Is Mispricing in Asset Prices Due to the Inflation Illusion?

Bong Soo Lee

(Professor and Patty Hill Smith Eminent Scholar Chair in Finance, Department of Finance, College of Business, Florida State University)

자산가격의 오류는 인플레이션의 착각 때문인가?

이 봉 수

(플로리다 주립대학교 패티힐 스미스 재무 석좌교수)

* 이봉수: (e-mail) blee2@cob.fsu.edu, (address) Department of Finance, College of Business, Florida State University, 311 Rovetta Building, Tallahassee, FL 32306-1110, USA.

ABSTRACT

We examine whether the observed negative relations between stock returns and inflation and between housing returns and inflation can be explained by the inflation illusion hypothesis. We identify the mispricing component in asset prices (i.e., stock prices and housing prices) based on present value models, linear and loglinear models, and we then investigate whether inflation can explain the mispricing component using the data from three countries (the U.S., the U.K., and Korea). When we take into account the potential asymmetric effect of positive and negative inflation on the mispricing components in asset prices, which is an important implication of the inflation illusion hypothesis, we find little evidence for the inflation illusion hypothesis in that both positive and negative inflation rates do not have a negative effect on the mispricing components. Instead, we find that behavioral factors such as consumer sentiments contribute to the mispricing of asset prices.

- -

본 논문에서는 주식수익률과 인플레이션 그리고 주택수익률과 인플레이션의 음의 관계가 인플레이션의 착각에 기인하는 것인가를 연구하고자 한다. 우선 자산가격의(즉, 주식가격과 주택가격의) 오류 부분을 선형 또는 비선형 현재가치 모델에 기인해 구해 내고 인플레이션이 이러한 오류 부분을 설명할 수 있는지를 세 개의 국가(즉, 미국, 영국 그리고 한국)의 데이터를 통해서 살펴보고자 한다. 다음에는 양의 인플레이션과 음의 인플레이션이 오류 부분에 비대칭적인 영향을 미치는지를 조사하고자 한다. 그 결과 양의 인플레이션과 음의 인플레이션이 모두 음의 효과를 가지지는 않는다는 사실을 발견하였는데, 이는 인플레이션이 이러한 오류 부분을 설명하지는 않는다는 것을 의미한다. 대신 소비자 심리에 기인한 행동적 요소가 자산가격의 오류에 크게 기여함을 발견하였다.

I. Introduction

The relation between asset returns (or asset prices) and inflation has been debated extensively in the literature and has received renewed interest in recent years (e.g., Ritter and Warr [2002]; Campbell and Vuolteenaho [2004]; Cohen, Polk, and Vuolteenaho [2005]; Brunnermeier and Julliard [2008]; Wei [2010]). In particular, given the recent implosion of the stock market and housing market price bubbles in many economies and various economic stimulus packages including the central bank's expansionary monetary measures during this economic downturn, there seems little doubt about the possibility of forthcoming inflation. Therefore, the relation between asset returns and inflation becomes a more relevant issue. In this paper, we reexamine the empirical relation between two types of asset returns (i.e., stock returns and housing returns) and inflation using international data of the U.K. and Korea as well as the U.S.

Several hypotheses have been put forward to explain the observed negative correlation between stock returns and inflation. Modigliani and Cohn (1979) propose the inflation illusion hypothesis, which maintains that stock market investors are subject to inflation illusion. According to the hypothesis, stock market investors fail to understand the effect of inflation on nominal dividend growth rates, and they extrapolate historical nominal growth rates even in periods of changing inflation. This implies that stock prices are undervalued when inflation is high and overvalued when it is low.

Feldstein (1980) proposes the tax hypothesis to explain the inverse relation between higher inflation and lower share prices. Fama (1981; 1983) proposes the proxy hypothesis. According to the proxy hypothesis, high expected inflation proxies for slower expected economic growth. That is, a positive association between stock returns and real activity, combined with a negative association between inflation and real activity based on a money demand model, leads to spurious negative relations between stock returns and inflation. The proxy hypothesis has been extended by Geske and Roll (1983), who emphasize the monetization of government deficits and a fiscal and monetary policy linkage. Given that inflation affects value by way of its effect on the risk premium, Brandt and Wang (2003) propose the time-varying risk aversion hypothesis. They present a model in which inflation makes investors more risk averse, driving up the required equity premium, and thus the real discount rate.

Campbell and Vuolteenaho (2004) revisit the issue of the stock price-inflation

relation based on the time-series decomposition of the loglinear dividend yield model, and they provide strong support for Modigliani and Cohn's (1979) inflation illusion hypothesis for the U.S. stock market. Additionally, Cohen, Polk, and Vuolteenaho (2005) present cross-sectional evidence supporting Modigliani and Cohn's hypothesis.

However, some recent studies raise questions about the empirical validity of the inflation illusion hypothesis. Thomas and Zhang (2007) find that the results in Campbell and Vuolteenaho (2004) are sensitive to model specifications including the sample period studied, the proxy used for expected inflation, the use of dividends versus earnings yields, and the VAR methodology employed. So they claim that it is premature to conclude that the market confuses real and nominal growth rates and suffers from the massive inflation illusion (see also Chen, Lung, and Wang [2009]; Wei and Joutz [2009]).

Regarding the housing market, Brunnermeier and Julliard (2008) examine potential mispricing in the housing market, focusing on the price-rent ratio. They argue that people suffer from money illusion and mistakenly assume that real and nominal interest rates move in lockstep. Hence, they wrongly attribute a decrease in inflation to a decline in the real interest rate and consequently underestimate the real cost of future mortgage payments. Therefore, they cause an upward pressure on housing prices when inflation declines.

Piazzesi and Schneider (2007) consider asset pricing in a general equilibrium model in which some, but not all, agents suffer from inflation illusion. Their model predicts a non-monotonic relationship between the price-to-rent ratio on housing and nominal interest rates. Wei (2010) explores an explanation for the positive association between inflation and dividend yields with no inflation illusion involved based on a dynamic general equilibrium New-Keynesian model.

Given the recent debate on the empirical validity of the inflation illusion hypothesis as discussed above and recent implosion of asset prices combined with potential inflationary pressure, we reexamine the empirical relation not only between stock returns and inflation but also between housing returns and inflation using international data of the U.K. and Korea as well as the U.S. For our empirical analyses, in addition to the two major economies of the U.S. and the U.K., we include Korea partly because it is one of representative developing countries hosting G-20 meeting in 2010 and partly because residential housing in Korea constitutes a largest portion of household wealth in the world.

In testing the inflation illusion hypothesis, previous studies tend to focus on the extent that the mispricing component in asset prices can be explained by inflation. However, there are additional important implications in the hypothesis. One is that

the inflation should have a negative effect on the mispricing component to explain the observed negative relation between asset returns and inflation. The other is that not only positive inflation but also negative inflation should have a negative effect on the mispricing component because the inflation illusion hypothesis implies that asset prices are undervalued when inflation is high and overvalued when it is low. In this paper, using various measures of the mispricing component in asset prices (i.e., stock prices and housing prices), we further examine these implications of the inflation illusion hypothesis using international data.

We find some evidence of the inflation illusion hypothesis for the stock return-inflation relation for the U.K. and Korea and for the housing return-inflation relation for Korea in that the inflation rates explain some fraction of mispricing components and their effect on mispricing is negative. However, these findings are obtained assuming a symmetric relation for positive and negative inflation in relation to the mispricing components. When we take into account potential asymmetric effects of positive and negative inflation on the mispricing components in asset prices, which is an important implication of the inflation illusion hypothesis, we find that none of these asset returns is compatible with the inflation illusion hypothesis in that both positive and negative inflation rates do not have a negative effect on the mispricing components. As discussed by Piazzesi and Schneider (2007), one way to understand the finding of limited evidence for the inflation illusion hypothesis is that only a small fraction of investors, if any, suffer from it. As a result we anticipate a non-monotonic relation between asset returns and inflation.

Since we find only limited evidence for the inflation illusion hypothesis, we further examine whether the mispricing in the asset prices is related to behavioral factors such as investor sentiment in an attempt to find other factors that may explain the mispricing in asset prices using consumer confidence as a measure of investor optimism. We find evidence that investor sentiment could have contributed to the mispricing in both stock market and housing market asset prices.

This paper's incremental contribution to the literature includes the following. First, we examine the robustness of the empirical validity of the inflation illusion hypothesis using alternative measures of mispricing component in asset prices based on conventional linear and loglinear models of asset prices (e.g., stock prices and housing prices).

Second, we look at extensive data for evidence of the inflation illusion for both stock prices and housing prices of the U.S., the U.K., and Korea. Korea is included as an example of developing economy, which may have a relatively larger mispricing component in asset prices and a potentially more important role of inflation illusion. We confirm this conjecture in the paper.

Third, we examine another important implication of the inflation illusion hypothesis: potential asymmetric effect of positive and negative inflation on mispricing. This important implication has been ignored in the prior literature. Fourth, since we find only a limited evidence for the inflation illusion hypothesis for stocks and housing, we further examine alternative variables (or factors) that may explain the mispricing in asset prices, and find an important role of consumer sentiment, as a proxy for behavioral factor, in explaining the mispricing.

The paper is organized as follows. In Section 2, we provide empirical identification of the mispricing component in asset prices using simple present value models, first in a linear model, then in a loglinear model allowing for time-varying discount rates. In Section 3, we present empirical results of the extent of the mispricing due to the inflation illusion using the stock market and housing market data from the U.S., the U.K., and Korea. In section 4, we examine whether the mispricing in the asset prices is related to behavioral factors such as consumer sentiment. We conclude in Section 5.

II. Empirical Identification of the Mispricing Component in Asset Prices

One way to examine the importance of the inflation illusion in the relation between asset returns and inflation is to see how much of the mispricing (or non-fundamental) component of asset prices is explained by inflation (e.g., Campbell and Vuolteenaho [2004], for stock market prices; Brunnermeier and Julliard [2008], for housing prices). In this section, we propose a model that helps identify the mispricing component, which is defined as the part of the asset prices that is not related to fundamentals. Then we can examine how much of the mispricing component is related to inflation as a measure of the inflation illusion.

1. Identification of the Mispricing Component in a Linear Model

Suppose that X_t represents a fundamental variable (e.g., dividends in stock prices or rents in housing prices). Assuming that the fundamental variable is a non-stationary series, we consider its first-differenced series, and it is assumed to have a MAR (moving average representation) by the Wold representation theorem:

$$\Delta X_t = c_{11}(L)\, u_{1t} = \sum_{k=0}^{\infty} c_{11}^{\,k}\, u_{1t-k} \tag{1}$$

where L is the lag operator (i.e., $L^n x_t = x_{t-n}$) and $c_{ij}(L)$ is a polynomial in the lag operator L (i.e., $c_{ij}(L) = \sum_k c_{ij}^k L^k$ with $\sum_k \equiv \sum_{k=0}^{\infty}$).

Assume that asset price P_t (e.g., stock price or housing price) has two components, fundamental and mispricing (i.e., non-fundamental) components:

$$P_t = P_t^* + b_t \tag{2}$$

where P_t^* is a fundamental component and b_t is a mispricing component, which is part of asset price that is not related to fundamental variable. We further assume that the fundamental component of asset price P_t^* is determined by the expected present discounted value of the fundamental variable X_t:

$$
\begin{aligned}
P_t^* &= E_t \sum_{j=1}^{\infty} \beta^j X_{t+j} \\
&= \frac{\beta}{1-\beta} X_t + \frac{1}{1-\beta} E_t \sum_{j=1}^{\infty} \beta^j \Delta X_{t+j}
\end{aligned}
\tag{3}
$$

where β is a constant discount factor.[1]

Now we consider a case where X_t and P_t are cointegrated of order (1, 1), CI(1, 1), and the other case where X_t and P_t are not cointegrated.

A. Cointegrated Case

Suppose $[X_t, P_t]'$ are cointegrated of order (1, 1), CI(1,1). We define a spread between (i.e., a linear combination of) X_t and P_t as S_t:

$$
\begin{aligned}
S_t &= P_t - \theta X_t = (P_t^* - \theta X_t) + b_t \\
&= S_t^* + b_t = \frac{1}{1-\beta} E_t \sum_{j=1}^{\infty} \beta^j \Delta X_{t+j} + b_t
\end{aligned}
\tag{4}
$$

---

[1] A model with a time-varying discount rate will be discussed in Section 2.2 with a loglinear model.

by setting $S_t^* = (P_t^* - \theta X_t) = \dfrac{1}{1-\beta} E_t \sum_{j=1}^{\infty} \beta^j \Delta X_{t+j}$ and $\theta = \dfrac{\beta}{1-\beta}$. Here, b_t represents the

mispricing component in price P_t.

To calculate the present value of expected future fundamental variables ΔX_{t+j}, we use the following lemma, whose proof is provided in Hansen and Sargent (1980):

Lemma: Given $\Delta X_t = C_{11}(L)\, u_{1t}$,

$$E_t \sum_{j=1}^{\infty} \beta^j \Delta X_{t+j} = \frac{\beta}{L-\beta}[C_{11}(L) - C_{11}(\beta)]\, u_{1t} \tag{5}$$

Using the lemma, it follows that

$$S_t = S_t^* + b_t = \frac{\beta}{1-\beta}\frac{1}{L-\beta}\,[c_{11}(L) - c_{11}(\beta)]u_{1t} + b_t \tag{6}$$

Let $b_t = c_{22}(L)\, u_{2t}$, where u_{2t} represents a non-fundamental shock that drives b_t. Then, it follows that

$$Z_t = \begin{bmatrix} \Delta X_t \\ S_t \end{bmatrix} = \begin{bmatrix} c_{11}(L) & c_{12}(L) \\ c_{21}(L) & c_{22}(L) \end{bmatrix} \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix} \tag{7}$$

Then, the cointegrated model is characterized by

$$\begin{aligned} c_{12}(L) &= 0, \\ c_{21}(L) &= \frac{\beta}{1-\beta}\frac{1}{L-\beta}[c_{11}(L) - c_{11}(\beta)] \end{aligned} \tag{8}$$

Then, using $u_{1t} = c_{11}(L)^{-1}\Delta X_t$ from (1), it follows that

$$\begin{aligned} S_t = P_t - \theta X_t &= (P_t^* - \theta X_t) + b_t \\ &= c_{21}(L)\, u_{1t} + c_{22}(L)\, u_{2t} = c_{21}(L)\, u_{1t} + b_t \end{aligned}$$

$$= c_{21}(L) \ c_{11}(L)^{-1} \Delta X_t + b_t$$

$$= \gamma(L) \Delta X_t + b_t \tag{9}$$

$$= \sum_{j=0}^{\infty} \gamma_j \, \Delta X_{t-j} + b_t$$

where $\gamma(L) = c_{21}(L) \ c_{11}(L)^{-1}$. This implies that u_{1t} is a fundamental shock, and $c_{22}(L)u_{2t}$ is a mispricing component b_t of asset price P_t. That is, when $[X_t, P_t]'$ are cointegrated of order (1, 1), CI(1,1), the mispricing component b_t of asset price P_t is extracted from the spread S_t as residuals after taking into account current and lagged ΔX_{t-j}:

$$b_t = c_{22}(L)u_{2t} = S_t - c_{21}(L)u_{1t} = S_t - c_{21}(L) \ c_{11}(L)^{-1} \Delta X_t$$

$$= S_t - \gamma(L) \Delta X_t = S_t - \sum_{j=0}^{\infty} \gamma_j \, \Delta X_{t-j} \tag{10}$$

Then we regress the mispricing component of asset prices, b_t, on inflation rates to see how much of b_t is explained by inflation:

$$b_t = \alpha + \beta \ \pi_t + e_t \tag{11}$$

If inflation π_t explains a substantial fraction of b_t, it can provide support for the inflation illusion hypothesis.

B. Non-cointegrated Case

Suppose $[X_t, P_t]'$ are not cointegrated although both series are integrated of order one, I(1), series. Then, we have the following bivariate MAR (moving average representation):

$$Z_t = \begin{bmatrix} \Delta X_t \\ \Delta P_t \end{bmatrix} = \begin{bmatrix} c_{11}(L) & c_{12}(L) \\ c_{21}(L) & c_{22}(L) \end{bmatrix} \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix} \ . \tag{12}$$

Given that X_t is a fundamental variable, we impose $c_{12}(L) = 0$, which identifies u_{1t} as a fundamental shock and u_{2t} as a non-fundamental shock. Then, it follows

$$S_t = P_t - \theta X_t = (P_t^* - \theta X_t) + b_t$$

$$= S_t^* + b_t = \frac{1}{1-\beta} E_t \sum_{j=1}^{\infty} \beta^j \Delta X_{t+j} + b_t \tag{13}$$

by setting $\theta = \dfrac{\beta}{1-\beta}$

Since $[X_t, P_t]'$ are not cointegrated, it follows that the spread S_t is integrated of order one, I(1), process. Thus, it follows from (13) that the mispricing component b_t is also an integrated order one, I(1), process:

$$\Delta P_t = c_{21}(L)u_{1t} + c_{22}(L)u_{2t} = c_{21}(L)u_{1t} + (1-L)b_t \tag{14}$$

That is, $c_{22}(L)u_{2t}$ $(= \Delta b_t)$ is a mispricing component of ΔP_t. Since $\Delta X_t = c_{11}(L)u_{1t}$, it follows that

$$\begin{aligned}
\Delta P_t &= c_{21}(L)\,u_{1t} + c_{22}(L)u_{2t} = c_{21}(L)u_{1t} + (1-L)b_t \\
&= c_{21}(L)c_{11}(L)^{-1}\Delta X_t + c_{22}(L)\,u_{2t} = \gamma(L)\Delta X_t + (1-L)b_t \\
&= \sum_{j=0}^{\infty}\gamma_j \Delta X_{t-j} + (1-L)b_t
\end{aligned} \tag{15}$$

where $\gamma(L) = c_{21}(L)\,c_{11}(L)^{-1}$.

Therefore, when stock price P_t and a fundamental variable X_t are non-stationary and non-cointegrated, the mispricing component in the price will be non-stationary and it is derived from ΔP_t as residuals after taking into account current and lagged ΔX_{t-j}.[2]

$$\begin{aligned}
\Delta b_t &= c_{22}(L)u_{2t} = \Delta P_t - c_{21}(L)u_{1t} = \Delta P_t - c_{21}(L)\,c_{11}(L)^{-1}\Delta X_t \\
&= \Delta P_t - \sum_{j=0}^{\infty}\gamma_j \Delta X_{t-j}
\end{aligned} \tag{16}$$

---

2 Therefore, it is shown that the presence of a cointegration CI(1,1) relation between cash flows (e.g., dividends or rents) and asset prices is a sufficient condition for the absence of a non-stationary mispricing component in the asset prices for the sample period. If we define the non-stationary mispricing component in the asset prices as a bubble in asset prices, this can be used as a condition for the presence of the bubble (see e.g., Lee [1998]).

Then, as in (11), we regress the mispricing component of asset prices, Δb_t, on inflation rates to see how much of the mispricing component Δb_t is explained by inflation.

2. Identification of the Mispricing Component in a Loglinear Model

Models in Section 2.1 are based on non-logged (real) asset prices and fundamentals with a constant discount rate. Previous studies such as Campbell and Shiller (1988a; 1989b), Campbell (1991), and Campbell and Ammer (1993) develop log-linear models allowing for time-varying discount rates. They show that the log price-dividend ratio s_{2t} is given by:

$$s_{2t} = p_t - d_t = E_t \sum_{j=0}^{\infty} \rho^j [\Delta d_{t+j} - h_{t+j}] + \eta_t \qquad (17)$$

where p_t and d_t are logged asset price and fundamental variable (e.g., dividend), h_t is time-varying returns, and η_t is an approximation error. Equation (17) states that the spread s_{2t}, the log price-dividend ratio, is an expected discounted value of all future dividend growth rates less returns discounted at the discount rate ρ. That is, the log price-dividend ratio is an expected discounted value of all future one-period 'discounted rate-adjusted dividend growth rates', $\Delta d_{t+j} - h_{t+j}$. As such, the log price-dividend ratio provides the optimal forecast of the discounted value of all future dividend growth rates, future returns, or both.

This model is characterized as the restrictions $c_{12}(L)=0$, $c_{13}(L)=0$, and $c_{23}(L)=0$, on the following trivariate MAR model:

$$Z_t = \begin{bmatrix} \Delta d_t \\ \Delta dr_t \\ s_{2t} \end{bmatrix} = \begin{bmatrix} c_{11}(L) & c_{12}(L) & c_{13}(L) \\ c_{21}(L) & c_{22}(L) & c_{23}(L) \\ c_{31}(L) & c_{32}(L) & c_{33}(L) \end{bmatrix} \begin{bmatrix} e_{dt} \\ e_{rt} \\ e_{nt} \end{bmatrix} \qquad (18)$$

Where $\Delta dr_t = \Delta d_t - h_t$, e_{dt} = dividend innovation, e_{rt} = stock return innovation, and e_{nt} = non-fundamental innovation (e.g., Lee [1998]).[3] That is, with the above

---

3 As in Campbell and Shiller (1988b), we also assume $E_t h_t = E_t r_t + c$. That is, we assume that there is some variable r_t whose beginning-of-period rational expectation, plus a constant term c, equals

identifying restrictions, we have the following:

$$\Delta d_t = c_{11}(L)e_{dt}, \quad \Delta dr_t = c_{21}(L)e_{dt} + c_{22}(L)e_{rt}, \text{ and}$$

$$s_{2t} = c_{31}(L)e_{dt} + c_{32}(L)e_{rt} + c_{33}(L)e_{nt}$$

In the above representation, the mispricing component in the logged price, b_t, is given by $c_{33}(L)e_{nt}$, which is part of the log price-dividend ratio s_{2t} that is not related to such fundamental variables as dividends and returns.

Then, the mispricing component in the logged price, b_t, is derived from s_{2t} as residuals after taking into account current and lagged Δd_{t-j} and Δdr_{t-j} for j = 0, 1, 2, … :

$$b_t = c_{33}(L)e_{nt} = s_{2t} - c_{31}(L)e_{dt} - c_{32}(L)e_{rt}$$
$$= s_{2t} - \sum_{j=0}^{\infty} \gamma_{1j}\,\Delta d_{t-j} - \sum_{j=0}^{\infty} \gamma_{2j}\, r_{t-j}$$

Then, as in (11), we regress the mispricing component of logged asset prices, b_t, on inflation rates to see how much of b_t is explained by inflation.

3. Test for the Inflation Illusion

The inflation illusion hypothesis can be tested, as in the previous studies, by examining whether a substantial fraction of the mispricing component of asset prices is explained by inflation. However, the hypothesis anticipates not only that inflation is playing an important role in explaining the mispricing component but also that inflation and asset prices are negatively related. That is, according to the inflation illusion hypothesis, when inflation is high, real as well as nominal interest rates will be high, future cash flows are heavily discounted, and asset prices will be lower. Therefore, inflation should affect the mispricing component negatively.

In regression (11), we examine the explanatory power of inflation by using only the current inflation rates. In a strict sense, we can consider only the current inflation

---

the ex ante return on stock h_t over the period. While Campbell and Shiller (1988b) consider the hypothesis that the expected real return on stock equals the expected real return on commercial paper plus a constant, we consider that the expected real return on stock equals the expected real return on the long-term government (10-year Treasury) bond plus a constant since we are also investigating the housing market in addition to the stock market. For details, see Section 3.1.

rate to examine the contemporaneous negative relation between asset returns and inflation. However, to be more flexible, we allow for lagged inflation rates to affect the mispricing components. Therefore, we consider the following three cases with inflation rates: only the current inflation rate, only the lagged inflation rates, and the current and lagged inflation rates.[4]

$$b_t = \alpha + \beta \pi + e_t \qquad (11.1)$$

$$b_t = \alpha + \sum_{j=1}^{k} \beta_j \pi_{t-j} + e_t \qquad (11.2)$$

$$b_t = \alpha + \sum_{j=0}^{k} \beta_j \pi_{t-j} + e_t \qquad (11.3)$$

We test for the null hypothesis that inflation rates as a group do not affect the mispricing component and for the null hypothesis that the net cumulative effect of inflation is zero, as follows:

H1$_0$: $\beta_j = 0$ for each j, and

H2$_0$: $\sum_j \beta_j = 0$

We consider another important implication of the inflation illusion hypothesis. According to the hypothesis, asset prices (i.e., stock prices or housing prices) are undervalued when inflation is high and become overvalued when inflation falls. Therefore, the hypothesis anticipates that both positive and negative inflation shocks drive only a negative asset return-inflation relation. This implies that both positive and negative inflation rates are negatively related to the mispricing component in asset prices. To examine this implication of the inflation illusion hypothesis, we employ a dummy variable regression:

$$b_t = a + b1 \ \pi 1_t + b2 \ \pi 2_t + e_t \qquad (11.4)$$

---

4 The mispricing component, b_t, is unobservable and thus needs to be identified and calculated, and then this proxy is used to be related to inflation. So naturally, additional measurement error related standard error can be a problem. However, as Pagan (1984) points out, the standard errors are not really a problem here. This is partly because we use the mispricing component, b_t, as the left hand side variable (i.e., regressand) rather than a right hand side variable (i.e., regressors).

where $\pi 1 = D_t \times \pi_t$ = positive inflation; $\pi 2_t = (1 - D_t) \times \pi_t$ = negative inflation; and $D_t = 1$ when $\pi_t > 0$, otherwise 0. That is, the inflation illusion hypothesis anticipates that both b1 < 0 and b2 < 0.

III. Empirical Results

1. Data and Preliminary Findings

For our empirical analysis, we use data from the U.S., the U.K., and Korea. For the empirical estimation for the U.S. stock market, we use the monthly S&P real price index and dividend series for the sample period of 1872:01 to 2009:06. The data are from Shiller's web page: http://www.econ.yale.edu/~shiller/data.htm. For the U.S. housing price index, we use the monthly average price of new one-family house sold during the month (USHOUSEP), which is from the Bureau of the Census. For the U.S. rent series, we use the monthly CPI component of rent for primary residence (USCPHRR.E), which is available from the Bureau of Labor Statistics.[5] For the housing price and rent index, the sample period is from 1981:01 to 2009:06. For interest rates, we use the long-term government (10-year Treasury) bond yield on Shiller's web page.[6]

For the empirical estimation for the U.K. stock market, we use the quarterly MSCI return index with and without dividend yield, which allows us to extract dividend series, obtained from Datastream for the sample period of 1988:I to

---

[5] There is still debate about the appropriate measure of housing prices and rents in relation to inflation. For example, *Journal of Housing Economics* recently had a "Special Issue on Owner Occupied Housing in National Accounts and Inflation Measures" in Volume 18, Issue 3, September 2009.
In its objective, it states that "The articles *(in this special issue)* take up various facets of the treatment of owner occupied housing (OOH) services in the official statistics of nations, and especially of the nation at the center of the global financial crisis: the United States. It is easy to understand why the cost of OOH services belongs in measures of consumer expenditure, national output and inflation. Most people in the United States – as in many other nations – live in homes they own, their homes constitute most of their wealth, and home values have been subject to large swings. Errors made in assessing the evolution over time, or levels, of prices for OOH services could distort key measures of national economic performance including the consumer price index (CPI)."

[6] See footnote 8 for the discussion of using interest rates for stock returns (see also Campbell and Shiller [1988b]).

2008:IV. For the U.K. housing market index, we use the quarterly IPD all property index and the corresponding rent index for the sample period of 1988:I to 2008:IV. For interest rates, we use the yield on the U.K. government 10-year bond.

For the empirical estimation for the Korean stock market prices, we use quarterly MSCI return index with and without dividend yield obtained from Datastream for the sample period of 1988:I to 2008:IV. For the Korean housing market index, we use the housing purchase price composite index and the corresponding CPI component of rent for the sample period of 1987:I~2009:II. The housing index is from Kookmin Bank and the rent series is from the National Statistics Bureau.[7] For interest rates, we use the five-year rate on the Korean National Housing Bond. The CPIs (not seasonally adjusted) for all the countries are originally from the International Financial Statistics of IMF, which are obtained from Datastream

<Table 1> reports the results of the regression of various asset returns on inflation rates and cross correlations between asset returns and inflation for the U.S. (Panel A), the U.K. (Panel B), and Korea (Panel C). We report not only contemporaneous correlations but also the cross correlations with one lag and one lead to allow for a potential mismatch in timing in the compilation of the data.

The regression for the U.S. in Panel A shows that nominal stock returns (SR) are positively related to inflation (coefficient = 0.39) but the coefficient is substantially less than one for the sample period of 1871-2009. As a result, real stock returns (RSR) are significantly negatively related to inflation (coefficient = -0.61), which is confirmed by the cross correlations between stock returns and inflation. For the housing returns, both nominal (HR) and real (RHR) housing returns are negatively related to inflation for the sample period of 1981~2009, which is also confirmed by the cross correlations. Therefore, we find that both (real) asset returns are negatively related to inflation for the U.S.

For the U.K. and Korea, we find that both nominal and real asset returns (i.e., stock returns and housing returns) are negatively related to inflation for the sample period, which is confirmed by cross correlations, while there is some variation in the

---

7 The housing index is available from Kookmin Bank web page:
http://land.kbstar.com/quics?asfilecode=5023&_nextPage=page=B002188&weblog=l_gnb_C4
The rent series is available from the National Statistics Bureau web page:
http://www.kosis.kr/domestic/theme/do01_index.jsp
Both series are also available from the Bank of Korea (http://ecos.bok.or.kr/).
For the Korean housing market index, we also use the quarterly 'National Apartment Purchase Price Indices' and the 'National Apartment Jeonse Price Indices' for the sample period of 1988 to 2008. The Jeonse price is an up-front lump-sum deposit from the tenant to the owner for the use of the property with no additional requirement for periodic rent payments. The empirical results are similar and they do not change any of our interpretation of the Korean empirical results.

<Table 1> Regressions and Cross Correlations

Dependent variable	Constant (t-stat)	INF (t-stat)	Adjusted R²	Cross correlations with INF (t-k)			Q stat
				-1	0	1	
Panel A: The U.S.							
Sample period: 1871:01 to 2009:06 (monthly)							
SR	0.3375 (3.3053)	0.3883 (4.1392)	0.0096	0.0968***	0.1011***	0.0092	32.73***
RSR	0.3440 (3.3699)	-0.6110 (-6.5150)	0.0243	0.0223	-0.1579***	-0.0635**	49.01***
Sample period: 1981:01 to 2009:06 (monthly)							
HR	0.4736 (1.7772)	-0.1511 (-0.2404)	-0.0028	-0.0140	-0.0131	0.0087	1.75
RHR	0.4745 (1.7838)	-1.1516 (-1.8353)	0.0069	-0.0567	-0.0992**	0.0259	4.71
Panel B: The U.K.							
Sample period: 1988:I to 2008:IV (quarterly)							
SR	2.4077 (1.9373)	-0.0512 (-0.0505)	-0.0124	-0.0917	-0.0056	-0.1445	2.52
RSR	2.4046 (1.9492)	-1.0543 (-1.0478)	0.0012	-0.1003	-0.1164	-0.1525	4.02
HR	0.5360 (1.2315)	-0.9435 (-2.6574)	0.0696	0.0233	-0.2848***	-0.1133	8.05**
RHR	0.5082 (1.1827)	-1.8868 (-5.3832)	0.2567	0.0020	-0.5157***	-0.1203	23.85***
Panel C: Korea							
Sample period 1988:I to 2008:IV (quarterly)							
SR	5.6645 (1.7111)	-2.5788 (-1.1306)	0.0034	-0.2032*	-0.1246	-0.3260***	14.02***
RSR	5.6733 (1.7272)	-3.5762 (-1.5802)	0.0179	-0.2084*	-0.1729	-0.3330***	15.83***
Sample period 1987:I to 2009:II (quarterly)							
HR	0.7133 (2.0470)	-0.7437 (-3.3908)	0.1066	0.2617***	-0.3417***	0.1128	18.10***
RHR	0.6971 (2.0255)	-1.6989 (-7.8425)	0.4074	0.2822***	-0.6436***	0.1598	47.37***

Notes: SR = nominal stock return; RSR = real stock return; HR = nominal housing return; RHR = real housing return; INF= inflation rate; Q-stat = Ljung-Box statistics for the test of the significance of three cross-correlations as a group.

*** , ** and * denote significance at 1%, 5%, and 10%, respectively.

magnitude of correlations in each country.[8] Therefore, we find that for all three countries, the relation between (real) asset returns and inflation is negative, and thus both stocks and housing in these countries are not a good short-term hedge against inflation for the sample period.

2. The U.S.

In <Table 2>, we report the results of unit root tests and cointegration tests for asset prices (i.e., stock prices and housing prices) and fundamental variables (i.e., dividends and rents). Panel A of <Table 2> shows that both the S&P prices and dividends are non-stationary, I(1), series; and the linear combination of the stock prices and dividends (i.e., the spread S1) is marginally stationary, implying that they are cointegrated of order (1,1). We further implement Johansen's cointegration tests using maximum likelihood and trace tests. Both tests show that the null of no cointegration is rejected at the conventional significance level of 10%, which indicates that there is at least one cointegration vector between real stock prices and dividends. This indicates that the mispricing component of the S&P stock price is stationary. This implies that the deviation of stock prices from fundamentals is not non-stationary, and that stock prices and fundamentals tend to move together over time so there is little chance of potential non-stationary bubbles in stock prices for the sample period.

As in equation (10), we regress the spread on current and lagged first-differenced dividends to derive a mispricing component of the S&P prices, and then we regress the mispricing component on inflation as in equation (11). The estimation results are presented in Panel A of <Table 3> under the heading SP (i.e., stock prices).

---

8 Hartzell, Liu, and Hoesli (1997) investigate whether real estate securities continue to act as a perverse inflation hedge in foreign countries given security design differences. They find that real estate securities provide a worse hedge against inflation relative to common stocks in some countries and are comparable to stocks in other countries. Regarding whether REITs provide an inflation hedge in the long run, previous studies find the lack of a positive relationship between general prices and REIT returns. As in most prior research, Chatrath and Liang (1998) also find no evidence that REIT returns are positively related to temporary or permanent components of inflation measures.

<Table 2> Unit Root and Cointegration tests

Panel A. The U.S.

A.1 Unit Root Tests

(i) Augmented Dickey-Fuller Regression

$$\Delta x_t = a_0 + \alpha x_{t-1} + \sum_{i=1}^{m} \gamma_i \Delta x_{t-i} + v_t$$

(ii) Phillips-Perron Regression

$$x_t = b_0 + b x_{t-1} + v_t$$

Variables (X_t)	Dickey-Fuller test		Phillips-Perron test	
	τ_α (2 lags)	τ_α (4 lags)	$Z(t_b)$ (2 lags)	$Z(t_b)$ (4 lags)
P	-0.96694	-1.11064	-0.89804	-0.96453
D	-0.72528	-1.06637	0.77621	0.42614
S1	-2.70089	-3.00865	-2.48044	-2.61577
HP	-1.35666	-1.13575	-1.72634	-1.56122
rent	-1.26378	-1.36215	-1.01396	-1.04611
S2	-2.37180	-1.98865	-3.64679	-3.65443

A.2 Cointegration Tests

Eigenvalu	L-max	Trace	H0: r	p-r	L-max90	Trace90
The S&P price and dividend series (monthly, real non-logged)						
0.0087	14.44	14.77	0	2	10.60	13.31
0.0002	0.33	0.33	1	1	2.71	2.71
The U.S. house price and rent series						
0.0380	13.15	15.41	0	2	10.60	13.31
0.0066	2.26	2.26	1	1	2.71	2.71

Notes: P = real stock prices; D = dividends; HP = housing prices; rent= rent series.
　　　1. Monthly data from 1872:01 to 2009:06 (non-logged real series)
　　　$P_t = -322.4787 + 57.4843\ D_t + S1_t$
　　　　　(-26.4518)　(44.2457)　　　　　　R Bar **2　0.7211
　　　Critical values: 1% = -3.437; 5% = -2.864; 10% = -2.568
　　　2. Monthly data from 1981:01 to 2009:06 (non-logged real series)
　　　$HP_t = -2233.6807 + 0.3487\ Rent_t + S2_t$
　　　　　(-15.8347)　(22.5187)　　　　R Bar **2　0.7370
　　　Critical values: 1% = -3.451; 5% = -2.870; 10% = -2.571
　　　(Fuller [1976], Tables 8.5.1 and 8.5.2, pp.371~373). The details of the adjusted *t*-statistics $Z(t_b)$ can be found in the work of Phillips and Perron (1988).
　　　Eigenvalue: Eignevalue corresponding to the maximum likelihood function,
　　　Ho: r:　Hypothesis about the cointegrating rank r.
　　　L-max: The likelihood ratio test statistic for testing r cointegrating vectors versus the alternative of r+1 cointegrating vectors; Trace: the likelihood ratio test statistic for testing the hypothesis of at most r cointegrating vectors. These are based on Johansen (1988). L-max90 and Trace90 are the corresponding critical values. Critical values indicate the corresponding statistics to be used for testing unit root.

Panel B. The U.K.

B.1 Unit Root Tests

(i) Augmented Dickey-Fuller Regression

$$\Delta x_t = a_0 + \alpha x_{t-1} + \sum_{i=1}^{m} \gamma_i \Delta x_{t-i} + v_t$$

(ii) Phillips-Perron Regression

$$x_t = b_0 + b x_{t-1} + v_t$$

Variables (X_t)	Dickey-Fuller test		Phillips-Perron test	
	τ_α (2 lags)	τ_α (4 lags)	Z(t_b) (2 lags)	Z(t_b) (4 lags)
P	-1.57939	-1.81124	-1.55336	-1.58780
D	-1.72130	-0.45011	-4.83084	-5.14922
S1	-2.20486	-1.63721	-5.65981	-6.08621
HP	-3.86504	-3.70483	-1.57092	-1.77748
rent	-0.31763	-2.11368	1.22393	0.94481
S2	-3.90989	-3.75319	-1.58722	-1.80037

B.2 Cointegration Tests

Eigenvalu	L-max	Trace	H₀: r	p-r	L-max90	Trace90
The U.K. stock price and dividend series (quarterly, real non-logged)						
0.1379	11.87	14.37	0	2	10.60	13.31
0.0308	2.50	2.50	1	1	2.71	2.71
The U.K. house price and rent series						
0.5057	57.08	57.75	0	2	10.60	13.31
0.0083	0.68	0.68	1	1	2.71	2.71

Notes: P = real stock prices; D = dividends; HP = housing prices; rent= rent series.
1. Monthly data from 1888:I to 2008:IV (non-logged real series)
P_t = 70.7287 + 84.2442 D_t + S1$_t$
    (4.4399) (10.09119)   R Bar **2   0.5469
Critical values: 1% = -3.512 5% = -2.897 10% = -2.586
2. Quarterly data from 1988:I to 2008:IV (non-logged real series)
HP_t = 104.0368 - 0.0534   Rent$_t$ + S2$_t$
      (14.0155) (-1.2164)   R Bar **2   0.0103
Critical values: 1% = -3.512 5% = -2.897 10% = -2.586
(Fuller [1976], Tables 8.5.1 and 8.5.2, pp.371~373). The details of the adjusted *t*-statistics Z(t_b) can be found in the work of Phillips and Perron (1988).
Eigenvalue: Eignevalue corresponding to the maximum likelihood function,
Ho: r: Hypothesis about the cointegrating rank r.
L-max: The likelihood ratio test statistic for testing r cointegrating vectors versus the alternative of r+1 cointegrating vectors; Trace: the likelihood ratio test statistic for testing the hypothesis of at most r cointegrating vectors. These are based on Johansen (1988). L-max90 and Trace90 are the corresponding critical values. Critical values indicate the corresponding statistics to be used for testing unit root.

Panel C. Korea

C.1 Unit Root Tests

(i) Augmented Dickey-Fuller Regression

$$\Delta x_t = a_0 + \alpha x_{t-1} + \sum_{i=1}^{m} \gamma_i \Delta x_{t-i} + v_t$$

(ii) Phillips-Perron Regression

$$x_t = b_0 + b x_{t-1} + v_t$$

Variables (X_t)	Dickey-Fuller test		Phillips-Perron test	
	τ_α (2 lags)	τ_α (4 lags)	$Z(t_b)$ (2 lags)	$Z(t_b)$ (4 lags)
P	-2.24168	-2.55055	-2.09893	-2.19550
D	-8.73675	-1.34687	-11.85300	-11.63770
S1	-2.05769	-3.16879	-2.53281	-2.66095
HP	-1.42662	-1.66996	-0.94946	-1.08881
rent	0.20365	-0.40403	0.11344	-0.01447
S2	-1.27780	-2.28815	-0.89537	-1.10946

C.2 Cointegration Tests

Eigenvalue	L-max	Trace	H₀: r	p-r	L-max90	Trace90
Korean stock price and dividend series (quarterly, real non-logged)						
0.5796	70.19	74.95	0	2	10.60	13.31
0.0571	4.76	4.76	1	1	2.71	2.71
Korean house price and rent series						
0.1171	10.96	12.76	0	2	10.60	13.31
0.0203	1.81	1.81	1	1	2.71	2.71

Notes: P = real stock prices; D = dividends; HP = housing prices; rent= rent series.
　　　1. Monthly data from 1988:I to 2008:IV (non-logged real series)
　　　P_t = 89.0082　+ 12.9584　D_t + $S1_t$
　　　　(21.0537)　(2.6088)　　　　　　R Bar **2　0.0435
　　　Critical values: 1% = -3.512 5% = -2.897 10% = -2.586
　　　2. Quarterly data from 1987:I to 2009:II (non-logged real series)
　　　HP_t = -11.4036 + 1.0165　$Rent_t$ + $S2_t$
　　　　(-1.9096)　(8.1871)　　　　　　R Bar **2　0.3917
　　　Critical values: 1% = -3.505 5% = -2.894 10% = -2.584
　　　(Fuller [1976], Tables 8.5.1 and 8.5.2, pp.371~373). The details of the adjusted *t*-statistics $Z(t_b)$ can be found in the work of Phillips and Perron (1988).
　　　Eigenvalue: Eignevalue corresponding to the maximum likelihood function,
　　　Ho: r　Hypothesis about the cointegrating rank r.
　　　L-max: The likelihood ratio test statistic for testing r cointegrating vectors versus the alternative of r+1 cointegrating vectors; Trace: the likelihood ratio test statistic for testing the hypothesis of at most r cointegrating vectors. These are based on Johansen (1988). L-max90 and Trace90 are the corresponding critical values. Critical values indicate the corresponding statistics to be used for testing unit root.

<Table 3> reports estimates of the regression of mispricing component on current inflation rate, lagged inflation rates, and current and lagged inflation rates:

$$NFi_t = \alpha_i + \beta_i \; INF_t + e_{i,t}, \tag{11.1}$$

$$NFi_t = \alpha_i + \sum_{i=1}^{m} \beta_i \; INF_{t-i} + e_{i,t}, \tag{11.2}$$

$$NFi_t = \alpha_i + \sum_{i=0}^{m} \beta_i \; INF_{t-i} + e_{i,t}, \quad \text{for i} = 1, 2, 3, \tag{11.3}$$

where NF1 = mispricing component in asset prices (e.g., stock prices or housing prices), NF2 = mispricing component in the first differenced asset prices, and NF3 = mispricing component in the difference in log prices and log dividends (or rents).

***, **, and * represent significance at 1%, 5%, and 10% level, respectively.

For model (11.1) with the current inflation, we report a constant and coefficient of the current inflation. Adjusted R^2 is in percentage. For model (11.2) with lagged inflation rates, we report χ^2 test of the null that each coefficient is zero, and the sum of coefficients with the χ^2 test that the sum is zero. Adjusted R2 is in percentage. For model (11.3) with the current and lagged inflation rates, we report χ^2 test of the null that each coefficient is zero, and the sum of coefficients of the current and lagged inflation rates with the χ^2 test that the sum is zero. Adjusted R^2 is in percentage. SP and HP denote mispricing component in stock price and housing price, respectively.

Since U.S. stock prices and dividends are cointegrated, we use a loglinear model as discussed above by regressing the mispricing component of the spread (= log(p(t))-log(d(t))), (i.e., b_t = NF3$_t$, mispricing component in the difference in log prices and log dividends or rents), on inflation. We find that the adjusted R^2 is 0.005 when the current inflation rate is used as the regressor, 0.002 when six lagged inflation rates are used [i.e., INF(t-1) through INF(t-6)], and 0.004 when the current and six lagged inflation rates are used. While inflation rates appear to affect the mispricing component, inflation still explains little variation (less than 1%) in the mispricing component. Further, their net effect is positive rather than negative, which is not consistent with the inflation illusion hypothesis.

Overall, we find that the U.S. S&P stock market prices and fundamentals tend to move together over time, and inflation explains only a small fraction of various mispricing components of stock market prices. This indicates that the inflation illusion hypothesis is not effective in explaining the observed negative U.S. stock return and inflation relation.

<Table 3> Explanatory Power of Inflation for the Mispricing Component in Asset Prices

Panel A. The U.S.

	NF3	NF3
Current INF		
Constant	0.00	-0.00
Coefficient	0.03***	0.00
Adj. R^2	0.005	-0.003
Lagged INF		
Each coeff. = 0	13.84**	2.32
Sum of coeff.	0.05***	0.04
Adj. R^2	0.002	-1.000
Current & Lagged INF		
Each coeff. = 0	20.14***	2.59
Sum of coeff.	0.06***	0.04
Adj. R^2	0.004	-1.003

Panel B. The U.K.

	NF3	NF3
Current INF		
Constant	0.05**	0.00
Coefficient	-0.06***	0.00
Adj. R^2	0.099	-0.001
Lagged INF		
Each coeff. = 0	71.39***	0.79
Sum of coeff.	-0.17***	0.02
Adj. R^2	0.311	-0.047
Current & Lagged INF		
Each coeff. = 0	67.66***	0.85
Sum of coeff.	-0.17***	0.02
Adj. R^2	0.311	-0.062

Panel C. Korea

	NF3	NF2
Current INF		
Constant	0.53***	0.03
Coefficient	-0.45***	-0.03
Adj. R^2	0.190	-0.010
Lagged INF		
Each coeff. = 0	43.76***	10.99**
Sum of coeff.	-0.87***	-0.62***
Adj. R^2	0.372	0.116
Current & Lagged INF		
Each coeff. = 0	44.89***	11.57**
Sum of coeff.	-0.92***	-0.57***
Adj. R^2	0.373	0.117

In Panel A of <Table 2>, we find that both U.S. housing prices and rent series are nonstationary, I(1), series, and the linear combination of the housing prices and rent series (i.e., the spread S2) is an I(0) series, in particular, by the Phillips-Perron unit root tests, implying that they are cointegrated of order (1,1). We further implement Johansen's cointegration tests using maximum likelihood and trace tests. Both tests show that the null of no cointegration is rejected at the conventional significance level of 10%, which indicates that there is at least one cointegration vector between real housing prices and rent series. This indicates that the mispricing component of housing price is stationary. This implies that the deviation of housing prices from fundamentals (i.e., rent) is not non-stationary, and that housing prices and fundamentals tend to move together over time so there is little chance of a potential non-stationary bubble in housing prices.

Since U.S. housing prices and rent series are cointegrated, we use a loglinear model by regressing the mispricing component of the spread (= log(hp(t))-log(rent(t))), (i.e., $b_t = NF3_t$), on inflation. We find that the adjusted R^2 is -0.003 when the current inflation rate is used as the regressor, -0.010 when six lagged inflation rates are used [i.e., INF(t-1) through INF(t-6)], and -0.013 when the current and six lagged inflation rates are used. Further, inflation rates tend to have an insignificant positive effect on the mispricing component, which is inconsistent with

the inflation illusion hypothesis.

Overall, we find a stationary mispricing component in the U.S. housing prices, and inflation does not explain the mispricing component of the housing prices regardless of different modeling of the mispricing component. Further, the effect of inflation on the housing mispricing component is insignificant. This implies that the inflation illusion is not effective in explaining the observed negative U.S. housing return and inflation relation.

Now we examine a potential asymmetric relation between mispricing and inflation as discussed in Section 2.3 with regression (11.4). The estimation results of the asymmetric regression models are presented in <Table 4>. In Panel A, we report the results for the U.S. stock and housing markets. For the U.S. stock market prices, the regression of the mispricing component in the loglinear model, NF3, has an adjusted R^2 of 0.077. In the regression of NF3, positive inflation has a negative effect, but negative inflation has a positive effect on the mispricing, which is not fully consistent with the illusion hypothesis.

For the U.S. housing market, positive inflation has an insignificant positive effect while negative inflation has an insignificant negative effect on the mispricing component, which is not consistent with the illusion hypothesis. That is, the negative relation between housing returns and inflation for the U.S. is not consistent with the inflation illusion hypothesis regardless of whether we take into account the potential asymmetric relations.

$$NFi_t = a + b1 \ \pi1_t + b2 \ \pi2_t, \text{ for i = 1, 2, 3,} \qquad (11.4)$$

where $\pi1_t$ = positive inflation; $\pi2_t$ = negative inflation,
NF1 = mispricing component in asset prices (e.g., stock prices or housing prices), NF2 = mispricing component in the first differenced asset prices, and NF3 = mispricing component in the difference in log prices and log dividends (or rents).

SP and HP denote mispricing component in stock price and housing price, respectively.

***, **, and * represent significance at 1%, 5%, and 10% level, respectively.

<Table 4> Asymmetric Relation between Mispricing and Inflation

Panel A. The U.S.

	NF3	NF3
Constant	0.08***	-0.00
Coeff. of $\pi 1_t$	-0.09***	0.02
Coeff. of $\pi 2_t$	0.17***	-0.01
Adj. R^2	0.077	-0.002
χ^2 (1) test	134.03***	0.76
Signi. level	0.000	0.382

Panel B. The U.K.

	NF3	NF3
Constant	0.05**	-0.01
Coeff. of $\pi 1_t$	-0.06***	0.01
Coeff. of $\pi 2_t$	-0.03	-0.10
Adj. R^2	0.088	-0.017
χ^2 (1) test	0.02	0.48
Signi. level	0.879	0.490

Panel C. Korea

	NF3	NF2
Constant	0.70***	0.06
Coeff. of $\pi 1_t$	-0.54***	-0.04
Coeff. of $\pi 2_t$	2.62***	-0.14
Adj. R^2	0.215	-0.022
χ^2 (1) test	14.61***	0.04
Signi. level	0.000	0.839

3. The U.K.

Panel B of <Table 2> shows that both stock prices and dividends are nonstationary, I(1), series, and the linear combination of the stock prices and dividends (i.e., the spread S1) is stationary, implying that they are cointegrated of order (1,1). To be more precise, we obtain somewhat mixed unit root test results. Dividends are stationary by the Phillips-Perron test and the spread between stock prices and dividends is nonstationary by the Dickey-Fuller test. However, the

Johansen tests show that they are cointegrated: Johansen's cointegration tests using maximum likelihood and trace tests show that the null of no cointegration is rejected at the conventional significance level of 10%, which indicates that there is at least one cointegration vector between real stock prices and dividends. This implies that the mispricing component of the U.K. stock market price is stationary as in the case of the U.S.

Since U.K. stock prices and dividends are cointegrated, we use a loglinear model by regressing the mispricing component of the spread (= log(p(t))-log(d(t))), (i.e., b_t = $NF3_t$), on inflation. We find that the adjusted R^2 is 0.099 when the current inflation rate is used as the regressor, 0.311 when four lagged inflation rates are used [i.e., INF(t-1) through INF(t-4)], and 0.311 when the current and four lagged inflation rates are used. Further, inflation rates affect the mispricing component, and their net effect is significantly negative, which is consistent with the inflation illusion hypothesis.

Overall, we find that the U.K. stock market prices and fundamentals tend to move together over time, and inflation explains some fraction of the mispricing component of stock market prices with their net effect being negative. This implies that the inflation illusion hypothesis helps explain the observed negative relation between U.K. stock returns and inflation.

We now turn to the U.K. housing market prices. Panel B of <Table 2> shows that both the housing index and rent series are nonstationary, I(1), series, and the linear combination (i.e., the spread S1) is stationary, implying that they are cointegrated of order (1,1). To be more precise, we obtain somewhat mixed unit root test results. Housing prices are stationary by the Dickey-Fuller test and the spread between housing prices and dividends is nonstationary by the Phillips-Perron test. However, the Johansen tests show that they are cointegrated: Johansen's cointegration tests in Panel B show that the null of no cointegration is rejected at the conventional significance level of 10%, which indicates that there is at least one cointegration vector between real housing index and rent series. This indicates that the mispricing component of the U.K. housing index is stationary.

Since U.K. housing prices and rent series are cointegrated, we use a loglinear model by regressing the mispricing component of the spread (= log(hp(t))-log(rent(t))), (i.e., b_t = $NF3_t$), on inflation. We find that the adjusted R^2 is -0.012 when the current inflation rate is used as the regressor, -0.048 when four lagged inflation rates are used [i.e., INF(t-1) through INF(t-4)], and -0.062 when the current and four lagged inflation rates are used. Further, inflation rates as a group do not affect the mispricing component, and their net effect is insignificant, which is not consistent with the inflation illusion hypothesis.

Overall, we find that the U.K. housing prices and fundamentals tend to move together over time, and inflation does not explain the mispricing component of housing prices with their net effect being insignificant. This indicates that the inflation illusion hypothesis does not help explain the U.K. housing return and inflation relation.

Now we examine a potential asymmetric relation between mispricing and inflation. In Panel B of <Table 4>, we report the results for the U.K. For the U.K. stock prices, using the loglinear model, NF3, the adjusted R^2 is 0.088. However, in the regression, while positive inflation has a negative effect on mispricing components, negative inflation does not have a significant negative effect on the mispricing component, which is not fully consistent with the illusion hypothesis. For the U.K. housing prices, inflation rates have little explanatory power for the regression. Overall, when we take into account the potential asymmetric relation for positive and negative inflation, we do not find any significant evidence in favor of the inflation illusion hypothesis either for the U.K. stock market or for the U.K. housing market.

4. Korea

In Panel C of <Table 2>, we find some mixed results for the unit root tests for Korean stock market prices and dividends. Still, we find some evidence that both stock prices and dividends are nonstationary, I(1), series, and the linear combination (i.e., the spread S1) is marginally stationary, implying that they are cointegrated of order (1,1). Johansen's cointegration tests in Panel C also show that the null of no cointegration is rejected at the conventional significance level of 10%, which indicates that there is at least one cointegration vector between real stock prices and dividends. This implies that the mispricing component of stock price is stationary as in the case of the U.S. and the U.K.

Since Korean stock prices and dividends are cointegrated, we use a loglinear model by regressing the mispricing component of the spread (= log(p(t))-log(d(t))), (i.e., $b_t = NF3_t$), on inflation. We find that the adjusted R^2 is 0.190 when the current inflation rate is used as the regressor, 0.372 when four lagged inflation rates are used [i.e., INF(t-1) through INF(t-4)], and 0.373 when the current and four lagged inflation rates are used. Further, inflation rates as a group affect the mispricing component, and their net effect is significantly negative, which is consistent with the inflation illusion hypothesis.

Overall, we find that Korean stock market prices and fundamentals tend to move

together over time, and inflation explains some fraction (up to 37%) of the mispricing component of stock market prices with their net effect being negative. This indicates that the inflation illusion hypothesis helps explain the Korean stock return and inflation relation.

We now turn to Korean housing market. Panel C of <Table 2> shows that although both the housing index and rent series are nonstationary, I(1), series, the linear combination of housing prices and rent series (i.e., the spread S1) is not stationary by either unit root test, implying that they are not cointegrated of order (1,1). However, Johansen's cointegration tests in Panel C show mixed results. The null of no-cointegration is rejected by the maximum likelihood test but is not rejected by the trace test at the conventional significance level of 10%. This implies that the mispricing component of housing prices is marginally nonstationary. This suggests that Korean housing prices may deviate from fundamentals so there is some chance of a potential bubble in Korean housing prices.

Given this finding, when we regress the mispricing component of the first differenced housing prices (i.e., $\Delta b_t = $ NF2$_t$, mispricing component in the first differenced asset prices), which can be appropriate for the Korean housing market because housing prices and rent series are not strongly cointegrated, the adjusted R^2 is -0.011 when the current inflation rate is used as the regressor, 0.117 when four lagged inflation rates are used [i.e., INF(t-1) through INF(t-4)], and 0.117 when the current and four lagged inflation rates are used. Here we find that inflation explains some variation in the mispricing component in the first differenced housing prices in particular when lagged inflation rates are included. Further, inflation rates as a group have a significant negative effect on the mispricing, which is consistent with the inflation illusion hypothesis.

Overall, we find that Korean housing prices and fundamentals are not strongly cointegrated, leaving a potential bubble in housing prices. When we use linear non-cointegrated model, inflation has significant negative effect on the mispricing component. This indicates that the inflation illusion hypothesis has some chance to explain Korean housing return and inflation relation.

Now we examine a potential asymmetric relation between mispricing and inflation as discussed in Section 2.3 with regression (11.4). In Panel C of <Table 4>, we report the results for Korea. For Korean stock prices, as in the case of the symmetric regressions, inflation rates have some explanatory power for the mispricing component of the loglinear model, NF3, with adjusted R^2 of 0.215. However, in the regression of NF3, while positive inflation has a significant negative effect on the mispricing component, negative inflation has a significant positive effect on the mispricing component, which is not fully consistent with the

illusion hypothesis.

For Korean housing prices, using the linear non-cointegrated model with NF2, adjusted R^2 is -0.022 and neither positive nor negative inflation has any significant effect on the mispricing component. Overall, when we take into the potential asymmetric relation for positive and negative inflation, we do not find any significant evidence in favor of the inflation illusion hypothesis for either the Korean stock market or for the Korean housing market.

IV. Further Analysis with Consumer Sentiments

Since we find only limited evidence for the inflation illusion hypothesis, we further examine whether the mispricing in the asset prices is related to more general behavioral factors such as investor sentiment in an attempt to find other factors that may explain the mispricing in asset prices using consumer confidence as a measure of investor optimism.[9]

An interesting question would be which variable, between inflation and consumer sentiment, has more explanatory power for the mispricing component. To answer this question, we include both the current inflation (INF) and consumer sentiment index (CS) in the regression of mispricing components:

$$ NFi_t = \alpha_i + \beta_i \ INF_t + \gamma_i \ CS_t + e_{i,t}, \quad \text{for i = 1, 2, and 3,} \tag{11.5} $$

where NF1 = mispricing component in asset prices (e.g., stock prices or housing prices), NF2 = mispricing component in the first differenced asset prices, and NF3 = mispricing component in the difference in log prices and log dividends (or rents).[10]

The estimation results are presented in <Table 5>. In Panel A for the U.S. stock

---

9 Consumer sentiment has received much attention in the literature as a potential measure of investor optimism (e.g., Fisher and Statman [2002]; Doms and Morin [2004]; Lemmon and Portniaguina [2006]).

10 The consumer sentiment index data are obtained from the University of Michigan for the U.S. for the sample period of 1978:1 through 2009:6 (http://www.sca.isr.umich.edu/main.php), from the web page of the European Commission for the U.K. for the sample period of 1989:I through 2008:III (http://ec.europa.eu/ economy_finance/db_indicators/surveys/index_en.htm), and from Bank of Korea for Korea for the sample period of 1995:II through 2009:II (http://www.index.go.kr/ egams/stts/jsp/potal/stts/PO_STTS_Idx Main.jsp ?idx_cd=1058).

market (under the heading of SP), for the mispricing component of stock prices based on linear models of NF1 and NF2, inflation does not explain the mispricing component while the consumer sentiment index is significant. Further, the consumer sentiment has a positive effect on both mispricing components. In the mispricing component of stock prices based on loglinear model (NF3), both inflation and consumer sentiment are significant. Overall, for the U.S. stock market, we find that consumer sentiment is more important than inflation in explaining the mispricing component.

<Table 5> reports estimates of the regression of mispricing component on inflation rate (INF) and consumer sentiment index (CS):

$$NFi_t = \alpha_i + \beta_i \ INF_t + \gamma_i CS_t + e_{i,t}, \tag{11.5}$$

where NF1 = mispricing component in asset prices (e.g., stock prices or housing prices), NF2 = mispricing component in the first differenced asset prices, and NF3 = mispricing component in the difference in log prices and log dividends (or rents).

***, **, and * represent significance at 1%, 5%, and 10% level, respectively.

For model (11.5), for each mispricing component, we report a constant and coefficients of the current inflation and the current consumer sentiment index. Adjusted R^2 is in percentage. SP and HP denote mispricing component in stock price and housing price, respectively.

In the column of the U.S. housing market (under the heading of HP), for the mispricing component of NF1 and NF3, consumer sentiment has a significantly positive effect on the housing mispricing component while inflation does not have any significant effect. Again, consumer sentiment seems to dominate in explaining U.S. housing market mispricing component. For NF2, the mispricing component based on non-cointegrated linear model, the model appears to be inappropriate given that the adjusted R^2 is negative.

In Panel B for the U.K. stock market, for both NF1 and NF3, consumer sentiment has stronger effect on the mispricing component than inflation. NF2 model appears to be inappropriate in this context given that the adjusted R^2 is negative. For the housing market, again consumer sentiment has significant positive effect on the mispricing component of NF1 and NF2 while inflation is insignificant in both mispricing component. Therefore, consumer sentiment seems to dominate inflation in explaining U.K. stock market and housing market mispricing components.

In Panel C for Korean stock market, consumer sentiment has significant positive effect on both NF1 and NF3 while inflation is insignificant in both models. In Korean housing market, in all three mispricing components, consumer sentiment is

<Table 5> Explanatory Power of Inflation and Consumer Sentiment for the Mispricing
           Component in Asset Prices

Panel A. the U.S.
1978:1 ~ 2009:6

	SP			HP		
	NF1	**NF2**	**NF3**	**NF1**	**NF2**	**NF3**
Current INF						
Constant	-13.34***	-42.55*	-1.33**	-97.47***	-18.04	-0.21***
Coefficient (INF)	-0.51	-1.15	1.66***	5.68	-0.88	0.002
Coefficient (CS)	0.16***	0.51**	-0.03***	1.06	0.21	0.002***
Adj. R^2	0.374	0.027	0.327	0.25	-0.002	0.144

Panel B. The U.K.
1989:1 ~ 2008:3

	SP			HP		
	NF1	**NF2**	**NF3**	**NF1**	**NF2**	**NF3**
Current INF						
Constant	37.31***	2.07	0.13***	2.37	0.55	-0.01
Coefficient (INF)	-9.32**	-1.91	-0.04**	-0.08	-0.09	0.002
Coefficient (CS)	3.56***	0.05	0.01***	0.28**	0.06**	0.001
Adj. R^2	0.494	-0.013	0.459	0.037	0.037	-0.024

Panel C. Korea
1995:3 ~ 2009:2

	SP			HP		
	NF1	**NF2**	**NF3**	**NF1**	**NF2**	**NF3**
Current INF						
Constant	-79.08***	-1.03	-2.08	5.10	-1.50**	0.11
Coefficient (INF)	-1.30	-1.26	-0.22	-0.03	-0.03	0.005
Coefficient (CS)	1.04***	0.04	0.03*	-0.08*	0.02***	-0.002*
Adj. R^2	0.103	-0.031	0.089	0.009	0.193	0.022

significant while inflation is insignificant. However, the sign of the consumer sentiment is weakly negative in NF1 and NF3 with relatively low adjusted R^2 (0.93% and 2.23%, respectively). But in NF2 model, consumer sentiment has strong positive effect on the housing mispricing component with relatively high adjusted R^2 of 19.30%. Therefore, overall, consumer sentiment seems to dominate inflation in explaining both Korean stock market and housing market mispricing components.

Overall, our finding shows that, between inflation rates and consumer sentiment indexes, the latter has a stronger explanatory power for the mispricing components in asset prices of the U.S. the U.K. and Korea regardless of the stock market or the housing market. This suggests that the mispricing in asset prices is more likely due to consumer sentiment than inflation illusion, although both may be behavioral factors.

V. Concluding Remarks

Given the recent debate on the empirical validity of the inflation illusion hypothesis and recent implosion of asset prices combined with potential inflationary pressure, we have examined whether the observed negative relations between stock returns and inflation and between housing returns and inflation can be explained by the inflation illusion. A subjective risk-premium proxy that is used for the calculation of the mispricing component for the U.S. stock market is not easily available for the housing market and other countries. Therefore, we identify the mispricing component in the asset prices (i.e., stock prices and housing prices) based on present value models, both linear and loglinear models, and then investigate whether inflation can explain the mispricing component by using the data from the three countries, the U.S., the U.K., and Korea. We examine not only the extent of the explanatory power of inflation rates for the mispricing components but also the negative effect of inflation rates, as the inflation illusion hypothesis anticipates.

We find some evidence for the inflation illusion hypothesis for the stock return-inflation relation for the U.K. and Korea and for the housing return-inflation relation for Korea in that the inflation rates explain some fraction of mispricing components and their effect on mispricing is negative. When we take into account a potential asymmetric effect of positive and negative inflation on the mispricing components in asset prices, which is an important implication of the inflation illusion hypothesis,

we find that none of these asset prices is compatible with the inflation illusion hypothesis in that both positive and negative inflation rates do not have a negative effect on the mispricing components.

Therefore, we find only limited evidence for the inflation illusion hypothesis, which is consistent with recent studies that cast doubt on the empirical validity of the hypothesis for various reasons (e.g., Thomas and Zhang [2007]; Chen, Lung, and Wang [2009]; Wei and Joutz [2009]). As discussed by Piazzesi and Schneider (2007), one way to understand the finding of limited evidence for the inflation illusion hypothesis is that a very small fraction of investors, if any, suffer from it and as a result we anticipate a non-monotonic relation between asset returns and inflation.

We further examine whether behavioral factors such as consumer sentiment can better explain the mispricing components in asset prices. When we include both the inflation rate and the consumer sentiment index in the regression of the mispricing components, the consumer sentiments tend to have a significant positive effect on the mispricing component while inflation loses its explanatory power. This observation is made for both stock market prices and housing market prices for the three countries we consider. Therefore, we find evidence that behavioral factors such as consumer sentiment could have contributed to the mispricing in asset prices.

References

Brandt, Michael W. and Kevin Q. Wang, "Time-varying Risk Aversion and Unexpected Inflation," *Journal of Monetary Economics* 50, 2003, pp.1,457~1,498.

Brunnermeier, Markus K. and Christian Julliard, "Money Illusion and Housing Frenzies," *Review of Financial Studies* 21(1), 2008, pp.135~180.

Campbell, John Y., "A Variance Decomposition for Stock Returns," *Economic Journal* 101, 1991, pp.157~179.

Campbell, J. Y. and John Ammer, "What Moves the Stock and Bond Markets? A Variance Decomposition for Long-term Asset Returns," *Journal of Finance* 48(1), 1993, pp.3~37.

Campbell, John Y. and Robert J. Shiller, "Stock Prices, Earnings and Expected Dividends," *Journal of Finance* 43, 1988a, pp.661~676.

_____, "The Dividend-price Ratio and Expectations of Future Dividends and Discount Factors," *Review of Financial Studies* 1(3), 1988b, pp.195~228.

Campbell, John Y. and Tuomo Vuolteenaho, "Inflation Illusion and Stock Prices," *American Economic Review Papers and Proceedings* 94, 2004, pp.19~23.

Chatrath, Arjun and Youguo Liang, "REITs and Inflation: A Long-run Perspective," *Journal of Real Estate Research* 16(3), 1998, pp.311~325.

Chen, Carl R., Peter P. Lung, and F. Albert Wang, "Stock Market Mispricing: Money Illusion or Resale Option?" *Journal of Financial and Quantitative Analysis* 44(5), 2009, pp.1,125~1,147.

Cohen, R., C. Polk, and T. Vuolteenaho, "Money Illusion in the Stock Market: the Modigliani-Cohn Hypothesis," *Quarterly Journal of Economics* 120, 2005, pp.639~668.

Doms, M. and N. Morin, "Consumer Sentiment, the Economy, and the News Media," Working Paper, Federal Reserve Bank of San Francisco, 2004.

Fama, E. F., "Stock Returns, Real Activity, Inflation and Money," *American Economic Review* 71, 1981, pp.545~565.

Fama, E. F., "Stock Returns, Real Activity, Inflation and Money: Reply," *American Economic Review* 73, 1983, pp.471~472.

Feldstein, Martin, "Inflation and the Stock Market," *American Economic Review* 70(5), 1980, pp.839~847.

Fisher, K. L. and M. Statman, "Consumer Confidence and Stock Returns," Working Paper, Santa Clara University, 2002.

Fuller, W., *Introduction to Statistical Time Series*, New York: John Wiley, 1976.

Geske, R. and R. Roll, "The Monetary and Fiscal Linkage between Stock Returns and Inflation," *Journal of Finance* 38, 1983, pp.1~33.

Hansen, L. P. and T. J. Sargent, "Formulating and Estimating Dynamic Linear Rational-expectations Models," *Journal of Economic Dynamics & Control* 2, 1980, pp.7~46.

Hartzell, David J., Crocker H. Liu, and Martin E. Hoesli, "International Evidence on Real Estate Securities as an Inflation Hedge," *Real Estate Economics* 25(5), 1997, pp.193~221.

Johansen, Soren, "Statistical Analysis of Cointegration Vectors," *Journal of Economic Dynamics & Control* 12, 1988, pp.231~254.

Lee, Bong Soo, "Permanent, Temporary, and Nonfundamental Components of Stock Prices," *Journal of Financial and Quantitative Analysis* 33(1), 1998, pp.1~32.

Lemmon, M. and E. Portniaguina, "Consumer Confidence and Asset Prices: Some Empirical Evidence," *Review of Financial Studies* 19(4), 2006, pp.1,499~1,529.

Modigliani, F. and R. Cohn, "Inflation, Rational Valuation, and the Market," *Financial Analysts Journal* 35, 1979, pp.24~44.

Pagan, Adrian, "Econometric Issues in the Analysis of Regressions with Generated Regressors, *International Economic Review* 25(1), 1984, pp.221~247.

Piazzesi, Monika and Martin Schneider, "Inflation Illusion, Credit, and Asset Pricing," NBER Working Paper, No. W12957, 2007.

Phillips, Peter C. B. and Pierre Perron, "Testing for a Unit Root in Time Series Regression," *Biometrika* 75, 1988, pp.335~346.

Ritter, J. R. and R. S. Warr, "The Decline of Inflation and the Bull Market of 1982~99," *Journal of Financial and Quantitative Analysis* 37, 2002, pp.29~61.

Thomas, Jacob and Frank Zhang, "Inflation Illusion and Stock Prices: Comment," Working Paper, Yale University, 2007.

Wei, Chao, "Inflation and Stock Prices: No Illusion," *Journal of Money, Credit and Banking* 42, 2010, pp.325~346.

Wei, Chao and Fred Joutz, "Inflation Illusion or No Illusion: What did Pre- and Post-War Data Say?" Working Paper, George Washington University, 2009.

⟨Website⟩

http://www.econ.yale.edu/~shiller/data.htm.

http://land.kbstar.com/quics?asfilecode=5023&_nextPage=page=B002188&weblog=l_gnb_C4.

http://www.kosis.kr/domestic/theme/do01_index.jsp.

http://ecos.bok.or.kr.

http://www.sca.isr.umich.edu/main.php.

http://ec.europa.eu/ economy_finance/db_indicators/surveys/index_en.htm.

http://www.index.go.kr/egams/stts/jsp/potal/stts/PO_STTS_Idx Main.jsp?idx_cd=1058.