Are REITs in Singapore and Hong Kong Being Inflation Hedging?

An empirical analysis of the relationship between REIT returns and inflation

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Abstract

This paper examines the relationship between real estate investment trust (REIT) returns and inflation in Singapore and Hong Kong between 2002 to 2021. The purpose is to investigate whether REITs can hedge against inflation. The inflation will be divided into expected inflation (EI) and unexpected inflation (UI). Furthermore, the empirical analysis will test the relationship between REIT price return (PI), dividend yield return (DY), and total return (TR) returns and inflation separately and attempt to find out what could be the possible sources of hedging against inflation. The Fama and Schwert (1977) model was applied to analyze the relationship between REIT returns and inflation. The ARIMA model (Baciu, 2015) was applied to measure the expected inflation. Regression results show that the Singapore REIT price returns and total returns positively correlated with unexpected inflation, while the dividend yield returns are negatively correlated with unexpected inflation. However, the Hong Kong REIT price and total returns negatively correlate with expected inflation. This research will provide knowledge about the inflation-hedging characteristics of Singapore and Hong Kong REITs and implications for portfolio management and inflation risk management.
Sammanfattning

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List of acronyms and abbreviations

REIT: real estate investment trust
ARIMA: autoregressive integrated moving average model
EI: expected inflation
UI: unexpected inflation
AI: actual inflation
TR: total return
PR: price return
DY: dividend yield return
IPO: initial public offering
1 Introduction

1.1 Research background

1.1.1 High-inflation economic situation in the global market
The global economy is facing significant uncertainty and downward pressure because of the pandemic, which has prompted many developed countries to apply expansionary fiscal policies and quantitative easing monetary policies, leading to a historically high level of inflation. According to Fisher’s theory of interest, higher inflation requires a higher nominal return on investment if the actual return is constant (Keirstead and Fisher, 1955). In other words, the investors demand higher nominal returns in periods of high inflation if they want to retain a comparable purchasing power or real return (Glascock, Lu and So, 2002). That is why inflation is a significant determinant of investment return and a critical factor when making investment decisions.

The inflation rate will be crucial in deciding the investment return and portfolio management (Glascock, Lu and So, 2002). Furthermore, it becomes more and more attractive in today’s high-inflation economic situation. With the inflation rate increasing to a higher level in many developed economies these years, investors have become increasingly concerned about the potential impact of inflation on investment return.

1.1.2 Thriving REITs investment in the Asian market
By the end of 2020, there were 185 REITs in Asia, with a total market value of US$281.4 billion, a fall of nearly 5% year over year (Cushman & Wakefield, 2021). The REITs in Japan, Singapore and Hong Kong SAR are the focus of the Asian market, which weigh 90% of the total Asian market value (Cushman & Wakefield, 2021). Policymakers and REIT managers responded to the pandemic’s impact with various actions, including multi-level support activities to help REITs retain resilience in the aftermath of the pandemic.

2021 has been a banner year for Asia Pacific REITs in terms of listings and acquisitions. In the Asia Pacific, roughly 30 newly listed REITs raised over $12 billion in the capital, 11 of which were from China. This year, REIT IPOs are projected to be robust, with other industrial portfolios from emerging markets expected to be included in the offerings (Real Estate Asia, 2022).
This trend is projected to continue, with 2022 being another year to watch as the sector gains investor interest. The Asia Pacific Real Assets Association predicts that capital raised by REITs in the region could surpass $20 billion by 2022 as mood improves and more investors become familiar with the asset class. Cross-border acquisitions and REIT mergers and acquisitions (M&A) will also be busy in 2021 as well (Real Estate Asia, 2022).

1.1.3 Singapore and Hong Kong REITs and real estate market

In 2020, the Singapore REITs market was active. Consolidation and merger activity were expected, owing to regulatory rules, and transaction liquidity improved. There were 42 REITs in Singapore by the end of 2020, with a total market value of roughly $81.4 billion and a dividend yield of 6.4 percent (Cushman & Wakefield, 2021).

In 2020, the REITs market in Hong Kong SAR faced challenges and adopted reforms. Total REITs’ stock prices dragged down by 11% overall, depressed both by the impact of COVID-19 and an environment of continuing social instability. The average dividend yield was 6.3 percent, with the average gearing ratio was 28% which was lower than those in Singapore and Japan. (Cushman & Wakefield, 2021)

1.2 Research gap

1.2.1 Major studies about the relationship between asset returns and inflation focus on stock, bonds, and real estate.

Plenty of studies document the relationship between inflation and different types of asset returns, such as the stock, bond, and real estate. These studies proceeded to investigate the inflation-hedging abilities of assets.

Fama and Schwert’s study on different asset returns was one of the most remarkable research projects, including treasury bills, treasury bonds, common stock, and real estate. The results showed that real estate could provide a complete or partial hedge against expected and unexpected inflation. At the same time, the government debt was able to hedge against expected inflation but failed to provide hedging against unexpected inflation. However, the common stock was negatively correlated to inflation.
This collection of findings presents quite different hedging characteristics of various assets. Many researchers continued to examine the different hedging characteristics of these assets by investigating how they react to fluctuations in inflation.

1.2.2 Major studies relevant to REITs focus on developed markets outside Asia. However, most of these studies are focused on American and European markets and lack a close look at the increasingly Asian market. As the essential components of Asian REITs, Singapore and Hong Kong REITs have diversified portfolios on their property types and geographical locations, which are usually used as representatives of Asian REITs. The study on these REITs could have implications for other Asian REITs.

The major studies relevant to real estate investment trust were focused on the developed markets outside Asia. Therefore, this study will focus on Singapore and Hong Kong markets and cover the periods from 2006 to 2021.

1.3 Research purpose
This study investigates whether REITs can provide a hedge or perverse hedge to inflation. The inflation will be divided into expected inflation (EI) and unexpected inflation (UI). Furthermore, the empirical analysis will test the relationship between REIT price return (PI), dividend yield return (DY), and total return (TR) returns and inflation separately and attempt to find out what could be the possible sources of hedging to inflation. The Fama and Schwert (1977) model was applied to analyze the relationship between REIT returns and inflation. A time-series forecasting model, the ARIMA model (Baciu, 2015) was applied to measure the expected inflation. This research will provide knowledge about the inflation-hedging characteristics of Singapore and Hong Kong REITs and implications for portfolio management and inflation risk management.
1.4 Research questions

The investigation of the relationship between Singapore and Hong Kong REIT returns and inflation, or in other words, the inflation-hedging characteristics of Singapore and Hong Kong REITs can be translated into below research questions:

- How do REITs' price return, dividend yield return, and total return respond to expected and unexpected inflation?
- Whether the REIT returns positively or negatively correlated with inflation?

With the results of the analysis, the further research questions to be discussed will be:

- If REITs return hedging to inflation, what could be the possible source of the hedging to inflation?
- What is the possible explanation for these relationships?

The next section of this paper reviews the relevant literature on REITs' inflation-hedging characteristics and summarizes previous studies' significant findings. Section 3 describes methodology and data collection based on Fama and Schwert's methodology. Moreover, the empirical analysis result and discussion will be presented in section 4. The final section summarizes the major findings of this research and draws conclusions and suggestions.
2 Literature review

2.1 Asset return and inflation

2.1.1 What is inflation hedging
Greater inflation necessitates a higher nominal return if the real return remains constant. In other words, during periods of severe inflation, investors will want higher nominal returns to maintain the same level of real returns or purchasing power. According to this viewpoint, inflation is a significant predictor of asset returns and a critical factor when making investment decisions. (Glascock, Lu and So, 2002).

Inflation hedges are investments whose return patterns positively correlate with inflation, which can be included in an investment portfolio to manage the inflation risk. In contrast, the assets that negatively correlate with inflation are not inflation hedges and have higher inflation risk (e.g., stocks). The ability of an asset to minimize or balance the loss in buying power caused by inflation is used to determine its effectiveness as an inflation hedge (Charles, Glenn and Donna, 1991).

2.1.2 Asset return and inflation
Many prior studies have looked at the relationship between different types of assets’ return and inflation, including common stocks, bonds, and real estate, and discovered that these investments perform differently. These analyses are based on different geographical locations, time periods, economic cycles, etc.

Most of the studies concluded with a common conclusion on one type of asset. Like the common stocks’ returns are negatively correlated to actual inflation. On the contrary, direct real estate investment returns positively correlate to actual inflation. Besides, the observed relationship between asset returns and inflation has been explained by several hypotheses.

This set of results raises a fascinating question: how do common stock returns "backed" by real estate related assets react to inflation fluctuations? Do REIT returns act like stock returns in general (fail as hedges) or like the returns of the underlying assets (perform as complete hedges) (Park, Mullineaux and Chew, 1990)?
2.2 Stock return and inflation

2.2.1 Negative relationship
Besides Fama and Schwert’s study in 1977, a negative relationship between inflation and real stock returns from the US and other countries was is documented in many empirical analyses, contrary to the common view and the Fisher hypothesis (Bodie, 1976; Jaffe and Mandelker, 1976; Nelson and Schwert, 1977; Geske and Roll, 1983; Gultekin, 1983).

2.2.2 No significant link
The recent empirical study carried out by Fleischmann, Friz and Sebastian (2019) using an ARIMA model highlighted the view that there is no significant link between stock returns and inflation. (Fleischmann, Fritz and Sebastian, 2019). Their analysis was based on the stock and consumer price data in Japan and Hong Kong markets between 1986 and 2009.

2.2.3 Asymmetric relationship
According to several empirical studies, the conclusions on the relationship between stock returns and inflation are mixed (Gallagher and Taylor, 2002; Ang, Brière and Signori, 2012). Furthermore, several explanations for these potential asymmetric return-inflation relationships have been proposed (Alqaralleh, 2020). In other words, stock returns are expected to hedge against inflation differently in periods of inflation and deflation (Bahloul, Mroua and Naifar, 2017).

2.3 Unsecuritized real estate returns and inflation

2.3.1 Perfect or partial hedge against inflation
Many previous studies have examined the correlation between real estate investment return and inflation and unsecuritized real estate investment (direct or traditional) and securitized real estate investment (such as REIT) react differently to inflation. Most researchers have found that REITs have a perverse inflation hedge characteristic, or a negative connection between REITs and inflation (Gyourko and Linneman, 1988; Goebel and Kim, 1989; Titman and Warga, 1989; Park, Mullineaux and Chew, 1990; Liu, Hartzell and Hoesli, 1997). Direct real estate
investment, on the other hand, showed perfect or partial inflation hedging capabilities in various instances, i.e., a positive connection with inflation in various cases (Hoag, 1980; Brueggeman, Chen and Thibodeau, 1984; Miles and McCue, 1984; Sirmans and Sirmans, 1987; Gyourko and Linneman, 1988).

Real estate provides a better hedging ability than stocks in most previous research. Moreover, different types of real estate properties perform differently. It is generally believed that real estate at least has partial inflation hedging ability in the US and other developed countries (Fama and Schwert, 1977). As the cash flow and value are believed to increase as well as the inflation. The ability of government bonds, Treasury bills, private residential real estate, and equities to hedge against inflation was studied by Fama and Schwert (1977) from 1953 to 1971. They discover that private residential real estate is the only asset that can completely hedge both predicted and unexpected inflation. Government bonds and Treasury bills hedge against predicted inflation entirely, but stocks negatively correlate with inflation. Real estate returns are positively and significantly associated with actual and predicted inflation, according to Brueggeman, Chen, and Thibodeau (1984). They do not discover the same evidence in the case of unexpected inflation. From 1973 through 1983, Hartzell, Heckman, and Miles (1987) demonstrated that diversified commercial real estate portfolios provide a comprehensive hedge against predicted and unexpected inflation.

According to Gyourko and Linneman (1988), the total real estate markets in the United States do not provide a buffer against inflation. However, different property types produce contradictory outcomes. Residential real estate can hedge against inflation more than commercial and industrial property types. The ability to hedge against inflation might vary greatly depending on the sort of real estate possessed. Retail leases, for example, may include rent provisions based on a percentage of gross sales, implying that retail property revenues would likely move directly with the consumer price level. Office leases may allow for the "pass-through" of operating expenses, allowing increased expenses not to affect net revenues (Charles 1991). Rubens, Bond, and Webb (1989) discover that residential real estate is the only effective inflation hedge from 1960 to 1986 (Rubens, Bond and Webb, 1989). Commercial real estate acts as a hedge against expected but not unexpected inflation. Farmland and residential real estate are good inflation hedges but not against expected inflation.
Charles, Glenn, and Donna (1991) look at office and industrial properties from 1977 to 1989 and argue that institutions interested in long-term investments, such as pension funds and insurance companies, buy various assets to manage inflation risk and protect against the adverse effects of inflation. Office premises were an effective hedge against inflation during low inflationary periods, whereas industrial assets were an effective hedge during high inflationary years. Furthermore, vacancy rates are factored into the research. The findings confirm the assumption that real estate is ineffective as a hedge when commercial markets are uneven (i.e., dramatically rising vacancy rates). High inflation does not help an overbuilt market or a market with a high vacancy rate. According to Quan and Titman (1999), commercial real estate is an excellent long-term inflation hedge, but it is not an effective year-to-year hedge (Quan and Titman, 1999).

Newell (1996) researched Australian data and discovered that industrial, office and retail assets offer an excellent inflation hedge (Newell, 1996). Barber, Robertson, and Scott (1997) examine commercial property in the United Kingdom from 1967 to 1994 and find mixed results: real estate equities are a good hedge for predicted inflation, whereas real estate is a good hedge for unforeseen inflation (Barber, Robertson and Scott, 1997). Furthermore, they demonstrate that inflation is not a significant driver of property performance.

2.4 REIT returns and inflation

2.4.1 Perverse hedge against inflation

There is a general agreement in the literature that unsecuritized real estate can be used as an inflation hedge (Hoag, 1980; Brueggeman, Chen and Thibodeau, 1984; Miles and McCue, 1984; Hartzell, Hekman and Miles, 1987; Sirmans and Sirmans, 1987; Gyourko and Linneman, 1988). Real Estate Investment Trusts (REITs) are expected to be inflation hedges because their underlying assets are predominantly real estate. However, empirical evidence on REITs' ability to hedge inflation is mixed. Existing evidence implies that REIT returns are negatively correlated with inflation in general (Gyourko and Linneman, 1988; Goebel and Kim, 1989; Titman and Warga, 1989; Park, Mullineaux and Chew, 1990; Liu, Hartzell and Hoesli, 1997).
2.4.2 Mixed hedge against inflation
However, the REITs provided some hedging capability against expected inflation, but perverse hedging capability against unexpected inflation as per Yobaccio, Rubens, and Ketcham’s examination in 1995. They examined REITs' inflation-hedging ability for a more extended time period than previous studies, from February 1972 to December 1992 (Yobaccio, Rubens and Ketcham, 1995).

2.5 The interaction between REIT returns and monetary policy or real activities
2.5.1 Relationships are derived from the monetary policy or real activities.
Another finding by recent studies was that the inconsistent results of the relationship between REIT returns and inflation might be derived from the monetary policy or real activities (Darrat and Glascock, 1989; Glascock, Lu and So, 2002; Simpson, Ramchander and Webb, 2007).

By investigating the linkage between REIT returns, anticipated inflation, unanticipated inflation, and other macroeconomic variables, Glascock et al. found that neither anticipated nor unanticipated inflation affects REIT returns. They concluded that REIT returns do not act as inflation hedges. The link between monetary policy and inflation contributes to the negative association between REIT returns and inflation. In this regard, REITs, whose primary underlying assets are mainly real estate, do not deviate from the real estate industry (Glascock, Lu and So, 2002). However, REITs behaved more like common stocks and deviated from traditional real estate in inflation-hedging characteristics. This is consistent with Darrat and Glascock’s study (1989) on the importance of monetary policy in explaining the apparent perverse inflation outcomes for REITs.

Simpson, Ramchander and Webb (2007) extended Glascock’s study and documented a significant asymmetry in the response of equity REIT returns to inflation. When expected and unexpected inflation is divided into positive and negative changes, the results show that stock REIT returns improve due to both rises and drops in inflation. They believed that the observed negative link between REIT returns and inflation was due to monetary policy changes.
3 Theory and methodology

3.1 Theoretical framework

3.1.1 Fisher effect theory (Keirstead and Fisher, 1955)
Fisher proposed this economic theory to explain the relationship between nominal, real interest rates, and inflation. The Fisher effect equation stated that the nominal interest rate is equivalent to the real interest rate plus the expected inflation rate. In the Fisher equation, the nominal interest rate is the provided interest rate that reflects the monetary growth, while the real interest rate reflects purchasing power.

In Fisher’s model, if the market is efficient and rational, the expected nominal return of assets should be one to one correlated to the inflation rate:

\[ E(R_{it}^n \mid \varnothing_{t-1}) = E(R_{it}^n \mid \varnothing_{t-1}) + E(\pi_t \mid \varnothing_{t-1}) \]  
(1)

3.1.2 Asset returns and inflation (Fama and Schwert, 1977)
Based on Fisher’s theory, Fama and Schwert divide the inflation into anticipated and unanticipated components and examine their relationships with asset returns accordingly.

\[ R_{it}^n = \alpha_i + \beta_i \pi_t^e + \gamma_i [\pi_t - \pi_t^e] + \varepsilon_{it} \]  
(2)

By investigating the value of \( \beta_i \) and \( \gamma_i \), researchers would be able to tell if the asset is a hedge against each inflation component. According to Fisher’s model, all assets should have an expected inflation coefficient \( \beta_i = 1 \). However, the coefficient \( \gamma_i \) for unexpected inflation may be distinct for various assets.

Since the expected inflation is uncorrelated with the unexpected inflation, the \( \beta_i = 1 \) that the asset is a complete hedge against expected inflation. Similarly, the \( \gamma_i = 1 \) suggests that the asset is a perfect hedge against unexpected inflation. And only the \( \beta_i = \gamma_i = 1 \) indicates that the asset is a complete hedge against inflation. That is, the nominal return of the asset is perfectly correlated with both the expected and unexpected inflation.
3.1.3 The proxy effect hypothesis (Fama, 1981)
To explain the perverse relationship between stock return and inflation during the post-1953 period, Fama raised the proxy effect hypothesis to test the correlation between stock returns, real variables, and inflation. This study proved the strong relationship between inflation and real activities, and the strong relationship between stock returns and real activities. To put it another way, the odd link between stock returns and inflation may be a proxy for the positive association between stock returns and real variables, which are a more fundamental determinant of stock returns/equity values (Fama, 1981).

Firstly, Fama demonstrated the negatively and strongly correlation between inflation and real activities. Then, he documented that the real variables are the fundamental determinants influencing stock returns. Next, he investigated the connection between stock returns and real variables, as well as the relationship between stock returns and inflation. Finally, he combined the examination to reveal that inflation, and expected inflation are strongly related to real activities. At the same time, the real stock returns are also strongly related to real future activities.

In conclusion, the negative correlation between stock returns and inflation was derived from the negative relationship between stock returns and real activities, and the positive relationship between inflation and real activities, which is the proxying effect.

3.1.4 The asymmetric response of REIT return to inflation is derived from the monetary policies (Darrat and Glascock, 1989; Glascock, Lu and So, 2002; Simpson, Ramchander and Webb, 2007).
In recent studies, an asymmetric response of REIT return to inflation was found, and the possible explanation was proposed and examined.

Glascock, Lu, and So (2002) documented neither expected nor unexpected inflation signal REIT returns by examining the relationships between REIT returns, predicted inflation, unexpected inflation, and other macroeconomic variables. They found that REIT returns are not perverse inflation hedging instruments. The interplay between monetary policy and inflation partially explains the negative association between REIT returns and inflation. In this regard,
REITs, whose underlying assets are predominantly real assets, do not depart from the real estate industry.

Using a pooled estimating technique on an extensive data set encompassing 195 publicly traded equity REITs from 1981 to 2002, Simpson, Ramchander and Webb identified a significant asymmetry in the reaction of equity REIT returns to inflation. When expected and unexpected inflation are divided into positive and negative changes, the results reveal that stock REIT returns improve in reaction to inflationary increases and declines.

An asymmetry in the inflation response of equity REIT returns was revealed. This indicates that EREIT returns negatively correlate with inflation, but this is most prevalent when inflation is falling. Therefore, equity REIT returns increase when inflation increases and drop when inflation falls. The paradoxical outcome of prior research is a byproduct of their technique, implying symmetrical equity REIT return reactions to inflation.

Moreover, the evidence that survives a battery of robustness assessments depends partly on the current monetary policy environment. Equity REIT returns increase with both inflationary increases and declines during expansionary periods. The paradoxical relationship between inflation and equity REIT returns during periods of tight monetary policy cannot be adequately explained. In conclusion, the negative relationship between equity REIT returns and inflation results from asymmetry and market players' monetary policy expectations.

### 3.2 Methodology

#### 3.2.1 Fama and Schwert Methodology to examine the relationship between REITs returns and inflation

Fama and Schwert's Methodology is widely used to examine the relationship between asset return and inflation rate. It is used in plenty of empirical studies about REITs returns and their inflation-hedging characteristics. (Park, Mullineaux and Chew, 1990; Yobaccio, Rubens and Ketcham, 1995; Liu, Hartzell and Hoesli, 1997; Glascock, Lu and So, 2002; Bahram, Arjun and Kambiz, 2004; Simpson, Ramchander and Webb, 2007; Fleischmann, Fritz and Sebastian, 2019)
It is based on Fisher’s theory of interest, the nominal rate of interest \( I \) is equal to the expected real interest rate \( E(I) \) plus the expected inflation rate \( E(\pi) \). Fama and Schwert developed this model into risk-bearing investment (Fleischmann, Fritz and Sebastian, 2019):

\[
E(R_{i,t}^n \mid \varphi_{t-1}) = E(R_{i,t}^r \mid \varphi_{t-1}) + E(\pi_t \mid \varphi_{t-1})
\]  

(1)

Where:

\( E(R_{i,t}^n \mid \varphi_{t-1}) = the \ expected \ nominal \ investment \ return \ of \ periods \ t - 1 \ to \ t, \ given \ information \ in \ t - 1. \)

\( E(R_{i,t}^r \mid \varphi_{t-1}) = the \ expected \ real \ return \ on \ investment \ from \ periods \ t - 1 \ to \ t, \ given \ information \ in \ t - 1. \)

\( E(\pi_t \mid \varphi_{t-1}) = the \ expected \ change \ in \ consumer \ prices \ from \ periods \ t - 1 \ to \ t, \ given \ information \ in \ t - 1. \)

3.2.2 ARIMA model to forecast the expected inflation

To decompose the inflation into expected and unexpected components in the ex-post study, the expected inflation needed to be forecasted, and then the difference between expected inflation and actual inflation is the unexpected inflation.

For the methodology to measure the actual inflation, expected inflation (EI), and unexpected inflation (UI), three commonly used approaches to forecast estimated inflation are forecasting based on the treasury bill rate, the Livingston survey, and the ARIMA model. Furthermore, the actual inflation is measured by the consumer price index; thus, unexpected inflation is the difference between actual inflation and expected inflation.

\[
\text{Unexpected inflation} = \text{actual inflation} - \text{expected inflation}
\]

This empirical analysis measures the expected inflation by the ARIMA method (Baciu, 2015) over the sample period, a time series forecasting model that uses the past realized inflation rates to estimate the future inflation rate.
3.2.3 Methods in empirical analysis

Under the conditions of valid Fisher’s hypothesis and independent factors in the hypothesis, the effectiveness of any investment can be examined by the following empirical regression model (Fleischmann, Fritz and Sebastian, 2019):

Fama and Schwert’s Methodology is the most relevant to the aims of this study. The analysis based on the regression model and hypothesis developed by Fleischmann, Fritz and Sebastian is referred to in this research to analyze the relationship between REIT returns and inflation. (Fleischmann, Fritz and Sebastian, 2019)

\[ R_{i,t}^n = \alpha_i + \beta_i \pi_t^e + \gamma_i [\pi_t - \pi_t^e] + \varepsilon_{i,t} \]  

(2)

Where:

- \( R_{i,t}^n \) = the nominal return on the \( i^{th} \) asset from periods \( t-1 \) to \( t \).
- \( \pi_t^e \) = the rate of inflation expected from periods \( t-1 \) to \( t \).
- \( \pi_t \) = the realized rate of inflation from periods \( t-1 \) to \( t \).
- \( \pi_t - \pi_t^e \) = unexpected inflation from periods \( t-1 \) to \( t \).
- \( \varepsilon_{i,t} \) = error term, \( \varepsilon_{i,t} \sim WN(0, \sigma^2) \)

The parameters \( \alpha_i, \beta_i \) and \( \gamma_i \) will be estimated individually for each REITs return index, including the price return (PI), total return (TR) and dividend yield return (DY) indices separately, to figure out what could be the source of the possibly hedging to inflation.

Then, the estimated parameters will be tested against two hypotheses:

1) \( H_0: \beta_i = 0; H_1: \beta_i \neq 0 \)
2) \( H_0: \gamma_i = 0; H_1: \gamma_i \neq 0 \)
Table 1. classification of inflation hedge (Fleischmann, Fritz and Sebastian, 2019)

<table>
<thead>
<tr>
<th>Value of $\beta_i, \gamma_i$ parameters</th>
<th>$[-\infty; 0]$</th>
<th>0</th>
<th>$[0; 1]$</th>
<th>1</th>
<th>$[1; \infty]$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hedge classifications</td>
<td>Negative hedge</td>
<td>No hedge</td>
<td>Partial hedge</td>
<td>Perfect hedge</td>
<td>Over hedge</td>
</tr>
</tbody>
</table>

ARIMA model to forecast expected inflation:

$$\pi_t^e = c + \sum_{j=1}^{p} a_j \pi_{t-j} + \sum_{k=1}^{q} b_k \varepsilon_{t-k} \quad (3)$$

Data preparation:

$$R^n_{i,t} = 100\% \ast \left( \frac{P_{i,t} - P_{i,t-1}}{P_{i,t-1}} \right) \quad (4)$$

$$\pi_t = 100\% \ast \left( \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \right) \quad (5)$$

ARIMA steps (Baciu, 2015):

1) Data used: monthly CPI data series from January 2001 to December 2021 for the inflation rate in Singapore and Hong Kong separately.
2) The analysis of the series stationarity
3) Identification of the model’s type
4) Parameters estimation of the econometric model
5) Testing the validity of the ARIMA specification (3,0,3) for Singapore inflation forecasting and ARIMA specification (0,0,1) for Hong Kong inflation forecasting

Testing the validity of the ARIMA specification (Baciu, 2015):

1) Testing the hypothesis that the error average is zero
2) Testing the hypothesis of homoscedasticity
3) Testing the hypothesis of errors normality
4) Testing the autocorrelation errors
3.3 Data collection

The monthly data of the REIT returns and consumer price indices (CPI) are sourced from the Refinitiv DataStream. In this paper, these REIT total returns, price returns, and dividend returns indices are used as proxies for the returns of REITs and these CPIs are used as proxies for the rates of inflation in local markets. The currency of these indices is local dollars.

3.3.1 Data from the Singapore market:

**Table 2. Data from the Singapore market.**

<table>
<thead>
<tr>
<th>Contents</th>
<th>Sources</th>
<th>Sample period</th>
</tr>
</thead>
<tbody>
<tr>
<td>The rate of inflation</td>
<td>SP CPI NADJ</td>
<td>Refinitiv DataStream</td>
</tr>
<tr>
<td>Returns on REITs:</td>
<td></td>
<td>January 2006 to December 2021</td>
</tr>
<tr>
<td>FTSE W Singapore REIT Price Index</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FTSE W Singapore REIT Total Return Index</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FTSE W Singapore REIT Dividend Yield Index</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.3.2 Data from the Hong Kong market:

**Table 3. Data from the Hong Kong market.**

<table>
<thead>
<tr>
<th>Contents</th>
<th>Sources</th>
<th>Sample period</th>
</tr>
</thead>
<tbody>
<tr>
<td>The rate of inflation</td>
<td>HK CPI COMPOSITE NADJ</td>
<td>Refinitiv DataStream</td>
</tr>
<tr>
<td>Returns on REITs:</td>
<td></td>
<td>July 2006 to December 2021</td>
</tr>
<tr>
<td>FTSE Hong Kong REIT Price Index</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FTSE Hong Kong REIT Total Return Index</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FTSE Hong Kong REIT Dividend Yield Index</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.4 Analysis process

Step 1: Collect data and prepare.

Step 2: Run the ARIMA model to forecast the estimated inflation (EI), and calculate the unexpected inflation (UI) accordingly.

Step 3: Make the descriptive analysis and correlation analysis.

Step 4: Conduct the regression analysis.
4 Results and discussions

4.1 Major results

4.1.1 Singapore market

4.1.2 Inflation rates in Singapore

In recent twenty years, the inflation rates in Singapore changed dynamically between -0.53\% to 6.63\%. Singapore was going through an inflation period most of the time.

\textit{Figure 1: Inflation rates of Singapore from 2002 to 2021.}

\textit{Date Source: Refinitiv DataStream.}

4.1.3 Descriptive statistics and Correlation analysis for Singapore data

The statistics description and correlation of these variables are presented in Table 4 and Table 5. Table 4 shows the dividend yield returns have the highest standard deviation of 7.2346\%, followed by price and total returns. On the contrary, the standard deviations of expected and unexpected inflation are pretty low, at 0.3167\% and 0.4212\%, respectively.

Table 5 presents that all three types of Singapore REIT return significantly correlate to unexpected inflation. The price and total returns are significantly correlated to unexpected inflation at the 0.05 level, while the dividend yield returns are significantly correlated to
unexpected inflation at the 0.01 level. However, there is no significant correlation between Singapore REIT returns and expected inflation.

**Table 4: Monthly means and standard deviations for REITs returns and inflation rates in Singapore from January 2006 to December 2021.**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price return</td>
<td>0.3215%</td>
<td>5.7454%</td>
<td>195</td>
</tr>
<tr>
<td>Total return</td>
<td>0.7732%</td>
<td>5.7816%</td>
<td>195</td>
</tr>
<tr>
<td>Dividend yield return</td>
<td>0.1831%</td>
<td>7.2346%</td>
<td>195</td>
</tr>
<tr>
<td>Expected inflation</td>
<td>0.1296%</td>
<td>0.3167%</td>
<td>195</td>
</tr>
<tr>
<td>Unexpected inflation</td>
<td>0.0357%</td>
<td>0.4212%</td>
<td>195</td>
</tr>
</tbody>
</table>

**Table 5: Correlations between Monthly REITs returns and inflation rates in Singapore from January 2006 to December 2021.**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Expected inflation</th>
<th>Unexpected inflation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price return</td>
<td>Pearson correlation</td>
<td>-.052</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.472</td>
</tr>
<tr>
<td>Total return</td>
<td>Pearson correlation</td>
<td>-.030</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.673</td>
</tr>
<tr>
<td>Dividend yield return</td>
<td>Pearson correlation</td>
<td>.034</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.641</td>
</tr>
</tbody>
</table>

*Notes: **. Correlation is significant at the 0.01 level (2-tailed), *. Correlation is significant at the 0.05 level (2-tailed)*

4.1.4 Regression analysis for Singapore data

The regression results examining how the Singapore REIT responds to expected and unexpected inflations are shown in Tables 6 and 7. The estimated coefficient of unexpected inflation for price returns $y^P_S$ are 2.329. Similarly, the estimated coefficient of unexpected inflation for total returns $y^TR_S$ are 2.319. On the other hand, the estimated coefficient of unexpected inflation for dividend yield returns $y^DY_S$ are -3.495.
Table 6: The results of Fama and Schwert regression analysis for Singapore REITs

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>$\beta_i$</th>
<th>$\gamma_i$</th>
<th>ARIMA-model</th>
<th>Adj. $R^2$</th>
<th>DW-Stat.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price return</td>
<td>-.928</td>
<td>2.329*</td>
<td>(3, 0, 3)</td>
<td>.022</td>
<td>2.045</td>
</tr>
<tr>
<td>Dividend yield</td>
<td>.751</td>
<td>-3.495**</td>
<td>(3, 0, 3)</td>
<td>.032</td>
<td>1.966</td>
</tr>
<tr>
<td>Total return</td>
<td>-.544</td>
<td>2.314*</td>
<td>(3, 0, 3)</td>
<td>.019</td>
<td>2.054</td>
</tr>
</tbody>
</table>

Notes: **. Correlation is significant at the 0.01 level (2-tailed), *. Correlation is significant at the 0.05 level (2-tailed). Expected inflation is estimated by ARIMA (3, 0, 3) model.

Table 7: The results of Fama and Schwert regression analysis for Singapore REITs

<table>
<thead>
<tr>
<th>REITs return</th>
<th>Price return index</th>
<th>Dividend yield</th>
<th>Total return index</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Y_{it}$</td>
<td>$\gamma_{SPI} = 2.329$</td>
<td>$\gamma_{SDY} = -3.495$</td>
<td>$\gamma_{STR} = 2.314$</td>
</tr>
</tbody>
</table>

The two key results of the above Fama and Schwert regression model are:

- The Singapore REITs returns are correlated to unexpected inflation (UI).
- The Singapore REITs’ total return (TR) and price return (PI) are over hedges against unexpected inflation (UI). In contrast, the dividend yield return (DY) is a perverse hedge against unexpected inflation (UI).

4.1.5 Hong Kong market

4.1.6 Inflation rates in Hong Kong

Between 2002 to 2021, the inflation rates in Hong Kong had climbed from -3.05%, reached its highest level 5.28% in 2011, and gradually decreased in recent years. Hong Kong was also going through an inflation period during the sample period from 2006 to 2021.
4.1.7 Descriptive statistics and Correlation analysis for Hong Kong data

Table 8 describes the dividend yield returns of Hong Kong REITs with the highest standard deviation of 12.4855%, which is also higher than the dividend yield returns of Singapore REITs. Like the Singapore market, the standard deviations of price returns and total returns are 5.4895% and 5.5684%, respectively, which are very close. Moreover, the expected and unexpected inflation standard deviation in Hong Kong is 0.4997% and 0.8076%, respectively.

The significance of the correlation between Hong Kong REIT returns and inflation can be seen in Table 9. The price and total returns are significantly correlated to expected inflation at 0.05 level and 0.01 level respectively. However, there are no significant correlation between Hong Kong REIT returns and unexpected inflation can be observed.

Table 8: Monthly means and standard deviations for REITs returns and inflation rates in Hong Kong from August 2006 to December 2021.

<table>
<thead>
<tr>
<th>Data</th>
<th>Mean</th>
<th>Std. Dev</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price return</td>
<td>0.8714%</td>
<td>5.4895%</td>
<td>185</td>
</tr>
</tbody>
</table>
Total return 1.2377% 5.5684% 185
Dividend yield return 1.1485% 12.4855% 185
Expected inflation 0.1209% 0.4997% 185
Unexpected inflation 0.1058% 0.8076% 185

Table 9: Correlations between Monthly REITs returns and inflation rates in Hong Kong from August 2006 to December 2021.

<table>
<thead>
<tr>
<th>REIT returns</th>
<th>Expected inflation</th>
<th>Unexpected inflation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price return</td>
<td>Pearson correlation</td>
<td>-.187*</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.011</td>
</tr>
<tr>
<td>Total return</td>
<td>Pearson correlation</td>
<td>-.191**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.009</td>
</tr>
<tr>
<td>Dividend yield return</td>
<td>Pearson correlation</td>
<td>.059</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.426</td>
</tr>
</tbody>
</table>

Notes: **. Correlation is significant at the 0.01 level (2-tailed), *. Correlation is significant at the 0.05 level (2-tailed)

4.1.8 Regression analysis for Hong Kong data

Tables 10 and 11 present the Fama and Schwert regression results for Hong Kong REITs. The estimated coefficient of expected inflation for price returns $\beta_{HK}^{PL}$ is -2.030, while for total returns $\beta_{HK}^{TR}$ is -2.099.

Table 10: the results of Fama and Schwert regression analysis for Hong Kong REITs.

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>$\beta_i$</th>
<th>$\gamma_i$</th>
<th>ARIMA-model</th>
<th>Adj. $R^2$</th>
<th>DW-Stat.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price return</td>
<td>-2.030*</td>
<td>-.229</td>
<td>(0, 0, 1)</td>
<td>.025</td>
<td>2.103</td>
</tr>
<tr>
<td>Dividend yield return</td>
<td>1.421</td>
<td>.522</td>
<td>(0, 0, 1)</td>
<td>-.006</td>
<td>1.998</td>
</tr>
<tr>
<td>Total return</td>
<td>-2.099**</td>
<td>-.297</td>
<td>(0, 0, 1)</td>
<td>.028</td>
<td>2.118</td>
</tr>
</tbody>
</table>

Notes: **. Correlation is significant at the 0.01 level (2-tailed), *. Correlation is significant at the 0.05 level (2-tailed). Expected inflation is estimated by ARIMA (3, 0, 3) model.
Table 11: the results of Fama and Schwert regression analysis for Hong Kong REITs

<table>
<thead>
<tr>
<th>REITs return</th>
<th>Price return index</th>
<th>Total return index</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_i$</td>
<td>$\beta_{HK}^{PI} = -2.030$</td>
<td>$\beta_{HK}^{TR} = -2.099$</td>
</tr>
</tbody>
</table>

The two key results of the above Fama and Schwert regression model are:

- The Hong Kong REIT returns negatively correlate to the expected inflation (EI).
- The Hong Kong REITs total return (TR) and price return are perverse hedges to expected inflation (EI).

4.2 Discussions

This study analyses the historical REITs’ return for Singapore and Hong Kong markets over the period from 2006 to 2021 to examine whether REITs can provide a hedge against inflation. Refer to the hypothesis test and classification of inflation hedge in the above analysis, three highlights based on the results as below.

4.2.1 Singapore REITs' total returns and price returns over hedge against the unexpected inflation while the dividend yield returns perverse hedge to unexpected inflation.

For Singapore REITs, the estimated coefficients of total returns and price returns $\gamma_{S}^{TR}$ and $\gamma_{S}^{PI}$ are positive, while the estimated coefficient of dividend yield returns $\gamma_{S}^{DY}$ is negative. As per Table 1 about the classification of an inflation hedge, it seems that Singapore REITs' total returns and price returns over hedge against the unexpected inflation, but the dividend yield returns perverse hedge against inflation. And there is no significant link between the Singapore REIT returns and expected inflation.

4.2.2 The Hong Kong REITs total and price returns perverse hedge to expected inflation.

For Hong Kong REITs, the estimated coefficients of total returns and price returns $\beta_{HK}^{TR}$ and $\beta_{HK}^{PI}$ are negative. In other words, the Hong Kong REITs' price returns and total returns perverse hedge against expected inflation. And there is no significant interplay between the Hong Kong REIT returns and unexpected inflation.
4.2.3 The total returns and price returns of both Singapore and Hong Kong REITs signal inflation sensitively in contrast. The inflation hedge characteristics of Singapore and Hong Kong REITs appear to be quite different. The total and price returns are significantly correlated to inflation, but different components and contrary. Specifically, the Singapore REIT total and price returns positively correlated to unexpected inflation, while the Hong Kong REIT total and price returns negatively correlated to expected inflation. A possible implication is that the price appreciation of REITs may drive the response to inflation.

Referring to the previous empirical studies, the findings of the relationship between REIT returns and inflation is mixed. Hong Kong REITs' perverse inflation hedging characteristics are more common and align with plenty of research (Gyourko and Linneman, 1988; Goebel and Kim, 1989; Titman and Warga, 1989; Park, Mullineaux and Chew, 1990; Liu, Hartzell and Hoesli, 1997). However, Singapore REITs' inflation hedging characteristics are partially consistent with Yobaccio, Rubens and Ketcham’s examination in 1995.

Most REITs distribute more than 90% of taxable income to investors as a high-dividend investment. For those long-term investors who rely on sustainable income or want to hold a portfolio in the long run, it is important to know how the dividend yield returns of REITs perform against inflation. On the other hand, for the investors interested in the capital gain of REITs or how REITs perform over a period, it is essential to know how the total returns and price returns respond to inflation.

This research investigated the REIT price returns, dividend yield and total returns separately. Obviously, the price return and total return perform highly consistently in both Singapore and Hong Kong as the price return is the main component of total return. Nevertheless, in the Singapore case, the dividend yield returns a perverse hedge against unexpected inflation compared to price returns and total returns.
5 Conclusions and future work

5.1 Conclusions

The inflation-hedge characteristics of Singapore and Hong Kong REITs are mixed. Based on the empirical analysis of REIT total returns, price returns and dividend yield returns in response to expected and unexpected inflation, it can be concluded that:

1) Singapore REITs' total returns and price returns over hedge against the unexpected inflation while the dividend yield returns perverse hedge against unexpected inflation.

2) The Hong Kong REITs' total and price returns perverse hedge to expected inflation.

The price returns and total returns respond to inflation significantly. It may indicate that the price appreciation signals inflation more sensitively. Furthermore, price appreciation seems to be the source of the inflation-hedging ability.

Based on these conclusions, the inflation-hedging characteristics of Singapore and Hong Kong REITs are revealed. First of all, the dividend yield returns and price or total returns are hedged differently against inflation. Then REIT returns responded to different components of inflation. It implies that some of these REIT returns can be included in the portfolio to hedge against partial inflation. However, to manage the inflation risk in the big picture, the investment time horizon and which kind of REIT returns are more valuable must be considered.

5.2 Limitations

This research only focuses on the REIT returns (price, dividend yield, and total) and inflation (expected and unexpected) in general. In contrast, it might be important to include the equity components of REITs, monetary policies, and real economic activities as well. It would enable to discover why REIT returns react to inflation so differently in the same time periods in various markets. Which also helps to re-examine if the relationship between REIT returns and inflation is spurious.

Due to the small sample size of Hong Kong REITs and lacking available property-type REIT returns and equity components data, this analysis is limited to the relationship between REIT returns and inflation but fails to provide more possible explanation of their relationship.
5.3 Reflections and future work

The Fama and Schwert regression method examined the relationship between different REIT returns and inflation to investigate REITs’ inflation-hedging ability in this research. This research clearly documented how these REITs respond to expected and unexpected inflation and raised two questions. One is why the dividend yield returns performed in contrast to price or total returns. Another one is why REIT returns respond to the different components of inflation in different markets.

It is beyond the scope of this study to address these two questions. Besides monetary policies and business cycles, future research can also focus on whether equity component or property-type is the factor in the different relationship between REIT returns and inflation.
References


Appendix

Variable descriptions (Fleischmann, Fritz and Sebastian, 2019):

\( R_{n,t} \)  Nominal investment return of asset I in time t
\( R_{r,t} \)  Real investment return
\( R_{TB,t} \)  Return of US Treasury Bill, used as the constant real interest rate
\( \emptyset_t \)  Information on which expectations are based
\( \pi_t \)  Actual inflation rate
\( \pi_t^e \)  Expected inflation rate
\( \pi_t - \pi_t^e \)  Unexpected inflation rate
\( \alpha_i \)  Intercept of regression model
\( \beta_i \)  Regression coefficient, signals hedging effectiveness to expected inflation
\( \gamma_i \)  Regression coefficient, signals hedging effectiveness to unexpected inflation
\( \varepsilon_{i,t} \)  Residuals of the estimated model
\( a_j \)  Coefficient of AR components of ARIMA model
\( b_k \)  Coefficient of MA components of ARIMA model
\( P_{i,t} \)  Price of asset i in time t
\( CPI_t \)  Consumer Price Index in time t