Inflation Targeting Regime and the Relationship between Stock Returns and Inflation: New Evidence using the VAR Approach

Unro Lee
University of the Pacific

Many industrialized and emerging countries have adopted inflation targeting monetary policy since 1990 to combat persistently high inflation rate. Based on the assertion that a unique and interesting relationship between stock returns and inflation rate exists for inflation targeting countries, this study investigates dynamic relationship between stock returns and inflation rate for a selected group of countries that implemented inflation targeting policy in the 1990s – namely, Brazil, Canada, Chile, Israel, South Korea, Sweden and the United Kingdom. It is found that changes in inflation rate precede or Granger cause changes in real stock returns for most of these countries. This relationship implies that forward-looking investors in inflation targeting countries are inclined to trade stocks based on anticipated future economic events resulting from a change in current inflation rate.

INTRODUCTION

Inflation targeting monetary policy accords either the government and/or the central bank a mandate to assign an explicit numerical target for the inflation rate and implement an appropriate monetary policy to achieve its inflation target. 9 industrialized countries and 18 developing and emerging countries have adopted inflation targeting monetary policy since 1990 to not only combat persistently high inflation rate and quell inflation volatility, but also to maintain low inflationary expectation.

The first country to formally adopt inflation targeting policy was New Zealand (1990), which was followed by Canada (1991), Chile (1991), Israel (1992), United Kingdom (1992), Peru (1994), Australia (1994), Sweden (1995), Czech Republic (1997), South Korea (1998), Poland (1998), Brazil (1999), and Colombia (1999). Fourteen other countries have implemented inflation targeting policy since 2000.[1] Many of these countries adopted inflation targeting policy after discretionary monetary policies they previously implemented failed to stabilize or curb inflation rate. Given the success that many of these countries have had in containing high inflation rate after the implementation of inflation targeting[2], especially during the recent financial crisis[3], it is widely expected that other countries will soon follow in adopting inflation targeting policy.[4]

There has been a plethora of research that documents a strong, negative relationship between real stock returns and inflation rate for both the United States and other countries during the post-Korean War period.[5] Several studies in particular [e.g., Fama (1981) and Geske and Roll (1983)] have focused on the dynamic (or causal) relationship between stock returns and inflation rate for the United States and other industrialized countries[6]. However, these studies, yielding conflicting results, appeared in the finance literature prior to 1990 when New Zealand became the first country to implement inflation targeting monetary policy.

This study revisits this empirical issue by investigating the dynamic relationship between real stock returns and inflation rate for a selected group of countries that adopted inflation targeting in the 1990s. Inflation targeting countries, unlike those that do not explicitly set the optimal target for inflation, endeavor to implement monetary policy so that inflation rate will gradually adjust to the predetermined target. Therefore one can surmise that the nature of the intertemporal relationship between stock returns and inflation rate in inflation targeting countries would be substantively different from that of countries that are not formally targeting inflation.

If inflation rate rises above the country's numerical inflation target, then forward-looking investors would predict that the central bank will precipitously implement a contractionary monetary policy (i.e., an increase in the short-term interest rate) to combat escalating inflation and the economy will contract as a result since an increase in interest rates will invariably weaken consumer spending, business investment spending, and net export. A slowdown in real economic activity will inevitably translate to plummeting corporate earnings. Anticipating such gloomy scenario, forward-looking investors would immediately reduce the demand for stocks, thus dampening current stock returns. Conversely, a decline in inflation rate relative to its target should boost current stock returns. Therefore forward-looking investors in inflation targeting countries are inclined to trade stocks based on anticipated future course of economic activity resulting from a change in current inflation rate.

As such, in an inflation targeting country, real stock returns should precede (or Granger cause) real economic activity, since investors are forward-looking, and inflation rate should precede (or Granger causes) real stock returns. These relationships can be readily tested within the Vector Autoregressive (VAR) framework.

This study therefore investigates dynamic relationships among real stock returns, inflation rate and real economic activity for Brazil, Canada, Chile, Israel, South Korea, Sweden and the United Kingdom. These seven countries are specifically chosen for this study because, as of 2016, at least 15 years have elapsed since these countries formally adopted inflation targeting monetary strategy. Such selection process obviously ensures adequacy of relevant data necessary to conduct meaningful and reliable empirical investigation.

It is confirmed that, for most inflation targeting countries, inflation rate Granger causes real stock returns and real stock returns Granger cause real economic activity, thereby repudiating the findings of previous studies that specifically focused on countries not targeting inflation. The findings of this paper obviously carry useful implications for those individuals or institutions with vested interest in implementing profitable investment strategies in inflation targeting countries.

This paper is organized as follows. Section II lays out the empirical framework for this study and proposes several testable hypotheses. Section III provides the description of data utilized in this study. Section IV presents the empirical findings, and the paper concludes with a brief summary in Section V.

EMPIRICAL FRAMEWORK

A myriad of studies appeared in the finance literature during the late 1970 and 1980s documenting a negative stock return-inflation rate relationship for the United States and other countries. This finding refutes traditionally held belief that common stocks are an effective hedge against inflation since stocks represent ownership of the perpetual income generated by real assets.

Several studies in particular focuses on the dynamic (or causal) relationship between stock returns and expected inflation rate. Fama (1981) claims such negative relationship is spurious since this relationship is induced by a positive relationship between stock returns and expected economic activity and an inverse relationship between expected economic activity and inflation rate. Positive relationship between current stock returns and expected economic activity exists since stock prices reflect the present value of future dividends which depend on real economic activity. Negative relationship between expected economic activity and inflation rate rests on the premise that downward revision of the expected output leads to decrease in the demand for money. If both the money supply and interest rates remain constant, then the resultant excess money supply would trigger an increase in both current and expected inflation rate. Therefore, according to Fama, inflation rate is merely serving as a proxy for expected economic activity and no causal relationship is detected between inflation rate and stock returns.

Geske and Roll (1983) assert that stock returns decline in response to negative real shock since such shock will result in a decline in future real economic activity. Sluggish economic condition will lead to increased deficit, which in turn will induce the central bank to monetize the federal debt. Increased money supply will then trigger an increase in inflation rate. So, according to Geske and Roll, stock returns precede or Granger cause changes in both real economic activity and inflationary expectation. Kaul (1987,1990), employing data for Canada, Germany, the United Kingdom and the United States, adds that countercyclical monetary policy normally implemented in response to negative real shock also leads to stock returns causing changes in both real economic activity and inflationary expectation.

Ram and Spencer (1983) empirically support Mundell hypothesis which ascribes negative relationship between stock returns and inflation rate to a positive relationship between inflation rate and economic activity and a negative relationship between stock returns and economic activity. They claim such relationships imply unidirectional causation from inflation rate to stock returns. James, Koreisha and Partch (1985) study causal links among stock returns, real economic activity, money supply and inflation rate in the context of a Vector Autoregressive Moving Average (VARMA) model, and find that stock returns Granger cause expected real economy and expected real economy Granger causes inflationary expectation. They also show that stock returns precede or Granger cause changes in inflationary expectation, thereby lending support to the finding of Geske and Roll.

Lee (1992) investigates dynamic relationship among stock returns, interest rates, real economic activity and inflation rate within the context of Vector Autoregressive (VAR) model and finds that although stock returns Granger cause real economic activity, no causal relationship can be detected between stock returns and inflation rate, which is consistent with Fama's finding.

These studies, yielding conflicting results, appeared in the finance literature prior to 1990 when New Zealand became the first country to implement inflation targeting monetary policy. No study has yet investigated the dynamic relationship between stock returns and inflation rate for inflation targeting countries.

The impetus for this paper comes from the assertion that a unique and interesting relationship between stock returns and inflation rate exists for inflation targeting countries. If inflation rate rises above the numerical inflation target, then forward-looking investors would predict that the central bank will implement a contractionary monetary policy (i.e., an increase in the short-term benchmark interest rate) to combat escalating inflation and economic contraction will therefore ensue as an increase in interest rates will weaken consumer spending, business investment spending, and net export. A slowdown in real economic activity will inevitably translate to plummeting corporate earnings. Anticipating such gloomy scenario, forward-looking investors would immediately reduce the demand for stocks, thus dampening current stock returns. Conversely, a decline in inflation rate relative to its target should boost current stock returns.

Therefore, in an inflation targeting country, real stock returns should precede (or Granger cause) real economic activity, since investors are forward-looking, and inflation rate should precede (or Granger causes) real stock returns.

These relationships for seven inflation targeting countries – Brazil, Canada, Chile, Israel, South Korea, Sweden and the United Kingdom -- can be readily tested within the Vector Autoregressive (VAR) framework. Granger causality test procedure will be performed in the context of the following standard Vector Autoregressive (VAR) model of 3 equations for these seven countries:

$$Z_t = \alpha + A_1 Z_{t-1} + A_2 Z_{t-2} + A_3 Z_{t-3} + \dots\dots\dots\dots + A_p Z_{t-p} + \varepsilon_t \qquad (1)$$

where $Z_t = [RSR_t , INFGAP_t, EXPGROWTH_t]'$, α is a 3 x 1 vector of constant terms, A_i is a 3 x 3 matrix of coefficients for i = 1,2, … p, where p is the optimal lag length of the VAR model, and ε_t is a 3 x 1 vector of serially uncorrelated white-noise error terms that have a zero mean and variance-covariance matrix $\sum_e$. RSR_t is the real stock return at time t, $INFGAP_t$ is the gap between inflation rate and the mean of the range of inflation rate target at time t, and $EXPGROWTH_t$ is the expected economic growth rate at time t that proxies for real economic activity.

The following null hypotheses will be tested using the standard F-test statistic in the context of the VAR model to determine causal relationships among these three variables:

$H_0 : a_{12}(1) = a_{12}(2) = a_{12}(3) = \ldots\ldots\ldots = a_{12}(p) = 0$, (i.e., inflation rate does not Granger cause real stock returns), and

$H_0 : a_{31}(1) = a_{31}(2) = a_{31}(3) = \ldots\ldots\ldots = a_{31}(p) = 0$, (i.e., real stock return does not Granger cause real economic activity)

$a_{ij}(p)$ in above null hypotheses represents the i, jth coefficient of the A_p matrix, which gauges the impact of the pth lagged value of jth variable on the variable i.

If estimated coefficients of the jth variable as a group is found to be statistically significant, then the past values of the variable j can explain variations in the variable i and therefore the variable j Granger causes the variable i. If, on the other hand, estimated coefficients of the jth variable as a group is statistically insignificant, then the past values of the variable j are not useful in explaining current fluctuations in the variable i and the variable j does not Granger cause variable i.

Determining the appropriate lag length of the VAR model prior to estimation is obviously very important. If the lag length is too small, the model may suffer from misspecification error and, if the lag length is too large, the model may run the risk of being overparametrized. The appropriate lag length, p, of the VAR model will be determined using the likelihood ratio test statistic of the following form [Sims (1980)]:

$$(N\text{-}k)(\log |\textstyle\sum_r| - \log |\textstyle\sum_u|), \qquad (2)$$

where N is the number of observations, k is the number of parameters estimated in each equation of the unrestricted model, and $\sum_r$ and $\sum_u$ respectively represent the variance/covariance matrix of the restricted and unrestricted models. The restrictive model contains p lags and the unrestrictive model contains lags greater than p (say q, where q >p). This statistic has an asymptotic χ^2 (Chi-square) distribution with degrees of freedom equal to the number of restrictions in the system. Large value of this statistic should lead to the rejection of the null hypothesis that the lag length of the VAR model is p, and q should be chosen as the appropriate lag for the VAR model. The likelihood ratio statistic is computed with lag lengths ranging from 4 to 12 at the increments of 4.

Since same lag length is imposed on all equations within the VAR model, the OLS estimation method, which yields consistent and asymptotically efficient estimates under this restriction, is employed to estimate the VAR model in this study.

DATA

The primary source of data for this study is the International Financial Statistics (IFS) database published by the International Monetary Fund (IMF). Monthly data for aggregate stock prices and inflation rate are obtained for Brazil, Canada, Chile, Israel, South Korea, Sweden, and United Kingdom from the IFS database.

The IFS database provides quarterly but not monthly data for real GDP. Since monthly data for industrial production for these seven countries are readily accessible from the IFS database, industrial production is used in this study as a proxy for real GDP.

The monthly data for the following period are utilized in this study for these seven countries – 2000:7 – 2011:12 for Brazil, 1992:1 – 2011:12 for Canada, 1992:1 – 2010:7 for Chile, 1993:1 – 2012:3 for Israel, 1999:4 – 2012:3 for South Korea, 1994:1 – 2012:3 for Sweden, and 1993:10 – 2012:3 for the United Kingdom.

RSR_t, real stock return for a given country at time t, is computed as the nominal stock return at time t minus the inflation rate at time t. Nominal stock return at time t is defined as the log SP_t – log SP_{t-1}, where SP_t is the aggregate stock market index of the country at time t. The inflation rate at time t is defined as the log CPI_t - log CPI_{t-1}, where CPI_t is the Consumer Price Index at time t. $INFGAP_t$ is defined as the gap between inflation rate at time t and the mean of the range of inflation rate target imposed by the central bank for time t. Economic growth rate at time t (DQ_t) is defined as the log Q_t – log Q_{t-1}, or $\log(Q_t/Q_{t-1})$, where Q_t is the industrial production at time t.

Although there is a wide array of estimation procedures that can be employed to extract expected economic growth rate (EXPGROWTH), Box-Jenkins time series (or ARIMA) model is used in this study to generate $EXPGROWTH_t$. Based on sample autocorrelation functions of the economic growth rate (DQ_t), it is found that MA (2) process, or the Moving Average process of order 2, of the following form best fits DQ_t for all seven countries:

$$DQ_t = \mu + \varepsilon_t - \theta_1\varepsilon_{t-1} - \theta_2\varepsilon_{t-2}\,, \tag{3}$$

where μ is the mean of the economic growth rate, and ε_t is a white noise process with mean 0 and variance σ_ε . This process has mean μ and variance $\sigma_\varepsilon\,(1 + \theta1^2 + \theta_2^2)$. Furthermore, the reported Q-statistics indicate that the null hypothesis of white noise residuals cannot be rejected at the 5% level for all fitted MA (2) models of economic growth rate.[7]

Table 1 (See Appendix) lists the inflation target width for seven countries selected for this study. These figures are obtained from Mishkin and Schmidt-Hebbel (2001) and various reports published by the central banks of these countries. The numerical inflation target adopted by these countries is in the form of a range, such as 1-3% for Israel, or a point target within a range, such as 4.5 % with a tolerance level of +/ - 2% for Brazil, or a specific point target, such as 2% for the United Kingdom. The inflation rate that is being targeted is the headline Consumer Price Index (CPI) for all countries.

Brazil, which implemented inflation targeting policy in July 1999, lowered its point target from 8% with a tolerance level of +/- 2% in 1999 to 4.5% +/- 2% effective 2006[8]. Canada, which began targeting inflation rate in February, 1991, modified its target range several times since then – between 3% and 5% in 1991, between 2% and 4% in 1992, between 1.5% and 3.5% during 1993-94, and between 1% and 3% thereafter. Chile's monetary policy was ostensibly more unstable. It set the target range of 15% - 20% in 1991 and 13% - 16% in 1992, and it has steadily lowered the target range every year to 2% - 4% in 2001. Israel's inflation target range has also varied significantly since it launched inflation targeting monetary policy in January 1992. Its initial target range was 14% - 15% in 1992, which gradually declined to 1% - 3% in 2003.

South Korea, which adopted inflation targeting policy in April 1998, lowered its target range from 9% +/- 1% in 1998 to 3% +/- 1% since 2010[9]. Sweden and United Kingdom, on the other hand, have implemented relatively stable inflation targeting policies since the 1990s. Sweden, which had launched its policy in January 1993, set the target range for inflation rate to be 1%-3% every year since its inception. United Kingdom, which formally adopted inflation targeting policy in 1992, had used 1% – 4% target range between 1992 and 1995 and a specific target of 2% since 2004.

Operating target employed to achieve inflation stability is either the overnight interest rate for Brazil, Canada, Chile and Israel, or 7-day repo rate for South Korea (also known as the Bank of Korea Base Rate), Sweden and the United Kingdom. Inflation target is set jointly by the government and the central bank for Brazil and Canada. Inflation target for Israel and the United Kingdom is set by the government, whereas the target for Chile, South Korea and Sweden is set by the central bank.[10]

EMPIRICAL RESULTS

Table 2 (See Appendix) summarizes the results of the Granger causality test. The optimal lag length of the VAR model is chosen as 12 for all seven countries by applying the likelihood ratio test. In an attempt to provide more complete description of the dynamic relationships among real stock returns, inflation rate and real economic activity, the following hypotheses are also tested for all countries:

$H_0 : a_{21}(1) = a_{21}(2) = a_{21}(3) = \ldots\ldots\ldots = a_{21}(p) = 0$, (i.e., real stock return does not Granger cause inflation rate), and

$H_0 : a_{13}(1) = a_{13}(2) = a_{13}(3) = \ldots\ldots\ldots = a_{13}(p) = 0$, (i.e., real economic activity does not Granger cause real stock return).

As can be seen from Panel A of Table 2, the null hypothesis of no Granger causality from inflation rate to real stock returns is rejected for Brazil, Israel, South Korea and Sweden at the 5% significance level, although it is not rejected for Canada, Chile and the United Kingdom. Also the null hypothesis of no Granger causality from real stock returns to inflation is not rejected for all seven countries. These results indicate that there is unidirectional causality from inflation rate to real stock returns (i.e., inflation rate signals changes in real stock returns, but not the other way around) for four out of seven countries – Brazil, Israel, South Korea and Sweden. These results lend support for the findings of Ram and Spencer (1983), but repudiates those of Fama (1981), Geske and Roll (1983), Kaul (1987,1990), James, Koreish and Partch (1985), and Lee (1992).

The null hypothesis of no Granger causality from real stock returns to real economic activity is rejected at the 5% significance level for Brazil, Israel, South Korea, Sweden and the United Kingdom. However this hypothesis is not rejected for Canada and Chile. The null hypothesis of no Granger causality from real economic activity to real stock returns is not rejected for all seven countries. Consequently, unidirectional causality from real stock returns to real economic activity is detected for five of seven countries – Brazil, Israel, South Korea, Sweden and the United Kingdom. This relationship is consistent with the findings of Fama (1981), Geske and Roll (1983), Kaul (1990), James, Koreish and Partch (1985) and Lee (1992) that claim the stock market efficiently and fully captures future changes in real economic activity.

Therefore, for most inflation targeting countries, changes in inflation rate precede or Granger cause changes in real stock returns and changes in real stock returns precede or Granger cause changes in real economic activity. These results apparently contradict the findings of previous studies that investigate the relationship between real stock returns and inflation rate for non-inflation targeting countries.

Econometric textbooks [e.g., Enders (1995)] normally suggest that traditional Granger causality test should be conducted in conjunction with more robust test procedures in order to shed more light on the dynamic of these relationships. In this regard, two additional tests --block exogeneity test and variance decomposition analysis -- are performed next. Block exogeneity test[11] is designed to ascertain whether lagged values of a given variable Granger causes other variables within a VAR model. Block exogeneity test utilizes a likelihood ratio test statistic very similar to equation (2):

$$(N-c)(\log |\textstyle\sum_r| - \log |\textstyle\sum_u|) , \qquad (2')$$

where N is the number of observations, c is the total number of parameters estimated in the unrestricted VAR model, and $\sum_r$ and $\sum_u$ respectively represent the variance/covariance matrix of the restricted and unrestricted models. This statistic has an asymptotic χ^2 distribution with degrees of freedom equal to twice the number of lagged values of a given variable excluded in the restricted model. $\sum_u$ can be obtained by estimating equation (1) with p lagged values of all three variables (RSR_t , $INFGAP_t$, $EXPGROWTH_t$). In order to determine, for example, whether INFGAP Granger causes either RSR or EXPGROWTH, $\sum_r$ is obtained by estimating equation (1) with p lagged values of INFGAP excluded. Large value of this test statistic should lead to the rejection of the null hypothesis that inflation (INFGAP) does not Granger cause either real stock returns (RSR) or real economic activity (EXPGROWTH). As can be seen from panel B of Table 2, results obtained with this procedure are very similar to those obtained from the Grange causality test. The null hypothesis that inflation rate does not Granger cause either real stock returns or real economic activity is rejected at the 5% significance level for Israel, South Korea and Sweden.

The variance decomposition analysis is performed next to gauge the impact of a random shock or an innovation in a given variable on the variance of the forecasting error of another variable. The main thrust of variance decomposition analysis can be explained as follows. First, rearrange lag terms in equation (1) as follows:

$$Z_t - A_1 Z_{t-1} - A_2 Z_{t-2} - A_3 Z_{t-3} - \ldots\ldots\ldots\ldots - A_p Z_{t-p} = B(L)\, Z_t = \alpha + \varepsilon_t \quad , \tag{4}$$

where $B(L) = (I - A_1 L - A_2 L^2 - A_3 L^3 \ \ldots\ldots\ldots\ldots - A_p L^p)$ is a polynomial of degree p in the lag operator such that $L^p Z_t = Z_{t-p}$. Then, Z_t can be expressed as

$$Z_t = B^{-1}(L)\, \alpha + B^{-1}(L)\, \varepsilon_t = C_0 + C(L)\, \varepsilon_t = C_0 + \sum_{k=0}^{\infty} C(k)\, \varepsilon(t-k), \tag{5}$$

where C(k) is a 3 x 3 matrix with coefficients representing the impact of a shock at time t-k on Z_t. Then the n-period forecast error, $Z_{t+n} - E_t Z_{t+n}$, can be expressed as

$$\sum_{k=0}^{n-1} C(k)\, \varepsilon(t + n - k)\ . \tag{6}$$

The percentage of the n-period forecast error variance of the i_{th} variable that is explained by a shock in the jth variable at time t can be expressed as

$$\left[\, \sigma^2_j \sum_{k=0}^{n-1} C_{ij}^2(k) \Big/ \sum_{m=1}^{3} \sigma^2_m \sum_{k=0}^{n-1} C_{im}^2(k) \,\right] \times 100. \tag{7}$$

where σ^2_j is the variance of a shock in the jth variable, $C_{ij}(k)$ represents i,j th coefficient of the C(k) matrix that measures the impact of a random shock on the jth variable on the variable i after k periods. $C_{ij}(k)$ for all possible values of i,j and k is known as the impulse response function. Since all values of $C_{ij}^2(k)$ are nonnegative, the variance of the forecast error increases as the forecast horizon n increases. If a shock in the jth variable at time t explains none of the forecast error variance of the ith variable at all forecast horizons, then the ith variable is deemed as exogenous with respect to variable j.

As can be seen from Table 3 (See Appendix), a shock in inflation rate accounts for 14%, 15%, and 15% of the forecast error variance of real stock returns for Israel, South Korea and Sweden, respectively, after 24 months. However the impact of inflation on real stock returns is not significant for Brazil, Canada, Chile and the United kingdom, where the percentage explained by inflation ranges from only 4.6% for the United Kingdom to 10.8% for Chile after 24 months. These findings corroborate the results from the Granger causality test, which find inflation rate signals changes in real stock returns for Brazil, Israel, South Korea and Sweden.

On the other hand, an innovation in real stock returns accounts for 14.4% and 11.7% of the forecast error variance of real economic activity for Brazil and South Korea, respectively, after 24 months, although the percentages are not that high for other countries, which ranges from 5.79% for Chile to 7.88% for the United Kingdom.

Therefore it is found that inflation rate Granger causes or signals real stock returns for Brazil, Israel, South Korea and Sweden, but not for Canada, Chile and the United Kingdom. Real stock returns Granger cause or precede real economic activity for Brazil, Israel, South Korea, Sweden and the United Kingdom, but not for Canada and Chile. The results from more robust tests generally seem to mirror these findings. These results are seemingly at odds with those of previous studies that investigate dynamic relationship among real stock returns, inflation rate and real economic growth for non-inflation targeting countries. Therefore it is safe to conclude from these results that a unique relationship between real stock returns and inflation rate exists in countries that explicitly target inflation rate.

More interestingly, these findings strongly support the notion that, in most inflation targeting countries, investors are forward-looking in the sense that they trade stocks based on anticipated future course of economic activity resulting from current changes in inflation rate. As such, current stock returns in these countries may be unduly sensitive to changes in inflation rate relative to its target.

Obviously these findings have useful implications for investors interested in trading stocks in these countries. If investors in an inflation-targeting country expect the inflation rate at time t, which will be announced at the end of time t, will be higher than its announced target, then they should either sell short or postpone purchasing stocks at the beginning of time t. On the other hand, if they expect the inflation rate at time t will be lower than its target, then they should purchase stocks, preferably on margin, at the beginning of time t. Of course, these strategies would be profitable only if (i) investors correctly predict the magnitude of the inflation rate relative to its target and (ii) transaction costs of executing these strategies do not outweigh the gross profit generated from these strategies.

CONCLUSION

This study investigates whether the implementation of inflation targeting strategy significantly affects the dynamic relationship between real stock returns and inflation rate for seven countries. It is hypothesized in this paper that, in inflation targeting countries, inflation rate signals real stock returns and real stock returns signal real economic activity. The findings of this paper support these assertions for the majority of seven countries. Accordingly, inflation rate explains a significant portion of variations in real stock returns for many inflation targeting countries, which suggests that forward-looking investors in these countries may be able to execute profitable investment strategies based on their expectation of the deviation of the actual inflation rate from its announced target.

ENDNOTES

1. These fourteen countries and the year in which they implemented inflation targeting are, alphabetically, Armenia (2006), Ghana (2002), Guatemala (2005), Hungary (2001), Iceland (2001), Indonesia (2005), Mexico (2001), Norway (2001), Philippines (2002), Romania (2005), Serbia (2002), South Africa (2000), Thailand (2000), and Turkey (2006). Finland, Spain and Slovakia dropped targeting inflation once they joined Eurozone (Finland and Spain in 1999 and Slovakia in 2009).
2. Recent empirical studies, for most part, document salutary effects of inflation targeting. Although Ball and Sheridan (2003) suggest factors other than inflation targeting policy must have played a role in reducing inflation rate and its volatility across industrialized countries, Bernanke, Laubach, Mishkin and Posen (1999), Mishkin and Schmidt-Hebbel (2007), IMF (2005), Vega and Winkelried (2005), Levin et al (2004), and Batini and Laxton (2007) find that level, persistence and volatility of inflation rate are unambiguously lower in inflation-targeting countries.
3. Rogers (2010) and Carvalho-Filho (2010) present evidence that inflation targeting has rendered targeting countries less vulnerable to the devastating consequences of the recent financial crisis.
4. Ben Bernanke, chairman of the Federal Reserve System of the United States between 2006 and 2014, has been a long-time advocate of inflation targeting policy. Bernanke made it clear through his writings and speeches that Federal Reserve Bank should strive to keep core inflation rate, i.e., inflation rate excluding prices of food and energy, between 1 and 2 % annually in order to permanently lower inflationary expectation and foster sustainable economic growth. However his successor, Janet Yellen, has not been forthcoming about her views on inflation targeting.
5. See, for example, Bodie (1976), Nelson (1976) and Fama and Schwert (1977).
6. Fama (1981) was the first to coin the term “proxy effect” to describe the causal relationship between stock returns and inflation rate. He finds a strong relationship between stock returns and future economic activity, and claims the negative relationship between stock returns and expected inflation is spurious since inflation is merely serving as a proxy for expected economic activity in such relationship.

7. Details of the ARIMA specification of the economic growth rate (DQ_t) used in this study are available from the author upon request.
8. Source: various publications from the Banco Central Do Brasil (Central Bank of Brazil).
9. Source: Kim and Park, "Inflation Targeting in Korea: a model of success", in Monetary Policy in Asia: Approaches and Implementation, BIS paper #31, December 2006; and various publications from the Bank of Korea.
10. Source: Hammond, Gill (2012), "State of the Art of Inflation Targeting", Centre for Central Banking Studies, Handbook No.29, Bank of England.
11. "Granger causality" is statistically a less stringent condition than "exogeneity". If there is a contemporaneous relationship between two variables, say X and Y, then Y may not be exogenous to X even if X does not Granger cause Y. [please refer to pp. 315-316, **Applied Econometric Time Series** (1995) by Walter Enders.]

REFERENCES

Ball, L. & Sheridan, N. (2003). Does inflation targeting matter? *NBER Working Paper Series #9577.*

Batini, N. & Laxton, D. (2007). Under what conditions can inflation targeting be adopted? *Monetary Policy under Inflation Targeting (F. Mishkin and K. Schmidt-Hebbel, ed.)*, Central Bank of Chile.

Bernanke, B.S. & Mishkin, F.S. (1997). Inflation targeting: a new framework for monetary policy? *Journal of Economic Perspectives,* 11, 97-116.

Bernanke, B.S., Laubach, T., Mishkin, F.S. & Posen, A.S. (1999). *Inflation Targeting: Lessons from the International Experience,* Princeton University Press, Princeton, New Jersey.

Bodie, Z. (1976). Common Stocks as a Hedge against Inflation. *Journal of Finance,* 31, 459-470.

Carvalho-Filho, I. (2010). Inflation targeting and the crisis: An empirical assessment. *IMF Working Paper* No. 10/45.

Enders, W. (1995). *Applied Econometric Time Series*. John Wiley and Sons, Inc., New York, New York.

Fama, E.F. (1981). Stock Returns, Real Activity, Inflation and Money. *American Economic Review,* 71, 545-565.

Fama, E.F. & Schwert, G.W. (1977). Asset Returns and Inflation. *Journal of Financial Economics*, 5, 115-146.

Geske, R. & Roll, R. (1983). The monetary and fiscal linkage between stock returns and inflation. *Journal of Finance*, 38, 1-33.

Hammond, G. (2012). State of the Art of Inflation Targeting. *Centre for Central Banking Studies, Handbook No.29,* Bank of England.

International Monetary Fund. (2005). *World Economic Outlook*, Washington.

James, C., Koreisha, S. & Partch, M. (1985). A VARMA analysis of the causal relations among stock returns, real output, and nominal interest rates. *Journal of Finance,* 40, 1375-1384.

Kaul, G. (1987). Stock returns and inflation: The role of the monetary sector. *Journal of Financial Economics,* 18, 253-276.

Kaul, G. (1990). Monetary regimes and the relation between stock returns and inflationary expectations. *Journal of Financial and Quantitative Analysis*, 25, 307-321.

Kim, S. & Park, Y.C. (2006). Inflation targeting in Korea: a model of success, *Monetary Policy in Asia: Approaches and Implementation, BIS Paper #31.*

Lee, B.S. (1992). Causal relations among stock returns, interest rates, real activity, and inflation. *Journal of Finance,* 62, 1591-1603.

Levin, A., Netalucci, F.M., & Piger, J.M. (2004). The macroeconomic effects of inflation targeting. *Federal Reserve Bank of St. Louis Review, July/August.*

Mishkin, F.S. & Schmidt-Hebbel, K. (2001). One decade of inflation targeting in the world: what do we know and what do we need to know? *NBER Working Paper Series #8397.*

Mishkin, F.S. & Schmidt-Hebbel, K. (2007). Does inflation targeting make a difference? *NBER Working Paper Series #12876.*

Nelson, C.R. (1976). Inflation and Rates of Return on Common Stocks. *Journal of Finance*, 31, 471-483.

Ram, R. & Spencer, D.E. (1983). Stock returns, real activity, inflation and money: Comment. *American Economic Review*, 73, 463-470.
Roger, S. (2010). Inflation targeting turns 20. *Finance and Development*, 46-49.
Sims, C. (1980). Macroeconomics and Reality. *Econometrica*, 48, 1-49.
Vega, M. & Winkelried, D. (2005). Inflation Targeting and Inflation Behavior: A Successful Story? *International Journal of Central Banking,* 1.

TABLE 1
INFLATION RATE TARGET WIDTH

	Implementation Date	Inflation Target Width	Target set by
I. Brazil	July 1999	8 ± 2% (1999) 6 ± 2% (2000) 4 ± 2% (2001) 3.5 ± 2% (2002) 8.5% (2003) 5.5% (2004) 4.5 ± 2.5% (2005) 4.5 ± 2% (2006 – present)	jointly by Central Bank (Banco Central Do Brasil) and Government
II. Canada:	February 1991	3-5% (1991) 2-4% (1992) 1.5 – 3.5% (1993-1994) 1-3% (1995 – present)	jointly by Central Bank (Bank of Canada) and Government
III. Chile:	January 1991	15-20% (1991) 13-16% (1992) 10-12% (1993) 9-11% (1994) 8 % (1995) 6.5% (1996) 5.5% (1997) 4.5% (1998) 4.3 % (1999) 3.5% (2000) 2-4% (2001- present)	Central Bank (Banco Central De Chile)
IV. Israel:	January 1992	14-15% (1992) 10 % (1993) 8% (1994) 8-11 % (1995) 8–10 % (1996) 7-10% (1997- 1998) 4 % (1999) 3-4% (2000) 2.5%-3.5% (2001) 2-3% (2002) 1-3% (2003-present)	Government
V. South Korea:	April 1998	9 ± 1 % (1998) 3 ± 1 % (1999) 2.5 ± 1 % (2000) 3 ± 1 % (2001) 2.5% (2002) 3 ± .5 % (2003- 2009) 3 ± 1 % (2010 - now)	Central Bank (Bank of Korea)
VI. Sweden:	January 1993	1-3% (1993 – present)	Central Bank (Sveriges Riksbank)
VII. United Kingdom:	October 1992	1-4% (1992-1995) 2.5 % (1996 –2003) 2% (2004 – present)	Government

[Source: Mishkin, Frederic and K. Schmidt-Hebbel (2001), "One Decade of Inflation Targeting in the World: What do we know and what do we need to know?", *NBER Working Paper #8397*; Kim and Park, "Inflation Targeting in Korea: a model of success" in *Monetary Policy in Asia: Approaches and Implementation*, *BIS paper #31*, December 2006; Hammond, Gill (2012), "State of the Art of Inflation Targeting", *Centre for Central Banking Studies, Handbook No.29,* Bank of England; various publications from the Bank of Korea; and various publications from the Banco Central do Brasil (Central Bank of Brazil)].

TABLE 2
GRANGER CAUSALITY TEST AND BLOCK EXOGENEITY TEST RESULTS

A. Granger Causality Test Results:

Null Hypothesis	F-Test
I. Brazil	
H_0: Inflation rate does not Granger cause real stock returns	F(12,101) = 2.6788*
H_0: Real stock return does not Granger cause inflation rate	F(12,101) = 1.1126
H_0: Real stock return does not Granger cause real economic activity	F(12,101) = 2.1927*
H_0: Real economic activity does not Granger cause real stock returns	F(12,101) = .8264
II. Canada	
H_0: Inflation rate does not Granger cause real stock returns	F(12,203) = 1.2235
H_0: Real stock return does not Granger cause inflation rate	F(12,203) = 1.0140
H_0: Real stock return does not Granger cause real economic activity	F(12,203) = 1.4916
H_0: Real economic activity does not Granger cause real stock returns	F(12, 203) = .6289
III. Chile	
H_0: Inflation rate does not Granger cause real stock returns	F(12,186) = 1.2796
H_0: Real stock return does not Granger cause inflation rate	F(12,186) = .9690
H_0: Real stock return does not Granger cause real economic activity	F(12,186) = 1.5639
H_0: Real economic activity does not Granger cause real stock returns	F(12,186) = .9484
IV. Israel	
H_0: Inflation rate does not Granger cause real stock returns	F(12, 192) = 1.7840*
H_0: Real stock return does not Granger cause inflation rate	F(12,192) = .4575
H_0: Real stock return does not Granger cause real economic activity	F(12,192) = 2.5219*
H_0: Real economic activity does not Granger cause real stock returns	F(12,192) = 1.212
V. South Korea	
H_0: Inflation rate does not Granger cause real stock returns	F(12, 116) = 2.1293*
H_0: Real stock return does not Granger cause inflation rate	F(12, 117) = .6568
H_0: Real stock return does not Granger cause real economic activity	F(12, 117) = 1.8252*
H_0: Real economic activity does not Granger cause real stock returns	F(12,116) = 1.3783
VI. Sweden	
H_0: Inflation rate does not Granger cause real stock returns	F(12, 180) = 1.8832*
H_0: Real stock return does not Granger cause inflation rate	F(12,180) = 1.4169
H_0: Real stock return does not Granger cause economic activity	F(12, 180) = 1.8415*
H_0: Real economic activity does not Granger cause real stock returns	F(12,180) = .4994
VII. United Kingdom	
H_0: Inflation rate does not Granger cause real stock returns	F(12, 184) = .8847
H_0: Real stock return does not Granger cause real economic activity	F(12,184) = .7045
H_0: Real stock return does not Granger cause real economic activity	F(12,183) = 2.0883*
H_0: Real economic activity does not Granger cause real stock returns	F(12, 183) = 1.4568

*- significant at the 5% level. Null hypotheses tested are
$H_0 : a_{12}(1) = a_{12}(2) = a_{12}(3) = \ldots = a_{12}(p) = 0$, (i.e., inflation rate does not Granger cause real stock return),
$H_0 : a_{31}(1) = a_{31}(2) = a_{31}(3) = \ldots = a_{31}(p) = 0$, (i.e., real stock return does not Granger cause real economic activity) ,
$H_0 : a_{21}(1) = a_{21}(2) = a_{21}(3) = \ldots = a_{21}(p) = 0$, (i.e., real stock return does not Granger cause inflation rate), and
$H_0 : a_{13}(1) = a_{13}(2) = a_{13}(3) = \ldots = a_{13}(p) = 0$, (i.e., real economic activity does not Granger cause real stock return)
where $a_{ij}(p)$ in above null hypotheses represents the i, jth coefficient of the A_p matrix in the equation (1):

$$Zt = \alpha + A_1 Z_{t-1} + A_2 Z_{t-2} + A_3 Z_{t-3} + \ldots + Ap\, Zt\text{-}p + \varepsilon t \qquad (1)$$

The variables in the vector Z_t are real stock returns (RSR), gap between inflation rate and inflation target (INFGAP), and expected economic growth rate (EXPGROWTH). The monthly data for the following period are employed in this study for seven countries -- 2000:7 – 2011:12 for Brazil, 1992:1 – 2011:12 for Canada, 1992:1 – 2010:7 for Chile, 1993:1 – 2012:3 for Israel, 1999:4 – 2012:3 for South Korea, 1994:1 – 2012:3 for Sweden, and 1993:10 – 2012:3 for the United Kingdom.

B. Block Exogeneity Test Results:

Null Hypothesis	Likelihood Ratio Test
I. Brazil	
H_0: inflation does not Granger cause real stock returns or real economic activity	χ^2 (24) = 17.7632
II. Canada	
H_0: inflation does not Granger cause real stock returns or real economic activity	χ^2 (24) = 28.9562
III. Chile	
H_0: inflation does not Granger cause real stock returns or real economic activity	χ^2 (24) = 28.0371
IV. Israel	
H_0: inflation does not Granger cause real stock returns or real economic activity	χ^2 (24) = 37.0071*
V. South Korea	
H_0: inflation does not Granger cause real stock returns or real economic activity	χ^2 (24) = 37.5257*
VI. Sweden	
H_0: inflation does not Granger cause real stock returns or real economic activity	χ^2 (24) = 40.3858*
VII. United Kingdom	
H_0: inflation does not Granger cause real stock returns or real economic activity	χ^2 (24) = 23.7039

***-** significant at the 5% level.

Block exogeneity test utilizes a likelihood ratio test statistic very similar to equation (2):

$$(N\text{-}c)(\log|\textstyle\sum_r| - \log|\textstyle\sum_u|), \quad (2')$$

where N is the number of observations, c is the total number of parameters estimated in the unrestricted VAR model, and $\sum_r$ and $\sum_u$ respectively represent the variance/covariance matrix of the restricted and unrestricted models. This statistic has an asymptotic χ^2 distribution with degrees of freedom equal to twice the number of lagged values of a given variable excluded in the restricted model. $\sum_u$ can be obtained by estimating equation (1) with p lagged values of all three variables (RSR_t , $INFGAP_t$, $EXPGROWTH_t$). $\sum_r$ is obtained by estimating equation (1) with p lagged values of a given variable excluded.

TABLE 3
VARIANCE DECOMPOSITION ANALYSIS RESULTS

A. Real Stock Return

Percentage of Forecast Error Variance Accounted by Shocks or Innovations in Inflation Rate

Horizon	Brazil	Canada	Chile	Israel
3 months	2.271	.137	7.345	5.526
6 months	5.565	5.333	7.649	10.379
12 months	7.143	7.265	9.934	12.561
24 months	8.260	7.468	10.767	13.996

Horizon	South Korea	Sweden	United Kingdom
3 months	8.973	4.728	.501
6 months	11.423	11.976	1.906
12 months	14.289	13.999	2.957
24 months	15.159	15.024	4.607

B. Real Economic Activity

Percentage of Forecast Error Variance Accounted by Shocks or Innovations in Real Stock Returns

Horizon	Brazil	Canada	Chile	Israel
3 months	9.260	.258	.020	.682
6 months	11.834	5.825	3.526	3.737
12 months	13.450	6.457	5.114	5.689
24 months	14.410	7.835	5.786	6.694

Horizon	South Korea	Sweden	United Kingdom
3 months	7.297	1.701	2.366
6 months	7.195	2.823	4.783
12 months	11.043	5.761	7.769
24 months	11.707	6.879	7.882

The percentage of the n-period forecast error variance of the i_{th} variable that can be explained by a shock in the jth variable at time t can be expresses as

$$\sum_{k=0}^{n-1} \left[\sigma^2_j \; \Sigma C_{ij}^2(k) / \; \sum_{m=1}^{3} \sigma^2_m \sum_{k=0}^{n-1} C_{im}^2(k) \right] \times 100. \tag{7}$$

where σ^2_j is the variance of a shock in the jth variable, C_{ij} (k) represents i,j th coefficient of the C(k) matrix that measures the impact of a random shock on the jth variable on the variable i after k periods. C(k) is a 3 x 3 matrix with coefficients representing the impact of a shock at time t-k on Z_t from equation (5):

$$Z_t = B^{-1}(L)\,\alpha + B^{-1}(L)\,\varepsilon_t = C_0 + C(L)\,\varepsilon_t = C_0 + \sum_{k=0}^{\infty} C(k)\,\varepsilon(t-k), \tag{5}$$