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# The Inflation-Hedging Ability of Real estate Evidence in Thailand: 1987-2011

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**Abstract**

This study examines whether real estate in Thailand can hedge against ex post and ex ante inflation during the 1987-2011. To achieve this, we follow the Fama and Schwert (1977)'s framework. The study finds that real estate returns have positive relation with both ex post and unexpected inflation over the period, even though the statistical evidence does not strongly support this. Furthermore, after separating the time series into sub-periods to control for the possible structural changes in the economy, we find that the relationship between inflation and real estate returns change under various economic environments.


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***Key words: real estate returns; inflation; hedging; Thailand***

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## 1. Introduction

The aim of rational investors is not only to maximize returns but also to reduce investment risks. Among the risks facing investors, inflation has become one of the predominant concerns because it erodes real returns on their investment. These assets are called inflation hedges (Zhou and Clements, 2010). Particularly, when the erosion of purchasing power by inflation is partially or fully offset by the increase in the investment asset's return, this asset is said to hedge against inflation (Fang, Wang and Nguyen, 2008). On this account, inflation-hedging assets are more attractive than others. In his theory of the interest rate, Fisher (1930) posits that expected nominal interest rates should move on a one-for-one basis with expected inflation. This so-called Fisher hypothesis, generalized to other investment assets, implies that the expected nominal return on any investment asset should be equal to the expected inflation rate plus its expected real return, which is assumed to be independent from inflation (Fama and Schwert, 1977).

Property practitioners often claim that real estate can act as a hedge against inflation. Among alternative investment assets, real estate has historically been viewed as a good investment asset and a powerful inflation hedge. From an investment perspective, directly investing in real estate serves both the need for housing and the wish to protect wealth against inflation. In addition, the widely held notion that real estate investments offer security, people may buy real estate to protect their portfolios from currency crises, recession, and high inflation (Fang, Wang and Nguyen, 2008). Moreover, the benefits of including real estate in investment portfolios have been recognized by the financial literature (see e.g. MacGregor and Nanthakumaran (1992)). These advantages comprise of diversifying the portfolio, increasing the investment income, and protecting the investment value against inflation (Le Moigne and La, 2008). Therefore, understanding the real Thai estate market's characteristics such as its inflation-hedging ability may benefit not only domestic investors but also international institutional investors (Newell and Razali, 2009). Given the relatively limited empirical evidence about this characteristic of the Thai real estate market, this paper is a valuable contribution to the literature. In addition, we also investigate the inflation-hedging ability of Thailand real estate market under various economic and political environments in which the nature of real estate-inflation relationship may have changed.

The structure of this paper is as follows. Section 2 reviews the existing literature. Section 3 sets out a conceptual framework for inflation hedging. The methodology and data are considered in section 4. In section 5, the empirical findings are presented and analyzed. The final section concludes the study with a summary of the key findings.

## 2. Literature survey

Early research on the relationship between real estate and inflation focuses on the U.S. It uses ordinary least squares (OLS) to investigate the expected and unexpected inflation hedge of corporate bonds, government bonds, treasury bills, real estate returns, common stock returns and wages (e.g., Fama and Schwert (1977)). For real estate this paper finds significantly positive and close-to-unity coefficients during the period 1953-1971. Moreover, its results indicate that only residential real estate can provide a perfect hedge against both expected and unexpected inflation. These findings are also corroborated by other studies: for the U.S., e.g., Bond and Seiler (1998), Rubens, Bond and Webb (1989) and for other countries, e.g., Hong Kong (Ganesan and Chiang (1998)) or Canada (Le Moigne and La (2008), Newell (1995)). However, studies on the inflation-hedging capability of other types of real estate in different countries provide mixed results (Limmack and Ward, 1988; Miles, 1996). For example, Rubens et al.(1989) investigate the inflation hedging-ability of three types of real estate, i.e. residential, commercial and farmland. They find that only the residential real estate can provide a perfect hedge against inflation, while the commercial real estate can hedge against the expected inflation, but not for unexpected inflation. Given the aforementioned empirical findings, various property types may show different sensitivity to the inflation due to differences in their characteristics such as their components of returns. Furthermore, Ganesan and Chiang (1998) refer to fixed rents that are often set for a long period one reason to explain why in general real estate in Hong Kong is not a good hedge against inflation. Conversely, we can expect that its property value would reflect the increase in the general price level whenever rental agreements are renegotiated. Moreover, real estate's inflation-hedging capacity may not only vary across property types, but also due to fluctuating economic conditions (Tenigbade, 2011). Li (2001) finds that the significant relationship between Canadian real estate and inflation found in a high inflation period (1974-1982) disappears when in the low inflation period (1983-1994). Le Moigne and La (2008) attributes this to the Bank of Canada following a strict inflation targeting framework in which inflation rates are always kept at low levels.

## 3. Methodology

### *3.1. The Fisher hypothesis*

Fisher (1930) states that the expected nominal interest rate is equivalent to the sum of the expected real interest rate and the expected inflation rate, and also that the real and monetary sectors of the economy are largely independent. Therefore, the expected inflation should be fully reflected into the expected nominal interest rate. The theory is generalized to nominal returns on any asset, which should move one-for-one with expected inflation (Fama and Schwert, 1977). Formally, the proposition can be represented by

$$[1 + E_{t-1}(R_t)] = [1 + E_{t-1}(r_t)][1 + E_{t-1}(\pi_t)], \qquad (1)$$

where $E_{t-1}$ is the conditional expectation operator at time $t-1$; $R_t$ denotes the nominal return on an asset from time $t-1$ to $t$; $r_t$ is the appropriate equilibrium real return on the asset from time $t-1$ to $t$ and $\pi_t$ represents the inflation rate from time $t-1$ to $t$.

Equation (1) can be equivalently reformulated as

$$E_{t-1}(R_t) = E_{t-1}(r_t) + E_{t-1}(\pi_t) + E_{t-1}(r_t)E_{t-1}(\pi_t). \qquad (2)$$

In (2), the cross-product term $E_{t-1}(r_t)E_{t-1}(\pi_t)$ is usually negligible. Hence, the representation of (2) is routinely as

$$E_{t-1}(R_{it}) = E_{t-1}(r_{it}) + E_{t-1}(\pi_t). \qquad (3)$$

### *3.2. Empirical model*

We investigate the *ex post* relationship between the nominal asset return and inflation using the following regression:

$$R_t = \varphi + \omega\pi_t + \epsilon_t, \qquad (4)$$

where $\varphi$ and $\omega$ are coefficients and $\epsilon_t$ is the error term.
Following (Fama and Schwert, 1977), we also estimate the following *ex ante* model in the second step:

$$R_t = \alpha + \beta E_{t-1}(\pi_t) + \gamma UE_{t-1}(\pi_t) + n_t, \qquad (5)$$

where $n_t$ is the error term.

Since both explanatory variables are orthogonal, consistent estimates of $\beta$ and $\gamma$ can be obtained as long as expected inflation is observable. In equation (5), (Fama and Schwert, 1977) indicate three cases for the hedging potential of an asset:

(a) If $\beta = 1.0$, the asset is said to be *a complete hedge against expected inflation*:
(b) If $\gamma = 1.0$, the asset is *a complete hedge against unexpected inflation*.
(c) If $\beta = \gamma = 1.0$, the asset is considered as *a complete hedge against inflation*.

It should be noted that the approach by (Fama and Schwert, 1977) requires a suitable measurement for the expected and unexpected inflation rates. We use the ARIMA model (Box and Jenkins, 1970) to estimate the expected and unexpected inflation for this study. We estimate all regressions by OLS (Ordinary Least Squares), since our focus is to examine the short-run influence of inflation on the asset returns, and not the feedback from returns to inflation. We use the Newey-West corrected covariance matrix when computing the test statistics in order to account for heteroskedasticity and residual autocorrelation (Newey and West, 1987).

## 4. Data and summary statistics

The consumer price index (CPI) in Thailand is used as a proxy for actual inflation. We decompose actual inflation rate into two components; the expected inflation and unexpected inflation in order to give a better way to defining the hedge against inflation. We follow a number of previous studies, e.g., Fama and Schwert (1977), Cohn (1981) and Bodie (1976) and use quarterly data aggregated from monthly data to avoid the inherent technical issues of monthly CPI data. CPI is obtained from the DataStream. We consider two available housing indices, i.e. the index for single-detached houses with land and the index for town houses with land, as proxies for the Thai real estate market. Data of both indices are provided by Bank of Thailand. Additionally, single house and townhouse returns are defined as log changes.

## 5. Empirical results

### *5.1. Regression results*

Table 1 reports the summary statistics for both kinds of housing indices, single house and townhouse returns, as well as for inflation rates. Both kinds of real estate have a positive average return with a relatively high standard deviation over the sample period. Besides, the distribution of all variables can be characterized as negatively skewed and leptokurtic.The autocorrelation coefficients show a quick decay after the first lag for all variables (see Table 4 in appendix). The inflation rate series indicate a high autocorrelation coefficient at the fourth lag. Given these results, we use AR (4) to decompose the inflation rates into expected and unexpected inflation rates. The portmanteau test (Ljung and Box, 1978) fails to find any remaining significant residual serial correlation, indicating the correct specification of the filter.

**Table 1. Summary statistics**

The table reports the summary statistics for all variables. In the table, $R_{SH}$ is the return on single detached houses**;** $R_{TH}$ is the return on town houses with land; π is the inflation rate; E(π) is the expected inflation rate; UE(π) is the unexpected inflation. All returns over period t are calculated by log changes from time (t-1) to t. Inflation rates are computed as log changes in the Consumer Prices Index from time (t-1) to t. Expected and unexpected inflation rates are decomposed from the actual inflation rates by using an Autoregressive (AR) model, where expected inflation rates are the linear prediction of the AR model and unexpected inflation rates are its residuals. For quarterly inflation rates, $(\pi_t = 0.0068 + 0.2526\pi_{t-4})$.

| | Mean | Median | Min | Max | Std | Skewness | Kurtosis | N |
|---|---|---|---|---|---|---|---|---|
| $R_{SH}$ (%) | 0.40 | 0.75 | -23.26 | 19.94 | 4.51 | -4.49 | 32.23 | 75 |
| $R_{TH}$ (%) | 0.44 | 0.59 | -21.72 | 18.05 | 3.90 | -4.34 | 30.74 | 75 |
| π (%) | 0.91 | 0.90 | -4.13 | 4.98 | 1.16 | -0.46 | 7.04 | 100 |
| E(π) (%) | 0.91 | 0.90 | -0.37 | 1.93 | 0.30 | -0.46 | 7.01 | 96 |
| UE(π) (%) | 0.00 | 0.05 | -5.15 | 3.85 | 1.14 | -0.67 | 7.52 | 96 |

Table 2 (panel B) presents the regression coefficients of real estate returns on expected and unexpected inflation. While single house returns have a positive relationship with both expected and unexpected inflation, townhouse returns have a negative relationship with the expected inflation. However, because of the relatively large standard errors, not a single coefficient is significantly different from zero or one. In other words, the results cannot reject the Fisher hypothesis of one-to-one relationship between real estate returns and the ex-ante inflation. Moreover, both coefficients on expected and unexpected inflation are found to be statistically jointly indistinguishable from one using an F-test ( ).

The fact that real estate returns in Thailand do not response immediately to changes in inflation or expected inflation could be explained by several factors pointed out by Le Moigne and La (2008). Those are, the long-term leases, the absence of a central market, the illiquid nature of real estate, the lengthier processes for property transactions, the slower information dissemination or limited information.

Since real estate markets in Thailand is still immature. Development of Thai real estate information center is a relatively recent phenomenon. The secondary market function is not efficient, which restricts the free and rapid adjustment of real estate prices to various macroeconomic shocks. Due to the fact that town houses in Thailand tend to be a generating-income property in nature, its returns response slowly and perhaps negatively to expected inflation (Huang and Hudson-Wilson, 2007; Le Moigne and La, 2008). Therefore, town houses are likely to hedge against unexpected inflation, but perverse hedge against expected inflation. These seem to confirm our above conjecture about the impact of this real estate type's dimension, (i.e., an income-generating investment asset) on its inflation-hedging ability.

**Table 2. Regression results of real estate returns on actual inflation rates, expected inflation and unexpected inflation.**

The table reports the regression results of real estate returns on actual inflation rates (panel A) and expected and unexpected inflation (panel B) at the contemporaneous term [equation (6) and (7)] as presented below for convenience. In the table, $R_{SH}$ is the returns on single houses**;** $R_{TH}$ is the returns on town houses; $\pi_t$ is the actual inflation rate at time t. Expected and unexpected inflation rates are decomposed from the actual inflation rates by using Autoregressive (AR) models, where expected inflation rates [$E(\pi_t)$] are the linear prediction of the AR model and unexpected inflation rates [ $UE(\pi_t)$ ] are the residuals of the AR model $(\pi_t = 0.0068 + 0.2526\pi_{t-4})$. In the table, $N$ is the number of observations, $\bar{R}^2$ is the adjusted R-squared; $F$ is F-test. The F-values for testing the hypothesis $H_0{:}\omega_i = 1$ or $H_0{:}\beta_i = 1$ or $H_0{:}\gamma_i = 1$ are shown in the brackets next to the coefficients, and the robust t-values for testing the hypothesis $H_0{:}\varphi_i = 0$ or $H_0{:}\omega_i = 0$ or $H_0{:}\alpha_i = 0$ or $H_0{:}\beta_i = 0$ or $H_0{:}\gamma_i = 0$ are reported in the parentheses below the coefficients. (***), (**) and (*) indicate significance at the 1%, 5% and 10% levels, respectively.

**Panel A: real estate returns on actual inflation rates.**

$$R_{it} = \varphi_i + \omega_i \pi_t + \varepsilon_t$$

| | $\varphi_i$ | $\omega_i$ | $N$ | $\bar{R}^2$ | $F$ |
|---|---|---|---|---|---|
| $R_{SH}$ | -0.01 | 0.63 [-0.66] | 75 | 0.01 | 1.33 |
| | (-0.68) | (1.15) | | | |
| $R_{TH}$ | -0.01 | 0.56 [-0.88] | 75 | 0.01 | 1.20 |
| | (-0.61) | (1.10) | | | |

| | $\alpha_i$ | $\beta_i$ | $\gamma_i$ | $N$ | $\bar{R}^2$ | $F$ |
|---|---|---|---|---|---|---|
| $R_{SH}$ | -0.00 | 0.40 [-0.39] | 0.65 [-0.60] | 75 | 0.01 | 0.66 |
| | (-0.26) | (0.26) | (1.11) | | | |
| $R_{TH}$ | 0.00 | -0.11 [-0.79] | 0.60 [-0.73] | 75 | 0.01 | 0.60 |
| | (0.03) | (-0.08) | (1.09) | | | |

*F-value* for testing the null hypothesis that $\beta = \gamma = 1$ : 0.27 ($R_{SH}$)
*F-value* for testing the null hypothesis that $\beta = \gamma = 1$: 0.67 ($R_{TH}$)

*5.2. Stability analyses*

We incorporate three dummies for four sub-periods at three break points to check the stability of the real estate return-inflation relationship. Dividing sub-periods in such a way can therefore provide a robustness check of the real estate-inflation relationship across different inflationary regimes. The first sub-period, before the 1997 Asian financial crisis, is from Q1 1987 until Q2 1997. We define this period as the pre-financial crisis period. The second period covers the financial crisis, but we extend it until July 2003 to check the severe economic conditions in Thailand. Next, we separate the effects of political shocks to Thai economy from Q4 2003 until Q4 2008. We separate the last sub-period with include the global economic recession. Due to its export-driven characteristics, Thailand severely suffered from the global economic recession starting at the end of 2008.

Taking these structural changes into account, we incorporate three dummies for four sub-periods at three break points, i.e., July 1997, October 2003 and January 2009, to check the stability of the real estate return-inflation relationship. Dividing sub-periods in such a way can therefore provide a robustness check of the real estate-inflation relationship across different inflationary regimes.

**Table 3. Stability analysis with dummy variable on actual, expected and unexpected inflation**

The table reports the regression results of real estate returns on actual, expected and unexpected inflation rates at the contemporaneous term [equation (4) and (5)] with dummies for sub-periods for Thailand, as presented below for convenience. There are four sub-periods, so three dummies are employed: $D_{1t}$ is a dummy variable for the 1st sub-period [1987Q1-1997Q2] ($D_{1t} = 1$ if the 1st sub-period and $D_{1t} = 0$, otherwise); $D_{2t}$ is a dummy variable for the 2nd sub-period [1997Q3-2003Q3] ($D_{2t} = 1$ if the 2nd sub-period and $D_{2t} = 0$, otherwise); $D_{3t}$ is a dummy variable for the 3rd sub-period [2003Q4-2008Q4] ($D_{3t} = 1$ if the 3rd sub-period and $D_{3t} = 0$, otherwise). The subscript of the coefficients refers to the respective sub-period. In the table, R denotes the real estate returns; $\pi$ is the actual inflation rate; $N$ is the number of observations, $\bar{R}^2$ is the adjusted R-squared; $F$ is the F-test. Expected and unexpected inflation rates are decomposed from the actual inflation rates by using Autoregressive (AR) models, where expected inflation rates [$E(\pi_t)$] are the linear prediction of the AR model and unexpected inflation rates [$UE(\pi_t)$] are the residuals of the AR model ($\pi_t = 0.0068 + 0.2526\pi_{t-4}$). The t-values for testing the hypothesis $H_0: \omega = 1$ or $H_0: \beta = 1$ or $H_0: \gamma = 1$ are shown in the brackets next to the coefficients, and the robust t-values for testing the hypothesis $H_0: \varphi = 0$ or $H_0: \omega = 0$ or $H_0: \alpha = 0$ or $H_0: \beta = 0$ or $H_0: \gamma = 0$ are reported in the parentheses below the coefficients. (***), (**) and (*) indicate significance at the 1%, 5% and 10% levels, respectively.

$$R_t = \varphi_4 + (\varphi_1 - \varphi_4)D_{1t} + (\varphi_2 - \varphi_4)D_{2t} + (\varphi_3 - \varphi_4)D_{3t} + \omega_4\pi_t + (\omega_1 - \omega_4)D_{1t}\pi_t + (\omega_2 - \omega_4)D_{2t}\pi_t + (\omega_3 - \omega_4)D_{3t}\pi_t + \varepsilon_t \quad (6)$$

$$R_t = \alpha_4 + (\alpha_1 - \alpha_4)D_{1t} + (\alpha_2 - \alpha_4)D_{2t} + +(\alpha_3 - \alpha_4)D_{3t} + \beta_4 E_{t-1}(\pi_t) + (\beta_1 - \beta_4)D_{1t}E_{t-1}(\pi_t) + (\beta_2 - \beta_4)D_{2t}E_{t-1}(\pi_t) + (\beta_3 - \beta_4)D_{3t}E_{t-1}(\pi_t) + \gamma_4 UE_{t-1}(\pi_t) + (\gamma_1 - \gamma_4)D_{1t}UE_{t-1}(\pi_t) + (\gamma_2 - \gamma_4)D_{2t}UE_{t-1}(\pi_t) + (\gamma_3 - \gamma_4)D_{3t}UE_{t-1}(\pi_t) + \xi_t \quad (7)$$

**Panel A: Single House returns.**

| Equation | (6) | | | (7) | |
|---|---|---|---|---|---|
| $\omega_1$ | -0.74 | [-3.66]***<br>(-1.55) | $\beta_1$ | 1.58 | [0.17]<br>(0.48) |
| $\omega_2$ | 0.80 | [-0.14]<br>(0.55) | $\beta_2$ | -2.95 | [-0.98]<br>(-0.73) |
| $\omega_3$ | 0.08 | [-10.12]***<br>(0.83) | $\beta_3$ | -0.52 | [-0.97]<br>(-0.33) |
| $\omega_4$ | 11.04 | [2.02]**<br>(2.22)** | $\beta_4$ | 8.04 | [1.89]*<br>(2.16)** |
| | | | $\gamma_1$ | -1.29 | [-2.67]***<br>(-1.50) |
| | | | $\gamma_2$ | 0.87 | [-0.1]<br>(0.61) |
| | | | $\gamma_3$ | 0.09 | [-7.12]***<br>(0.72) |
| | | | $\gamma_4$ | 13.21 | [2.51]**<br>(2.71)*** |
| $N$ | | 75 | | 75 | |
| $\bar{R}^2$ | | 0.15 | | 0.17 | |
| $F$ | | 2.24** | | 2.18** | |
| $F$-test for dummy coefficients are 0 | | 3.18*** | $E(\pi_t)$<br>$UE(\pi_t)$ | 1.79<br>3.41** | |

**Table 4. Stability analysis with dummy variable on actual, expected and unexpected inflation**

The table reports the regression results of real estate returns on actual, expected and unexpected inflation rates at the contemporaneous term [equation (4) and (5)] with dummies for sub-periods for Thailand, as presented below for convenience. There are four sub-periods, so three dummies are employed: $D_{1t}$ is a dummy variable for the 1st sub-period [1987Q1-1997Q2] ($D_{1t} = 1$ if the 1st sub-period and $D_{1t} = 0$, otherwise); $D_{2t}$ is a dummy variable for the 2nd sub-period [1997Q3-2003Q3] ($D_{2t} = 1$ if the 2nd sub-period and $D_{2t} = 0$, otherwise); $D_{3t}$ is a dummy variable for the 3rd sub-period [2003Q4-2008Q4] ($D_{3t} = 1$ if the 3rd sub-period and $D_{3t} = 0$, otherwise). The subscript of the coefficients refers to the respective sub-period. In the table, R denotes the real estate returns; $\pi$ is the actual inflation rate; $N$ is the number of observations, $\bar{R}^2$ is the adjusted R-squared; $F$ is the F-test. Expected and unexpected inflation rates are decomposed from the actual inflation rates by using Autoregressive (AR) models, where expected inflation rates [$E(\pi_t)$] are the linear prediction of the AR model and unexpected inflation rates [$UE(\pi_t)$] are the residuals of the AR model ($\pi_t = 0.0068 + 0.2526\pi_{t-4}$). The t-values for testing the hypothesis $H_0{:}\,\omega = 1$ or $H_0{:}\,\beta = 1$ or $H_0{:}\,\gamma = 1$ are shown in the brackets next to the coefficients, and the robust t-values for testing the hypothesis $H_0{:}\,\varphi = 0$ or $H_0{:}\,\omega = 0$ or $H_0{:}\,\alpha = 0$ or $H_0{:}\,\beta = 0$ or $H_0{:}\,\gamma = 0$ are reported in the parentheses below the coefficients. (***), (**) and (*) indicate significance at the 1%, 5% and 10% levels, respectively.

$$R_t = \varphi_4 + (\varphi_1 - \varphi_4)D_{1t} + (\varphi_2 - \varphi_4)D_{2t} + (\varphi_3 - \varphi_4)D_{3t} + \omega_4\pi_t + (\omega_1 - \omega_4)D_{1t}\pi_t + (\omega_2 - \omega_4)D_{2t}\pi_t + (\omega_3 - \omega_4)D_{3t}\pi_t + \varepsilon_t \quad (6)$$

$$R_t = \alpha_4 + (\alpha_1 - \alpha_4)D_{1t} + (\alpha_2 - \alpha_4)D_{2t} + +(\alpha_3 - \alpha_4)D_{3t} + \beta_4 E_{t-1}(\pi_t) + (\beta_1 - \beta_4)D_{1t}E_{t-1}(\pi_t) + (\beta_2 - \beta_4)D_{2t}E_{t-1}(\pi_t) + (\beta_3 - \beta_4)D_{3t}E_{t-1}(\pi_t) + \gamma_4 UE_{t-1}(\pi_t) + (\gamma_1 - \gamma_4)D_{1t}UE_{t-1}(\pi_t) + (\gamma_2 - \gamma_4)D_{2t}UE_{t-1}(\pi_t) + (\gamma_3 - \gamma_4)D_{3t}UE_{t-1}(\pi_t) + \xi_t \quad (7)$$

**Panel B: Townhouse returns.**

| Equation | (6) | | | (7) | |
|---|---|---|---|---|---|
| $\omega_1$ | -0.68 | [-3.69]***<br>(-1.49) | $\beta_1$ | 0.93 | [-0.00]<br>(0.47) |
| $\omega_2$ | 0.89 | [-0.1]<br>(0.61) | $\beta_2$ | -2.97 | [-1.04]<br>(-0.78) |
| $\omega_3$ | 0.04 | [-15.37]***<br>(0.64) | $\beta_3$ | 0.06 | [-0.9]<br>(0.00) |
| $\omega_4$ | 8.66 | [1.91]*<br>(2.16)** | $\beta_4$ | 5.78 | [1.71]*<br>(2.06)** |
| | | | $\gamma_1$ | -1.06 | [-4.97]***<br>(-2.56)** |
| | | | $\gamma_2$ | 0.97 | [-0.00]<br>(0.68) |
| | | | $\gamma_3$ | 0.04 | [-11.05]***<br>(0.46) |
| | | | $\gamma_4$ | 10.74 | [2.62]**<br>(2.89)*** |
| $N$ | 75 | | | 75 | |
| $\bar{R}^2$ | 0.15 | | | 0.18 | |
| $F$ | 2.21** | | | 3.18*** | |
| $F$-test for dummy coefficients are 0 | | | $E(\pi_t)$ | 1.55 | |
| | | | $UE(\pi_t)$ | 5.38*** | |

Considering the results for both single house and townhouse in equation (6), the ex post real estate return-inflation relationship is consistently positive for all subsamples except the first one, where the coefficient is significant and greater than one in the last sub-period, but negative for the first one. Especially, the coefficient for the third and the last sub-period is significantly different from one at the 1% and 5% level respectively, rejecting a complete hedge against the ex post inflation, while that is not the case for the other sub-periods. Regarding regression (7), the coefficient for both types of housing index on expected inflation is large and positive for the last sub-period. For unexpected inflation relationship is consistently positive for all subsamples but negative for the first one. The coefficient is significantly greater than one in the last sub-period, but significantly negative for the first sub-period. The pre-financial crisis provides negative coefficients against unexpected inflation and the coefficient is significantly different from one at the 1% for both single-house and townhouse. It means that both kinds of houses provided a perverse hedge against unexpected inflation in the pre-financial crisis.

Interestingly, as expected the results in the pre-financial crisis period show a negative relationship between real estate returns and expected inflation. The major reason is a significant drop on property returns due to a large influx of foreign capital into the market eventually creating the collapse of the Thai real estate market in 1999. Moreover, the findings in the sub-period analysis prove that the relation between real estate returns and inflation are not stable over time. These findings corroborates other recent results (Hoesli, Lizieri and MacGregor, 2008; Roache and Attie, 2009). The reasons for the instability might be due to the other variables such as changes in global markets or changes in monetary policy. Ever since the inflation targeting policy was adopted by the Bank of Thailand in May 2000, inflation has mostly been maintained within a narrow band between 1% and 3% per year. From this study we find that both single house and townhouse can provide the inflation hedge against actual and unexpected inflation in the third and the last sub-period, even though Thai government mandated the Bank of Thailand to target inflation. This contradicts with Le Moigne and La (2008) who found that since the Bank of Canada adopted inflation targeting in 1991, the Canadian real estate has ceased to be an inflation hedge.

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