ISSN 1975-5163

WORKING PAPER No.352

November
2008

Inflation Volatility and Stock Returns: Some International Evidence

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I would like to thank Jeff Madura, Alan Viard, H. Youn Kim, Keun Y. Lee, Yun Dokko, Tong H. Lee, Charles Register, Jon Ford, Seung H. Jwa, Joo H. Nam, and seminar participants at the Bank of Korea, Texas A&M University, Florida Atlantic University, Yonsei University, and the Korea Economic Research Institute (KERI) for valuable comments and suggestions. Comments on the earlier version of the paper provided by H. Youn Kim and Alan Viard have improved the paper significantly. This work was financially supported by the Institute for Monetary and Economic Research(IMER) at the Bank of Korea. I am particularly grateful to the IMER for providing me with an opportunity to present the paper at the 2008 KAEA-BOK conference. Any errors are the responsibility of the authors.

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Since negative relations between stock returns and expected inflation were observed in the post-war U.S. data, a number of studies have attempted to explain the seemingly paradoxical return-inflation puzzle. Our model links the variability of real stock returns to the variability of consumption velocity and shows that real stock returns tend to co-vary negatively with expected inflation during a period of stable inflation (or in a stable-price regime) and to co-vary positively with expected inflation during a period of volatile inflation (or in a volatile-price regime). Long-run real stock returns are shown to be positively related to expected inflation. We have conducted an empirical investigation of our propositions using quarterly data for 16 countries. The empirical results provide consistent support for our propositions, suggesting that the relation between stock returns and expected inflation is negative when the standard deviation of the inflation rate is lower than 10 percent, and positive when the standard deviation of the inflation rate is higher than 10 percent. Our propositions and findings are parallel to those of Akerlof-Dickens-Perry and Lucas who have found that the relationship between the unemployment rate and the inflation rate is contingent on inflation volatility.

Key Words: real stock returns, hedge, Fisher effect, velocity, volatile inflation, stable inflation, CRRA

JEL Classification Number: E44, G12

Ⅰ. Introduction

Conventional wisdom suggests that if investors hold stocks as a hedge against inflation, stock returns and expected inflation should be positively related. Such a positive relation appears to be consistent with investors' optimal portfolio choice. While this assumed positive relation is intuitively appealing, empirical evidence on the issue is, at best, not persuasive and, at worst, contradictory. There has been a wealth of evidence that negative relations between stock returns and inflation have prevailed since the 1950s in the United States and other countries as well.

The theoretical basis for the assumed positive relation between returns on common stocks and inflation is provided by the extended version of the Fisher effect which states that the expected rate of return on common stocks consists of a real return and the expected inflation rate and that the real return is not affected by the rate of inflation. The earlier work of Nelson (1976), Jaffe and Mandelker (1976), Bodie (1976), Fama and Schwert (1977), Solnik (1983), and Gultekin (1983) was mainly concerned with whether the Fisher hypothesis holds true in the U.S. stock market. Most of the studies found that nominal stock returns were negatively related to inflation rates over the post-war period, thus rejecting the view that common stocks are effective hedges against inflation.[1]

Subsequent studies including Fama (1981), Stulz (1986), Kaul (1987), Lee (1992) have been extended to analyze the relationship between real (ex post and ex ante) stock

1. Fama and Schwert (1977) show that U.S. government bonds were a complete hedge against expected inflation, and private residential real estate was a complete hedge against both expected and unexpected inflation.

returns and expected inflation, changes in expected inflation, and unexpected inflation. The majority of studies have confirmed negative relations between real stock returns and both expected and unexpected inflation, although the strength of a negative relationship is varying.[2] Schwert (1981) has further observed that the stock market reacted negatively to the announcement of unexpected inflation, but concluded that the most puzzling result of why aggregate stock returns were negatively related to the level of expected inflation remained a mystery.

The literature in this area has evolved with different layers of assumptions and specifications over the past three decades or so. Some studies such as LeRoy (1984), Stulz (1984), Danthine and Donaldson (1986), and Bakshi and Chen (1996) have sought to explain the anomalous results in the context of general equilibrium models, while others have analyzed the relation in the partial equilibrium framework. Some models such as Fama (1981), Fama and Gibbons (1982), Geske and Roll (1983), and Hasbrouck (1984) have attempted to establish a link between inflation and real activity, but many studies including LeRoy (1984), Stulz (1986), Danthine and Donaldson (1986), Boyle (1990),

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2. Fama (1981) examined relations between real stock returns and both expected and unexpected inflation, but the evidence on the relations between real stock returns and unexpected inflation is less consistent. Stulz (1986) investigated the relationship between real stock returns and expected inflation, changes in expected inflation, and unexpected inflation and found that the strength of the relationship was weaker when the increase in expected inflation was caused by an increase in money growth rather than by a worsening of the investment opportunity set. Kaul (1987) found negative relations between real stock returns and expected, unexpected, and changes in expected inflation under counter-cyclical monetary policy regimes and positive relations under pro-cyclical monetary policy regimes. Lee (1992) observed that nominal stock returns and changes in expected inflation are weakly negatively correlated, and real stock returns and ex post inflation are mildly negatively correlated.

Marshall (1992), Bakshi and Chen (1996) have explained the stock return-inflation relation in the monetary asset pricing setting.

The return-inflation relation has recently provoked further controversies among economists as some studies have found even positive relations between real stock returns and expected inflation. These recent studies focus on the theoretical reconciliation of the seemingly contradictory results. The issues discussed in the recent literature include (1) the measure of expected inflation constructed from time series models versus survey data (Hasbrouck, 1984); (2) increases in expected inflation caused by an increase in money growth versus a worsening of the production opportunity set (Stulz, 1986); (3) counter-cyclical versus pro-cyclical monetary policy responses (Kaul, 1987, Park and Ratti, 2000); (4) inflation generated by monetary fluctuations versus inflation resulting from real economic fluctuations (Danthine and Donaldson, 1986, Marshall, 1992); (5) short-horizon versus long-horizon returns (Boudoukh and Richardson, 1993); and (6) cyclical versus non-cyclical movements in industry output (Boudoukh, Richardson, and Whitelaw, 1994). Although these recent studies have attempted to reconcile the conflicting results, no clear resolution of the puzzle has been provided yet.

The purpose of this study is to offer a consistent explanation for the return-inflation paradox within an inter-temporal portfolio choice framework. One important channel connecting real stock returns and expected inflation in this study is the behavior of velocity in the context of asset choices. The importance of velocity in explaining the behavior of asset prices has been noted by several authors such as Fama (1981), Friedman

(1988), Boyle (1990), Marshall (1992), and Bakshi and Chen (1996).[3] Our model converts the consumption-based asset pricing model into a relation between asset returns and consumption velocity and establishes a link between the high volatility of asset returns and the high volatility of velocity.

This approach is particularly important in that the traditional representative-agent model, given its reliance on consumption growth, has failed to reconcile the high variability of real asset returns with the low variability of consumption growth. Cochrane (1991, 1992, 1996), Kim (2003), and others have noted that production variables such as output growth, investment, and technology shocks are more volatile than consumption and proposed production-based (or investment-based) asset pricing models in which expected stock returns are significantly correlated to production activity. Our study offers a new perspective on the relation between stock returns and expected inflation by linking explicitly the behavior of stock returns to the velocity of consumption that contains information about inflation, production, and monetary growth.

The essence of our velocity-based capital asset pricing model (VCAPM) is that relations between real stock returns and expected inflation are contingent on the degree of

3. Fama (1981) implicitly recognizes the importance of the role of velocity in explaining the relation between real stock returns and expected inflation. He notes that the spurious negative relations between inflation and expected real returns are induced by a somewhat unexpected characteristic of the money supply process during the post-1953 period, in particular, the fact that most of the variation in real money demanded in response to variation in real activity has been accommodated through offsetting variation in inflation rather than through nominal money growth. The money supply process, real money demanded, real activity, and inflation are all essential elements of velocity. Bakshi and Chen (1996) also note that nominal stock prices are negatively related to the contemporaneous velocity of money, while real stock prices are positively correlated with the velocity of money three quarters ahead (Friedman, 1988).

the volatility of inflation. More specifically, our model suggests that real stock returns tend to co-vary negatively with expected inflation in a period of stable inflation (or in a stable-price regime) and to co-vary positively with expected inflation in a period of volatile inflation (or in a volatile-price regime). Furthermore, the model predicts that in the long run real stock returns should be positively related to expected inflation. One possible explanation for the positive relation associated with volatile inflation is that increased inflation uncertainty may lead to an increased required risk premium for stocks.

We have conducted an empirical analysis of our model using quarterly data for 16 countries. Our empirical study has confirmed a negative relation between real stock returns and expected inflation in stable-price countries and a positive relation in volatile-price countries, thus providing consistent support for our propositions. We have further found that the standard deviation of the inflation rate that divides between positive and negative relations is roughly 10 percent.

To a surprising extent, the results derived from our velocity-based asset pricing model appear to be similar to those obtained from rational expectations macroeconomic models which have shown that the degree of inflation volatility matters in economic relations. For example, Lucas (1973) has demonstrated that the trade-off between inflation and unemployment holds more strongly in a stable price country than in a volatile price country. Put differently, the Phillips curve is steeper in a volatile price regime than in a stable price regime. In a recent study, Akerlof, Dickens, and Perry (2000) have found that the relation between inflation and the natural rate of unemployment depends on the volatility of inflation, indicating that unemployment can be reduced below its natural level without inducing a rise in inflation when inflation is low and stable. Our conclusion is parallel to this line of research.

The plan of the paper is as follows: Section 2 reviews the recent theoretical and empirical literature. In section 3, we develop a velocity-based capital asset pricing model (VCAPM) in the context of the inter-temporal portfolio choice problem. Section 4 discusses the implications of the VCAPM in relation to the stock return-inflation puzzle. Section 5 presents empirical results. Section 6 contains a summary and concluding remarks.

Ⅱ. A Review of the Recent Literature

This review focuses on the recent attempts to reconcile seeming contradictions concerning the relation between stock returns and expected inflation. Day (1984) has attempted to resolve the puzzle by noting that the correlation between expected real returns and expected inflation is affected by investors' preferences and the form of the production process. When the production function exhibits stochastic constant returns to scale, the model explains the negative relation between expected real returns and expected inflation.

Hasbrouck (1984) has argued that there has been an invariably significant negative relation between real stock returns and the expected inflation measure constructed from time series models, but survey data (the Livingston forecasts of economic activity) have been shown to be somewhat negatively related to expected inflation when monetary growth is held constant. When the proxy for real uncertainty is included in the return specification along with economic activity and expected inflation, the coefficient of expected inflation using the Livingston expected inflation proxy becomes positive (but not significant). Stulz (1986) has shown that variability of real activity and expected inflation are negatively related. He has argued that the fall in real wealth associated with an increase in expected inflation decreases the expected real rate of return of the market portfolio. The expected real rate of return of the market portfolio falls less, for a given increase in expected inflation, when the increase in expected inflation is caused by an increase in money growth rather than by a worsening of the production opportunity set.

Danthine and Donaldson (1986) have argued that asset and commodity prices, rates of return, and rates of inflation are variables that are simultaneously determined and consequently are not independent of one another. Their general equilibrium model supports the evidence that real rates of return are negatively correlated with the rate of inflation. Their study also suggests that common stocks are not a good hedge against inflation of a non-monetary origin, but stocks will offer protection over the long run against purely monetary inflation. Bakshi and Chen (1996) have also offered a monetary asset pricing model in a general equilibrium setting in which the price level, inflation, asset prices, and the real and nominal interest rates are determined simultaneously and in relation to each other. They have shown that for many types of monetary economies, real stock returns are negatively correlated with expected or unexpected inflation, and are positively correlated with money growth.

Kaul (1987) has examined two types of monetary responses: counter-cyclical and pro-cyclical. He has proposed that counter-cyclical monetary responses lead to negative relations between real stock returns and expected inflation (or unexpected inflation or changes in expected inflation). Kaul has further hypothesized that money demand effects combined with pro-cyclical monetary responses would result in insignificant or even positive relations between stock returns and inflation, as was confirmed in the United States during the 1930s. Marshall (1992) has investigated the relation between real stock returns and expected inflation in the dynamic context of a monetary inter-temporal asset pricing model. He has found that the relation between real stock returns and expected inflation is strongly negative when inflation is caused by real economic fluctuations and is ambiguous in sign and small in magnitude when inflation is caused by monetary fluctuations.

Boudoukh and Richardson (1993) have employed a long-horizon representation of the Fisher equation to test the hypothesis that long-horizon nominal returns are positively related to long-term inflation, and short-horizon returns are negatively related to short-term inflation. For U.S. stock returns during the period 1802 –1990, they have found that the coefficient of five-year stock returns regressed on the contemporaneous five-year inflation rate was significantly positive and concluded that long-term nominal stock returns and inflation tend to move together.[4] Boudoukh, Richardson, and Whitelaw (1994) have also explored the stock return-inflation relation in a Fisherian context, and found that the sign and magnitude of the covariance between nominal stock returns and expected inflation may be affected by cyclical movements in industry output. They have found that returns on stocks of cyclical industries tend to co-vary negatively with expected inflation while the reverse holds for non-cyclical industries.

4. Boudoukh and Richardson have obtained similar results using ex ante inflation.

Gultekin (1983) has ascribed the lack of the positive relation between stock returns and inflation to the errors-in-variables problem. If observed stock returns and observed inflation are related to their ex ante counterparts with error terms, then the regression of the actual rate of return against the actual rate of inflation could cause the estimate of the coefficient to be biased. If the covariance between the two errors is negative, that is, the market reacts negatively to the unexpected inflation, the bias could result in a negative relation.

Some recent evidence on international stock markets is also puzzling. A negative relation between stock returns and inflation has been reported for India by Chatrath, Ramchander and Song (1997), for Japan by Najand and Noronha (1998), for China by Zhao (1999), and for Australia by Crosby (2001). Adrangi, Chatrath and Raffiee (1999) have studied the effects of macroeconomic variables on stock returns for Korea and Mexico and shown that a negative relationship between real stock returns and unexpected inflation exists in these countries. Choudhry (2001) has found a positive relationship between current stock returns and current inflation in four high-inflation countries (Argentina, Chile, Mexico and Venezuela). Omran and Pointon (2001) have confirmed a negative relationship for Egypt. Apergis and Eleftheriou (2002) have obtained a negative relationship for Greece, whereas Spyrou (2001) has observed a negative relationship between inflation and stock returns only for the period until 1995 while for the remaining period until 2000 he has found no statistically significant relationship. Rapach (2002) has shown that estimates of the long-run real stock price response to a permanent inflation shock are zero or positive for 16 industrialized countries. Spyrou (2004) has reported a positive relation between the two variables for 10 emerging stock markets (Chile, Mexico, Brazil, Argentina, Thailand, South Korea, Malaysia, Hong Kong, Turkey, and the Philippines) during the period of the 1990s. Finally Hondroyiannis and Papapetrou (2006) have shown that real stock returns are not related to expected and unexpected inflation.

Although recent studies, especially those by Kaul (1987), Marshall (1992), Boudoukh and Richardson (1993), Boudoukh, Richardson, and Whitelaw (1994) have substantially contributed to unraveling the mystery of stock return-inflation relations, these models still remain unsatisfactory in providing consistent explanations for the puzzle. Most of all, the recent attempts to reconcile the empirical conflicts are based on strong assumptions about the behavior of economic agents. For example, the Boudoukh and Richardson, and Boudoukh, Richardson, and Whitelaw models are constructed based on the Fisher equation, not on the optimizing behavior of market participants. As Marshall (1992) notes, the Fisher relation does not generally address the implications of dynamic economic equilibria when the role of money is explicitly taken into consideration. Dokko and Edelstein (1987) warn that the Fisher relation should be viewed as a reduced-form equation derived from a set of unknown behavioral equations.

The Marshall model is an important improvement in that it investigates correlations between real asset returns and inflation in the dynamic monetary equilibrium context. However, the model itself is not clear about the distinction between inflation induced by real economic shocks and inflation induced by monetary shocks. Furthermore, although the Marshall model recognizes some association between the variability of consumption velocity and the variability of real asset returns, it does not explicitly incorporate this point into the model.

Ⅲ. The Theoretical Model

A la Lucas (1978) and Mehra and Prescott (1985), we assume that there is one productive unit producing y_t at time *t*. Let A_t be the share of the productive unit, which is competitively traded in capital markets. A representative consumer is assumed to maximize the expected value of a time-separable von Neumann-Morgenstern utility function:

$$(1) \qquad E\left[\sum \beta^t U\left(c_t, \frac{M_t^D}{P_t^c}\right) | \, \Omega_t\right], \quad 0 < \beta < 1$$

where *U* is a one-period utility function satisfying $\partial U_t / \partial c_t > 0$, $\partial U_t / \partial (M_t / P_t^c) > 0$ and the strict concavity restrictions, c_t represents real consumption at time t, M_t^D denotes money demand, P_t^c is the price index of the composite consumption good, β is the discount factor, and E_t denotes the expectations operator conditional upon information Ω_t available at time t. The discount factor β is equal to 1 / (1 + ρ) where ρ is the subjective rate of time preference.

The objective function (1) is maximized with respect to {c_t, M_t / P_t^c} subject to the budget constraint:

(2) $$A_{t+1} + \frac{M_{t+1}}{P^c_{t+1}} = R_t\left(A_t + y_t - c_t\right) + \frac{M_t}{P^c_t}$$

where R_t is one plus the real rate of return (r_t), and $M_t / P_t = m_t$ indicates real money balances. This budget constraint is similar to the one formulated by Sargent (1987).[5] The real money supply is determined by its growth rate θ_t as follows:[6]

(3) $$m^S_{t+1} = \theta_t m^S_t = (\theta + \varepsilon_t) m^S_t$$

The money growth rate θ_t consists of the trend θ and innovations ε_t, where ε_t is i.i.d. with mean zero and variance σ^2_ε, and θ is assumed to be greater than one. It is further assumed that ε is not in the representative agent's information set at time *t*. The demand for real money balances is determined endogenously as a function of income, the price of the consumption good and the asset price. The money market equilibrium thus reads

(4) $$m_{t+1}(P^c_{t+1}, P^A_{t+1}, y_{t+1}) = \theta_t m_t$$

Substituting (4) into the budget constraint gives rise to

(5) $$A_{t+1} = R_t(A_t + y_t - c_t) + m_t\left[1 - (\theta + \varepsilon_t)\right]$$

In order to solve the dynamic optimization problem faced by the representative consumer, the value function is given by

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5. See Sargent (1987), p. 143.

6. The nominal money variable may be a decision or control variable in an income determination model as suggested by H. Youn Kim in his comment on the earlier version of this paper. However, in an asset pricing model, the nominal money supply could be assumed to be an exogenous process, as suggested by Alan Viard.

(6) $$V_t(A_t) = \max E\left[\Sigma\beta^{s-t}U(c_s, m_s) \mid \Omega_t\right]$$

Then the Bellman equation is defined as

(7) $$V_t(A_t) = \max\{U(c_t, m_t) + \beta E[V_{t+1}(A_{t+1}) \mid \Omega_t]\}$$

The first-order conditions for the optimization problem (with the notation of Ω_t omitted) are given by

(8.1) $$\frac{\partial U(c_t, m_t)}{\partial c_t} - E_t\left[\beta R_t V'_{t+1}(A_{t+1})\right] = 0$$

(8.2) $$\frac{\partial U(c_t, m_t)}{\partial m_t} - E_t\left[\beta\{(\theta+\varepsilon_t)-1\}V'_{t+1}(A_{t+1})\right] = 0$$

By the application of the envelope theorem and the first-order conditions, we obtain

(9.1) $$\frac{\partial U(c_t, m_t)}{\partial c_t} = E_t\left[\beta R_t \frac{\partial U(c_{t+1}, m_{t+1})}{\partial c_{t+1}}\right]$$

(9.2) $$\frac{\partial U(c_t, m_t)}{\partial m_t} = E_t\left[\beta\{(\theta+\varepsilon_t)-1\}\frac{\partial U(c_{t+1}, m_{t+1})}{\partial m_{t+1}}\right]$$

This study considers an economy in which all consumers are identical, and the representative consumer's utility function is of the CRRA (constant relative risk aversion) type:

(10) $$U(c_t, m_t) = \frac{\left[\left(c_t^{1-\gamma} m_t^{\gamma}\right)^{1-\alpha} - 1\right]}{1-\alpha}$$

where α is the Arrow-Pratt measure of relative risk aversion. This form of the CRRA utility function is found in Prescott (1986), Boyle (1990), and others. If α approaches one, the CRRA utility function becomes

(11) $$U(c_t, m_t) = (1-\gamma)\ln c_t + \gamma \ln m_t$$

For analytical tractability, the preferences of the agent are assumed to be represented by the logarithmic utility function. Substituting the partial derivatives of U with respect to its arguments into (9) yields

(12.1) $$\frac{1-\gamma}{c_t} = \beta E_t\left[R_t \frac{1-\gamma}{c_{t+1}}\right]$$

(12.2) $$\frac{\gamma}{m_t} = \beta E_t\left[\{(\theta+\varepsilon_t)-1\}\frac{\gamma}{m_{t+1}}\right]$$

After some mathematical manipulation, we obtain the following relationship:

(13) $$E_t\left[R_t \frac{c_t}{c_{t+1}}\right] = E_t\left[\{(\theta+\varepsilon_t)-1\}\left(\frac{m_t}{m_{t+1}}\right)\right]$$

It can be shown that

(14) $$E_t\left\{\left[(\theta+\varepsilon_t)-1\right]\left[\frac{m_t}{m_{t+1}}\right]\right\} = (\theta-1)E_t\left[\frac{m_t}{m_{t+1}}\right] - \frac{\sigma_\varepsilon^2}{\theta^2}$$

(The proof is provided in the Appendix.) Taking logs of both sides of (14) gives

(15) $$\ln E_t\left[R_t\left(\frac{c_{t+1}}{c_t}\right)^{-1}\right] = \ln\left[(\theta-1)E_t\left[\frac{m_{t+1}}{m_t}\right]^{-1} - \frac{\sigma_\varepsilon^2}{\theta^2}\right]$$

By a Taylor series expansion, $\ln\left[(\theta-1)E_t\left[\frac{m_{t+1}}{m_t}\right]^{-1} - \frac{\sigma_\varepsilon^2}{\theta^2}\right]$ can be approximated by $\ln\left[(\theta-1)E_t\left[\frac{m_{t+1}}{m_t}\right]^{-1}\right] + \varphi\left(\frac{\sigma_\varepsilon^2}{\theta^2}\right)$. Thus,

(16)
$$\ln E_t\left[R_t\left(\frac{c_{t+1}}{c_t}\right)^{-1}\right] \approx \ln\left[(\theta-1)E_t\left[\frac{m_{t+1}}{m_t}\right]^{-1}\right] + \varphi\left(\frac{\sigma_\varepsilon^2}{\theta^2}\right)$$

It is assumed that $z_t = R_t(c_{t+1}/c_t)^{-1}$ and $(m_{t+1}/m_t)^{-1}$ are both log-normally distributed with constant variances σ_z^2 and σ_m^2, and conditional means μ_{zt} and μ_{mt}. In our model, σ_z^2 is the variance of real stock returns divided by consumption growth, and σ_m^2 is the variance of the reciprocal of money growth. Thus, σ_z^2 is a measure of real shocks, and σ_m^2 is a measure of monetary shocks. This joint log-normality assumption has been adopted by several authors such as Grossman and Shiller (1981) and Hansen and Singleton (1983). As was discussed by Hansen and Singleton, the log-normality assumption together with the CRRA utility function has the attractive feature of allowing one to derive closed-form equilibrium pricing equations. This distributional characterization implies that movements in the conditional distributions of the logarithms of asset returns, consumption, and real money balances are completely summarized by movements in the conditional means of the variables.

Under the log-normality assumption, we have

(17.1)
$$\ln E_t\left[R_t\left(\frac{c_{t+1}}{c_t}\right)^{-1}\right] = E_t \ln\left[R_t\left(\frac{c_{t+1}}{c_t}\right)^{-1}\right] + \frac{1}{2}\sigma_z^2$$

(17.2)
$$\ln E_t\left[\left(\frac{m_{t+1}}{m_t}\right)^{-1}\right] = E_t \ln\left[\left(\frac{m_{t+1}}{m_t}\right)^{-1}\right] + \frac{1}{2}\sigma_m^2$$

where $E_t \ln\left[R_t\left(\frac{c_{t+1}}{c_t}\right)^{-1}\right] = \mu_{zt}$ and $E_t \ln\left[\left(\frac{m_{t+1}}{m_t}\right)^{-1}\right] = \mu_{mt}$. Substituting equations (17.1) and (17.2) into equation (16), then:

$$(18) \qquad E_t \ln R_t = \ln(\theta - 1) + \frac{1}{2}\left(\sigma_m^2 - \sigma_z^2\right) + \varphi\left(\frac{\sigma_\varepsilon^2}{\theta^2}\right) + E_t\left[\ln\left(\frac{c_{t+1}}{c_t}\right) - \ln\left[\frac{m_{t+1}}{m_t}\right]\right]$$

Equation (18) can be rewritten as

$$(19) \qquad E_t \ln R_t = \ln(\theta - 1) + \frac{1}{2}\left(\sigma_m^2 - \sigma_z^2\right) + \varphi\left(\frac{\sigma_\varepsilon^2}{\theta^2}\right) + E_t\left[\ln\left(\frac{c_{t+1}}{m_{t+1}}\right) - \ln\left[\frac{c_t}{m_t}\right]\right]$$

If we assume that the economy produces a single composite consumption good (y_t), c_t / m_t represents the consumption velocity of money (V_t):

$$(20) \qquad V_t = \frac{P_t^c y_t}{M_t} = \frac{P_t^c c_t}{M_t} = \frac{c_t}{m_t}$$

Thus, equation (19) allows us to obtain the following velocity-based asset pricing model (VCAPM):

$$(21) \qquad E_t \ln R_t = \ln(\theta - 1) + \frac{1}{2}\left(\sigma_m^2 - \sigma_z^2\right) + \varphi\left(\frac{\sigma_\varepsilon^2}{\theta^2}\right) + E_t\left[\ln V_{t+1} - \ln V_t\right]$$

It follows from the equation of exchange that

$$(22) \qquad E_t \ln R_t = \ln(\theta - 1) + \frac{1}{2}\left(\sigma_m^2 - \sigma_z^2\right) + \varphi\left(\frac{\sigma_\varepsilon^2}{\theta^2}\right) + E_t g_t + E_t \pi_t - E_t \mu_t$$

where g_t is the growth rate of real output $\left(g_t = \ln\left(y_{t+1}/y_t\right)\right)$, π_t is the inflation rate $\left(\pi_t = \ln\left(P_{t+1}/P_t\right)\right)$, and μ_t is the growth rate of the money supply

$(\mu_t = \ln(M_{t+1}/M_t))$. Eq. (22) shows that expected returns are determined by market fundamentals (expected inflation, expected output growth, expected money growth), and money and real shocks (σ_m^2, σ_z^2 and σ_ε^2).

Ⅳ. The Return-Inflation Relation Is Contingent on the Volatility of Inflation

1. Three Propositions

The dynamics of stock returns represented by equation (22) lays a theoretical foundation for resolving the observed return-inflation puzzle. In our velocity-based asset pricing model, expected stock returns do not move one-for-one with expected inflation. The covariance between real stock returns and expected inflation is given by

(23)

$$\begin{aligned} Cov\{E_t \ln R_t, E_t\pi_t\} &= Cov\left\{\ln(\theta-1)+\frac{1}{2}\left(\sigma_m^2-\sigma_z^2\right)+\varphi\left(\frac{\sigma_\varepsilon^2}{\theta^2}\right)+E_t g_t+E_t\pi_t-E_t\mu_t, E_t\pi_t\right\} \\ &= Cov\{E_t g_t, E_t\pi_t\}-Cov\{E_t\mu_t, E_t\pi_t\}+Var\{E_t\pi_t\} \end{aligned}$$

The relation (23) can be used to demonstrate that given monetary and real shocks, a negative relation between expected real stock returns and expected inflation holds in a period of stable inflation, and a positive relation prevails in a period of volatile inflation.

Proposition 1: Real stock returns are negatively related to expected inflation when inflation is stable and low.

Proof: It follows from equation (23) that a negative relation between real stock returns and expected inflation is obtained when the following condition is satisfied:

$$(24) \qquad Cov\{E_t\mu_t, E_t\pi_t\} > Cov\{E_t g_t, E_t\pi_t\} + Var\{E_t\pi_t\}$$

When the covariance between expected monetary growth ($E_t\mu_t$) and expected inflation ($E_t\pi_t$) is greater than the sum of the covariance between expected output growth ($E_t g_t$) and expected inflation ($E_t\pi_t$) and the variance of expected inflation ($E_t\pi_t$), then expected real stock returns are negatively related to expected inflation.

Economic theory and empirical evidence show that expected monetary growth tends to move together with expected inflation (i.e., $Cov\{E_t\mu_t, E_t\pi_t\} > 0$), and expected output growth tends to move together with expected inflation contemporaneously (i.e., $Cov\{E_t g_t, E_t\pi_t\} > 0$)[7]. Thus, the condition for the negative correlation between real stock returns and expected inflation is most likely to be satisfied when the variance of expected inflation is sufficiently small, and the covariance between expected real growth and expected inflation is weaker than the covariance between expected monetary growth and expected inflation. (The latter condition is believed to hold true in most situations.)

Proposition 2: Real stock returns are positively related to expected inflation when inflation is volatile.

Proof: When the variance of expected inflation is sufficiently large enough to reverse the inequality, then we have

7.The discussant of this paper at the Bank of Korea Conference (July 2008) argues that $Cov\{E_t g_t, E_t\pi_t\}$ should be negative. This paper is concerned with the covariance between the expected growth rate of output and the expected rate of inflation in the same period of time. Of course, a higher rate of inflation will lead to a lower rate of output growth with some time lag. However, the covariance between these two variables should be positive contemporaneously.

(25) $$Cov\{E_t\mu_t, E_t\pi_t\} < Cov\{E_t g_t, E_t\pi_t\} + Var\{E_t\pi_t\}$$

When this happens, the covariance between real stock returns and expected inflation is positive. Thus, there is a tendency for real stock returns to co-vary positively with expected inflation when inflation is highly volatile.

It is clear that the extent to which the volatility of inflation leads to a negative or positive relation between real stock returns and expected inflation depends on the magnitude of the variance of inflation and the relative strength of the covariance between expected inflation and expected monetary growth ($Cov\{E_t\mu_t, E_t\pi_t\}$) and the covariance between expected inflation and expected output growth ($Cov\{E_t g_t, E_t\pi_t\}$). As conditions (24) and (25) indicate, the variance of inflation should be smaller than the difference between $Cov\{E_t\mu_t, E_t\pi_t\}$ and $Cov\{E_t g_t, E_t\pi_t\}$ for the return-inflation relation to be negative and greater than the difference between $Cov\{E_t\mu_t, E_t\pi_t\}$ and $Cov\{E_t g_t, E_t\pi_t\}$ for the return-inflation relation to be positive.

<u>Proposition 3</u>: In the long run, real stock returns co-vary positively with expected inflation.

<u>Proof</u>: If the long-run neutrality of money holds, then $E_t\mu_t = E_t\pi_t$, so that the return equation reduces to

(26) $$E_t \ln R_t = \ln(\theta - 1) + \frac{1}{2}\left(\sigma_m^2 - \sigma_z^2\right) + \varphi\left(\frac{\sigma_\varepsilon^2}{\theta^2}\right) + E_t g_t$$

In the long run, expected stock returns are primarily determined by expected real economic growth (g_t) and monetary and real shocks σ_m^2, σ_z^2 and σ_ε^2. The covariance between real stock returns and expected inflation over a long horizon is thus given by

$$(27) \qquad Cov\{E_t \ln R_t, E_t\pi_t\} = Cov\left\{\ln(\theta-1) + \frac{1}{2}\left(\sigma_m^2 - \sigma_z^2\right) + \varphi\left(\frac{\sigma_\varepsilon^2}{\theta^2}\right) + E_t g_t, E_t\pi_t\right\}$$

$$= Cov\{E_t g_t, E_t\pi_t\} > 0$$

Since the contemporaneous covariance between expected output growth and expected inflation is positive, condition (27) shows that real stock returns and expected inflation tend to move together in the long run. Thus, the stock return-inflation relation is also subject to the time horizon being considered. In short, stocks will offer protection against inflation over the long run, and investors will be fully compensated for the erosion of purchasing power. This conclusion is in agreement with that of Danthine and Donladson (1986), Boudoukh and Richardson (1993), and Boudoukh, Richardson, and Whitelaw (1994), Rapach (2002), Osamah and Pyun (2004).

2. Implications

Our propositions imply that market participants do not require a high risk premium associated with inflation when inflation is low and stable, but they will demand an inflation uncertainty-induced premium in stock returns when they perceive inflation to be high and volatile.

Using the Livingston survey data, Dokko and Edelstein (1991) have found a strong positive correlation between expected inflation and inflation uncertainty (0.879 for the 1960 - 1985 period and 0.875 for the 1966 -1980 period) and a strong positive correlation between inflation uncertainty and the risk premium (0.435 for the 1960 -1985 period and 0.537 for the 1966 -1980 period). These observations indicate that the higher the expected inflation, the more volatile is expected inflation, and the greater is the required risk premium. They have further discovered that once inflation uncertainty is controlled for, an increase in expected inflation causes a decrease in the expected real rate of return for stocks. Thus, they argue that when the effect of inflation uncertainty on the required return is ignored, the misspecification results in a spuriously positive relation between stock returns and expected inflation.

Alternatively, the positive (or negative) relation between real stock returns and expected inflation can be viewed as reflecting economic agents' perceptions about inflation volatility. This interpretation is a simple rational-expectations version of Lucas' (1973) misperception model and is in the same vein as that of Akerlof, Dickens, and Perry (2000) concerning the relation between inflation and the natural rate of unemployment. In his well-known paper, Lucas has shown that in a stable-price country, there is a strong negative relation between inflation and unemployment, but in a volatile-price country, such a relation does not exist. More interestingly, the Akerlof-Dickens-Perry model shows that when inflation is low and stable, economic agents tend to ignore past inflation and do not fully incorporate it in wage bargaining processes. Their study reveals that when the inflation rate is between zero and 4 percent, the unemployment rate can be reduced below the natural level without generating higher inflation, but when the inflation rate is higher than 4 percent, the unemployment rate eventually approaches the conventional natural level as firms and workers fully incorporate inflationary expectations.[8]

8. Akerlof, Dickens, and Perry (2000) break down the sample from 1954 through 1999 into two sub-samples:

Ⅴ. Empirical Analysis

1. The Estimation Equation

In order to examine the relationship between real stock returns and expected inflation empirically, we regress real stock returns on the rate of expected inflation, the growth rate of real GDP, and the growth rate of the money supply. In estimating the relationship, one delicate estimation issue is how one can obtain an estimate of expected inflation. In the literature, several different methods have been proposed. First, one can use the contemporary inflation rate as a proxy for expected inflation (Gultekin (1983)). However, when observed stock returns and observed inflation are related to their ex ante counterparts with error terms such as

(28.1) $$r_t = E(r_t \mid \Omega_{t-1}) + u_t$$

(28.2) $$\pi_t = E(\pi_t \mid \Omega_{t-1}) + v_t$$

then the slope coefficient in the regression of r_t on the expected inflation rate is biased (Nelson (1976), Gultekin (1983)).

Some researchers use short-term interest rates such as the Treasury Bill rate as proxies for expected inflation assuming a constant real interest rate (Jaffe and Mandelker

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those quarters when the five-year average of inflation was below 3 percent and those when it was above 4 percent. The samples have mean inflation rates of 2.0 percent and 6.3 percent, respectively. They have found the coefficient on inflationary expectations in the Phillips curve to be consistently and substantially larger in periods of high inflation than in periods of low inflation. Thus, they have concluded that the incorporation of price expectations varies with the inflation rate.

(1976), Fama and Schwert (1977), Schwert (1981), Gultekin (1983)). Another method to estimate expected inflation is to decompose inflation into expected and unexpected components by ARIMA models, and to use inflation forecasts from ARIMA as estimates of expected inflation (Gultekin (1983)). However, Fama and Schwert (1977) Schwert (1981), Hillion and Solnik (1982), Solnik (1983) and others have shown that the ARIMA representation of expected inflation does not significantly outperform short-term nominal interest rates as a predictor of expected inflation.

Finally one can use lagged inflation rates as an estimate of expected inflation. For instance, Jaffe and Mandelker (1976) used three lagged inflation rates as a proxy for expected inflation. Nelson (1976) included the four lags of inflation rates to examine the relationship between real stock returns and inflation. Gultekin (1983) has used four lagged inflation rates to represent expected inflation. One important rationale for using lagged inflation rates is that people adjust their expectations of inflation on the basis of past inflation rates. Furthermore, as Gultekin indicates, regressing stock returns on past inflation rates could eliminate the errors-in-variables bias due to the negative covariance, since past inflation rates contain no new information for the market.[9] In this study, we include four lagged inflation rates to represent expected inflation.

To estimate the velocity-based capital asset pricing model, we use the GARCH (1,1)-M model. Because this paper deals with low-frequency data, the GARCH effect may not be pronounced, and EGARCH-type specifications may serve better. Since the main thrust of this paper does not lie in investigating asymmetric volatility, however, a

9. See Nelson (1976) and Gultekin(1983)

GARCH-M specification seems to fit the nature of this research. The mean and variance equations of the GARCH (1,1)-M model are specified as follows[10]:

(29.1) $r_t = \beta_0 + \beta_1 INF_t + \beta_2 INF_{t-1} + \beta_3 INF_{t-2} + \beta_4 INF_{t-3} + \beta_5 RGDP_t + \beta_6 M_t + \gamma \log(\sigma) + u_t$

(29.2) $$\sigma_t = \sqrt{Var(u_t | \Omega_{t-1})}$$

(29.3) $$u_t | \Omega_{t-1} \sim N(0, \sigma_t^2)$$

(29.4) $$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 \sigma_{t-1}^2 + \alpha_3 \sigma(INF_{t-1})$$

where INF is the rate of inflation, RGDP is the growth rate of real GDP, and M is the growth rate of the money supply. In Equation 29.2, σ_t is the conditional standard deviation of the error term based on past information, Ω_{t-1}. The logarithm of the standard deviation represents the effect of volatility on stock returns that is less than proportional in the mean.[11] Equation 29.4 is the conditional-variance equation. The conditional-variance equation consists of three parts: α_1 measures the effect of squared innovations on volatility from the previous period (the ARCH term), and the coefficient α_2 denotes the effect of the forecast variance of the last period (the GARCH term). The sum of α_1 and α_2 measures the extent of the persistence of volatility. We

10. The discussant of this paper at the Bank of Korea Conference indicates that our estimation model is different from the theoretical formulation of the paper. It is not uncommon for researchers to conduct an empirical investigation of a theoretical model that captures the essence of the theoretical aspect when it is inadequate to estimate the theoretical model in its original form. For example, see Lucas (1973).

11. Empirically, the logarithm of the conditional variance is better than the standard deviation but this method cannot affect the significance of coefficients.

introduce the conditional volatility of inflation $\sigma(INF_t)$. Incorporating the effect of inflation volatility on the stock return distribution is important because inflation volatility influences the volatility of real stock returns in our model. Therefore, α_3 captures the effect of unexpected conditional inflation volatility on the conditional volatility of real stock returns.[12]

2. The Description of the Data

The data used in this study have been taken from the International Monetary Fund's online *International Financial Statistics* (IFS). We have used quarterly data to estimate the GARCH(1,1)-M model. The countries that are included in our sample are those countries that have the following data series: the consumer price index (CPI), nominal share price index, GDP, GDP deflator, and M2. There are 33 countries that meet this selection criterion. We have eliminated countries that have fewer than 70 observations.[13] Thus, we have finally obtained 16 countries. The starting and ending dates are different in our data set.

Real stock returns are obtained from the nominal share price index series (IFS series 62..ZF..) deflated by the consumer price index. The inflation rate is calculated by taking

12. See Mansur and Elyasiani (1998), Ryan and Worthington (2004) for using more other volatility variables in conditional variance equation.

13. We eliminate some countries since quarters of data are not enough to estimate the GARCH specification. Germany, Portugal, Sweden, Switzerland in OECD countries and Argentina, Brazil, Chile, and Colombia in South America and most of developing countries have below 70 quarters.

the first difference of the natural logarithm of the consumer price index series (IFS series 64..ZF..). The growth of real GDP is calculated from the GDP series (IFS series 99B..ZF.. and 99B..CZF..) deflated by the GDP deflator (IFS series 99..BIR..ZF..). The M2 series (IFS series 35L..ZF.. and 59MB..ZF..) is the sum of currency outside banks, demand deposits other than those of central government, time and savings deposits, and foreign currency deposits of residents other than the central government. The annualized values of the series are used.

3. Empirical Results

<Table 1> reports basic statistics for the variables used in this study. The table shows that the average annual rate of real stock returns ranges from -1.2% to 24%, and the average annual inflation rate ranges from 1.8% to 50%. The standard deviation of real stock returns is relatively large in the Philippines (83.64%), Mexico (73.87%), Peru (76.47%), Israel (50.30%), and South Korea (50.05%) and the smallest in the United States (24.53%). On the other hand, the standard deviation of the inflation rate is pronouncedly large in Peru (129.77%), Israel (40.99%), and Mexico (25.74%), whereas other countries have a standard deviation of the inflation rate that is less than 10%. (The standard deviation of the Philippines (10.25%) is close to 10%.) Thus, Peru, Israel, and Mexico can be classified as volatile-price countries, whereas the rest of the countries in our sample are characterized as stable-price countries. Because our data set includes countries with highly volatile price movements as well as countries with stable price movements, our sample provides a good laboratory for testing for our propositions.

<Table 1> Basic Statistics

COUNTRY	Real Stock Returns		Inflation Rates		Real GDP Growth Rates		M2 Growth Rates		Number of Sample and Sample Period
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	
AUSTRALIA	2.024	33.505	5.179	4.443	3.543	4.633	10.172	8.940	189 59.Q4-07.Q1
CANADA	2.264	28.541	4.042	3.398	3.575	4.059	10.548	23.109	199 57.Q2-07.Q1
FRANCE	8.281	35.387	4.965	4.180	2.040	1.972	6.013	13.606	83 77.Q3-98.Q4
ISRAEL	4.588	50.299	30.979	40.990	4.691	113.243	37.656	71.672	140 71.Q2-06.Q2
ITALY	7.810	48.514	7.074	4.900	1.927	3.059	7.221	21.673	74 80.Q2-98.Q4
JAPAN	3.493	32.036	3.471	5.064	4.912	39.179	10.956	17.864	199 57.Q2-07.Q1
KOREA	1.958	50.046	6.139	6.758	7.190	56.780	15.777	13.036	114 78.Q2-06.Q4
MEXICO	16.047	73.868	22.867	25.743	2.544	18.373	26.240	44.039	91 84.Q2-07.Q1
NETHERLAND	8.046	31.588	2.926	2.466	2.293	3.471	8.631	24.999	82 77.Q2-97.Q4
NEW ZEALAND	3.671	49.083	2.656	2.380	2.696	4.298	10.840	32.780	77 87.Q2-06.Q4
NORWAY	3.407	43.071	5.786	4.077	3.677	20.808	9.666	13.539	139 66.Q3-01.Q2
PERU	24.014	76.468	51.255	129.768	4.113	28.045	58.379	121.881	71 89.Q2-07.Q1
PHILIPPINES	4.394	83.639	9.001	10.247	2.711	39.257	15.664	38.315	101 81.Q2-07.Q1
SPAIN	-1.238	42.953	9.275	6.043	2.904	3.638	11.991	16.354	114 70.Q2-98.Q4
U.K.	3.430	33.595	6.343	6.028	2.446	4.308	10.910	23.389	163 58.Q2-99.Q1
U.S.	2.547	24.527	3.988	3.041	3.213	3.603	7.391	6.254	199 57.Q2-07.Q1

<Table 2> GARCH(1,1)-M Estimation with Proxies for Expected Inflation

	β_0	B_1	β_2	β_3	β_4	SUM	β_5	β_6	Γ	α_0	α_1	α_2	α_3	Q(12)	$Q^2(12)$
AUSTRALIA	55.266^{**}	-2.025^{**}	0.375	0.572	0.782	-0.295^{**}	-0.706	0.117	-7.746^{**}	12.833	0.353^{**}	0.582^{**}	24.009	25.657^{**}	6.201
CANADA	44.051^{**}	-1.407^{*}	-1.959^{**}	0.972	1.392	-1.002^{**}	-0.250	0.048	-5.584^{**}	466.061^{*}	0.133	-0.306	123.699^{*}	26.189^{**}	7.298
FRANCE	-16.371	4.107^{**}	-4.906^{**}	0.667	-1.328	-1.461^{**}	-0.388	0.491	4.649^{*}	2142.211^{**}	0.156	-0.528^{*}	-192.576^{**}	12.396	18.126
ISRAEL	154.469^{**}	-0.530^{**}	0.001	0.310^{**}	0.079	-0.140^{**}	0.031^{**}	-0.097^{**}	-18.536^{**}	4623.325^{**}	0.071^{**}	-1.044^{**}	5.376^{**}	12.477	10.997
ITALY	-490.78^{**}	-0.798	7.949^{**}	1.486	-10.380^{**}	-1.743^{**}	-0.671	0.461^{**}	68.310^{**}	690.743^{**}	0.291^{**}	0.241^{*}	25.966	7.133	5.680
JAPAN	20.801^{*}	-0.678^{*}	0.411	-1.167^{**}	-0.642	-2.077^{**}	0.038	0.284^{**}	-1.766	73.397^{**}	-0.058^{**}	1.026^{**}	-8.529^{**}	29.387^{**}	9.695
KOREA	-184.87	-1.535^{*}	-1.176	0.418	0.592	-1.701^{**}	0.003	-0.631^{*}	27.104	369.276	0.192^{**}	0.635^{**}	4.167	18.160	9.068
MEXICO	123.974	-0.836	1.293^{**}	-0.617	0.190	0.030^{**}	-0.334	-0.056	-13.022	940.814^{**}	0.662^{**}	0.143^{*}	13.454	11.374	9.684
NETHERLAND*	59.613	-0.145	-4.129^{**}	-2.009	5.597^{**}	-0.686^{**}	0.325	0.226^{**}	-0.071	436.736	0.059	-0.114	144.254	13.924	4.776
NEW ZEALAND	1625.181	-3.871	-1.405	-2.725	0.328	-7.673^{**}	-0.471	-0.124^{**}	-223.11	753.998^{**}	0.032	0.427^{**}	-27.805	5.176	0.914
NORWAY	84.513^{**}	-2.097^{**}	-0.661	0.780	-1.571	-3.550^{**}	0.265^{**}	0.460^{*}	-8.759^{**}	1293.544	-0.091^{**}	0.536^{**}	-82.961	24.453^{**}	16.089
PERU	-523.49	-0.023	-0.001	0.035	0.098	0.109^{**}	-0.216	-0.107	62.668	5043.408	0.199	0.133	-6.746^{**}	6.770	18.039
PHILIPPINES	528.432^{**}	-1.817^{**}	0.389	0.024	0.137	-1.266	0.349^{**}	0.678^{**}	-59.561^{**}	11628.66^{**}	0.236^{**}	-1.018^{**}	145.402	10.320	13.046
SPAIN	41.768	-2.375^{**}	-1.298^{*}	-0.970^{*}	0.869	-3.775^{**}	1.906^{**}	0.080	-2.273	439.655^{*}	0.451^{**}	0.372^{**}	-15.0289	24.088^{**}	12.329
UK	-17.354	-0.315	-1.052^{**}	-0.251	0.411	-1.208^{**}	-0.355	0.088	4.210	510.772^{*}	0.344^{**}	-0.137^{**}	47.505	13.107	10.334
US	25.801^{**}	-4.215^{**}	-1.504	0.969	2.017	-2.734^{**}	0.239	0.399^{*}	-2.703	236.302^{**}	0.316^{*}	-0.112	63.412^{**}	15.859	20.276^{*}

(1) $r_t = \beta_0 + \beta_1 INF_t + \beta_2 INF_{t-1} + \beta_3 INF_{t-2} + \beta_4 INF_{t-3} + \beta_5 RGDP_{t-1} + \beta_6 M2GROWTH_{t-1} + \gamma \log(\sigma_t^2) + \varepsilon_t$
$\sigma^2_t = \alpha_0 + \alpha_1 \varepsilon^2_{t-1} + \alpha_2 \sigma^2_{t-1} + \alpha_3 \sigma(INF_{t-1})$
(2) Bollerslev and Wooldridge's robust variance estimator is employed.
(3) Q-test is the test for serial correlation and Q^2-test is the test for dependency in squared residuals.
(4) ** and * are significant at 5% and 10% level, respectively.

<Table 2> presents the results of the GARCH(1,1)-M estimation. First, the non-negativity constraint seems to be satisfied. Since the variance cannot be negative, the non-negativity condition requires that all the α coefficients be non-negative. Although this condition is not directly met, the sum of all these coefficients is positive, indicating that the variance is surely positive in all sample countries. The stationarity constraint restricts α's to lie in the stable range. This condition implies that $\alpha_1 + \alpha_2 < 1$. This condition is satisfied in most sample countries.

Our primary concern lies in the relationship between real stock returns and expected inflation. We are particularly concerned with whether the rate of real stock returns is negatively related to the inflation rate in a stable-price country and is positively related to the inflation rate in a volatile-price country. Our sample contains three volatile-price countries (Mexico, Peru, and Israel) and 13 stable-price countries.

Interestingly enough, the relationship between inflation (measured by the sum of the coefficients of the lagged inflation terms) and real stock returns has turned out to be negative in all stable-price countries. Furthermore, our Wald test shows that the coefficients taken together are significant at the conventional level of significance in all stable-price countries only except for the Philippines. (It is worth noting that the standard deviation of the Philippines' inflation rate was about 10 percent.) On the other hand, two volatile-price countries, Mexico and Peru, have a significantly positive relationship between inflation and real stock returns. Israel is the exception to our propositions: The relationship has been negative in Israel, but the coefficients taken together are insignificant. Our empirical analysis suggests that the relation between stock returns and expected inflation is negative when the standard deviation of the inflation rate is lower than 10 percent, and positive when the standard deviation of the inflation rate is higher than 10 percent. Thus, our model provides a clear resolution of the return-inflation puzzle.

Our findings can be compared with those of Gultekin (1983) who investigated the relation between the rate of return on common stocks and the expected inflation rate (represented by four lags) for 14 advanced countries from 1947 to 1979 using the same data source as ours (*International Financial Statistics*). He found that with the exception of the United Kingdom, the sum of the coefficients of the four lagged terms of the inflation rate was negative. Although his findings are in the same context as ours, his model is not able to distinguish between stable-price regimes and volatile-price regimes in identifying the relationship between stock returns and expected inflation.

We should also expect the dependence of real stock returns on inflation volatility to hold in a time series over time. McCown and Fitzgerald (2006) have examined the simple coefficient of correlation between real stock returns and expected inflation for industrialized countries during the pre- and post-World War II periods. Their sample includes Denmark (1923-1939), France (1857-1913, 1919-1937), Germany (1871-1913), the United Kingdom (1868-1913, 1919-1939), and the United States (1802-1913, 1919-1939, 1802-1939). McCown-Fitzgerald's evidence showed some stylized pattern in the relation between real stock returns and expected inflation: when the standard deviation of the inflation rate was roughly less than 10%, the correlation coefficient was negative; when the standard deviation of the inflation rate was greater than 10%, the correlation coefficient was positive.[14] The only exception occurred in France during the 1857 -1913 period, but the correlation was insignificant at the 5 percent level.

Ⅵ. Concluding Remarks

Since negative relations between real (or nominal) stock returns and expected inflation were observed in the post-war U.S. data, there has been a proliferation of studies which have attempted to resolve the return-inflation puzzle. Although the existing studies have explained some important aspects of the anomalous relations, the stock return-inflation puzzle still remains unresolved. The purpose of this study is to provide theoretical foundations and empirical evidence for the seemingly paradoxical results within an inter-temporal portfolio-choice framework. One novel feature of our study is that it converts the consumption-based capital asset pricing model into a relationship between real stock returns and consumption velocity and links the volatility of asset returns to the volatility of velocity. The traditional consumption-based capital asset pricing model fares poorly in explaining asset price movements because it is unable to reconcile the high variability of real asset returns with the low variability of consumption growth.

In our velocity-based asset pricing model (VCAPM), expected real stock returns are determined by market fundamentals such as the expected values of inflation, money growth, and real output growth, and by monetary and real shocks. Given monetary and

14. The correlation coefficient was significant in Germany (1871-1913) and the United Kingdom (1868-1913, 1919-1939) at the 5 percent level of significance.

real shocks, the relation between real stock returns and expected inflation can be of either sign depending on the degree of inflation volatility. Our model suggests that real stock returns are negatively related to expected inflation in a period of low volatility of inflation (or in a stable-price regime) and positively related to expected inflation in a period of high volatility of inflation (or in a volatile-price regime). The model further predicts that in the long run, real stock returns will co-vary positively with expected inflation. Thus, stock returns compensate for inflation during periods of rapid inflation and over long horizons.

In order to test for our propositions, we have employed a GARCH(1,1)-M model and conducted an empirical investigation of the velocity-based asset pricing model using quarterly data for 16 countries. The data set includes 13 stable-price countries and three volatile-price countries. Our empirical results have confirmed that the relationship between real stock returns and expected inflation was negative in all stable-price countries and positive in volatile-price countries only with the exception of Israel, thus providing consistent support for our propositions. Israel experienced volatile inflation during the sample period, but a negative relation between real stock returns and expected inflation was found, although the coefficient was not significant at any reasonable level of significance.

Our empirical analysis suggests that a 10 percent of the standard deviation of the inflation rate is a dividing line between negative and positive return-inflation relations. Our conclusion can be compared with that of Akerlof, Dickens, and Perry who have found that the unemployment rate can be reduced below the natural level without stimulating higher inflation when the inflation rate is between zero and 4 percent, but the unemployment rate eventually approaches the conventional natural level when the inflation rate is higher than 4 percent. The most important conclusion drawn from this study is that the relation between real stock returns and expected inflation is significantly affected by the degree of inflation volatility.

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Appendix

Since c_t and m_t are known at time t, equation (12) can be rewritten as

(1a) $$1 = \beta E_t\left[R_t \frac{c_t}{c_{t+1}}\right] \quad \text{and}$$

(1b) $$1 = \beta E_t\left[(\theta - 1 + \varepsilon_t)\frac{m_t}{m_{t+1}}\right].$$

We divide (1a) by (1b) to obtain

(2) $$E_t\left[R_t \frac{c_t}{c_{t+1}}\right] = (\theta - 1)E_t\left[\frac{m_t}{m_{t+1}}\right] + E_t\left[\varepsilon_t \frac{m_t}{m_{t+1}}\right]$$

$$= (\theta - 1)E_t\left[\frac{m_t}{m_{t+1}}\right] + E_t[\varepsilon_t]E_t\left[\frac{m_t}{m_{t+1}}\right] + Cov_t\left[\varepsilon_t, \frac{m_t}{m_{t+1}}\right]$$

$$= (\theta - 1)E_t\left[\frac{m_t}{m_{t+1}}\right] + Cov_t\left[\varepsilon_t, \frac{m_t}{m_{t+1}}\right].$$

It can be shown that

(3) $$Cov_t\left[\varepsilon_t, \frac{m_t}{m_{t+1}}\right] = -\ \frac{\sigma_\varepsilon^2}{\theta^2}$$

$$Cov_t\left[\varepsilon_t, \frac{m_t}{m_{t+1}}\right] = Cov_t\left[\varepsilon_t, \frac{m_t}{(\theta + \varepsilon_t)m_t}\right]$$

$$= Cov_t\left[\varepsilon_t, \frac{1}{(\theta + \varepsilon_t)}\right]$$

We evaluate $Cov_t\left[\varepsilon_t, \dfrac{1}{(\theta+\varepsilon_t)}\right]$ in the context of the limiting distribution:

$$Cov_t\left[\varepsilon_t, \frac{1}{(\theta+\varepsilon_t)}\right] = \lim_{t\to\infty}\left\{(\varepsilon_t - E_t\varepsilon_t)\left[\left(\frac{1}{(\theta+\varepsilon_t)}\right) - E_t\left(\frac{1}{(\theta+\varepsilon_t)}\right)\right]\right\}$$

$$= \lim_{t\to\infty} E_t\left\{\varepsilon_t\left[\left(\frac{1}{(\theta+\varepsilon_t}\right) - E_t\left(\frac{1}{(\theta+\varepsilon_t)}\right)\right]\right\}$$

The Slutsky theorem can be used to show that

(4) $$\lim_{t\to\infty} E_t\left(\frac{1}{(\theta+\varepsilon_t)}\right) = p\lim\left(\frac{1}{(\theta+\varepsilon_t)}\right) = \frac{1}{\theta} \quad .$$

Thus,

(5) $$Cov_t\left[\varepsilon_t, \frac{1}{(\theta+\varepsilon_t)}\right] = p\lim\left\{\varepsilon_t\left[\left(\frac{1}{(\theta+\varepsilon_t)}\right) - \frac{1}{\theta}\right]\right\}$$

$$= p\lim\left[\frac{-\varepsilon_t^2}{\theta^2 + \theta\varepsilon_t}\right]$$

$$= -\frac{\sigma_\varepsilon^2}{\theta^2}$$ by the Slutsky theorem.

< Abstract in Korean >

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주식이나 채권에 대한 투자는 최소한 인플레이션에 대한 헤지 (hedge)가 되어야 할 것이다. 이와 같이 인플레이션이 진행되면 이들 자산에 대한 명목수익률도 함께 증가하여야 한다. 그러나 전후 미국과 기타 선진국들의 자료를 대상으로 한 많은 실증분석 연구들은 이러한 이론적 예측과는 달리 인플레이션율과 투자수익률 간에 부의 관계가 있음을 발견하였다. 초기의 연구들은 주식 수익률에도 피셔가설이 적용되는 것으로 보고 주로 명목수익률과 인플레이션율 간에 정의 관계가 있는가를 집중적으로 규명하였다. 이들 대부분의 연구들은 명목수익률과 인플레이션율 간에 부의 관계가 있음을 확인하였다.

특히 Fama는 명목수익률뿐만 아니라 실질수익률도 예상 인플레이션율과 부의 관계가 있음을 보고했으며 그 뒤 일련의 연구들은 실질수익률과 예상 인플레이션율, 예상 인플레이션율의 변동치, 그리고 예상치 못한 인플레이션율 간에도 정도의 차이는 있지만 대체적으로 부의 관계가 있음을 밝혔다. 최근에는 일부 연구들이 주식수익률과 예상 인플레이션율 간에 정의 관계가 있음을 발견함으로써 주식수익률과 인플레이션율 간의 관계는 아직도 해결되지 못한 퍼즐로 남아있다.

본 연구는 주식수익률과 예상 인플레이션율 간의 관계를 시제간 포트폴리오 선택의 관점에서 모형화하였다. 먼저 이론적인 모형을 개발하고 이를 토대로 16개국을 대상으로 실증분석을 행하였다. 이 모형에서 주식수익률과 인플레이션율을 연결짓는 중요한 고리는 통화의 유통속도이다. 본 연구의 Velocity-Based Capital Asset Pricing Model (VCAPM)은 기존의 CCAPM 모형에 비해 몇 가지 장점을 갖는다. 무엇보다 화폐의 유통속도는 인플레이션, 실질 생산, 그리고 통화증가율에 관한 정보를 내포하고 있기 때문에 VCAPM은 주식수익률의 가변성에 대한 설명력을 높여준다. 본 연구의 이론적 모형은 인플레이션율이 높고 가변적일 경우 실질수익률과 인플레이션율 간에 정의 관계가 존재하며 인플레이션율이 낮고 안정적일 경우 실질수익률과 인플레이션율 간에 부의 관계가 있음을 보여준다. 또한 VCAPM은 장기적으로 실질수익률과 인플레이션율이 같은 방향으로 움직임을 예측한다.

실증분석을 위하여 IMF의 International Financial Statistics로부터 구한 분기별 자료를 사용하였다. 기준을 충족한 나라는 모두 16개국이었는데 이들 국가 가운데 3개국 (페루, 이스라엘, 멕시코)은 물가불안국으로, 그리고 나머지 13개국은 물가안정국으로 분류되었다. GARCH-M모형을 사용하여 추정한 실증분석 결과는 놀라울 정도로 본 연구의 이론적 제안들을 지지해주고 있다. 모든 물가안정국에서는 실질수익률과 인플레이션율 간에 부의 관계가 나타났으며 그 추정계수도 필리핀만 제외하고 5%의 수준에서 유의한 것으로 나타났다. 한편 3개의 물가불안국 가운데에서 멕시코와 페루에서는 실질수익률과 인플레이션율 간에 양의 관계가 나타났으며 그 계수도 유의한 것으로 나타났다. 오직 이스라엘만이 음의 계수를 갖는 것으로 나타났지만 추정계수는 유의하지 않았다.

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본고는 한국은행 금융경제연구원의 외부연구용역사업의 일환으로 작성되었습니다. 연구내용은 집필자의 개인의견이며 한국은행의 공식견해와는 무관합니다. 따라서 본 논문의 내용을 보도하거나 인용할 경우에는 집필자명을 반드시 명시하여 주시기 바랍니다.