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The relationship between European REITs and inflation

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ABSTRACT

From theory and research, it is concluded that non-securitized real estate values correlate positively with expected inflation. However, people certainly disagree when asked whether this correlation can also be seen in securitized real estate. Previous studies in the United States show a negative relationship in the short term and a positive one in the long term. This thesis will examine Europe's long-term and short-term correlation between securitized Real Estate Investment Trusts (REITs) and inflation by the use of Dynamic Ordinary Least Squared regression. This will prove there is a negative relationship in the short term and a positive one in the long term.

Keywords: REITs, Inflation, Europe, Hedgeability, Stocks

JEL Classification: E4, E5,

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Chapter 1: Introduction

During the last year, the word 'Inflation' is probably one of the most used words. Inflation is defined as the general increase in prices and a fall in the purchasing value of money. The European Central Bank's (ECB) primary objective is to maintain price stability, that is, to preserve the purchasing power of the euro. Price stability creates conditions for more stable economic growth and a more stable financial system. The quantitative target set by the ECB for the inflation rate is 2% per annum. The process and activities to keep inflation below or equal to the target is called monetary policy. The ECB has two means of keeping this inflation rate in line with its goal:

The first means is the conventional monetary policy. The primary instrument for the ECB is to change the interest rate (base ECB rate). As a result of the tool, the people and businesses are influenced by the level of the interest rate on how much they spend and invest, which has a direct effect on the inflation rate.

The second means is unconventional monetary policy. Economic objectives can be reached by tools other than changing interest rates. One example is buying and selling of government bonds. If the European Central Bank buys government bonds in the open market, it increases the money supply in the economy, resulting in an increased amount of cash, stimulating the growth of the economy.

Societal relevance

The volatility in inflation makes it difficult for investment and pension funds to achieve fixed asset returns. The wide variety of asset classes makes their investment policy extreme complex. They can choose stocks, bonds, commodities and other asset classes. The risk profiles of these portfolios determine the distribution of these asset classes. One of these risks is inflation. Stock returns are generally negatively correlated with inflation (Fama and Schwert 1977). So, if the portfolio consists primarily of stocks and during times of higher inflation, low returns are expected. On the other hand, commodities such as gold are positively correlated with inflation (Ghosh et al. 2004, Lucy et al. 2017, Batten et al. 2014). During times of higher inflation, it is recommended to have a larger share of gold in your portfolio. Asset and fund managers must always determine the portfolio risks and choose the best allocation. A financial instrument having a positive relationship with inflation is called an inflation hedge. One of these inflation hedges is the purchase of real estate (Rubens et al. 1989). The real estate prices will increase during times of higher inflation, but the relative value of the mortgage used to acquire that asset in the past will go down. Therefore, owners of real estate with a mortgage will financially benefit (mortgage debt in real terms will decline) during periods of high inflation.

Research Question

Investors seek to invest in liquid investments (like stocks), which can be turned into cash quickly. Real estate is considered an illiquid investment. Investing directly in real estate is therefore not considered an option. An alternative method to invest in real estate without buying the underlying asset directly is to invest in Real Estate Investment Trusts (REITs). The question is whether or not the returns of the trusts are positively correlated with inflation, just like the direct purchase of real estate. This effect needs to be studied for both the short and long term. For the purpose of the thesis, the following research question was defined:

What is the relationship between expected inflation and Real Estate Investment Trust (REITs) returns in Europe?

Academic Relevance

Much research has been done in the past on the relationship between expected inflation and asset returns. Many references by economic researchers were made to the findings of Fisher (1930). He concluded that the expected inflation is incorporated in the nominal asset price, with a positive relationship between asset return and expected inflation. However, later research indicates a negative relationship (Nelson 1976 and Gultekin 1983) between stock returns and inflation. These findings will be discussed in more detail in Chapter 2. Further, specific research has subsequently been conducted on Real Estate Investment Trusts and expected inflation in the United States (Gyourko and Linneman (1988), Park et al. (1990)). The European Real Estate Association has also conducted research in European countries. Their focus was on the different relationships between developed and emerging countries in Europe. This paper will examine the relationship between expected European inflation and returns of European Real Investment Trusts. An index called FTSE EPRA Developed Europe tracks various REITs in countries such as France, Germany and Italy. The return of this index depends on European inflation. This relationship has not been explored further and will be examined in this paper.

In conclusion, there is a negative short-term relationship between the expected inflation and Real Estate Investment Trust returns in Europe. This relationship is in the same direction (negative) as the relationship between expected inflation and common stock returns; REIT returns behave as common stock in the short term in terms of expected inflation. Long-term, expected inflation is positively related to REIT returns. Common stock returns are positively correlated to the expected inflation in the long term as well.

The theoretical framework will be discussed in more detail in chapter 2. Subsequently, all findings will be discussed and evaluated, and six hypotheses will be formulated. Chapter 3 will describe the data that was used to validate the hypotheses. In chapter 4, the data will be used to research the hypotheses to

support the research question. In chapter 5, the final results will be presented and finally, chapter 6 will give a conclusion and limitations of this research.

Chapter 2: Literature Review

This chapter reviews and describes the current literature on the relationship between inflation and real estate stocks, specifically REITs. Both results and conclusions of these studies will be presented as well as the correlation of these studies. Finally, six hypotheses will be presented to answer the research question.

Definitions

In order to further examine the existing studies that have already been carried out to research the relationship between REITs and inflation, the concepts of REITS and inflation will be further explained below.

Real Estate Investment Trust (REITS)

A Real Estate Investment Trust is a company that owns large amounts of real estate and operationally generates cash from real estate proceeds or offers long-term financing for income-generating real estate investments. A REIT is actually a pool of several investments. The advantage for investors is that income is generated in the form of dividends in real estate without actually purchasing real estate. One of the typical characteristics of REITs is that they are publicly available for purchase, making them highly liquid. This characteristic makes it attractive for the illiquid real estate sector. REITs invest in a wide range of real estate sectors, such as residential properties, shopping centres, hospitals and business parks. A REIT must meet several predefined requirements. For example, 70% of total assets must be invested in real estate and 90% of total income must be returned to shareholders as dividends.

A REIT uses a securitized form of real estate investment, which is an aggregated pool of smaller investments, while an unsecuritized investment is an unpooled single investment.

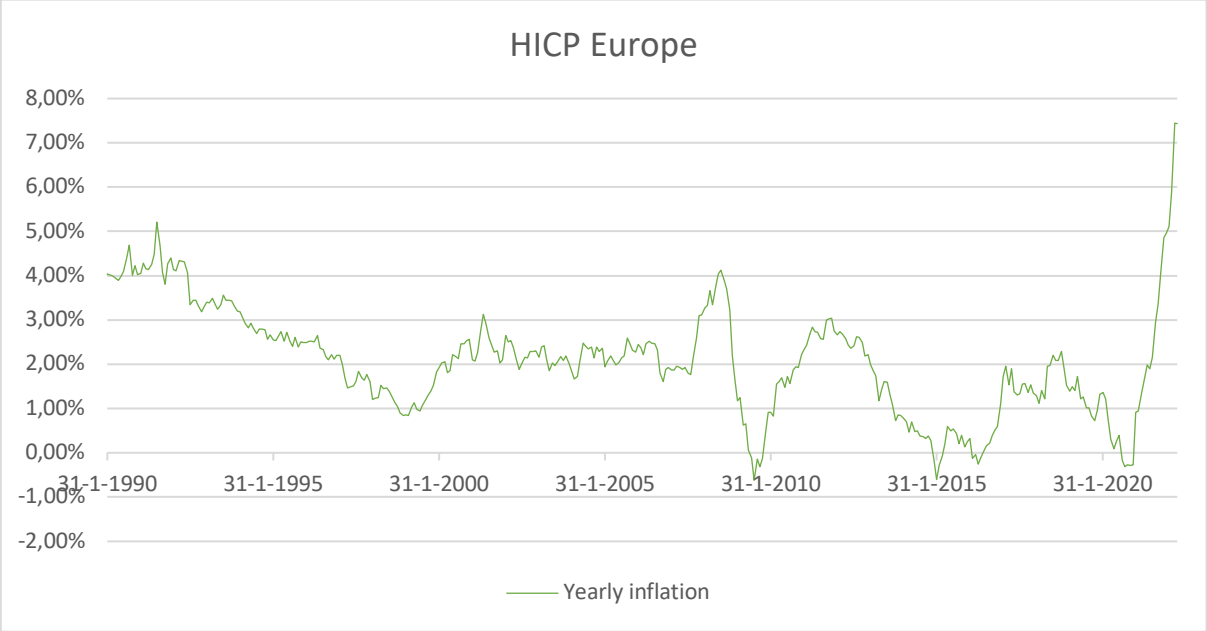
Inflation

Inflation is perhaps one of the most essential terms in the field of macroeconomics. Inflation is the decline in purchasing power over time. Inflation is calculated using the price level of a basket of pre-selected goods and the increase of the prices of these same goods over time (1 year) equals inflation. As a result, a smaller portion of the basket can be bought for the same price after this defined period. The opposite of inflation is deflation, resulting in an increase in purchasing power over time. When an economy moves into deflation, people and companies tend to postpone their spending and investments because prices will decrease over time, resulting in lower negative economic growth.

An inflation index is calculated by collecting the prices of these baskets. The mostly used index is the Consumer Price Index (CPI). This is calculated on a monthly basis for each country. In this study, the REITs used are all EU based, so a European index will be used: The Harmonized Index of Consumer

Prices of Europe (HICP). The HICP can be computed by using the harmonized CPI of each individual European country. Eurostat is publishing these indices on a monthly basis.

Figure 1: Harmonized Index Consumer Prices from Jan 1990 till April 2022



Until the start of the COVID crisis in 2020, the European inflation rate was around 2%. A significant event in 2008 was the credit crisis causing a spike in the inflation rate at the beginning of 2008 due to high gas prices, but this was only temporary. At the end of 2008, the inflation was more or less back to a normal rate of 2%. Mazumder (2018) researched inflation after the credit crisis of 2008. He concluded that after this event, the ECB failed to reach the target of a 2% inflation rate. Similarly, Łyziak and Paloviita (2017) researched Europe's inflation in the period after the credit crisis.

They also concluded that inflation expectations are sending signals of de-anchoring. Simply put, it is becoming increasingly difficult for the ECB to meet its target of 2% inflation or less. They, therefore, concluded that a new policy needs to be written.

The relationship between expected inflation and common stocks

An incredible amount of research has been done in the past on the relationship between inflation and common stocks. One of the very first and also one of the best-known theories is that of Fisher (1930). He stated that the expected nominal return on assets equals the expected real return on assets and the expected inflation. In the event of an increase in inflation, an investor expects a higher return from his investment. This is because the nominal return also goes up. According to this theory, there is, therefore, a positive relationship between expected inflation and stock returns in the long term. Luintel and Paudyal (2006) tested the Fisher equation by testing if it is inflation-hedgeable. Inflation-hedging is a technique used to secure the positive relationship between inflation and an asset return. They researched their

hypothesis by using stock returns and prices of goods in the UK. They conclude that long-term elasticities are higher than one, indicating a positive relationship. Anari and Kolalri (2014) performed the same study but studied at different time frames. They concluded that in the long run, there is a positive relationship between inflation and stock returns, but in the short run, there is a negative relationship. In conclusion, these findings are again in line with the Fisher equation, but it takes time to recover the inflation in the common stock return.

Perverse inflation hedge phenomenon

Since Fisher (1930), a large number of studies have been carried out in the field of the relationship between expected inflation and stock returns. Most of these studies came up with precisely the opposite; a negative relationship between inflation and stock returns. For example, Nelson (1976) concluded in his study that a negative relationship exists between common stock returns, both expected and unexpected inflation, by regressing them. Gulktekin (1983) attempted to further prove this outcome by testing the relationship in 26 countries. In most of these countries, there was too little evidence of a positive relationship and thus, this outcome also contradicts Fisher (1930). The negative relationship between inflation and stock returns is called the perverse inflation hedge phenomenon.

Proxy theory

Many studies show a negative association, but relatively little research has been done on its explanation. Fama (1981) was one of the first to do so. He concluded that the so-called proxy effects could explain the negative suspected inflation-return relationship. The link would come from the negative relationship between real activities (capital expenditures, output, and the average real rate of return on the capital stock) and common stock returns. Between expected inflation and real activity, there is a positive relationship. The negative relationship between expected inflation and common stock returns can be explained by the conjunction of the two relationships stated before. This is called the proxy theory.

Geske and Roll (1983) concluded a negative relationship between expected inflation and common stock returns. However, they claim that it is not a causal relationship. Their explanation is as follows: an exogenous negative real output shock has a negative effect on stock returns. The earnings of the companies will be lower and the government will receive fewer tax revenues. As the government expenditures stay the same to accommodate the change in revenue, this leads to a deficit in the treasury. The government needs to borrow money from the public. The Federal Reserve System will take a part of the debt in the treasury. The Fed pay for it by expanding the growth of base money (inflation). Rational investors know and recognize this domino effect and they adjust their prizes of short-term securities immediately after the shock. This is called the spurious causality effect.

In summary, we agree that there is a negative relationship between stock returns and expected inflation in the short term, but it is not causal. However, this paper will examine the negative relationship between real estate returns and inflation. Fortunately, there is also much research on this relationship. However, the reported conclusions are less consistent.

Expected Inflation and real estate returns in the short run

Securitized and non-securitized real estate have entirely different correlations with expected inflation. Larsen and Mcqueen (1995) studied the behaviour of gold shares versus REITs. Gold shares are the securitized form of gold. Gold itself is a complete hedge for inflation, but gold *shares* are negatively correlated with inflation. Thus, the conclusion is that the relationship between expected inflation and securitized REITs does not necessarily have to be the same as the relationship between expected inflation and non-securitized real estate. Rubens et al. (1989) researched the relationship between non-securitized real estate similar to gold thus. They concluded a positive correlation between expected inflation and non-securitized real estate. There was even a complete hedge between unexpected inflation and non-securitized real estate. Mengden and Hartzell (1986) looked at whether Real Estate Investment Trusts (i.e., the gold shares) behave like common stock. They concluded that they were almost identical and negatively correlated with inflation in the short term. So, to sum this up, non-securitized real estate is positively correlated with expected inflation and securitized real estate is negatively correlated with expected inflation in the short term.

In the United States, there was research done by Gyourko and Linneman (1988). They examined the short-term relationship between residential and non-residential real estate with inflation. In order to compare hedgeability, the relationship between common stock and inflation was also examined. They confirmed that although real estate is positively correlated with inflation, REITs are negatively correlated with expected inflation. In addition, they also found that REITs are negatively correlated with the price of energy. Fama and Schwert (1977) investigated the short-term relationship between REIT returns and expected inflation and found a negative relationship by using a formula that will be used in this paper. Liu et al. (1997) did never find a significant positive relationship between Real Estate returns and expected inflation over the short run, even though they expected a positive relationship. They even found a significant negative relationship in many countries.

Larsen and Mcqueen (1995), like Geske and Roll (1983), explained the negative correlation between expected inflation and stocks, not on common stock but on REITs. They also concluded that there is a positive relationship between REITs and expected real activity, which makes expected inflation and REITs return to a non-causal relationship.

Expected inflation and long-term real estate returns

All of these studies above deal with the short-term relationship. However, little research has been done on the long-term relationship between expected inflation and REIT returns. Lee et al. (2012) and Hoesli et al. (2008) did. They both found a long-term positive relationship between expected inflation and REIT returns. However, due to the underlying assets and the limitations on the management of the REITs (like strict rules on dividend payments), the inflation hedgeability may vary from one country to another.

Boudoukh and Richardson (1993) researched the long-term relationship between expected inflation and stock returns and concluded a positive relationship. This confirms that REITs function fairly similarly to common stock (Mengdel and Hartzell (1996)).

Methods to view the relationship inflation-REIT return

For the short-run relationship, an OLS regression is used. However, concluding from the above studies, the long-term macroeconomic effect of inflation on REITs needs to be looked at, controlling for monetary policy and real activities. In the past, there have been several methods to look at the relationship. Initially, the method of Engle and Granger (1987) was seen as the ideal method. They stated different variables were stationary as if first-differenced. These variables are cointegrated with a vector variable. Their model takes all of this into account. Next came the Vector Error-Correction Method by King et al. (1991). Empirical research was done on the effect of a change in stochastic trends known from multiple macroeconomic series. Later, Stock and Watson (1993) came up with their own method for testing long-term macroeconomic effects. This is called a Dynamic Ordinary Least Squared Regression (DOLS regression). Research by them indicates that when it comes to a long-term relationship, the DOLS regression works better than the cointegration method of Engle and Granger (1987) and the VECM method of King et al. (1991).

In conclusion, studies of the relationship between REITs returns and inflation point to a negative short-term and positive long-term relationship, as REITs behave almost like common stocks.

Table 1: Summary of key findings in the literature.

Author(s) (publication year)	Title	Time period	Region	Method	Conclusion
Fisher (1930)	The Theory of Interest	-	-	Mathematical Reasoning	Indeed, expected inflation plus real inflation is nominal inflation. As a result, expected inflation is positively correlated with nominal returns.

Nelson (1976)	Inflation and rates of return on common stocks.	1953 - 1972	United States	Regression between expected inflation and common stock returns	There is a negative relationship between expected inflation and common stock.
Fama & Schwert (1977).	Asset returns and inflation.	1953 - 1971	United States	Regression between different asset returns and (un)expected inflation	Common stock returns are negatively correlated with expected and probably unexpected inflation in the near term.
Fama (1981)	Stock returns, real activity, inflation, and money	1953 - 1971	United State	Regression between common stock returns, real activities and (un)expected inflation	There is a negative correlation, but it is caused by real activities in the short term.
Gultekin (1983)	Stock market returns and inflation: evidence from other countries.	1947 - 1979	26 countries	Regression between expected inflation and common stock returns	There is consistently a lack of evidence from before the Fisher equation.
Geske & Roll (1983)	The Fiscal and Monetary Linkage Between Stock Returns and Inflation.	1968 - 1980	United States	Regression between common stock returns, real activities, (un)expected inflation and M2 money supply.	There is a negative correlation, but it is caused by real activities and by short-term monetary policy.
Gyourko & Linneman (1988)	Owner Occupied Homes, Income-Producing properties, and REITs as Inflation Hedges: Empirical Findings	1973 - 1986	United States	Regression between expected inflation and common stock returns	Non-securitized residential and non-residential real estate is positively correlated, but REITs are negatively correlated.
Rubens, Bond & Webb (1989)	The inflation-hedging effectiveness of real estate.	1960 - 1986	United States	Regression between non-securitized properties.	There is a positive correlation between inflation and non-securitized real estate.
Larsen & Mcqueen (1996)	REITs, Real Estate and Inflation: Lesson from the gold market	1972 - 1992	United States	Regression between expected inflation and REITs returns.	There is a negative relationship between REIT returns and inflation, just as there is between gold returns and inflation in the short run.
Lui, Hartzell and Hoesli (1997)	International evidence on real estate securities as an inflation hedge	1972 - 1995	United States	Johansson Cointegration Test between CPI and REIT	No evidence that there was a positive association in the short term. In the long term, there was a little bit of evidence.
Luintel & Paudyal (2006)	Are common stocks a hedge against inflation?	1955 - 2002	United Kingdom	Viewing price elasticity over a period of time.	A positive relationship between commodity prices and common stock.
Hoesli, Lizierie and MacGregor (2008)	The Inflation Hedging Characteristics of US and UK Investments: A Multi-Factor Error Correction Approach.		The United States & United Kingdom	A Multi-Factor Error Correction Approach between (Un)expected inflation, REIT returns, M2 money supply and Industrial Production Index.	At the time the M2 money supply and the Industrial Production Index are added, there is a positive relationship between expected inflation and REIT returns.

Empire

Based on the literature researched, six hypotheses were formulated, which will be tested on European data. The first step will be to look at the relationship between REIT returns and nominal inflation (real inflation plus expected inflation). According to empirical research, this relationship is negative since this is also true for common stock. Two hypotheses can be formulated to test this assumption.

Hypothesis 1:

Nominal inflation has a negative relationship with REIT return in the short term

Hypothesis 2:

Nominal inflation has a negative relationship with common stock returns in the short term. REIT returns behave, therefore, like common stocks in the short term

Further research indicates that especially the effect of expected inflation is reflected in the Returns of REITs in the short term (Fama and Schwert , 1993). This relationship is considered negative. Moreover, research also indicates that this is also true for common stock. The following two hypotheses can be formulated:

Hypothesis 3:

Expected inflation has a negative relationship with REIT returns in the short term

Hypothesis 4:

Expected inflation has a negative relationship with common stock returns in the short term

Research shows that this relationship is not causal but could also be caused by other macroeconomic variables. As a consequence, control variables will need to be added to check for an omitted variable bias. As mentioned earlier, Geske and Roll (1983) concluded that this could be checked by monetary policy and real activities. In later studies, Lee et al. (2011) used proxies for these two changes. They used the M2 money supply for monetary changes and the industrial production index for real activities. Hoesli et al. (2008) also used these proxies to look at the long-term relationship between expected inflation and REIT returns in the UK and the US. They found a positive relationship.

Hypothesis 5:

There is a positive relationship between expected inflation and REIT returns in the long term

Hoesli et al. (2008) also investigated this same relationship, but with common stock returns. They concluded that this relationship would be the same. However, these may be different underlying assets. In addition, Boudoukh and Richardson (1993) investigated the long-term relationship between expected

inflation and common stock returns, and they concluded that it is positive. Thus, the final hypothesis is formulated as:

Hypothesis 6:

There is a positive relationship between expected inflation and common stock returns in the long term

Chapter 3: Data

It is important for a study to choose the right dataset. The dataset must be reliable and representative. Therefore, this chapter will discuss how the data was chosen and how it was prepared. All data used will be explained based on content and characteristics. To test the research question and to test the different hypotheses, different data is needed.

FTSE EPRA REIT Total Developed Europe Index

To test both the research question and the six hypotheses, we need data on the monthly returns of real estate stocks in Europe. The data can be found in Bloomberg since 1990. It is important to note that it must be the total return (TR). The high dividends caused by strict regulations must be taken into account.

Actual inflation

The second is the so-called Consumer Price Index. This will be used to calculate both the actual inflation and the (un)expected inflation. In the Eurozone, this is called the Harmonized Indices of Consumer Price Index (HICP). The HICP is the change over time in the prices of consumer goods and services bought by European households. The change in HICP is used for the actual inflation. The Eurozone was chosen because the EPRA REIT Index tracks REITs across all of Europe. The term Harmonized is used because all countries use the same method to calculate the HICP. When different methods are used, it is not possible to compare them. The HICP is published by Eurostat. For this survey, monthly data was obtained from the European Commission database and the data is available from January 1990 onwards.

(Un)expected inflation

The HICP is again used to determine both expected and unexpected inflation. This is because unexpected inflation is the difference between actual inflation and expected inflation (Hartzell et al. 1997). The unexpected inflation can be calculated by the use of the following formula:

$$UI_t = I_t - EI_t \quad (1)$$

Where,

$UI_t = Unexpected\ inflation\ at\ time\ t$

$I_t = Actual\ inflation\ at\ time\ t$

$EI_t = Expected\ inflation\ at\ time\ t$

The expected inflation rate will be determined by a Box Jenkings Arima model. Once the expected inflation is known, the unexpected inflation can be easily calculated using the formula above. This will be further explained in the *Method* section.

MSCI Europe

To test hypotheses 2, 4 and 6, MSCI Europe monthly Net Returns will be used. These are available from 1986 onwards. Data from 1990 is used to align the data set. The data was obtained from DataStream.

M3 Money Supply and Industrial Production Index

To better understand the effect of inflation on real estate returns, control variables are needed. Fama (1981) and Darrat and Glascock (1989) conducted research on what other factors affect stock returns. They concluded that these factors are the change in monetary policy and the change in real output. To better understand the relationship between expected and unexpected inflation and REIT returns, they will be added to our model. For this research, the M3 money supply from the ECB database will be used as a proxy for monetary policy. The M3 money supply is used for the calculation of the velocity of money in Europe. For real output, the Industrial Production Index, again from the ECB database, will be used.

Table 2: Variables and their sources

Contents	Sources	Period
REIT Total Return Index	Bloomberg	1990 - 2022
Harmonized Consumer Price Index Europe	Database ECB	1990 - 2022
M3 Money Supply Index	Database ECB	1990 - 2022
Industrial Production Index	Database ECB	1990 - 2022
MSCI Europe Index	Bloomberg	1990 - 2022

Descriptive Table

Table 3 shows the descriptive statistics. First, the table shows the mean for each variable. What stands out is that the Harmonized Consumer Price Index Europe has a mean of 1.925%. This is in line with the ECB's aim to keep inflation below 2%. We see that the expected inflation is mostly positive, but the mean and median are both lower than the Harmonized Consumer Price Index The difference between these two is the unexpected inflation. The median is negative, but the mean is positive. Outliers only affect the mean, so there are positive outliers. The outliers can be explained by high unexpected high inflation now with COVID and the Russian war as a reason. The MSCI Europe index applies some negative outliers in the returns. In addition, the median, standard deviation, maximum, minimum, kurtosis, and skewness are shown in respective order.

Table 3: Descriptive statistics

Content	Mean	Median	Std Dev	Max	Min	Kurtosis	Skewness
REIT Total Return Index	0.573%	0.737%	4.543%	20.069%	-21.503%	3.559	-0.485
Harmonized Consumer Price Index Europe	1.925%	2.016%	1.066%	4.988%	-0.620%	-0.016	0.033
Unexpected Inflation	0.001%	-0.003%	0.232%	1.823%	-0.636%	11.322	1.542
Expected Inflation	1.924%	1.987%	1.038%	5.038%	-0.695%	0.071	-0.013
M2 Money Supply Index	5.700%	5.400%	2.698%	12.600%	-0.400%	-0.262	0.116
Industrial Production Index	0.110%	0.113%	1.804%	13.904%	-18.960%	47.611	-2.142
MSCI Europe Index	0.802%	1.501%	4.419%	14.471%	-14.187%	0.985	-0.527

Chapter 4: Method

This section will explain how we will test each hypothesis. First is the relationship between nominal inflation and REIT returns, then we will look at the relationship between expected and unexpected inflation with REIT returns and after that, we will check for the long-term relationship between expected and unexpected inflation with REIT returns. We will also add control variables to control more for omitted variable bias.

For all these three hypotheses, a comparison will also be made with common stocks. This will be done by running the regression with common stocks as well.

Hypothesis 1

The first hypothesis was formulated as follows:

Nominal inflation has a negative relationship with REIT return in the short term

The regression of this test is relatively easy because inflation is the independent variable, and real estate returns are the dependent variable. The regression is, therefore, the following:

$$R_t = a + \beta \Pi_t + \varepsilon_t \ (2)$$

Where,

$R_t = nominal\ real\ estate\ returns\ during\ period\ t$

$\Pi_t = actual\ inflation\ during\ period\ t$

ε_t = error term

Equation 2 will be tested using an OLS regression. If it is the residuals are heteroskedastic, then White's standard errors will be used. When the bèta is a negative number that is also significant, then there is a negative relationship. As we test $B < 0$, the test leads to a one-sided t-test.

Hypothesis 2

The second hypothesis was formulated as follows:

Nominal inflation has a negative relationship with common stock returns in the short term. REIT returns behave, therefore, like common stocks in the short term

The regression of this hypothesis is the same as that of hypothesis 2. Instead of real estate returns as the dependent variable, the MSCI Europe Index returns are now used. Once again, we will test for heteroskedastic residuals. When this is the case, White's standard errors will be used. A significant negative bèta also means a negative relationship. So again, we want the beta to be negative ($B < 0$). Therefore, the test will be a one-sided t-test.

Hypothesis 3

The third hypothesis was formulated as follows:

Expected inflation has a negative relationship with REIT returns in the short term

Before the regression can be carried out, the expected inflation rate has to be determined. This will be done using a Seasonal ARIMA model, just as Meyler and Kenny (1998) did when they wanted to determine Irish inflation. They also did this using the Harmonized Index of Consumer Prices (HICP).

A Seasonal ARIMA model is a combination of an Auto-Regressive and a Moving Average model. This means that it expresses the current values of a time series in terms of the historical values themselves (Auto-Regressive) and also in terms of the historical values of the error term (Moving Average). The I stands for integrated. This represents the number of times the time series must be differenced before it is stationary. All the data used for the regressions is monthly.

An ARIMA model is expressed as follows:

ARIMA $(p,d,q)\,(P,D,Q)_m$
Whereby,
$p = the\ order\ of\ the\ AR\ term$
$d = the\ number\ of\ differencing\ required\ to\ make\ time - series\ stationary$
$q = the\ order\ of\ the\ MA\ term$
$P = the\ order\ of\ the\ Seasonal\ AR\ term$
$D = the\ number\ of\ differencing\ required\ to\ make\ the\ Seasonal\ time\ series\ stationary$
$Q = the\ order\ of\ the\ Seasonal\ MA\ term$
$m = number\ of\ observations\ per\ year$

Determining the appropriate ARIMA model will be done using the Box-Jenkins method (Box and Jenkins (1976). This method consists of three steps:

1. Identification: First, we are going to look at the normal and partial autocorrelation correlograms to pick out the most logical ARIMA models.
2. Estimation: Then, using Akaike's information criterion (AIC) and the Bayesian criterion (BIC), the most logical models will be used to determine which model is the best. The lower these criteria are, the better the model.
3. Diagnostic checking: Finally, it is important to look at the residuals. These must be White noise. White noise means that they are random. This can be tested by the White Noise test.

The model that comes out best at the end of these three steps is the model used for this study. The residuals and the model that comes out of this are the unexpected and expected inflation, respectively. Next, of course, we need to test the hypothesis. We are going to test this hypothesis using the Fama and Schwert (1977) model. This model is based on Fisher's hypothesis. We have seen this equation before in calculating expected and unexpected inflation. Accordingly, the model looks like this:

$$R_t = \alpha + \beta EI_t + \gamma UI_t + \varepsilon_t \quad (4)$$

Where,

$R_t = nominal\ real\ estate\ returns\ during\ period\ t$

$\mathrm{EI}_t = expected\ inflation\ during\ period\ t$

$UI_t =$ unexpected inflation during period t

ε_t = error term

Testing will be done for heteroscedastic residuals. When there is, White's standard errors will be used. A significant negative bèta indicates a negative correlation (B < 0). We use a one-sided t-test to test the negative beta.

Hypothesis 4

The fourth hypothesis was formulated as follows:

Expected inflation has a negative relationship with common stock returns in the short term.

To test this hypothesis, formula 4 of Fama and Schwert (1977) is needed from hypothesis 3. The only difference is that in place of nominal real estate returns, the nominal common stock returns are used as the dependent variable. For expected and unexpected inflation, the same Seasonal ARIMA model is used as in Hypothesis 3. Again, we are interested in a negative beta. To test that, we do a one-sided t-test.

Hypothesis 5

The firth hypothesis was formulated as follows:

There is a positive relationship between expected inflation and REIT returns in the long term

To indicate the long-term macroeconomic relationship, we will use a Dynamic Ordinary Least Squared regression (DOLS regression) like Lee and Lee (2014). This model was created by Stock and Watson (1993). First, we need to test for unit root. This will be done with an Augmented Dicky-Fuller test. The moment there is non-stationarity, the firs-difference will have to be tested. It is expected that it will be stationary. When all variables are I(1), then cointegration testing should be done using a Johansson test. This is because the DOLS regression is only possible if there is I(1) and cointegration.

This regression looks as follows:

$$\ln(R_t) = \alpha + \beta_1 \ln(EI_t) + \beta_2 \ln(UEI_t) + \beta_3 \ln(M3_t) + \beta_4 \ln(IP_t) + \sum_{k=-p}^{p} \gamma_{1k} \Delta \ln(EI_{t+k}) + \sum_{k=-p}^{p} \gamma_{2k} \Delta \ln(EUI_{t+k}) + \sum_{k=-p}^{p} \gamma_{3k} \Delta \ln(M3_{t+k}) + \sum_{k=-p}^{p} \gamma_{4k} \Delta \ln(IP_{t+k}) \quad (5)$$

Whereby:

$R_t = nominal\ real\ estate\ returns\ during\ period\ t$

$EI_t = expected\ inflation\ during\ period\ t$

$UI_t =$ unexpected inflation during period t

$M3_t = M3\ money\ supply\ period\ t$

$IP_t =$ Industrial production index during period t

$\varepsilon_t \quad =$ error term

The lags and leads will be determined by Akaike's information criterion (AIC) and the Bayesian criterion (BIC). The combination with the lowest criteria is the best. The various parameters will have to reveal what relationships are in place, but we are the most interested in the beta. The hypothesis gives a positive relationship between expected inflation and REIT returns. Therefore, we test $\beta_1 > 0$ by using a one-sided t-test.

Hypothesis 6

The sixth hypothesis was formulated as follows:

There is a positive relationship between expected inflation and common stock returns in the long term

To test this hypothesis, a DOLS regression in the form of equation 5 will again be used. The dependent variable REIT returns will be exchanged for the common stock returns. Furthermore, unit root should again be tested, and if necessary, the first difference should be taken. We will test if $\beta_1 > 0$ by using a one-sided t-test.

Chapter 5: Results

The chapter will describe the results of the studies for each hypothesis. First, the results of the regression between nominal inflation and REIT returns will be discussed and compared with the regression between nominal inflation and MSCI Europe Index returns. Next, inflation will be split into expected and unexpected inflation. An OLS regression will again take place and will be discussed and compared with the regression between expected and unexpected inflation with MSCI Europe Index returns. Then the results of the DOLS regression will be discussed, initially with the REIT returns and then also with the MSCI Europe Index.

Hypothesis 1

The first hypothesis was formulated as follows:

Nominal inflation has a negative relationship with REIT return in the short term

To test this hypothesis, an OLS regression is executed between the variable nominal inflation and REIT returns. The results are shown in Table 4.

Table 4: Result of the relationship between REIT returns and Nominal Inflation

Parameter	Estimated Value	Standard Error	T-statistic
$R_t = a + \beta\Pi_t + \varepsilon_t$			
a	0.019	0.005	4.026***
$Nominal\ inflation$	-0.707	0.218	-3.238***
Adjusted R^2 = 0.025	N = 388	Std. Error = White	F-statistic = 5,19

*Note: * Significant at 10% level. ** Significant at 5% level. *** Significant at 1% level.*

There is a clear negative significant relationship between nominal inflation and REIT returns. This agrees with empirical research (Larsen and Mcqueen, 1995). The F-statistic is bigger than all the T-statistics, so the parameters are jointly significant.

Hypothesis 2

The second hypothesis was formulated as follows:

Nominal inflation has a negative relationship with common stock returns in the short term. REIT returns behave, therefore, like common stocks in the short term

To test this hypothesis, an OLS regression is executed between the variable nominal inflation and MSCI Europe Index returns. The results are shown in Table 5.

Table 5: Result of the relationship between MSCI Europe Index returns and nominal inflation

Parameter	Estimated Value	Standard Error	T-statistic
$R_t = a + \beta\Pi_t + \varepsilon_t$			
a	0.014	0.004	4.114***
$Nominal\ inflation$	-0.781	0.233	-3.001***
Adjusted R^2 = 0.022	N = 388	Std. Error = White	F-statistic = 4,17

*Note: * Significant at 10% level. ** Significant at 5% level. *** Significant at 1% level.*

This relationship, like hypothesis 2, is negative and significant. It may be even more negative, but that cannot be compared like that because they are different returns. This result is consistent with the findings of Nelson (1976) and Gultekin (1983). The results from hypotheses 1 and 2 are also consistent with the theory of Mengden and Hartzell (1986) that REITs behave like common stocks. They both are negatively correlated with nominal inflation in the short term. The F-statistic is bigger than all the T-statistics, so the parameters are jointly significant.

Hypothesis 3

The third hypothesis was formulated as follows:

Expected inflation has a negative relationship with REIT returns in the short term

To examine this hypothesis, it is necessary to be able to determine the expected inflation rate. As in chapter 4, the Box-Jenkins method through an ARIMA model was selected. The Augmented Dicky-Fueller test, as mentioned in chapter 4, should reveal whether there is a unit root. Both tests show that there is a random walk with no drift and no trend. Then the best 4 Seasonal-ARIMA models are created based on the normal and partial autocorrelation correlograms and shown in table 6.

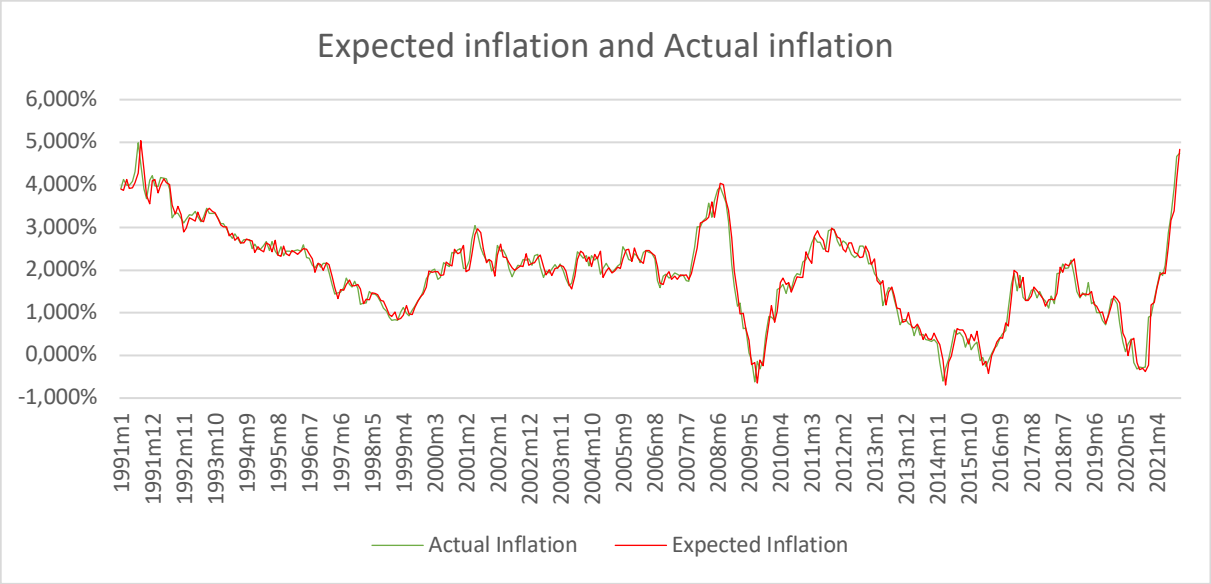
Table 6: Different ARIMA Models

Model	AIC	BIC	Significant	Residuals White Noise?
(2,1,1) (0,0,1) 12	-3508.91	**-3485.40**	**4/4**	Yes
(2,1,2) (0,0,1) 12	**-3510.56**	-3483.12	4/5	Yes
(2,1,2) (1,0,1) 12	-3508.75	-3481.32	3/5	Yes
(3,1,3) (1,0,1) 12	-3508.13	-3469.07	4/7	Yes

*Note: * Significant at 10% level. ** Significant at 5% level. *** Significant at 1% level*

The selected ARIMA model is (2,1,1) (0,0,1) 12 because it scores best on three of four points.

Figure 2: The expected and the actual inflation



Next, an OLS regression will be done, correcting for heteroskedasticity by using White's standard errors. The results of this regression are shown in Table 7. There is a significant negative relationship between expected inflation and REIT returns. This is consistent with the literature of Liu et al. (1997) and Fama and Schwert (1977). The relationship between unexpected inflation and REIT returns appears positive but is insignificant. This is consistent with the findings of Liu et al. (1997). They also found insignificant positive relationships.

Table 7: OLS regression between the REIT returns and unexpected/expected inflation

Parameter	Estimated Value	Standard Error	T-statistic
$R_t = \alpha + \beta EI_t + \gamma UI_t + \varepsilon_t$			
α	0.021	0.005	4.21***
$Expected\ inflation$	-0.775	0.224	-3.46***
$Unexpected\ inflation$	0.597	1.003	0.60
Adjusted R^2 = 0.032	N = 388	Std. Errors = White	F-statistic = 4.67

*Note: * Significant at 10% level. ** Significant at 5% level. *** Significant at 1% level.*

Hypothesis 4

The fourth hypothesis was formulated as follows:

Expected inflation has a negative relationship with common stock returns in the short term

To test this hypothesis, an OLS regression was executed just like hypothesis 3 but between expected and unexpected inflation with MSCI Europe Index returns. Heteroskedasticity is corrected by using White's standard errors. The results are as follows:

Table 8: OLS regression between the MSCI Europe Index returns and unexpected/expected inflation

Parameter	Estimated Value	Standard Error	T-statistic
$R_t = \alpha + \beta EI_t + \gamma UI_t + \varepsilon_t$			
α	0.014	0.004	4.11***
$Expected\ inflation$	-0.814	0.250	-3.31***
$Unexpected\ inflation$	0.440	1.21	0.55
Adjusted R^2 = 0.029	N = 388	Std. Errors = White	F-statistic = 4.37

*Note: * Significant at 10% level. ** Significant at 5% level. *** Significant at 1% level.*

There is a significant negative relationship between expected inflation and MSCI Europe Index returns. Also, unexpected inflation has an insignificant positive relationship with MSCI Europe index returns, just like hypothesis 3. This is consistent with the findings of Fama and Schwert (1977), who also found a negative relationship with expected inflation. The F-statistic is bigger than all the T-statistics, so the parameters are jointly significant.

Hypothesis 5

The firth hypothesis was formulated as follows:

There is a positive relationship between expected inflation and REIT returns in the long term

$$\ln(R_t) = \alpha + \beta_1 \ln(EI_t) + \beta_2 \ln(UEI_t) + \beta_3 \ln(M2_t) + \beta_4 \ln(IP_t) + \sum_{k=-p}^{p} \gamma_{1k} \Delta \ln(EI_{t+k}) + \sum_{k=-p}^{p} \gamma_{2k} \Delta \ln(EUI_{t+k}) + \sum_{k=-p}^{p} \gamma_{3k} \Delta \ln(M2_{t+k}) + \sum_{k=-p}^{p} \gamma_{4k} \Delta \ln(IP_{t+k}) \quad (5)$$

Here again, is the formula to clarify Table 9.

Like Lee et al. (2012), the long-term macroeconomic relationship will be tested by dynamic ordinary least squared regression. According to expectations, all variables are non-stationary, and the first-difference is stationary. Through a Johansson Cointegration test, it turns out that there is cointegration between all variables. This is in line with expectations. There appears to be a long-term relationship

between the variables. The DOLS regression will prove this relationship. The result of this regression is shown in Table 9.

Table 9: DOLS-regression REIT-returns

Parameter	Estimated Value	Standard Error	T-statistic
Regression (x)			
α	136.586	8.050	17.06***
$Expected\ inflation$	1.563	0.224	6.98***
$Unexpected\ inflation$	-30.053	1.743	-17.25***
$M3\ money\ supply$	0.019	0.025	0.73
$Industrial\ Production$	4.620	0.424	10.90***
Adjusted R^2 = 0.945	N = 357	Std. Error = White	

*Note: * Significant at 10% level. ** Significant at 5% level. *** Significant at 1% level.*

There is a significant positive relationship between expected inflation and REIT returns. This is consistent with the theory of Hoesli et al. (2008). Furthermore, there is also a positive relationship between the M3 money supply (insignificant) and the Industrial Production Index (significant) on REIT returns. This shows increased returns when inflation is high not only because of that increased inflation but other factors play a role as well. In contrast, there is a negative relationship between unexpected inflation and REIT returns.

Hypothesis 6

The sixth hypothesis was formulated as follows:

There is a positive relationship between expected inflation and common stock returns in the long term

$$\ln(R_t) = \alpha + \beta_1 \ln(EI_t) + \beta_2 \ln(UEI_t) + \beta_3 \ln(M2_t) + \beta_4 \ln(IP_t) + \sum_{k=-p}^{p} \gamma_{1k} \Delta \ln(EI_{t+k}) + \sum_{k=-p}^{p} \gamma_{2k} \Delta \ln(EUI_{t+k}) + \sum_{k=-p}^{p} \gamma_{3k} \Delta \ln(M2_{t+k}) + \sum_{k=-p}^{p} \gamma_{4k} \Delta \ln(IP_{t+k}) \quad (5)$$

Here again, is the formula to clarify Table 10.

To test this hypothesis, the same steps were performed as for hypothesis 5. Testing is done for autocorrelation and for cointegration. This turns out to be both there, so the first difference must be used. The presence of cointegration means that there is a long-term relationship. Next, the DOLS regression is performed. The results are shown in Table 10.

Table 10: DOLS regression MSCI Europe Index

Parameter	Estimated Value	Standard Error	T-statistic
Regression (x)			
α	31,297	7,387	2,41***
$Expected\ inflation$	0,418	0,683	0,38
$Unexpected\ inflation$	-7,888	3,098	-2,43***
$M3\ money\ supply$	-0,224	0,096	-1,77
$Industrial\ Production$	2,680	0,917	2,40***
Adjusted R^2 = 0.841	N = 357	Std. Error = White	

*Note: * Significant at 10% level. ** Significant at 5% level. *** Significant at 1% level.*

The results show an admittedly insignificant positive relationship between common stock and expected inflation. Unexpected inflation and common stocks are negatively correlated. This relationship is significant. The M3 money supply is negatively insignificant and the Industrial Production Index is positively significant. This is consistent with expectations, but there is no significance in two cases.

Robustness test

To test whether the results change if one parameter is changed, we use different parameters instead of the control variables. For the M3 money supply, the M2 money supply will be used. For the Industrial Production Index, the Grow Domestic Product per capita will be used. Tables 12 and 13 in the Appendix show the results. The parameters do not change if the control variable M2 money supply is used. M2 is significant unlike M3. However, if the GDP per capita is used instead of the Industrial Production Index change. The parameter of expected inflation changes from positive to negative and the parameter of unexpected inflation changes from negative to positive. In that case, the long-term relationship between expected inflation and REIT returns is negative. The model is sensitive to parameter change and is not very robust.

Chapter 6: Conclusion

This thesis examined the relationship between expected inflation and short- and long-term REIT returns. It also looked at possible other variables that affect REIT returns. For example, monetary policy and real activities were examined. Proxies were used for this purpose; these are the M3 money supply and the Industrial Production Index, respectively. Thus, the question that was central to this thesis was:

What is the relationship between expected inflation and Real Estate Investment Trust (REITs) returns in Europe?

To answer this question, there are six hypotheses formulated. The first two are centered around the relationship between nominal inflation and REIT returns and nominal inflation and MSCI Europe Index returns. For this, an Ordinary Least Squared (OLS) regression was used. From both of these regressions, a significant negative relationship was found. This is not consistent with Fischer's (1930) theory but was consistent with later theories.

The third and fourth hypotheses dealt with the relationship between expected inflation and REIT returns and expected inflation and the MSCI Europe Index. Expected inflation was determined using an ARIMA (2,1,1) (0,0,1) 12 model. The residual of this model would then be the unexpected inflation. Next, an OLS regression was performed using the Fama and Schwert (1977) formula. In both regressions, a significant negative relationship with expected inflation was found. The unexpected inflation is insignificantly positive in both cases.

A slightly more complicated regression was used long run for the fifth and sixth hypotheses. This was to determine the long-term relationship between expected inflation and REIT returns and expected inflation and MSCI Europe Index returns. The regression used for this is called the Dynamic Ordinary Least Squared regression. The M3 money supply index and the Industrial Production Index were added as control variables. This regression revealed that in the long-term, there is a slight positive significant relationship between expected inflation and REIT returns. In contrast, unexpected inflation is negative and significant. This is consistent with the theory. The MSCI Europe index had an insignificant positive relationship with expected inflation in the long term, and with unexpected inflation, it is negative and significant. The robustness test showed the non-robustness of the DOLS model.
In conclusion, a negative relationship between Real Estate Investment Trust returns and expected inflation in the short term was found, but a positive relationship in the long term.

Limitations

One of the most important things that could be improved is the use of the correct Harmonized Index for Consumer Prices. In this thesis, the general European index is used, but it would be better to calculate the correct weighting using the FTSE REIT Index Developed Europe, resulting in a similar weighting of the HICP as of the FTSE Index. This might explain the insignificance of some results.
Furthermore, it might be interesting to be able to compare REIT returns by sector. FTSE publishes these by sector, but they are not available from the university due to high purchase prices.

Table 11: Conclusions summed up

Hypothesis:	Conclusion
Nominal inflation has a negative relationship with REIT return in the short term	Accepted
Nominal inflation has a negative relationship with common stock returns in the short term. REIT returns behave, th erefore, like common stocks in the short term	Accepted
Expected inflation has a negative relationship with REIT returns in the short term	Accepted
Expected inflation has a negative relationship with REIT returns in the short term	Accepted
There is a positive relationship between expected inflation and REIT returns in the long term	Accepted (but not robust)
There is a positive relationship between expected inflation and common stock	Accepted (but not robust)

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Appendix

Table 12: Dynamic Ordinary Least Squared regression with GDP instead of Industrial Production Index as a control variable

Method: Dynamic Least Squares (DOLS)
Date: 08/05/22 Time: 12:43
Sample (adjusted): 2 360
Included observations: 359 after adjustments
Cointegrating equation deterministics: C
Automatic leads and lags specification (lead=12 and lag=0 based on SIC criterion, max=16)
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UNEXP_INF	47,455	4,514	10,514	0,000
EXP_INF	-13,464	1,757	-7,665	0,000
GDP	20,881	1,693	12,331	0,000
M2	0,537	0,028	19,154	0,000
C	-224,597	21,083	-10,653	0,000

R-squared	0.967720	Mean dependent var	5.212.912
Adjusted R-squared	0.961735	SD dependent var	0.634338
SE of regression	0.124086	Sum squared resid	4.650.018

Table 13: Dynamic Ordinary Least Squared regression with M2 instead of M3 as a control variable

Dependent Variable: REIT
Method: Dynamic Least Squares (DOLS)
Date: 08/05/22 Time: 12:39
Sample (adjusted): 8 364
Included observations: 357 after adjustments
Cointegrating equation deterministics: C
Automatic leads and lags specification (lead=8 and lag=6 based on SIC criterion, max=16)
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UNEXP_INF	-14,055	16,692	-8.419.941,000	0,000
EXP_INF	2,775	0,239	11,605	0,000
IP	1,899	0,418	4,549	0,000
M2	0,253	0,038	6,710	0,000
C	63,043	7,682	8,207	0,000

R-squared	0.955481	Mean dependent var	5.233.918
Adjusted R-squared	0.945723	SD dependent var	0.639253
SE of regression	0.148929	Sum squared resid	6.476.508