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The association between exchange rates and stock returns

Abstract

The paper investigates the effects of exchange rates of four of the trading partners of the U.S. on the U.S. stock market and on ten sectors of the U.S. economy, from 2000 to 2012. The Chinese yuan was the least volatile of the four currencies and the euro was the most volatile; however, the euro appreciated the most during the study period. The author also found the nondurable sector the least volatile and the energy sector, which happened to have the highest average return, the most volatile. On average, the association between the Japanese yen and the U.S. stock market was significantly and consistently negative while euro and the pound were positively and significantly associated with U.S. stocks. Moreover, U.S. stocks were positively but insignificantly associated with the yuan, which is surprising considering U.S. concern about Chinese government's direct interventions in the foreign exchange market designed to depreciate the yuan and give competitive advantage to Chinese exporters in the international export market.

Keywords: exchange rates, stock returns, correlation, U.S. economic sectors, currency manipulations.
JEL Classification: F21, F23, F31, F65, G11, G23, M20, N2, N34, N35.

Introduction

A large number of well formulated studies on the relation between exchange rates and stock prices have not provided a definite conclusion concerning the relation between the two variables. Some of the studies examined stock prices and exchange rate levels, some the first differences of the series of prices, and others rate of returns. Also, the differencing intervals of the price series have not been the same. Various researchers have used daily, monthly or quarterly data over their various sample periods. Some studies have reported a negative relation between exchange rates and stock prices, some a positive relation, and others a feedback interaction between the two variables. Overall, the findings have been controversial, according to Solnik (1987).

Aggarwal (1981) has reported a positive correlation between the two variables over the 1974 to 1978 period, using monthly data. For the 1973 to 1983 sample period, Solnik (1987) reported a negative relation between monthly and quarterly real stock returns and real exchange rates with a positive relation only in the sub-period from 1979 to 1983. Ma and Kao (1990), on the other hand, found that, for an export-dominant economy, currency depreciation is negatively related to stock prices, but positively related for an import-dominant economy. Soenen and Hennigar (1988), using data from 7 U.S. industries, found no significant relation for 3 industries, and a negative relation for the other industries. They concluded that, overall, exchange rates had little impact on stock returns of individual industries and sectors[1]. They also argued that exchange rates only moderately affect corporate cash flows and stock prices.

Granger et al. (2000), who investigated the causal relation between exchange rates and stock prices, using data from South Asian countries, observed that exchange rates lead stock prices for South Korea, and that for the Philippines, stock prices lead exchange rates − with a negative correlation between the two variables. With regard to Hong Kong, Malaysia, Singapore, Thailand, and Taiwan, they reported a strong feedback relation between stock prices and exchange rates. Data from Indonesia and Japan did not reveal any pattern. Furthermore, they pointed out that, although Granger causality may exhibit some statistical relations, it is sometimes difficult to interpret the underlying fundamental economic relation based on those results, and that the results may be generated from other structure relations, such as interest rate parity condition. Finally, Abdalla and Murinde (1997) found that exchange rates lead stock returns for developing countries. They found that exchange rates Granger cause stock prices in Korea, Pakistan, and India, but that stock prices Granger cause exchange rates in the Philippines.

This study investigates the effect of foreign exchange rates of four major trading partners of the U.S. on the stock prices of ten separate economic sectors of the U.S. economy. It is confined to associations between exchange rates and stock returns in each of the ten industries and avoids causality tests in view of the seeming impossibility of identifying causal relations between economic variables.

The effect of exchange rates on stock prices is not easily identifiable. An OECD Policy Paper by Huchet-Bourdon and Korinek (2011) has questioned the theoretical cause-effect relation between exchange rate volatility and exchange rate levels on trade. The study examined the impact of exchange rates and their volatility on trade flows in China, the euro-zone, and the U.S. relating to agriculture, manufacturing, and mining. The findings are that

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[1] The industries examined by Soenen and Hennigar (1988) included Automobile, computer, machinery, paper, textile, steel, and chemical.

exchange rate volatility impacts trade flows only slightly. Exchange rate levels, however, were found to effect trade but that they do not explain "in their entirety" the trade imbalances in three of the countries studied. According to Huchet-Bourdon and Korinek (2011), Evenett (2010) had found multiple factors contributed to the trade imbalance between the U.S. and China; exchange rates were only one of these factors. Huchet and Korinek (2011) found a higher long-term impact of the real exchange rates on exports than on imports, and a more pronounced impact of exchange rates on exports of agriculture than that of manufacturing. Also, they found that exports generally include high import content and that the impact of exchange rate depreciation or appreciation on any finished product was complex.

In reviewing the trade flows and exchange rates of China, the U.S., and Europe (Wall Street Journal, January 8, 2013), Professor Edward Lazear of Stanford's Graduate School of Business explained that exchange rates are not the main determinant of trade flows. The empirical studies failed to establish a clear-cut relation between exchange rates and stock prices, because exchange rates are not the primary determinants of multinational trade, corporate cash flows, and stock prices.

Wooldridge (2006) had argued that most economic questions are ceteris paribus by nature, i.e., other variables being equal. This notion of ceteris paribus, according to Wooldridge, plays an important role in causal analysis. We are not able to know the causal effect of one variable on another unless other relevant variables are held fixed. This perhaps accounts for the disparate research results concerning the relation between exchange rates and stock prices. Researchers have not been able to simulate a ceteris paribus analysis with regard to the effect of exchange rates on stock prices. For example, it is well known that exchange rates relate to several other factors, such as differential interest rates, differential inflation, investors' expectations, and government control that affect stock prices. It is not possible to hold all of these factors fixed when examining the effect of exchange rates on stock prices.

Furthermore, Peter Kennedy (2003) asserts that the traditional, dictionary meaning of causality is impossible to test, and that Granger causality just provides information about "precedence" rather than about causality. According to Kennedy, "Consider, for example, the fact that Christmas-card sales Granger cause Christmas!" Similarly, Eviews (1995) points out that Granger causality does not by itself indicate causality in the common use of the term. An association between two variables does not establish a causal relation. Other criteria external to the specific characteristics and results of a single study must be considered, according to Kleinbaum, et al. (1998). Kleinbaum et al. assert that causality cannot be established by statistical analysis because statistical analysis models using regression or multivariate methods are not deterministic models.

1. The data

The data consist of daily excess stock returns for ten separate U.S. economic sectors, including durable goods, nondurable goods, manufacturing, energy, hi-tech, telecommunications, shops, utilities, health, and "others." The study period is from January 2000 to December 2012. Daily stock returns for each of the ten sectors and for the U.S. stock market represented by the value weighted returns on all CRSP firms incorporated in the U.S. and listed on NYSE, Nasdaq, and Amex were obtained from Ken French's data library[1]. Corresponding exchange rates for the euro, the pound, the yuan, and the yen were obtained from the Federal Reserve district bank of New York[2]. The exchange rates used in this study are all direct quotations. Average daily returns for the ten economic sectors and corresponding changes in exchange rates are shown in Table 1.

Table 1. Average daily excess returns
(January 2000 to December 2012)

Economic sector	*N*	Mean	Standard deviation
NoDur	3269	0.071	1.117
Durbl	3269	0.045	1.563
Manuf	3269	0.074	1.465
Enrgy	3269	0.101	2.092
Hi-tech	3269	0.065	1.617
Telcm	3269	0.028	1.753
Shops	3269	0.076	1.325
Utils	3269	0.051	1.125
Health	3269	0.094	1.332
Other	3269	0.064	1.167
Stock market	3269	0.009	1.362
Currency	*N*	Mean	Standard deviation
Euro	3220	0.012	0.660
Pound	3220	0.005	0.608
Yuan	3214	0.009	0.094
Yen	3220	0.007	0.653

Note: The ten separate U.S. economic sectors, shown in the table, are nondurable goods (NoDur), durable goods (Durbl), manufacturing (Manuf), energy (Enrgy), hi-tech (Hi-tech), telecommunications (Telcm), shops, utilities (Utils), health, and others, as defined in Professor Ken French's data library[3]. The exchange rates are direct quotations and the U.S. stock market is represented by the value-weighted returns on all CRSP firms incorporated in the U.S. and listed on NYSE, Nasdaq, and Amex.

[1] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french.
[2] http://www.ny.frb.org/markets/fx.
[3] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french.

Table 1 shows the Chinese yuan was the least volatile of the four currencies as indicated by its standard deviation of 0.094, on average, over the 13 year study period; the euro was the most volatile, though it also appreciated the most during the 13 year period, as indicated by its mean return and standard deviation of return, respectively. Of the ten economic sectors, Energy had the highest average return but was also the most volatile. The least volatile sector was nondurables followed by utilities. The most volatile sector was telecommunications, followed by the durables sector.

2. The methodology

I measured the effect of exchange rates on the U.S. stock returns using the following regression model:

$$S_{it} = \hat{\alpha}_i + \hat{\beta}_{i1} E_t + \hat{\beta}_{i2} P_t + \hat{\beta}_{i3} Y_t + \hat{\beta}_{i4} J_t + \\ + \hat{\beta}_{i5} R_{mt} + e_{it}, \quad (1)$$

where S_{it} is the return on sector i's stock index in excess of Treasury-bills return, on day t; E_t is the percentage change in the euro on day t; P_t is the percentage change in the pound sterling on day t; Y_t is the percentage change in the Chinese yuan on day t; J_t is the percentage change in the Japanese yen on day t; R_{mt} is the excess return on the U.S. stock market on day t; and e_{it} is the random error term.

The estimated parameters $\hat{\beta}_1, ..., \hat{\beta}_5$ represent the sensitivity of the sector-stock index to the variability in the respective currency. I included a market factor in the above equation because fluctuations in the general level of stock prices (the market) also influence stock prices within a particular sector. Thus to isolate the influence of the stock market from exchange rate influences, I included daily rates of returns on the CRSP index as an additional independent variable. The effects of any other relevant, but missing, factors are captured by the random error term.

3. Empirical results

3.1. Correlation coefficients among the currencies. Table 2 shows pairwise correlation coefficients among the foreign currencies and the U.S. stock market. The first column contains estimates over the entire study period, January 2000 to December 2012. Subsample 1 refers to the 2000 to 2003 period, subsample 2 refers to the 2004 to 2007 period, and subsample 3 refers to the 2008 to 2012 period. For the full 13 year study period, all calculated correlations were positive, except those between the Japanese yen and the U.S. stock market, and between the yen and the Chinese yuan. The euro and the pound had the highest correlations of 0.679, whereas the yen and the U.S. stock market had the lowest correlation of -0.171. It is remarkable that the yuan was positively but weakly correlated with the U.S. stocks market. The pairwise correlation coefficients between yen and the yuan, and between the yen and the U.S. stock market were negative for all three sub-periods and for the full 13-year study period.

Table 2. Pearson correlation coefficients between U.S. dollar rate of returns (January 2000 to December 2012)

Variables	Full sample	Subsample 1	Subsample 2	Subsample 3
Euro/Pound	0.679	0.652	0.788	0.657
Euro/Yuan	0.085	-0.006	0.044	0.128
Euro/Yen	0.253	0.271	0.508	0.131
Euro/Stocks	0.089	-0.171	0.031	0.265
Pound/Yuan	0.080	-0.018	0.028	0.118
Pound/Yen	0.129	0.228	0.456	-0.059
Pound/Stocks	0.123	-0.119	0.009	0.271
Yuan/Yen	-0.010	-0.023	-0.010	-0.012
Yuan/Stocks	0.038	-0.025	-0.019	0.067
Yen/Stocks	-0.171	-0.062	-0.081	-0.268

Note: "Full sample" refers to the entire study period (2000-2012); "subsample 1" refers to the 2000 to 2003 period; "subsample 2" refers to 2004 to 2007 period; and "subsample 3" refers to 2008 to 2012. "Stocks" refers to the excess returns on the U.S. stock market as measured by the value weighted returns on all CRSP firms incorporated in the U.S. and listed on NYSE, Nasdaq, and Amex.

These correlation coefficients suggest that, on average, whenever the yen depreciated (i.e., whenever the U.S. dollar appreciated against the yen), the U.S. stock market rose, and whenever the yen appreciated (whenever the dollar depreciated against the yen), the U.S. stock market declined. The yuan and the U.S. stock market were weakly associated with each other positively, which appears to justify U.S. concerns about the manipulation of the yuan by the Chinese government through direct intervention in the foreign exchange market, designed to give Chinese exporters a competitive advantage in the interna-tional export market.

The correlations do not appear to be stable over time. For the 2000 to 2003 period (subsample 1), the correlations were mostly negative, but were mostly positive for the other two subsamples and for the full study period. For example, the correlations for the euro and the yen varied from -0.006 for subsample 1 to 0.128 for subsample 3. The correlation between the euro and U.S. stocks varied from -0.171 to 0.265, and the correlation between the pound and the yen varied from -0.059 to 0.456.

Because of this appearance of instability of the correlation coefficients, I conducted a formal statistical test of temporal stability of the coefficients using the nonparametric Kruskal-Wallis one way ANOVA. According to Sprent (1993), the Kruskal-Wallis test is equivalent to using what is known as "least significant differences," such as the Friedman's test and Fisher's LSD procedure. The chi-square turned out to be 2.4742 with three degrees of freedom. The result (p = 0.4800) indicates that the Pearson correlation coefficients were not significantly different among pairwise time intervals. I cannot therefore reject the null hypothesis that the calculated coefficients were stable over the 13 year study period.

3.2. Effects of exchange rates on the stock market. To further investigate the effects of currency movements on the U.S. stock market, I regressed the stock market returns, R_{mt}, on the percentage rates of return on the four currencies, as follows (t statistic is in parentheses; and "*" indicates statistical significance at the 5% level):

$$R_{mt} = \hat{\alpha} + \hat{\beta}_1 E_t + \hat{\beta}_2 P_t + \hat{\beta}_3 Y_t + \hat{\beta}_4 J_t + e_t \qquad (2)$$

The results are:

1. Full sample (2000-2012):

$$R_{mt} = \underset{(0.13)}{0.003} + \underset{(2.99)*}{0.147}E_t + \underset{(4.19)*}{0.218}P_t + \underset{(1.31)}{0.322}Y_t - \underset{(-11.34)*}{0.417}J_t.$$

2. Subsample 1 (2000-2003):

$$R_{mt} = \underset{(-0.40)}{-0.018} - \underset{(-3.78)*}{0.342}E_t - \underset{(-0.30)}{0.036}P_t - \underset{(-0.84)}{4.042}Y_t - \underset{(-0.51)}{0.038}J_t.$$

3. Subsample 2 (2004-2007):

$$R_{mt} = \underset{(0.94)}{0.023} + \underset{(2.18)*}{0169}E_t - \underset{(-0.45)}{0.034}P_t - \underset{(-0.77)}{201}Y_t - \underset{(-3.52)*}{0.174}J_t.$$

4. Subsample 3 (2008-2012):

$$R_{mt} = \underset{(0.79)}{0.034} + \underset{(6.75)*}{0.519}E_t + \underset{(2.69)*}{0.209}P_t + \underset{(0.81)}{0.275}Y_t - \underset{(-10.95)*}{0.649}J_t.$$

These results indicate that all of the estimated parameters bear the same signs as the pairwise correlations shown in Table 2. For example, for the full sample, all parameters have positive signs except the Japanese yen. Thus, on average, the U.S. stock market tended to decline whenever the yen appreciated (i.e. whenever the U.S. dollar depreciated against the yen). The U.S. stock market tended to rise whenever the yen depreciated (whenever the U.S. dollar appreciated against the yen); however, whenever the euro and the pound appreciated (i.e., whenever the U.S. dollar appreciated against these currencies), the U.S. stock market tended to rise, and to decline whenever the euro and the pound depreciated. Surprisingly, the U.S. stock market did not significantly move with the yuan, perhaps because a substantial portion of the international trade between the U.S. and China were inter-firm transactions the volume of which is not affected by changes in the value of the yuan. These conclusions are similar to those obtained using the calculated correlation coefficients shown in Table 2.

Also, the estimated parameters for the three subsamples all bear the same signs as the correlation coefficients shown in Table 2, and the conclusions are similar. For the 2000-2003 subsample, the U.S. stock market moved up and down positively with the euro but did not move significantly with the other three currencies. For the 2004-2007 subsample, the U.S. stock market moved up and down positively with the euro, but moved inversely with the yen. The stock market did not move significantly with the pound and the yuan. Finally, for the 2008-2012 subsample, the euro and the pound moved up and down positively with the U.S. stock market and the yen moved inversely with U.S stocks. It is remarkable that, for the full sample and the three subsamples, the yuan did not move significantly with U.S. stocks.

In summary, on average, the U.S. stock market moved up and down directly with the euro and the pound, but inversely with the yen. The yuan did not significantly move with U.S. stocks during the 13-year study period. This is surprising considering U.S. and European concerns regarding Chinese direct interventions in the foreign exchange market designed to weaken the yuan and thus give Chinese exporters a competitive advantage in the international export market.

3.3. Effects of foreign exchange on U.S. economic sectors. I investigated the effects of exchange rate movements on the ten U.S. economic sectors using regression analysis, in accordance with equation (1), above. The estimated parameters are shown in Table 3. As shown in the table, movements of the yuan did not significantly effect any of the U.S. economic sectors with the exception of the energy sector. The Japanese yen, on the other hand, significantly effected seven of the ten sectors. Telecommunication, utilities, and health were not significantly effected by changes in the yen, on average, over the 2000 to 2012 period. Six of the

other seven sectors were negatively effected and the high tech sector was positively effected by changes in the yen. It appears that, on average, whenever the yen depreciated, most of the U.S. sector stocks rose, and whenever the yen appreciated, sector stocks declined.

Table 3. Regression of U.S. stock returns on changes in exchange rates of the U.S. trading partners (daily data: January 2000 to December 2012)

Estimate	Economic Sectors										MKT Hi-tech
	Manuf	Hi-tech		Manuf	Hi-tech		Manuf	Hi-tech		Manuf	
α_i	0.066*	0.057*	α_i	0.066*	0.057*	α_i	0.066*	0.057*	α_i	0.066*	0.057*
$\hat{\beta}_1$	0.105*	-0.063*	$\hat{\beta}_1$	0.105*	-0.063*	$\hat{\beta}_1$	0.105*	-0.063*	$\hat{\beta}_1$	0.105*	-0.063*
$\hat{\beta}_2$	0.101*	0.002	$\hat{\beta}_2$	0.101*	0.002	$\hat{\beta}_2$	0.101*	0.002	$\hat{\beta}_2$	0.101*	0.002
$\hat{\beta}_3$	0.107	0.053	$\hat{\beta}_3$	0.107	0.053	$\hat{\beta}_3$	0.107	0.053	$\hat{\beta}_3$	0.107	0.053
$\hat{\beta}_4$	-0.104*	0.059*	$\hat{\beta}_4$	-0.104*	0.059*	$\hat{\beta}_4$	-0.104*	0.059*	$\hat{\beta}_4$	-0.104*	0.059*
$\hat{\beta}_5$	0.945*	1.026*	$\hat{\beta}_5$	0.945*	1.026*	$\hat{\beta}_5$	0.945*	1.026*	$\hat{\beta}_5$	0.945*	1.026*
Pr > *F*	<.0001	<.0001	Pr > *F*	<.0001	<.0001	Pr > *F*	<.0001	<.0001	Pr > *F*	<.0001	<.0001
Adj. R^2	0.809	0.726	Adj. R^2	0.809	0.726	Adj. R^2	0.809	0.726	Adj. R^2	0.809	0.726

Note: Economic sectors include: manufacturing (Manuf), Hi-tech, telecommunications (Telcm), utilities (Utils), non-durable goods (NoDur), durable goods (Durbl), energy (Enrgy), Shops, and "other", from Ken French's data library. MKT refers to the U.S. stock market as measured by the value weighted returns on all CRSP firms incorporated in the U.S. and listed on NYSE, Nasdaq, and Amex (R_{mt}). Regression equation (1) and equation (2) were used to estimate the above parameters, as follows:

$$S_{it} = \hat{\alpha}_i + \hat{\beta}_{i1} E_t + \hat{\beta}_{i2} P_t + \hat{\beta}_{i3} Y_t + \hat{\beta}_{i4} J_t + \hat{\beta}_{i5} R_{mt} + e_{it},$$

$$R_{mt} = \hat{\alpha} + \hat{\beta}_1 E_t + \hat{\beta}_2 P_t + \hat{\beta}_3 Y_t + \hat{\beta}_4 J_t + e_t.$$

The variables in these equations are defined in the methodology section. * Significant at the 5% level.

Movements in the British pound significantly effected seven of the ten sectors positively, and the euro significantly effected six of the ten sectors − five positively and one negatively. The results suggest that whenever the two European currencies depreciated (i.e. when the U.S. dollar appreciated against these European currencies), most of the ten U.S. economic sectors lost value. Countries often take steps through direct and indirect interventions to have their currencies depreciate relative to other specific currencies in order to gain competitive advantage in the international export market. Because the U.S. and European nations compete aggressively in the export markets, their currencies tend to move together sometimes negatively and at other times positively. Soenen and Hennigar (1988) observe that exchange rates effect industries differently.

Summary and conclusions

I investigated the effects of foreign-exchange rates on the U.S. stock market and on ten sectors of the U.S. economy, from 2000 to 2012. I find that the Chinese yuan was the least volatile of the four currencies and the euro was the most volatile; however, the euro appreciated the most during the 2000-2012 study period. As for the economic sectors, I find that the nondurable sector was the least volatile and the energy sector, which happened to have the highest average return, was the most volatile.

On average, the correlation between the Japanese yen and the U.S. stock market was significantly negative. The yen was also negatively correlated with U.S. stocks over all three subsample periods while the euro and the pound correlated positively. The correlation between the Chinese yuan and U.S. stocks was positive but weak. The results suggest that whenever the yen depreciated (i.e. whenever the dollar appreciated against the yen), the U.S. stock market went up, which suggests that capital flows toward the U.S. might have overwhelmed the negative effects of greater U.S. imports from Japan. The results suggest that whenever the euro and the pound depreciated (i.e. whenever the U.S. dollar strengthened against the euro or the pound), the U.S. stock market declined, which is to be expected because of the negative effects of increased U.S. imports from Europe and reduced U.S. exports to Europe.

When I tested for the stability of the pairwise correlations among the foreign currencies and the U.S. stock market over the full sample period, and over each of the three subsample periods, the results were consistent with the null hypothesis of temporal stability of the calculated correlations.

The results obtained using multiple regression analysis supports the aforementioned results. For the full study period, the U.S. stock market moved up

and down directly with the euro and the pound, and inversely with the yen. U.S. stocks were positively but insignificantly associated with the yuan, which is surprising considering U.S. and European concern about Chinese direct interventions in the foreign exchange market designed to weaken the yuan and thus give Chinese exporters a competitive advantage in the international export market.

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