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Exchange rate volatility and stock returns for the U.S.

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This study attempted to examine the effects of exchange rate volatility, using the squared residuals from the autoregressive moving average (ARMA) models, on stock returns for the U.S. for the period 1980 to 2008. Even though the core variable was exchange rate volatility, this article used several other explanatory variables to explain changes in the stock returns for the U.S. This paper found that exchange rate volatility affects US stock returns. Even though firms engaged in international operations had some methods, such as hedging possibilities, to protect themselves from exchange rate risk, exchange rate volatility might negatively affect firms' profitability because of increasing cost of covering exchange rate risk under a flexible rate system.

Key words: Exchange rate volatility, international trade, US stock returns.

INTRODUCTION

This study analyzes the effects of exchange rate volatility, using the squared residuals from the ARMA process, on stock returns for the U.S.A. Previous studies emphasized relationship between exchange rate uncertainty and trade volume. Those studies generally found that exchange rate uncertainty has a negative and significant effect on trade volume.

In this paper, we aim to test the effect of exchange rate volatility on the profits of firms in the U.S. While the relationship between inflation rates or interest rates and the value of the firm has been extensively analyzed, the association between exchange rates and the value of the firm has not been subject to much empirical research. In order to measure firms' profitability, this paper uses the stock returns data for these countries because volatility in stock returns indicates a change in the profits of the firms. In addition to exchange rate volatility, the study uses the federal funds rate to examine the relationship between monetary policy and stock returns. We also use several other explanatory variables to help explain changes in the stock returns using monthly data from 1980 to 2008. We found that there is a significant positive relationship between some of these variables and U.S. stock returns. These variables are the difference in returns between 20-year risky bonds and 20-year government bonds, which is the default premium, and the difference in returns between 20-year and 1-month

treasury bonds, which is the horizon premium. We did not find any relationship between exchange rate volatility and U.S. stock returns because most of the firms in the United States have some methods, such as hedging possibilities, to protect themselves from exchange rate risk. We also found that there is no relationship between U.S. stock returns and federal funds rate which is accepted as an indication of monetary policy. We also did not get a significant relationship between unanticipated inflation and U.S. stock returns.

Further, in data and methodology, we will set up our hypotheses which are related to variables used in this study and their relationships with U.S. stock returns and give detailed explanations for all variables and our expectations.

LITERATURE REVIEW

The first theoretical papers emphasized that the effect of exchange rate uncertainty or risk, in the absence of any mechanism to reduce the risk, would reduce the volume of trade. Ethier (1973) finds that if traders are uncertain about how the exchange rate will affect their firms' revenue, the volume of trade, most probably, will reduce. However, Clark (1973) notes that while risk-aversion, comes from exchange rate uncertainty, might lessen the

volume of a country's exports (and exports revenue), and complete forward markets might reduce this negative effects. Baron (1976) stresses that if forward markets are sufficiently developed, investors may still be unsure about how much foreign exchange they want to cover. Hooper and Kohlhagen (1978) find that if traders are risk-averse, an increase in exchange risk has a negative impact on the volume of trade, whether the risk is borne by importers or exporters; however, the effects on the price depend on who bears the exchange risk. De Grauwe (1988) considers a model where an individual producer has the choice of producing for foreign and domestic markets, both perfectly competitive. In his model, the degree of risk aversion determines the impact of the exchange rate risk. According to his findings, if producers are sufficiently risk averse, an increase in the exchange rate risk raises the expected marginal utility of exports revenues and therefore induces producers to increase their export activity.

An often-cited early theoretical study on the profitability effect of exchange rate uncertainty on the value of multinational firms is Shapiro (1975). In a partial equilibrium model, this study looks at the major factors affecting a multinational firm's exchange rate risk and, in turn, the relationship between that risk and the change in the value of the corporation. Shapiro concludes that exporting firms gain in profitability from a depreciation of the domestic currency; this is also consistent with conventional wisdom.

Grossman and Levinsohn (1989) have developed a method to assess the sensitivity of stock-market returns to variations in import competition. Their model also includes foreign exchange rate news as an independent variable in explaining the stock market returns of firms in six U.S. import-competing industries. Grossman and Levinsohn find an insignificant relationship between exchange rate news and firms' profit streams in all industries.

Conventional wisdom states that a decline in the value of the U.S. dollar is advantageous to U.S. exporting companies; however, an appreciation of the U.S. dollar hurts these companies. It is believed that changes in the exchange rate affect not only interest rates, prices, and national income, but also companies' value. Jorion (1990) examines the exposure of U.S. multinationals to foreign currency risk. He finds that the relationship between stock returns and exchange rates differs systematically across companies. Jorion finds that when the weight of exports in sales increases, the response of companies' stock prices to exchange rates will increase.

In spite of the common belief that exchange rate changes influence the value of multinational enterprises, exchange rate exposure is difficult to identify when exchange risk sensitivity is analyzed on the aggregate level. Choi and Prasad (1995) focus on individual firm value and develop a model of firm valuation to examine the exchange rate risk sensitivity of 409 U.S. multinational

firms during the 1978 to 1989 periods. Choi and Prasad find that approximately sixty percent of firms with significant exchange risk exposure gain from a depreciation of the dollar.

Arize et al. (2000) examine empirically the impact of real exchange rate volatility on the export flows of 13 less developed countries (LDC) over the quarterly period 1973 to 1996. Their major results show that increases in the volatility of the real effective exchange rate exert a negative significant effect on export demand in both the short-run and the long-run in each of the 13 LDC's. On the other hand, Baum et al. (2004) investigate empirically the impact of exchange rate volatility on real international trade flows utilizing 13-country data set of monthly bilateral real export during the period of 1980 to 1998. They find that the effect of exchange rate volatility on trade flows is nonlinear, which depends on importing country's volatility of economic activity and it also varies for each country pairs examined.

Adjasi et al. (2008) examine the relationship between stock markets and foreign exchange market for Ghana for the period January 1995 to June 2005. They find that there is an inverse relationship between exchange rate volatility and stock returns.

Statistical properties of stock returns

Normality

A key assumption for economic models of security returns is that security returns follow a stable symmetric distribution. Pioneering research was made by Fama (1965) who analyzed the distribution of the thirty stocks that make up the Dow Jones Industrial Average. Fama reported that security returns deviate from the typical assumption of normality and are "fat-tailed" or have kurtosis, which is greater than 3 (Hagerman, 1978).

The study supposes the assumption of normality because with this assumption, the OLS estimators will be 1) unbiased, 2) efficient estimators, 3) consistent, and 4) best unbiased estimators (BUE). Also, the central limit theorem (CLT) states that if the sample size is sufficiently large, the study can accept the normality assumption. Another reason why the study accepts the normality assumption is that the study took the natural log of stock returns. Then it was said that stock returns have a lognormal distribution.

Dependency

Linear dependency

The theory of random walks says that successive price changes are independent and identically distributed random variables, meaning the series of price changes

has no memory. Hence, the random walk theory claims that the past cannot be used to predict the future in any meaningful way (Fama, 1965).

Using the daily return series, Akgiray (1989) has found that the time series of daily stock returns exhibit a much higher degree of statistical dependence than has been reported in previous studies. Akgiray has identified that the presence of common market factors, the problem of thin trading in some stocks, the speed of information processing by market participants, and the day of the week effects could contribute partially to the observed first-order autocorrelations.

Nonlinear dependency

Hsieh (1989) states that it is possible for exchange rate changes to be linearly uncorrelated and nonlinearly dependent. According to Hsieh, "there is no reason to believe that economic systems must be intrinsically linear." Hsieh finds that although the data contain no linear correlation, empirical evidence indicates the presence of substantial nonlinear dependence. Hsieh reveals that a generalized autoregressive conditional Heteroscedasticity (GARCH) model can explain a large part of the nonlinearities in the data.

DATA AND METHODOLOGY

Even though the purpose of this study is to shed light on the effect of exchange rate volatility on the profits of firms in the U.S., the study uses several other explanatory variables as well. Hypotheses formulated in this study (1) address the impacts of the exchange rate volatility on the stock returns in the U.S; (2) address the impacts of monetary policy on the stock returns; (3) suggest relationships between unexpected inflation, current expected inflation, news about industrial production and the stock returns; and finally, (4) suggest a significant association between the default premium on bonds and stock returns.

The first difference of the exchange rate series is used. The source of the exchange rate data is the IMF's International Financial Statistics data base. The federal funds rate variable is the residual of a regression of the federal funds rate on six lags of federal funds rate, six lags of inflation, six lags of industrial production growth, six lags of commodity prices, six lags of non-borrowed reserves, and six lags of total reserves.

The inflation variables come from a regression of inflation on lagged inflation and current and lagged Treasury bill rates. Industrial production is just measured as a growth rate, following Chen et al. (1986). Data on the horizon premium, the default premium, and inflation are obtained from Ibbotson Associates (1994).

Hypotheses

As indicated in previous studies, exchange rate volatility negatively affects trade volume. However, empirical evidence for the negative impact of exchange rate volatility on trade volume is not conclusive for a firm, because the profitability of a firm is more important for an entrepreneur.

Even though firms engaged in international operations have some methods, such as hedging possibilities, to protect themselves

from exchange rate risk, exchange rate volatility may negatively affect firms' profitability because of the increasing cost of covering exchange risk under a flexible rate system. This argument leads me to the first hypothesis:

H₁: There is a negative association between exchange rate volatility and U.S. stock returns.

The study uses the federal funds rate as an indication of monetary policy, because the federal funds rate is related to the credit market conditions (when banks' credit needs are high, the federal funds rate will be high).

The conventional view suggests that a restrictive monetary policy results in higher interest rates, lower income, and lower consumption. On the other hand, an expansive monetary environment creates lower interest rates and higher economic activity. Also, the wealth transmission mechanism indicates a positive relationship between monetary policy and stock returns. According to this mechanism, an expansionary monetary policy results in an increase in stock prices, which in turn causes the value of financial wealth to increase, increasing the life time resources of consumers, so that consumption and production increase. Hence, the second hypothesis:

H₂: There is a negative relationship between the federal funds rate and U.S. stock returns.

The default premium, which is the difference in returns between a 20-year risky bond and a 20-year government bond, is expected to have a positive association with U.S stock returns. When the default premium increases, returns on corporate bonds increase relative to treasury bonds, which in turn cause interest rates on corporate bonds to decrease relative to treasury bonds; this means lower risk and higher stock returns. Thus, the third hypothesis:

H₃: There might be a positive association between the default premium and U.S. stock returns.

The horizon premium, which is the difference in returns between a 20-year and a one-month Treasury bond, is expected to have a positive interaction with stock returns. U.S Treasury bonds, which are the most liquid of all the money market instruments, have usually been considered to have no default risk when compared with corporate bonds. If the expected rate of return on a given long-term U.S. Treasury bond increases, investment in long-term U.S. Treasury bonds will be more profitable for investors, because of their higher returns. Demand for long-term bonds will increase, leading the interest rate on long-term U.S. Treasury bonds to decrease and stock prices to increase. Hence, our fourth hypothesis:

H₄: There might be positive relationship between U.S. Stock returns and the horizon premium.

Another variable that has an impact on stock returns is inflation. Using an equilibrium asset pricing model, Marshall (1992) finds a negative correlation between asset returns and expected inflation. Marshall's model predicts that the inflation-asset return correlation will be more strongly negative when inflation is generated by fluctuations in real economic activity than when it is generated by monetary fluctuations. Then, Marshall states that the response of equity returns to an expansionary monetary policy will be positive because the main source of fluctuations in inflation is fluctuations in real economic activity. Therefore, Marshall's explanation is consistent with the findings that observe positive correlations between money growth and asset return.

The performance of the economy contains some information about the direction of inflation, interest rates, and the exchange rate. Based on this information, the Federal Reserve will decide

what kind of monetary policy should be implemented to achieve desirable results for overall economic agents. Hence, when unanticipated inflation occurs, financial markets believe that news of inflation will generate a monetary tightening, which is implemented by the Federal Reserve.

This expectation will reduce the present value of future earnings and thus current stock returns (Thorbecke, 1997). Thus, we derive two additional propositions:

H₅: There is a negative relationship between unanticipated inflation and U.S. stock returns.

H₆: There is a negative relationship between current expected inflation and stock returns.

The next hypothesis emphasizes a relationship between industrial production and stock returns. Increased production leads to higher revenues, which in turn bring about a larger supply of credit and higher stock returns. This argument leads to the seventh hypothesis:

H₇: Increased production raises the stock returns.

The study has collected monthly data on the U.S. for the years 1980 to 2008 to assess the behavior of U.S. stock returns. The study uses the S and P 500 Index to obtain U.S. stock returns. The return from the index, R_t , is computed as follows:

$$R_t = \log(P_t / P_{t-1}) * 100$$

where P_t is the current closing price and P_{t-1} is the previous closing price.

The study uses the autoregressive moving average (ARMA) model to fit movements in the exchange rate (h_t). Exchange rate volatility, which influences returns in the stock markets, is a random walk and can be modeled with autoregressive integrated moving average (ARIMA) or an ARMA. "An ARMA model is a univariate model which seeks to model a single variable as an autoregressive moving average process; an ARMA process is fully described by two parameters, p and q , where p is the order of the autoregressive component, and q is the order of the moving average component" (Darnell, 1994). The general autoregressive-moving average (ARMA) model can be presented as follows:

Consider variable x_t which is modeled as a stationary process that evolves according to the equation:

$$x_t = \mu + \alpha_1 x_{t-1} + \alpha_2 x_{t-2} + \dots + \alpha_p x_{t-p} + \varepsilon_t + \beta_1 \varepsilon_{t-1} + \beta_2 \varepsilon_{t-2} + \dots + \beta_q \varepsilon_{t-q} \quad (1)$$

where ε_t is a white-noise random variable (it is stationary with a zero mean, mutually uncorrelated, and has a constant variance). The p terms in lagged x include the autoregressive component, and the q terms in the innovations ε_t comprise the moving average terms, and the model is called ARMA (p , q) model. If $q = 0$, the process is called a pure autoregressive process denoted by AR (p), and if $p = 0$, the process is a pure moving average process described by MA (q). Using the lag operator, equation (1) may be rewritten as:

$$\alpha(L)x_t = \beta(L)\varepsilon_t$$

Where,

$$\alpha(L) = 1 - \alpha_1 L - \alpha_2 L^2 - \dots - \alpha_p L^p \text{ and } \beta(L) = 1 - \beta_1 L - \beta_2 L^2 - \dots - \beta_q L^q.$$

The stationarity of an ARMA process depends entirely on its autoregressive component, and requires that the roots of $\alpha(L) = 0$ lie outside of the unit circle. If the variable y is not stationary then an ARMA model could not be adequate, since it requires stationarity,

and the ARIMA process can be used in this case (Darnell, 1994).

The squared residuals from the ARMA model are used by Asseery and Peel (1991) and De Grauwe (1988) as a measure of exchange rate volatility. The study follows these steps to determine changes in the stock returns in response to exchange rate volatility. First, the study uses the Augmented Dickey-Fuller test to check the stationarity of my data and correct the data where appropriate. Second, the study use exchange rate volatility which is measured as the squared residual from the ARMA model applied to exchange rate series.

For the U.S., the study uses the squared residuals from an AR (1) to obtain the exchange rate volatility:

$$h_t = \phi h_{t-1} + \varepsilon_t$$

Then, the study states that the movements in the exchange rates (h_t) at time t depend on its values in the previous time period and a random term (ε_t). In other words, this model says that the forecast values of exchange rates (h_t) at time t is simply a proportion (ϕ) of their values at time ($t-1$) plus a random shock or disturbance at time t .

Various exchange rate volatility measures have been proposed in the literature, including the absolute percentage change of the exchange rate, the average absolute difference between the previous forward and current spot rate, the moving average of the standard deviation of the exchange rate, variance of the spot exchange rate around its trend, and the ARCH models. Asseery and Peel (1991) use squared residuals from the ARMA process to measure exchange rate volatility. In particular, they use an AR (1) process for the United States. They find that other measures of volatility, specifically employing conditional variances based on ARCH, give inferior results. Asseery and Peel's explanation confirms that we chose the best fitting model to measure the exchange rate volatility for the United States.

Having computed the stock return series and exchange rate volatility, we have used the ordinary least squares (OLS) in order to observe empirically, how U.S. stock returns are affected by exchange rate volatility, the Federal funds rate, the default premium, the horizon premium, unanticipated and expected inflation, and news about industrial production. The model used can be written as follows:

$$\text{Str} = \beta_0 + \beta_1 h_t + \beta_2 \text{ffr} + \beta_3 \text{default} + \beta_4 \text{horizon} + \beta_5 \text{uninf} + \beta_6 \text{cinf} + \beta_7 \text{dip} + \mu_t$$

where Str is U.S. stock returns, h_t is exchange rate volatility, ffr is the federal funds rate, default premium is the difference in returns between 20-year risky bonds and 20-year government bonds, horizon is the difference in returns between 20-year and 1-month treasury bonds, uninf is unexpected inflation, cinf is change in expected inflation, and dip is news about industrial production.

RESULTS AND ANALYSES

This study reports results and analyzes the hypotheses proposed in the previous section. As can be seen in Table 1, exchange rate volatility is negatively related to U.S. stock returns and is statistically significant. Even though the U.S. has quite sophisticated foreign exchange derivative markets, such as the currency forward market and the futures contract market, firms engaged in international operations cannot protect themselves against the adverse effect of exchange rate risk on production, exports, and hence, profits.

The difference in returns between 20-year risky bonds

Table1. Exchange rate volatility and U.S. stock returns.

Dependent variable: STR		Method: Least squares	
Variable	Coefficient	Std. error	t-statistic
C	1.144	0.317	3.77
Ht	-0.134	0.033	-3.5
FFR	0.054	0.394	0.126
INFTRES	-50.34	112.4	-0.5
DEPI	20.16	241.89	0.127
HORIZON	40.22	9.55	4.323
DEFAULT	55.32	22.34	2.94
DIP	-45.23	35.13	-1.35
R ² : 0.15		Durbin-Watson stat: 2.05	
Adjusted R ² : 0.13			

Where STR is stock returns, Ht is exchange rate volatility, FFR is the Federal funds rate, INFTRES is unanticipated inflation, DEPI is change in expected inflation, HORIZON is the difference in returns between 20-year and one-month treasury bonds, the DEFAULT is the difference in returns between 20-year risky and 20-year government bonds, and DIP is news about industrial production.

and 20-year government bonds, which is the default premium, and the difference in returns between 20-year and 1-month treasury bonds, which is the horizon premium, are positively related to U.S. stock returns and statistically significant, as expected.

When the default premium increases, the return on corporate bonds will increase relative to Treasury bonds, and the increasing demand for risky bonds causes interest rates on corporate bonds to decrease, which in turn causes stock prices to increase. These explanations contain considerable information about factors influencing the future course of the economy. Stock prices, in particular, are a popular leading indicator. But in this representation, the difference in returns between corporate bonds and Treasury bonds forecasts future stock prices because of its informative features, as has been pointed out by Bernanke (1990). Bernanke argues that the commercial paper-Treasury bill spread is informative because it measures (1) perceived default risk and (2) the stance of monetary policy. We have explained the measurement of the perceived risk (the default premium) which comes from the difference in returns between 20-year corporate bonds and 20-year treasury bonds. The second feature of the commercial paper-Treasury bill spread is that it measures the stance of the monetary policy. Hence, the default and the monetary policy expectations forecast future economic activity.

As has been explained, the commercial paper-treasury bill spread provides information about future monetary policy. According to this explanation, if investors expect the economy to turn down in the near future, because such a movement increases the riskiness of privately issued debt relative to safe public debt, an expansionary monetary policy should be implemented in order to mitigate the negative effect of a recession. Hence, there might be an association between the default premium

and monetary policy. As it was emphasized by Bernanke (1990) and Bernanke and Blinder (1992), the default premium may predict the future course of the economy, mainly because it measures the stance of monetary policy.

Also, the difference in returns between 20-year and 1-month treasury bonds (the horizon premium) is positive and statistically significant. Investors demand long-term treasury bonds because long-term treasury bonds contain more risk and higher return than short-term. Also, interest rates on long-term bonds will decrease due to increasing demand for long-term bonds, which in turn will cause stock prices to increase. This finding is consistent with the hypothesis that there is a positive association between the horizon premium and U.S. stock prices.

As has been argued by Bernanke (1990), the difference in returns between long and short term Treasury bonds is a monetary policy indicator. That difference is thought to reflect a loose monetary policy, indicating lower market interest rates and readily available credit in the economy. The low market interest rates may pull money out of bonds and into stocks. Hence, the prices of stocks will increase because of the higher demand for stocks.

Conclusions

This paper tested the effect of exchange rate volatility on the profits of firms in the U.S. using the squared residuals from the ARMA model to generate estimates of volatility. Overall, the study found that exchange rate volatility negatively affected U.S. stock returns since the availability of hedging instruments could not lessen the negative effect of exchange rate volatility on trade volume.

Even though the purpose of this study was to shed light on the effect of exchange rate volatility on U.S. stock

returns, we used several other explanatory variables in order to reveal how U.S. stock returns change with these variables. The study found a significant positive relationship between some of these variables and U.S. stock returns. These variables were the difference in returns between 20-year risky bonds and 20-year government bonds, which was the default premium, and the difference in returns between 20-year and 1-month treasury bonds, which is the horizon premium.

As has been emphasized by several authors, such as Bernanke, Bernanke and Blinder, the default premium and the horizon premium can be called as monetary policy indicators. Therefore, we concluded that there was a significant relationship between U.S. stock returns and monetary policy. However, the study found that the Federal funds rate, unanticipated inflation, and current expected inflation had no significant effect on stock returns.

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