.554	-0.074	1.000	0.489	-0.073	0.999
COP (4 lags)	0.014	-0.042	0.614	0.009	-0.044	0.533
CMU (4 lags)	-0.035	-0.036	0.054	-0.017	-0.038	0.162
CFU (4 lags)	-0.002	-0.016	0.275	-0.031	-0.040	0.084
MKT (3 lags)	-0.065	-0.044	0.022	-0.088	-0.042	0.006
SMB (3 lags)	-0.005	-0.037	0.305	-0.024	-0.054	0.148
HML (3 lags)	0.006	-0.031	0.520	0.006	-0.036	0.508
RMW (3 lags)	-0.002	-0.016	0.324	0.011	-0.033	0.740
CMA (3 lags)	-0.004	-0.039	0.306	-0.009	-0.049	0.294
CSP (3 lags)	0.016	-0.033	0.917	-0.064	-0.051	0.036
TSP (3 lags)	-0.002	-0.022	0.383	-0.006	-0.043	0.318
LIQ (3 lags)	-0.003	-0.038	0.354	0.002	-0.045	0.549
REM (3 lags)	-0.294	-0.080	0.000	-0.344	-0.091	0.001
MOM (3 lags)	0.017	-0.016	0.881	-0.046	-0.031	0.021
RCG (3 lags)	-0.333	-0.067	0.000	-0.423	-0.077	0.000
CEI (3 lags)	0.033	-0.051	0.779	0.005	-0.057	0.523
CUI (3 lags)	-0.003	-0.040	0.376	-0.008	-0.062	0.324
PEC (3 lags)	-0.481	-0.037	0.000	-0.559	-0.049	0.000
CUR (3 lags)	-0.128	-0.052	0.001	-0.140	-0.066	0.000
CMS (3 lags)	0.108	-0.046	1.000	0.117	-0.052	0.995
COP (3 lags)	0.012	-0.042	0.745	0.010	-0.060	0.697
CMU (3 lags)	0.095	-0.055	0.947	0.059	-0.076	0.840
CFU (3 lags)	0.045	-0.036	0.924	0.042	-0.046	0.848
MKT (2 lags)	0.098	-0.039	0.957	0.049	-0.048	0.861
SMB (2 lags)	0.019	-0.045	0.789	0.017	-0.060	0.748
HML (2 lags)	0.003	-0.035	0.538	0.001	-0.051	0.483
RMW (2 lags)	-0.006	-0.017	0.159	-0.042	-0.040	0.042
CMA (2 lags)	-0.003	-0.026	0.289	-0.002	-0.035	0.367
CSP (2 lags)	0.065	-0.075	0.910	0.024	-0.089	0.692
TSP (2 lags)	-0.019	-0.046	0.154	-0.011	-0.053	0.255

LIQ (2 lags)	0.004	-0.027	0.786	0.000	-0.044	0.525
REM (2 lags)	-0.448	-0.092	0.000	-0.528	-0.106	0.000
MOM (2 lags)	-0.060	-0.033	0.010	-0.039	-0.040	0.055
RCG (2 lags)	-0.243	-0.058	0.000	-0.269	-0.076	0.000
CEI (2 lags)	-0.002	-0.026	0.355	-0.005	-0.040	0.312
CUI (2 lags)	-0.012	-0.059	0.286	-0.018	-0.075	0.277
PEC (2 lags)	-0.359	-0.043	0.000	-0.464	-0.052	0.000
CUR (2 lags)	-0.222	-0.061	0.000	-0.262	-0.083	0.000
CMS (2 lags)	-0.182	-0.028	0.000	-0.315	-0.046	0.000
COP (2 lags)	0.017	-0.058	0.722	-0.009	-0.077	0.371
CMU (2 lags)	0.116	-0.065	0.935	0.072	-0.098	0.817
CFU (2 lags)	0.057	-0.046	0.845	0.013	-0.058	0.591
MKT (1 lag)	0.091	-0.037	0.960	0.074	-0.048	0.927
SMB (1 lag)	0.016	-0.047	0.844	0.003	-0.069	0.606
HML (1 lag)	-0.004	-0.050	0.265	-0.006	-0.052	0.267
RMW (1 lag)	-0.005	-0.018	0.193	-0.006	-0.035	0.281
CMA (1 lag)	0.012	-0.043	0.650	0.005	-0.053	0.528
CSP (1 lag)	0.083	-0.048	0.817	0.024	-0.066	0.623
TSP (1 lag)	-0.014	-0.033	0.150	-0.021	-0.052	0.166
LIQ (1 lag)	0.000	-0.022	0.545	-0.002	-0.039	0.427
REM (1 lag)	-0.625	-0.103	0.000	-0.659	-0.119	0.000
MOM (1 lag)	0.019	-0.023	0.921	0.009	-0.037	0.713
RCG (1 lag)	-0.006	-0.034	0.315	-0.044	-0.052	0.067
CEI (1 lag)	0.000	-0.019	0.494	0.005	-0.041	0.646
CUI (1 lag)	-0.026	-0.058	0.177	-0.042	-0.070	0.120
PEC (1 lag)	0.216	-0.041	1.000	0.246	-0.066	1.000
CUR (1 lag)	-0.206	-0.065	0.000	-0.201	-0.069	0.000
CMS (1 lag)	-0.333	-0.031	0.000	-0.292	-0.044	0.000
COP (1 lag)	0.001	-0.036	0.635	0.000	-0.062	0.572
CMU (1 lag)	0.110	-0.064	0.909	0.051	-0.084	0.771
CFU (1 lag)	0.021	-0.035	0.761	0.019	-0.046	0.709
MKT (no lags)	0.050	-0.032	1.000	0.067	-0.051	0.987
SMB (no lags)	0.002	-0.027	0.618	-0.012	-0.044	0.205
HML (no lags)	-0.006	-0.015	0.162	-0.029	-0.026	0.041
RMW (no lags)	0.017	-0.047	0.821	0.011	-0.052	0.724
CMA (no lags)	0.000	-0.024	0.519	-0.001	-0.042	0.459
CSP (no lags)	0.019	-0.050	0.702	0.028	-0.067	0.731
TSP (no lags)	-0.017	-0.036	0.148	-0.016	-0.048	0.211
LIQ (no lags)	-0.006	-0.039	0.262	-0.005	-0.046	0.313
REM (no lags)	-0.600	-0.102	0.000	-0.702	-0.119	0.000
MOM (no lags)	-0.127	-0.050	0.002	-0.156	-0.056	0.001
RCG (no lags)	0.175	-0.049	1.000	0.109	-0.060	0.988
CEI (no lags)	0.005	-0.041	0.752	-0.006	-0.056	0.377
CUI (no lags)	-0.028	-0.043	0.095	-0.024	-0.051	0.147
PEC (no lags)	-0.091	-0.037	0.003	-0.119	-0.047	0.003
CUR (no lags)	-0.100	-0.035	0.003	-0.131	-0.046	0.003
CMS (no lags)	-0.378	-0.042	0.000	-0.486	-0.053	0.000
COP (no lags)	0.003	-0.048	0.580	0.000	-0.062	0.571
CMU (no lags)	0.058	-0.054	0.851	-0.011	-0.068	0.298
CFU (no lags)	0.003	-0.027	0.519	0.007	-0.041	0.605
		Multiple test			Multiple test	
		-0.153	0		-0.182	0
Panel B: Baseline is **REM (1 lag)**						
		Multiple test			Multiple test	
		-0.636	1		-0.728	0.983

Table 10B: **Retail Property Type from 2009-2018 (Balanced Dataset – Liquidity Adjusted)**

Note: This table presents the results for the retail property type with a balanced dataset from 2009 to 2018. The risk factors are included in their contemporaneous and in their lags. All CBSA have 36 consecutive quarterly observation. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty. Only the multiple test in the second pass of the algorithm is presented as its results is above the threshold.

Panel A: Baseline is no factor

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5^{th}-percentile	p-value
MKT (4 lags)	-0.078	-0.044	0.007	-0.080	-0.057	0.019
SMB (4 lags)	-0.008	-0.027	0.207	-0.014	-0.039	0.194
HML (4 lags)	0.010	-0.025	0.663	0.013	-0.034	0.682
RMW (4 lags)	0.020	-0.032	0.796	0.012	-0.039	0.713
CMA (4 lags)	-0.007	-0.024	0.232	-0.008	-0.036	0.279
CSP (4 lags)	-0.015	-0.033	0.211	-0.014	-0.051	0.254
TSP (4 lags)	-0.002	-0.018	0.284	-0.001	-0.028	0.365
LIQ (4 lags)	0.021	-0.036	0.773	0.032	-0.047	0.791
REM (4 lags)	-0.099	-0.046	0.006	-0.081	-0.053	0.018
MOM (4 lags)	0.096	-0.055	0.982	0.137	-0.076	0.993
RCG (4 lags)	-0.146	-0.044	0.000	-0.147	-0.049	0.001
CEI (4 lags)	0.004	-0.010	0.372	0.002	-0.014	0.321
CUI (4 lags)	0.021	-0.021	0.741	0.020	-0.033	0.679
PEC (4 lags)	-0.235	-0.032	0.000	-0.190	-0.033	0.000
CUR (4 lags)	-0.029	-0.030	0.056	-0.019	-0.032	0.114
CMS (4 lags)	0.353	-0.057	1.000	0.407	-0.071	1.000
COP (4 lags)	0.005	-0.018	0.557	0.007	-0.027	0.572
CMU (4 lags)	-0.018	-0.024	0.090	-0.026	-0.042	0.114
CFU (4 lags)	-0.010	-0.015	0.096	-0.018	-0.029	0.101
MKT (3 lags)	-0.006	-0.021	0.180	-0.047	-0.034	0.026
SMB (3 lags)	0.000	-0.020	0.467	0.007	-0.027	0.783
HML (3 lags)	0.002	-0.011	0.431	0.004	-0.018	0.497
RMW (3 lags)	0.001	-0.018	0.615	0.006	-0.032	0.775
CMA (3 lags)	-0.004	-0.026	0.319	-0.002	-0.034	0.402
CSP (3 lags)	0.015	-0.029	0.925	0.009	-0.034	0.840
TSP (3 lags)	0.001	-0.018	0.591	0.011	-0.027	0.834
LIQ (3 lags)	-0.002	-0.023	0.361	-0.004	-0.035	0.326
REM (3 lags)	-0.184	-0.063	0.006	-0.179	-0.068	0.008
MOM (3 lags)	0.025	-0.023	0.914	0.036	-0.028	0.936
RCG (3 lags)	-0.178	-0.038	0.000	-0.183	-0.047	0.000
CEI (3 lags)	0.016	-0.025	0.749	0.015	-0.029	0.693
CUI (3 lags)	-0.002	-0.031	0.381	0.000	-0.031	0.474
PEC (3 lags)	-0.200	-0.022	0.000	-0.198	-0.032	0.000
CUR (3 lags)	-0.069	-0.035	0.002	-0.046	-0.040	0.029
CMS (3 lags)	0.013	-0.035	0.969	0.080	-0.051	1.000
COP (3 lags)	0.008	-0.024	0.792	-0.004	-0.024	0.293
CMU (3 lags)	0.057	-0.035	0.958	0.030	-0.034	0.877
CFU (3 lags)	0.032	-0.032	0.899	0.023	-0.038	0.853
MKT (2 lags)	0.089	-0.036	0.982	0.123	-0.045	0.989
SMB (2 lags)	0.011	-0.028	0.779	0.015	-0.033	0.785
HML (2 lags)	0.002	-0.024	0.506	0.003	-0.032	0.520
RMW (2 lags)	-0.003	-0.013	0.220	-0.012	-0.024	0.139
CMA (2 lags)	-0.004	-0.019	0.275	-0.007	-0.033	0.295
CSP (2 lags)	0.049	-0.056	0.924	0.024	-0.062	0.788

TSP (2 lags)	-0.010	-0.030	0.211	-0.014	-0.036	0.187
LIQ (2 lags)	0.003	-0.022	0.732	-0.001	-0.034	0.466
REM (2 lags)	-0.330	-0.086	0.000	-0.316	-0.095	0.000
MOM (2 lags)	0.000	-0.016	0.330	0.018	-0.024	0.715
RCG (2 lags)	-0.110	-0.032	0.001	-0.123	-0.047	0.003
CEI (2 lags)	-0.001	-0.020	0.410	0.004	-0.029	0.668
CUI (2 lags)	-0.009	-0.050	0.364	-0.016	-0.060	0.269
PEC (2 lags)	-0.035	-0.016	0.009	0.000	-0.026	0.410
CUR (2 lags)	-0.111	-0.033	0.000	-0.087	-0.039	0.002
CMS (2 lags)	-0.194	-0.025	0.000	-0.166	-0.029	0.000
COP (2 lags)	0.011	-0.036	0.731	0.021	-0.046	0.799
CMU (2 lags)	0.064	-0.039	0.949	0.053	-0.042	0.907
CFU (2 lags)	0.034	-0.032	0.832	0.045	-0.037	0.870
MKT (1 lag)	0.046	-0.033	0.977	0.050	-0.042	0.968
SMB (1 lag)	0.009	-0.025	0.875	0.002	-0.033	0.588
HML (1 lag)	-0.002	-0.028	0.316	-0.001	-0.033	0.359
RMW (1 lag)	-0.002	-0.015	0.315	0.001	-0.026	0.496
CMA (1 lag)	0.001	-0.016	0.461	-0.008	-0.021	0.152
CSP (1 lag)	0.046	-0.042	0.840	0.057	-0.053	0.836
TSP (1 lag)	-0.014	-0.031	0.159	-0.021	-0.041	0.127
LIQ (1 lag)	0.000	-0.023	0.502	0.001	-0.032	0.619
REM (1 lag)	-0.574	-0.116	0.000	-0.569	-0.117	0.000
MOM (1 lag)	0.010	-0.019	0.828	0.050	-0.028	0.988
RCG (1 lag)	0.054	-0.023	1.000	0.067	-0.034	1.000
CEI (1 lag)	0.001	-0.015	0.561	0.002	-0.023	0.608
CUI (1 lag)	-0.019	-0.045	0.200	-0.014	-0.050	0.261
PEC (1 lag)	0.297	-0.029	1.000	0.267	-0.038	1.000
CUR (1 lag)	-0.112	-0.034	0.000	-0.124	-0.046	0.001
CMS (1 lag)	-0.318	-0.031	0.000	-0.354	-0.038	0.000
COP (1 lag)	0.001	-0.042	0.603	0.001	-0.045	0.604
CMU (1 lag)	0.061	-0.042	0.927	0.056	-0.049	0.897
CFU (1 lag)	0.006	-0.022	0.716	-0.004	-0.032	0.322
MKT (no lags)	0.011	-0.029	0.993	0.041	-0.041	0.997
SMB (no lags)	0.000	-0.017	0.454	-0.006	-0.026	0.233
HML (no lags)	0.003	-0.009	0.528	0.011	-0.019	0.741
RMW (no lags)	0.012	-0.029	0.853	0.023	-0.033	0.894
CMA (no lags)	0.001	-0.033	0.572	0.001	-0.046	0.599
CSP (no lags)	0.008	-0.029	0.721	-0.010	-0.036	0.222
TSP (no lags)	-0.009	-0.029	0.222	-0.010	-0.043	0.266
LIQ (no lags)	-0.001	-0.024	0.412	-0.004	-0.034	0.367
REM (no lags)	-0.741	-0.105	0.000	-0.777	-0.122	0.000
MOM (no lags)	-0.016	-0.018	0.060	0.005	-0.027	0.570
RCG (no lags)	0.199	-0.043	1.000	0.273	-0.058	1.000
CEI (no lags)	0.004	-0.031	0.755	0.000	-0.040	0.564
CUI (no lags)	-0.007	-0.021	0.196	-0.025	-0.033	0.079
PEC (no lags)	0.216	-0.031	1.000	0.323	-0.041	1.000
CUR (no lags)	-0.010	-0.018	0.105	0.057	-0.026	0.991
CMS (no lags)	-0.373	-0.038	0.000	-0.294	-0.053	0.000
COP (no lags)	0.002	-0.035	0.603	0.001	-0.048	0.557
CMU (no lags)	0.025	-0.029	0.845	0.010	-0.032	0.696
CFU (no lags)	-0.005	-0.033	0.362	-0.013	-0.041	0.252
		Multiple test			Multiple test	
		-0.133	0		-0.151	0
Panel B: Baseline is **REM (no lags)**						
		Multiple test			Multiple test	
		-0.666	0.999		-0.748	0.982

Appendix C: Statistics from 2008-2018

Table 1C: **Descriptive Statistics (balanced dataset 2008-2018)**

This table presents basic descriptive statistics for the quarterly risk factor data used in this research. It includes data from 2008 to 2018 extracted from various resources. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Summary Statistics

	N	Mean	St. Dev.	Min	Max
MKT	44	2.33%	8.11%	-22.41%	16.43%
SMB	44	0.45%	3.69%	-8.11%	7.58%
HML	44	-0.48%	5.81%	-14.71%	16.83%
RMW	44	0.87%	3.15%	-3.32%	8.52%
CMA	44	0.08%	2.81%	-4.43%	6.89%
CSP	44	0%	1.13%	-5.17%	3.75%
TSP	44	0%	0.36%	-0.96%	0.76%
LIQ	44	-0.16%	7.64%	-19.80%	23.76%
REM	44	1.47%	2.79%	-8.51%	4.60%
MOM	44	0.69%	1.48%	-3.49%	5.81%
RCG	44	1.64%	2.54%	-8.40%	5.5%
CEI	44	0.01%	0.47%	-2.08%	1.17%
CUI	44	-0.06%	0.54%	-2.62%	0.97%
PEC	44	0.84%	0.70%	-2.45%	1.79%
CUR	44	-0.49%	6.00%	-9.30%	19.04%
CMS	44	1.50%	0.84%	-0.04%	4.63%
COP	44	0.63%	19.13%	-67.16%	41.48%
CMU	44	-0.16%	2.35%	-5.22%	7.98%
CFU	44	0.10%	2.08%	-3.96%	4.96%

Table 2C: **Pearson Correlation – Risk Factors (2008-2018)**

Pearson coefficients of correlation between the risk factors. The risk factors are quarterly time-series from 2008 to 2018. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

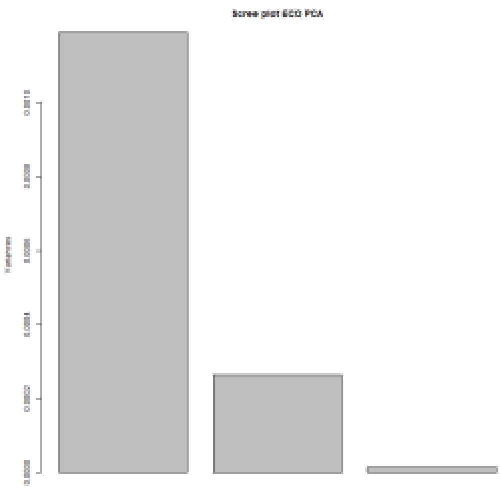
	MKT	SMB	HML	RMW	CMA	CSP	TSP	LIQ	REM	MOM	RCG	CEI	CUI	PEC	CUR	CMS	COP	CMU	CFU
MKT	1																		
SMB	0.39	1																	
HML	0.3	0.42	1																
RMW	**-0.58**	-0.48	-0.21	1															
CMA	0.13	0.3	**0.65**	-0.09	1														
CSP	**0.61**	0.31	0.4	-0.47	0.07	1													
TSP	-0.02	-0.25	-0.23	0.12	-0.13	-0.01	1												
LIQ	0.28	0.15	-0.23	-0.22	-0.23	0.28	0.01	1											
REM	0.24	-0.05	0.11	-0.19	-0.02	0.12	0.34	0.12	1										
MOM	-0.38	-0.18	-0.12	0.29	0.06	-0.45	0.07	-0.42	-0.09	1									
RCG	**0.55**	0.04	0.04	-0.18	-0.18	0.41	0.33	0.37	**0.63**	-0.29	1								
CEI	0.24	0.1	0	-0.28	-0.23	0.52	0.02	**0.5**	0.21	-0.3	0.35	1							
CUI	**0.51**	0.22	0.17	-0.33	-0.21	0.7	-0.06	**0.54**	0.19	-0.52	0.35	**0.57**	1						
PEC	0.49	0.07	0.25	-0.25	-0.07	**0.57**	0.15	0.35	**0.68**	-0.2	**0.77**	0.47	**0.52**	1					
CUR	-0.45	0.1	-0.18	0.25	0.01	-0.23	-0.25	0.02	**-0.78**	0.17	**-0.73**	-0.12	-0.17	**-0.68**	1				
CMS	**-0.64**	-0.39	-0.26	0.45	-0.01	**-0.54**	0.13	-0.48	-0.12	0.38	**-0.56**	-0.37	-0.44	-0.48	0.27	1			
COP	0.47	0.25	0.15	-0.36	-0.14	**0.53**	-0.27	**0.52**	0.07	-0.47	0.3	**0.63**	**0.79**	0.43	-0.11	-0.44	1		
CMU	-0.4	-0.01	0.11	0.37	0.07	-0.49	-0.03	-0.2	0.21	0.33	-0.1	-0.17	-0.34	-0.01	0.03	0.24	-0.4	1	
CFU	**-0.57**	-0.22	-0.09	0.45	-0.25	-0.34	0.05	-0.05	0.11	0.27	-0.03	0	-0.15	0.08	0.11	0.12	-0.21	**0.64**	1

Appendix D: Principal Component Analysis Results

Table 1D: **Scree Plots for PCA Analysis**

Panel A shows the scree plot for the ECO cluster and panel B shows it for the PRI cluster. In both cases, the “elbow” is observed after the first principal component.

Panel A: Scree Plot for ECO cluster



Panel B: Scree Plot for PRI cluster

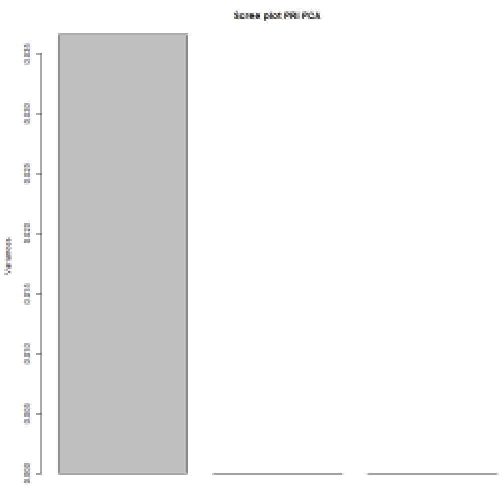


Table 2D: **Descriptive Statistics (PCA factors)**

This table presents basic descriptive statistics for the economic condition (ECO) and price (PRI) risk factors obtained through a principal component analysis performed on the risk factor data from 2008 to 2018. Panel B presents the correlation of the ECO and PRI risk factors with the remaining risk factors and between each other. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, MOM is the real estate momentum factor, CMS is the change in monetary supply, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Summary Statistics

	N	Mean	St. Dev.	Min	Max
ECO	44	0%	6.72%	-9.51%	24.02%
PRI	44	0%	19.13%	-40.85%	67.86%

Panel B: Correlation Matrix

	ECO	PRI	MKT	SMB	HML	RMW	CMA	CSP	TSP	LIQ	MOM	CMS	CMU	CFU
ECO	1	0.13	-0.46	0.08	-0.17	0.24	0.03	-0.25	-0.29	-0.05	0.18	0.3	0.01	0.07
PRI	0.13	1	-0.47	-0.25	-0.15	0.36	0.14	-0.53	0.27	-0.52	0.47	0.44	0.4	0.21

Table 3D: **Aggregated Property Types from 2008-2018 (Balanced Dataset with PCA)**

Note: This table presents the results for the aggregated property types with a balanced dataset from 2008 to 2018 including the two PCA risk factors – ECO which is a proxy for the general economic conditions and PRI which is a proxy for the price level. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, MOM is the real estate momentum factor, CMS is the change in monetary supply, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Baseline is no factor						
		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5th-percentile	p-value
ECO	0.000	-0.244	0.509	0.000	-0.256	0.508
PRI	0.000	-0.051	0.312	0.000	-0.057	0.317
MKT	-0.115	-0.083	0.022	-0.078	-0.092	0.065
SMB	0.012	-0.064	0.635	0.046	-0.069	0.816
HML	0.013	-0.040	0.543	0.027	-0.048	0.626
RMW	0.088	-0.090	0.889	0.107	-0.100	0.899
CMA	0.001	-0.051	0.436	0.004	-0.063	0.497
CSP	0.000	-0.021	0.212	0.000	-0.025	0.208
TSP	0.010	-0.145	0.500	0.010	-0.156	0.507
LIQ	0.004	-0.053	0.452	0.009	-0.059	0.504
MOM	0.045	-0.043	0.651	0.038	-0.049	0.588
CMS	0.338	-0.057	0.981	0.346	-0.063	0.979
CMU	0.025	-0.050	0.585	0.028	-0.057	0.590
CFU	-0.009	-0.044	0.210	-0.007	-0.053	0.254
		Multiple test			Multiple test	
		-0.262	0.408		-0.282	0.635

Table 4D: **Apartment Property Type from 2008-2018 (Balanced Dataset with PCA)**

Note: This table presents the results for the apartment property type with a balanced dataset from 2008 to 2018 including the two PCA risk factors – ECO which is a proxy for the general economic conditions and PRI which is a proxy for the price level. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, MOM is the real estate momentum factor, CMS is the change in monetary supply, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Baseline is no factor						
		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5th-percentile	p-value
ECO	0.000	-0.261	0.511	0.000	-0.263	0.511
PRI	0.000	-0.047	0.305	0.000	-0.053	0.317
MKT	-0.119	-0.078	0.020	-0.146	-0.089	0.015
SMB	0.006	-0.058	0.576	0.001	-0.069	0.462
HML	0.012	-0.039	0.502	0.022	-0.044	0.569
RMW	0.082	-0.083	0.886	0.070	-0.089	0.857
CMA	-0.002	-0.053	0.354	-0.001	-0.059	0.396
CSP	0.000	-0.017	0.197	0.000	-0.021	0.201
TSP	0.010	-0.169	0.505	0.011	-0.182	0.513
LIQ	0.004	-0.048	0.445	0.004	-0.053	0.426
MOM	0.051	-0.044	0.661	0.062	-0.046	0.706
CMS	0.346	-0.058	0.991	0.385	-0.064	0.991
CMU	0.018	-0.035	0.541	0.010	-0.045	0.473
CFU	-0.005	-0.044	0.253	-0.006	-0.045	0.259
		Multiple test			Multiple test	
		-0.275	0.404		-0.286	0.334

Table 5D: **Industrial Property Type from 2008-2018 (Balanced Dataset with PCA)**

Note: This table presents the results for the industrial property type with a balanced dataset from 2008 to 2018 including the two PCA risk factors – ECO which is a proxy for the general economic conditions and PRI which is a proxy for the price level. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, MOM is the real estate momentum factor, CMS is the change in monetary supply, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Baseline is no factor						
		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5^{th}-percentile	p-value
ECO	0.000	-0.224	0.514	0.000	-0.228	0.514
PRI	0.000	-0.047	0.303	0.000	-0.051	0.320
MKT	-0.100	-0.065	0.021	-0.058	-0.070	0.066
SMB	0.019	-0.065	0.711	0.037	-0.071	0.795
HML	0.013	-0.056	0.543	0.005	-0.060	0.458
RMW	0.082	-0.089	0.893	0.084	-0.099	0.896
CMA	0.005	-0.054	0.512	0.009	-0.064	0.592
CSP	0.000	-0.019	0.199	0.000	-0.026	0.213
TSP	0.009	-0.144	0.531	0.008	-0.155	0.530
LIQ	0.002	-0.040	0.406	-0.002	-0.041	0.314
MOM	-0.005	-0.034	0.183	0.026	-0.037	0.527
CMS	0.314	-0.056	0.985	0.335	-0.069	0.987
CMU	0.028	-0.046	0.592	0.027	-0.048	0.579
CFU	-0.013	-0.044	0.156	-0.014	-0.048	0.173
		Multiple test			Multiple test	
		-0.247	0.487		-0.257	0.759

Table 6D: **Office Property Type from 2008-2018 (Balanced Dataset with PCA)**

Note: This table presents the results for the office property type with a balanced dataset from 2008 to 2018 including the two PCA risk factors – ECO which is a proxy for the general economic conditions and PRI which is a proxy for the price level. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, MOM is the real estate momentum factor, CMS is the change in monetary supply, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Baseline is no factor						
		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5^{th}-percentile	p-value
ECO	0.000	-0.302	0.520	0.000	-0.332	0.521
PRI	0.000	-0.048	0.297	0.000	-0.069	0.312
MKT	-0.094	-0.070	0.029	-0.170	-0.099	0.014
SMB	0.032	-0.062	0.714	0.056	-0.093	0.773
HML	0.012	-0.035	0.472	-0.008	-0.061	0.225
RMW	0.093	-0.088	0.897	0.009	-0.117	0.569
CMA	0.003	-0.057	0.466	0.009	-0.079	0.551
CSP	0.000	-0.020	0.189	0.000	-0.041	0.217
TSP	0.010	-0.146	0.535	0.014	-0.179	0.571
LIQ	0.002	-0.042	0.387	0.003	-0.064	0.403
MOM	-0.021	-0.037	0.099	-0.039	-0.057	0.081
CMS	0.311	-0.060	0.981	0.119	-0.086	0.815
CMU	0.040	-0.076	0.642	0.035	-0.101	0.613
CFU	-0.017	-0.063	0.172	-0.024	-0.090	0.194
		Multiple test			Multiple test	
		-0.307	0.543		-0.345	0.348

Table 7D: **Retail Property Type from 2008-2018 (Balanced Dataset with PCA)**

Note: This table presents the results for the retail property type with a balanced dataset from 2008 to 2018 including the two PCA risk factors – ECO which is a proxy for the general economic conditions and PRI which is a proxy for the price level. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, MOM is the real estate momentum factor, CMS is the change in monetary supply, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Baseline is no factor						
		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5^{th}-percentile	p-value
ECO	0.000	-0.208	0.504	0.000	-0.218	0.504
PRI	0.000	-0.043	0.330	0.000	-0.052	0.335
MKT	-0.102	-0.067	0.019	-0.148	-0.087	0.011
SMB	0.011	-0.046	0.648	-0.016	-0.055	0.199
HML	0.012	-0.031	0.527	0.023	-0.043	0.612
RMW	0.088	-0.086	0.925	0.092	-0.104	0.906
CMA	0.000	-0.042	0.387	0.000	-0.052	0.394
CSP	0.000	-0.018	0.207	0.000	-0.028	0.230
TSP	0.008	-0.115	0.517	0.007	-0.122	0.518
LIQ	0.003	-0.041	0.422	0.004	-0.046	0.431
MOM	0.107	-0.042	0.847	0.140	-0.051	0.884
CMS	0.198	-0.048	0.968	0.197	-0.057	0.956
CMU	0.018	-0.030	0.577	0.017	-0.028	0.556
CFU	-0.003	-0.030	0.284	-0.003	-0.038	0.329
		Multiple test			Multiple test	
		-0.218	0.369		-0.233	0.231

Table 8D: **Aggregated Property Types from 2008-2018 (Balanced Dataset)**

Note: This table presents the results for the aggregated property types with a balanced dataset from 2008 to 2018. All CBSA have 44 consecutive quarterly observation. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change and CFU is the change in financial uncertainty.

Panel A: Baseline is no factor

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5[th]-percentile	p-value
MKT	-0.115	-0.076	0.022	-0.078	-0.081	0.054
SMB	0.012	-0.062	0.647	0.046	-0.070	0.828
HML	0.013	-0.039	0.516	0.027	-0.046	0.609
RMW	0.088	-0.092	0.894	0.107	-0.100	0.905
CMA	0.001	-0.053	0.453	0.004	-0.061	0.502
CSP	0.000	-0.019	0.194	0.000	-0.023	0.197
TSP	0.010	-0.151	0.531	0.010	-0.161	0.541
LIQ	0.004	-0.050	0.443	0.009	-0.056	0.492
REM	-0.730	-0.273	0.000	-0.779	-0.284	0.000
MOM	0.045	-0.040	0.631	0.038	-0.045	0.586
RCG	-0.616	-0.159	0.000	-0.668	-0.167	0.000
CEI	-0.004	-0.044	0.223	-0.005	-0.048	0.225
CUI	0.031	-0.037	0.473	0.043	-0.039	0.516
PEC	-0.561	-0.164	0.000	-0.580	-0.174	0.000
CUR	-0.107	-0.182	0.164	-0.091	-0.191	0.208
CMS	0.338	-0.055	0.982	0.346	-0.062	0.977
COP	-0.003	-0.049	0.268	-0.005	-0.055	0.247
CMU	0.025	-0.049	0.593	0.028	-0.056	0.594
CFU	-0.009	-0.045	0.201	-0.007	-0.055	0.243
		Multiple test			Multiple test	
		-0.293	0		-0.309	0

Panel B: Baseline is **REM**

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5[th]-percentile	p-value
MKT	0.018	-0.185	0.705	0.056	-0.206	0.814
SMB	0.013	-0.073	0.667	0.000	-0.085	0.480
HML	0.005	-0.078	0.492	0.050	-0.092	0.746
RMW	0.018	-0.170	0.759	-0.035	-0.187	0.333
CMA	-0.002	-0.065	0.374	-0.028	-0.075	0.159
CSP	-0.002	-0.056	0.286	0.008	-0.063	0.373
TSP	-0.018	-0.319	0.752	-0.159	-0.353	0.260
LIQ	-0.002	-0.087	0.387	-0.033	-0.096	0.181
REM						
MOM	-0.018	-0.071	0.192	0.042	-0.079	0.609
RCG	0.059	-0.507	0.970	0.011	-0.570	0.947
CEI	-0.002	-0.123	0.433	-0.039	-0.133	0.244
CUI	-0.016	-0.100	0.301	-0.036	-0.106	0.205
PEC	0.266	-0.550	0.991	0.174	-0.626	0.983
CUR	0.012	-0.630	0.982	0.018	-0.696	0.982
CMS	0.234	-0.109	0.960	0.176	-0.123	0.919
COP	0.000	-0.075	0.358	-0.002	-0.081	0.333
CMU	0.021	-0.128	0.708	0.107	-0.147	0.890
CFU	0.001	-0.088	0.499	0.009	-0.103	0.610
		Multiple test			Multiple test	
		-0.638	0.999		-0.707	0.979

Table 9D: **Apartment Property Type from 2008-2018 (Balanced Dataset)**

Note: This table presents the results for the apartment property type with a balanced dataset from 2008 to 2018. All CBSA have 44 consecutive quarterly observation. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Baseline is no factor

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5^{th}-percentile	p-value
MKT	-0.119	-0.081	0.022	-0.146	-0.089	0.017
SMB	0.006	-0.055	0.581	0.001	-0.065	0.465
HML	0.012	-0.038	0.509	0.022	-0.046	0.582
RMW	0.082	-0.083	0.890	0.070	-0.094	0.852
CMA	-0.002	-0.055	0.356	-0.001	-0.062	0.381
CSP	0.000	-0.020	0.196	0.000	-0.026	0.203
TSP	0.010	-0.164	0.539	0.011	-0.178	0.546
LIQ	0.004	-0.051	0.460	0.004	-0.056	0.448
REM	**-0.721**	**-0.284**	**0.000**	**-0.794**	**-0.288**	**0.000**
MOM	0.051	-0.042	0.676	0.062	-0.047	0.714
RCG	-0.585	-0.154	0.000	-0.626	-0.161	0.000
CEI	-0.004	-0.037	0.204	-0.006	-0.043	0.201
CUI	0.028	-0.036	0.475	0.018	-0.044	0.408
PEC	-0.540	-0.151	0.000	-0.597	-0.158	0.000
CUR	-0.103	-0.171	0.166	-0.121	-0.175	0.131
CMS	0.346	-0.059	0.988	0.385	-0.066	0.988
COP	-0.003	-0.047	0.262	-0.005	-0.055	0.250
CMU	0.018	-0.037	0.542	0.010	-0.047	0.477
CFU	-0.005	-0.042	0.262	-0.006	-0.049	0.260
		Multiple test			Multiple test	
		-0.301	0		-0.312	0

Panel B: Baseline is **REM**

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5^{th}-percentile	p-value
MKT	0.044	-0.184	0.798	0.038	-0.210	0.770
SMB	0.024	-0.070	0.761	-0.004	-0.080	0.381
HML	-0.016	-0.071	0.218	-0.073	-0.083	0.063
RMW	-0.048	-0.155	0.262	-0.141	-0.175	0.078
CMA	-0.005	-0.064	0.320	-0.027	-0.074	0.167
CSP	-0.020	-0.053	0.151	-0.002	-0.062	0.278
TSP	0.013	-0.335	0.865	-0.028	-0.374	0.727
LIQ	-0.006	-0.089	0.355	0.053	-0.098	0.793
REM						
MOM	-0.034	-0.074	0.131	0.059	-0.082	0.696
RCG	0.160	-0.489	0.987	0.363	-0.558	0.994
CEI	-0.015	-0.117	0.342	0.006	-0.129	0.489
CUI	-0.059	-0.092	0.111	-0.072	-0.106	0.099
PEC	0.586	-0.526	1.000	0.695	-0.587	0.999
CUR	-0.058	-0.612	0.970	-0.139	-0.678	0.956
CMS	0.093	-0.106	0.859	-0.097	-0.117	0.071
COP	-0.001	-0.069	0.334	0.000	-0.079	0.359
CMU	0.059	-0.106	0.813	0.023	-0.123	0.682
CFU	0.000	-0.068	0.459	-0.007	-0.081	0.324
		Multiple test			Multiple test	
		-0.621	0.996		-0.690	0.988

Table 10D: **Industrial Property Type from 2008-2018 (Balanced Dataset)**

Note: This table presents the results for the industrial property type with a balanced dataset from 2008 to 2018. All CBSA have 44 consecutive quarterly observation. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Baseline is no factor

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5th-percentile	p-value
MKT	-0.100	-0.061	0.017	-0.058	-0.070	0.065
SMB	0.019	-0.063	0.709	0.037	-0.066	0.800
HML	0.013	-0.045	0.537	0.005	-0.052	0.451
RMW	0.082	-0.093	0.883	0.084	-0.099	0.877
CMA	0.005	-0.056	0.511	0.009	-0.064	0.577
CSP	0.000	-0.021	0.197	0.000	-0.027	0.215
TSP	0.009	-0.146	0.529	0.008	-0.153	0.527
LIQ	0.002	-0.042	0.402	-0.002	-0.046	0.304
REM	**-0.723**	**-0.240**	**0.000**	**-0.751**	**-0.247**	**0.000**
MOM	-0.005	-0.035	0.200	0.026	-0.039	0.533
RCG	-0.624	-0.146	0.000	-0.658	-0.155	0.000
CEI	-0.004	-0.041	0.225	-0.002	-0.046	0.244
CUI	0.026	-0.033	0.446	0.030	-0.036	0.467
PEC	-0.621	-0.166	0.000	-0.571	-0.175	0.000
CUR	-0.103	-0.174	0.170	-0.117	-0.182	0.148
CMS	0.314	-0.053	0.976	0.335	-0.061	0.976
COP	-0.002	-0.049	0.287	0.002	-0.054	0.376
CMU	0.028	-0.052	0.604	0.027	-0.054	0.595
CFU	-0.013	-0.047	0.166	-0.014	-0.049	0.175
		Multiple test			Multiple test	
		-0.266	0		-0.278	0

Panel B: Baseline is **REM**

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5th-percentile	p-value
MKT	-0.013	-0.161	0.435	-0.039	-0.176	0.319
SMB	0.004	-0.074	0.547	0.013	-0.084	0.649
HML	0.021	-0.084	0.634	0.035	-0.091	0.705
RMW	0.071	-0.174	0.911	0.224	-0.184	0.982
CMA	0.007	-0.072	0.556	-0.008	-0.081	0.323
CSP	0.012	-0.052	0.384	0.028	-0.063	0.465
TSP	0.026	-0.318	0.897	0.089	-0.350	0.956
LIQ	-0.002	-0.073	0.366	0.024	-0.082	0.638
REM						
MOM	-0.044	-0.059	0.076	-0.053	-0.063	0.066
RCG	-0.046	-0.494	0.913	-0.117	-0.546	0.836
CEI	0.013	-0.120	0.525	-0.020	-0.131	0.308
CUI	0.015	-0.092	0.471	0.046	-0.097	0.570
PEC	-0.134	-0.549	0.872	-0.176	-0.619	0.841
CUR	0.206	-0.630	0.993	0.227	-0.692	0.992
CMS	0.458	-0.102	0.993	0.243	-0.113	0.955
COP	0.000	-0.069	0.353	0.005	-0.074	0.426
CMU	-0.001	-0.125	0.576	-0.060	-0.131	0.195
CFU	0.002	-0.087	0.511	-0.019	-0.093	0.248
		Multiple test			Multiple test	
		-0.636	0.987		-0.701	0.983

Table 11D: **Office Property Type from 2008-2018 (Balanced Dataset)**

Note: This table presents the results for the office property type with a balanced dataset from 2008 to 2018. All CBSA have 44 consecutive quarterly observation. The baseline model includes the pre-selected risk factors. SI_{ew}^{m} and SI_{ew}^{med} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Baseline is no factor

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5th-percentile	p-value
MKT	-0.094	-0.067	0.026	-0.170	-0.091	0.012
SMB	0.032	-0.067	0.729	0.056	-0.093	0.783
HML	0.012	-0.038	0.477	-0.008	-0.063	0.227
RMW	0.093	-0.092	0.906	0.009	-0.120	0.572
CMA	0.003	-0.059	0.468	0.009	-0.084	0.547
CSP	0.000	-0.018	0.182	0.000	-0.036	0.213
TSP	0.010	-0.157	0.535	0.014	-0.189	0.575
LIQ	0.002	-0.046	0.402	0.003	-0.072	0.434
REM	-0.497	-0.330	0.000	-0.576	-0.353	0.000
MOM	-0.021	-0.039	0.097	-0.039	-0.060	0.084
RCG	-0.497	-0.181	0.000	-0.604	-0.204	0.000
CEI	-0.003	-0.046	0.231	-0.005	-0.069	0.250
CUI	0.019	-0.029	0.401	-0.012	-0.051	0.161
PEC	0.001	-0.198	0.486	-0.207	-0.224	0.063
CUR	-0.125	-0.220	0.183	-0.141	-0.246	0.165
CMS	0.311	-0.055	0.978	0.119	-0.081	0.824
COP	0.001	-0.056	0.340	-0.003	-0.077	0.307
CMU	0.040	-0.075	0.617	0.035	-0.100	0.587
CFU	-0.017	-0.060	0.168	-0.024	-0.084	0.174
		Multiple test			Multiple test	
		-0.342	0		-0.375	0

Panel B: Baseline is **REM**

		Single test			Single test	
Risk Factor	SI_{ew}^{m}	5-th percentile	p-value	SI_{ew}^{med}	5th-percentile	p-value
MKT	-0.014	-0.296	0.599	0.037	-0.382	0.708
SMB	0.023	-0.076	0.634	-0.019	-0.107	0.263
HML	0.000	-0.068	0.371	-0.012	-0.099	0.262
RMW	-0.058	-0.161	0.237	-0.154	-0.205	0.093
CMA	-0.006	-0.096	0.387	-0.005	-0.138	0.433
CSP	-0.066	-0.134	0.172	-0.080	-0.180	0.179
TSP	-0.007	-0.314	0.810	-0.141	-0.388	0.377
LIQ	-0.037	-0.133	0.271	-0.257	-0.193	0.019
REM	0.078	-0.684	1.000	0.107	-0.768	0.989
MOM	0.024	-0.119	0.496	0.052	-0.168	0.568
RCG						
CEI	-0.075	-0.186	0.242	-0.106	-0.243	0.226
CUI	-0.105	-0.137	0.098	-0.215	-0.197	0.037
PEC	0.845	-0.594	0.996	0.737	-0.681	0.989
CUR	0.666	-0.619	0.999	0.938	-0.704	0.998
CMS	2.527	-0.238	1.000	2.532	-0.325	1.000
COP	-0.045	-0.120	0.175	-0.049	-0.177	0.214
CMU	0.001	-0.074	0.316	-0.007	-0.103	0.261
CFU	-0.010	-0.075	0.233	0.016	-0.102	0.502
		Multiple test			Multiple test	
		-0.685	0.932		-0.772	0.897

Table 12D: **Retail Property Type from 2008-2018 (Balanced Dataset)**

Note: This table presents the results for the retail property type with a balanced dataset from 2008 to 2018. All CBSA have 44 consecutive quarterly observation. The baseline model includes the pre-selected risk factors. SI^{m}_{ew} and SI^{med}_{ew} measure the difference in scaled mean/median absolute regression intercept. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, REM is the real estate market risk premium, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty.

Panel A: Baseline is no factor						
		Single test			Single test	
Risk Factor	SI^{m}_{ew}	5-th percentile	p-value	SI^{med}_{ew}	5th-percentile	p-value
MKT	-0.102	-0.065	0.017	-0.148	-0.079	0.011
SMB	0.011	-0.045	0.645	-0.016	-0.052	0.190
HML	0.012	-0.030	0.531	0.023	-0.043	0.617
RMW	0.088	-0.087	0.906	0.092	-0.102	0.893
CMA	0.000	-0.043	0.396	0.000	-0.054	0.406
CSP	0.000	-0.019	0.214	0.000	-0.028	0.230
TSP	0.008	-0.121	0.524	0.007	-0.128	0.526
LIQ	0.003	-0.038	0.436	0.004	-0.044	0.433
REM	-0.640	-0.245	0.000	-0.704	-0.255	0.000
MOM	0.107	-0.041	0.862	0.140	-0.048	0.891
RCG	-0.480	-0.121	0.000	-0.565	-0.129	0.000
CEI	-0.004	-0.039	0.225	-0.004	-0.040	0.212
CUI	0.030	-0.034	0.493	0.039	-0.040	0.528
PEC	-0.605	-0.113	0.000	-0.697	-0.123	0.000
CUR	-0.087	-0.147	0.167	-0.107	-0.153	0.128
CMS	0.198	-0.047	0.965	0.197	-0.055	0.952
COP	-0.003	-0.044	0.261	-0.007	-0.050	0.223
CMU	0.018	-0.033	0.577	0.017	-0.034	0.557
CFU	-0.003	-0.032	0.286	-0.003	-0.039	0.320
		Multiple test			Multiple test	
		-0.254	0		-0.270	0
Panel B: Baseline is **REM**						
		Single test			Single test	
Risk Factor	SI^{m}_{ew}	5-th percentile	p-value	SI^{med}_{ew}	5th-percentile	p-value
MKT	0.009	-0.155	0.677	0.066	-0.186	0.857
SMB	0.007	-0.055	0.616	0.082	-0.063	0.930
HML	-0.002	-0.061	0.363	0.071	-0.082	0.835
RMW	0.050	-0.154	0.897	0.271	-0.184	0.992
CMA	-0.005	-0.052	0.304	0.006	-0.063	0.556
CSP	-0.001	-0.055	0.313	0.043	-0.069	0.579
TSP	-0.017	-0.257	0.743	0.027	-0.282	0.908
LIQ	-0.002	-0.072	0.388	0.013	-0.078	0.584
REM						
MOM	0.158	-0.079	0.930	0.396	-0.089	0.987
RCG	0.140	-0.391	0.990	0.164	-0.451	0.988
CEI	-0.004	-0.107	0.425	0.067	-0.113	0.711
CUI	0.006	-0.087	0.460	0.135	-0.100	0.782
PEC	0.434	-0.408	0.999	0.591	-0.481	0.999
CUR	-0.101	-0.518	0.959	0.140	-0.595	0.993
CMS	0.024	-0.085	0.649	-0.102	-0.099	0.047
COP	0.000	-0.064	0.362	-0.003	-0.076	0.317
CMU	-0.009	-0.088	0.435	-0.042	-0.094	0.178
CFU	-0.003	-0.047	0.345	0.007	-0.055	0.583
		Multiple test			Multiple test	
		-0.521	0.988		-0.599	0.989

Appendix E: LASSO Results

Figure 1E**: Average Mean-Squared Error Curve**

This graph shows the average mean-squared error curve from the cross-validation simulations of the LASSO regression. The optimal value of log(λ) is -4.81 which corresponds to the mean-squared error of 0.00033. The value of λ used for the LASSO regression is thus 0.008078.

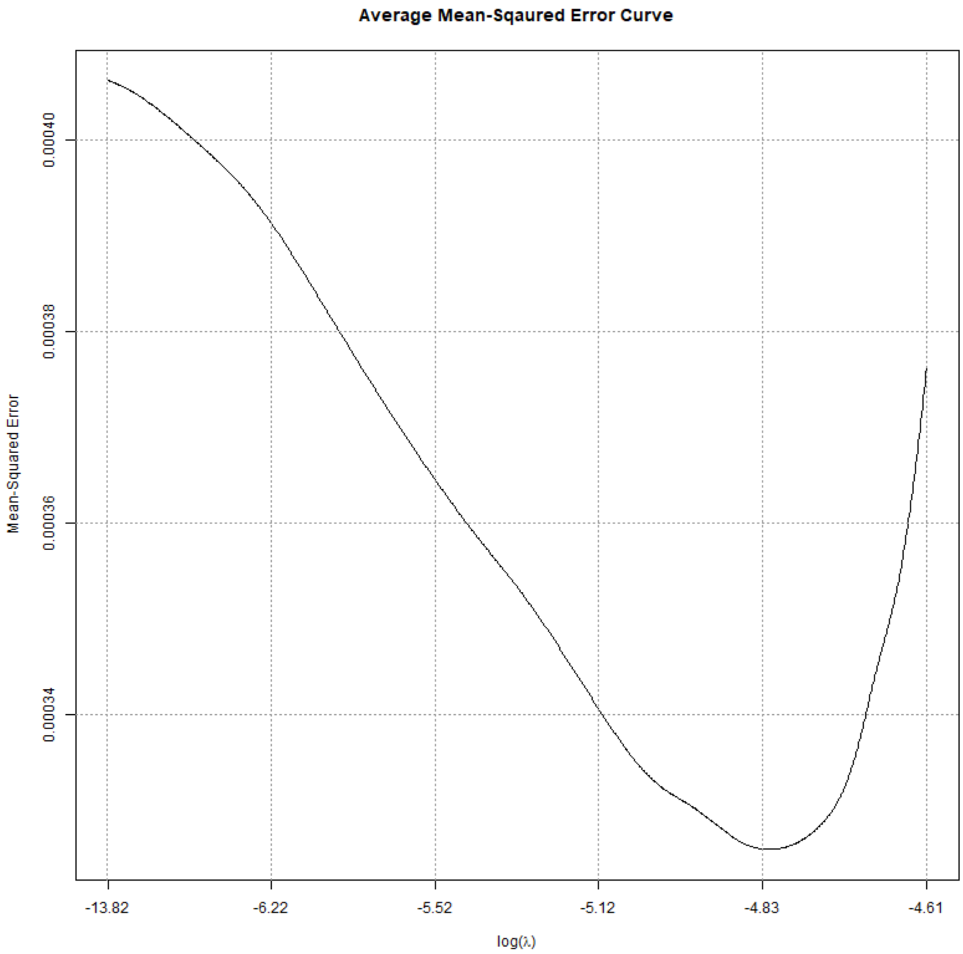


Table 1E: **LASSO Regression Coefficients**

The table shows the coefficients of the LASSO regression where REM, the real estate market risk premium, is the dependent variable and the other risk factors are the independent variables. MKT is the stock market risk premium, SMB is the size factor, HML is the book-to-market factor, RMW is the profitability factor, CMA is the investment factor, CSP is the change in credit spread factor, TSP is the change in term spread factor, LIQ is the liquidity factor, MOM is the real estate momentum factor, RCG is the change in GDP, CEI in the change in expected inflation, CUI is the change in unexpected inflation, PEC is the change in personal consumption expenditure, CUR in the change in unemployment rate, CMS is the change in monetary supply, COP in the change in oil price, CMU is the change in macroeconomic uncertainty and CFU is the change in financial uncertainty. The only risk factor which survive the regularization is CUR.

	Dependent variable:
	REM
Constant	0.0113
MKT	-
SMB	-
HML	-
RMW	-
CMA	-
CSP	-
TSP	-
LIQ	-
MOM	-
RCG	-
CEI	-
CUI	-
PEC	-
CUR	-0.0305
CMS	-
COP	-
CMU	-
CFU	-

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