An Empirical Study of Japanese and South Korean Exchange Rates Using the Sticky-Price Monetary Theory

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Abstract

Researchers have studied connections between exchange rates and macroeconomic variables for developed and emerging market economies. However, few address whether relationships differ by market classification. This study examines the impact that macroeconomic variables in the sticky-price monetary theory has on exchange rates for Japan and South Korea. Results show money supply and inflation differentials constitute a significant impact for South Korea, whereas no macroeconomic variable within the model had a significant impact on Japan. In addition, the autoregressive error analyses yielded small coefficients for South Korea. Given those estimates and low error variance, the study suggest there may not be a significant difference in how the sticky-price monetary theory predicts exchange rates by market classification. Therefore, firms may use forecasting techniques similarly between developed and emerging market economies.

INTRODUCTION

Exchange rate fluctuations are an important risk for firms that do business in other countries (Demirhan & Atis, 2013). A key component of a firm's aggregate demand is the import and export of its goods and services, which is affected by exchange rate fluctuation (Were, Kamau, & Kisinguh, 2013). As exchange rates increase and decrease, the prices that firms are able to charge for goods and services become more or less attractive to their customers. Firms that are engaged in international business transactions expect and plan for exposure to exchange rate volatility; however, local firms not engaged might also be affected (Aggarwal & Harper, 2010). Therefore, the problem exists in that exchange rate volatility affects a firm's bottom line, thus influencing the financial performance of the firm.

Studies provide evidence that large costs occur when entering export markets (Bernard & Wagner, 2001). The costs derive from creating networks for distribution, modifying products to satisfy foreign tastes and regulations, and identifying potential target markets (Becker, Chen, & Greenberg, 2012). Various

risks may also increase the costs incurred by a firm. A firm's exposure to foreign currencies yield various types of risks, such as transaction risks, translation risks, and economic risks.

Translation risks occurs from the process of translating a firm's financial statements from one currency to a different functional currency for reporting purposes (FASB, 1981). Nazarboland (2003) argued that converting a firm's financial statements from a local currency to the currency of the home country affects the book value of the firm through the fluctuations in exchange rates. Likewise, firms experience transaction risks when their monetary liabilities and assets are denominated in various currencies that result in gains or losses due to the movements of exchange rates (Gunter, 1992). Economic risk is the changes in currency values that affect a firm's competitive performance, and thus its market value. Therefore, further knowledge of exchange rate behavior may assist firms in hedging risk and increasing financial performance.

Background

An extensive amount of research has explored various determinants of exchange rate movements (Were, Kamau, & Kisinguh, 2013). Evidence concerning the major determinants of fluctuations in rates of exchange suggest that monetary factors are most often responsible for influencing movements (Cuiabano & Divino, 2010). These macroeconomic variables include gross domestic product, inflation, interest, and money supply (Butt, Rehman, & Azeem, 2010).

Khan and Qayyum (2011) examined how monetary fundamentals influenced exchange rates in Pakistan and determined monetary variables were able to forecast movements in the exchange rate. Liew, Baharumshah, and Puah (2009) studied long-run relations among determinants of movements with rates of exchange and the Japanese yen, finding that movements within exchange rates might be forecasted using money supply, interest rates, and income as indicating variables. Additionally, Craigwell, Wright, and Ramjeesing (2011) found similar results studying exchange rate behaviors between the U.S. and Jamaica with respect to money supply, inflation, and the rate of interest.

The sticky-price monetary theory has been a leading, and widely used method of examining the extent that specific macroeconomic variables may affect exchange rate movements (Were, Kamau, & Kisinguh, 2013). Therefore, it was the rationale of the study that the sticky-price monetary theory might provide insight into the differing effects of the macroeconomic variables with respect to market classification. This study examined the sticky-price monetary theory in the context of developed and emerging market classifications.

The sticky-price monetary model evaluates changes in movements within rates of exchange with respect to interest, money supply, gross domestic product, and inflation. The theory suggest that fluctuations are consistent with rational

expectations (Dornbusch, 1976). This theory explains the overshooting of currency exchange rates, and provides reasoning for the volatility and misalignment of currency exchange rates with purchasing power parity (Datta & Mukhopadhyay, 2014).

Research question

The study addressed the problem by investigating the following generalized research question: To what extent did macroeconomic variables affect the exchange rates of developed economies differently from emerging economies relative to the U.S. dollar between February 1, 1989 and February 1, 2015?

Regression analyses addressed these research questions by examining the results of the various models. Comparing and contrasting these results provided insight into the differing effects that each variable had with respect to the corresponding market classification. Answering the research questions directly met the purpose of this study, and provided context that added to the body of knowledge regarding exchange rate volatility under the sticky-price monetary theory. These analyses may guide financial decision-makers with respect to investing in developed and emerging market economies.

LITERATURE REVIEW

The foreign exchange market is the largest liquid market consisting of a global network of sellers and buyers of currency (Chen, 2014). The financial exchange market trades more than $5 trillion daily, surpassing any other financial market (Bank of International Settlement, 2013). Ever since the termination of Bretton Woods, understanding the effects of exchange rate policy and currency movements has been the dominant area in international financial research as the value of a currency affects households and businesses (Chen, 2014). Exchange rate instability increases uncertainty for the participants of foreign exchange markets, and influences flows of international trade (Peree & Steinherr, 1989).

Post-Bretton Woods literature suggest an adverse effect on trade flow. Clark (1973) demonstrated the uncertainty of a firm's trade revenue being the effect of exchange rate instability reducing the volume of trade. Literature supports the argument that uncertainty in exchange rate fluctuation affects trade (Hooper & Kohlhagen, 1978). On the other hand, later theoretical studies demonstrated positive effects on international trade flows from higher exchange rate volatility. Literature also supports the argument of a positive correlation between trade and exchange rate instability (Broll & Eckwert, 1999).

Market influences

Elections, terrorist activities, war, and political scandals have considerable influence on the foreign exchange market. Exchange rates react faster to geopolitical events than any other form of financial investment (McFarlin, 2011).

Election outcomes have the potential to threaten asset prices and the economy as a whole (Webb, 2006). Chandiok (1996) argued that a political resignation could potentially cause abnormal returns in the field and affect currency markets. A geopolitical event will have a negative impact on the domestic currency when the event undermines the confidence of investors.

During political instability, investors seek safety by divesting their investments, which depreciates the exchange rate. According to Bernhard and Leblang (2002), the democratic processes contribute to the risk premiums that affect exchange rates as political events raise doubts and concern about the government. Presidential candidates often float policies that could strengthen or weaken domestic currency, therefore causing investors to anticipate uncertainties in which a premium will be required for a forward position, thus affecting spot and forward exchange rates (Bernhard & Leblang, 2002).

Money supply and productivity. Economic growth and trade are fundamental factors affecting the foreign exchange market (McFarlin, 2011). Economic output or productivity has shown to have an impact on exchange rate movements. Growth in economic output measures the output of a country with respect to a specific level of input (Carbaugh, 2005). The ability to produce goods at a lower cost than what competitors are able to achieve demonstrates higher productivity in the global marketplace. Therefore, an increase in productivity pushes prices lower for consumers, thus influencing the volume of imports and exports, and therefore currency valuation through appreciation and depreciation.

According to Kuepper (2008), the gross domestic product is a comprehensive economic indicator and is an undeniable important fundamental for growth (Zhuk & Gharleghi, 2015). The per capita gross domestic product is a substantial driver of exchange rate fluctuations (Chen, Mancini-Griffoli, & Sahay, 2015), and study has shown that the growth in GDP has adverse effects on exchange rates as a result of decreasing prices (Cuiabano & Divino, 2010). Tille, Stoffels, and Gorbachev (2001) and Schnatz, Vijselaar, and Osbat (2004) studied links between exchange rate movements and output and found that changes in output can be used to determine exchange rate movements. The production index is widely used for as a monthly indicator assessing the current situation and the short-term position for GDP (Sedillot & Pain, 2003).

Interest and inflation. According to Afzal and Hamid (2013), data show that the variances in interest rates may influence exchange rates greatly in emerging economies. Some literature suggests that real interest rate shocks in foreign currencies have little effect on labor, output, and consumption (Hoffmaister & Roldos, 1997; Schmitt-Grohe, 2000), while other literature suggest these shocks play a role in explaining cyclical variations (Blankenau, Kose, & Yi, 2001). Interest rate shocks do not affect floating currencies as they do with pegged currencies (di Giovanni & Shanbaugh, 2008). Recently, Zhang, Li, and Chia

(2014) found trade-offs between exchange rate volatility and real output to interest rate shocks.

Pearce (1960) contended that an escalation in a country's interest rate would result in domestic assets becoming more attractive to investors worldwide. The higher returns gained through higher interest rates would stimulate capital inflow from abroad and appreciate the domestic exchange rate. Camarero (2008) examined the effects that productivity and interest rate differentials had on exchange rate movements, and found that those variables only provided a partial explanation.

Forecasting exchange rates

A commonly held assessment in finance is that exchange rates are predictable (Austin & Dutt, 2014). According to Huber (2016), "forecasting exchange rates has been one of the major challenges in international economics since the early eighties, when Meese and Rogoff (1983) concluded that no structural model was able to improve upon a simple random walk benchmark in terms of short-term predictive capabilities" (pg. 193). He, Wang, Zou, and Lai (2014) argued that exchange rate fluctuations affect firms because of the sensitivity that exchange rates have with many factors of global integration. Authors, such as Dornbusch and Fischer (1980), Solnik (1987), and Soyoung (2015) suggest that exchange rates affect firms engaged in the international financial market by affecting its capital flows in foreign currencies.

Quantitative methods with a positivist perspective that tests theory with hypotheses are the most common approach for finance research (Robson, 2002). Experimental designs include random sampling and treatment. These designs control some variables while manipulating others. Quasi-experimental designs are similar to experimental designs, except they randomly assigned treatments. Non-experimental research designs study un-manipulated data that require explaining (Robson, 2002). Non-experimental research designs are the most pertinent to the study of finance and tend to use the approaches of survey research, archival research, and ex-post facto.

The two approaches used for forecasting exchange rates are the technical and fundamental approach (Hwang, 2001). Based on extrapolations of price trends, the technical approach does not rely on underlying economic determinants. These models rely on filters, momentum indicators, and moving averages for a chart analysis. Filter models examine the autocorrelation of asset prices to generate indications whether to buy or sell when exchange rates increase or decrease a set percentage (the filter) about a recent tough or peak.

Momentum models determine an asset's strength by examining the speed in which asset prices change, and advise investors to buy when asset prices increase at an increasing rate (Schulmeister, 2008). Moving average models use erratic

swings of prices to indicate trends. The indication to buy and sell using moving average models are generated when short-run moving averages of past rates intersect with long-run moving averages because the moving average in the long-run is expected to lag short-run moving averages.

The fundamental approach uses structural equilibrium models based on economic variables (Hwang, 2001; Botha & Pretorius, 2009). Significant difference between observed and forecasted rates signal investors to buy or sell. The fundamental approach uses theoretical models, i.e. purchasing power parity, to generate forecasts; however, several issues exists that would benefit from further research. The issue of correct specification questions whether forecasters are using the most appropriate model, which leads into the second issue of model estimation. Models strive to estimate coefficients for economic variables within the model, but poor estimates may mislead financial decision-making, which then goes back to the model. A third issue is that some explanatory variables are contemporaneous, which requires simultaneous equations models to estimate.

***Sticky-price monetary theory*.** Dornbusch, Fischer, and Startz (2011) stated that "capital is perfectly mobile when it has the ability to move instantly, and with a minimum of transactions costs, across national borders in search of the highest return" (p. 609). This provides the assumption that the purchasing power parity continuously holds. If the constant in the equation equals zero, then this equation implies that absolute purchasing power parity holds, and if the constant does not equal zero, the equation implies that relative purchasing power parity holds (Civcir, 2003).

The model assumes that the purchasing power parity holds between the countries in question for broad prices indices (Civcir, 2003). To stay pure to the sticky price monetary theory and previous published works using the model, the assumptions Gujarati (2003) relates to the classical linear regression model. Logarithms and exponentials serve an important function in finance and economics because they are favorite means of executing positive monotonic transformations. Logarithmic treatment of the Y-axis differs from linear treatments in that a logarithmic chart provides an equal percentage change along the axis whereas a linear chart provides an equal distance along the axis. An increase of three spaces on a linear chart may indicate an increase from, i.e. \$10 to \$13, but an increase of three spaces on a log chart may indicate, i.e., a 15% increase. Small changes in natural logarithms are directly interpretable as percent changes to a very close approximation.

METHOD

This study investigated the sticky-price monetary theory in the context of developed and emerging market classifications. This study extended the research of Kim, An, and Kim (2015) on the comparison of developed versus emerging

market economies, and directly answered the call of Kehinde (2014) for additional research to address the gap in knowledge regarding the effects. This study built on various work, including Hassan and Gharleghi (2015), Frenkel (1976), Chin, Azali, and Matthews (2007), Dornbusch (1976), and Frankel (1979).

This explanatory quantitative study used the regression technique found within the sticky-price monetary theory as shown below in equation (1) where *r* represents the exchange rate, *c* represents the constant, *m* represents log money supply, *y* represents productivity, *i* represents interest, π represents inflation, and ε represents the error term. The asterisks represent non-U.S. data. Traditionally, y has represented log gross domestic product; however, this study used a monthly production index as a proxy for gross domestic product. According to Cuche and Hess (2000), "economists are sometimes forced to use variables that proxy GDP and that are available at a higher frequency. In many countries, a common proxy is industrial production which is often recorded at monthly frequency" (pg. 153).

$$r = c + \beta_1(m - m^*) + \beta_2(y - y^*) + \beta_3(i - i^*) + \beta_4(\pi - \pi^*) + \varepsilon \quad (1)$$

The differentials serve as the predictor variables that affect the dependent variable. The specific variables selected for this study include Money Supply (M1), Consumer Price Index (percent change for inflation), Production Index of Total Industry (percent change for productivity), Rates of Exchange, and Discount Interest Rates. The null hypothesis indicates no statistically significant relation between the independent and dependent variables, whereas the alternate hypothesis suggests a significant relationship exists.

RESULTS

Tables 1 and 2 provide the descriptive statistics for Japan and South Korea respectively.

TABLE 1
Descriptive Statistics for Japan

Statistic	Exchange Rate	Money Supply	Productivity	Interest	Inflation
Mean	0.009203	329 trillion	0.000261	0.0112	0.0004
Median	0.009011	285 trillion	0.002045	0.0050	0.0000
Std Deviation	0.001504	173 trillion	0.019003	0.0157	0.0038
Minimum	0.006275	101 trillion	-0.158049	0.0010	-0.0107
Maximum	0.013096	618 trillion	0.065984	0.0600	0.0207
Standard Error	0.000085	9 trillion	0.001074	0.0008	0.0002
Kurtosis	0.111715	-1.6760	17.990875	2.6394	5.6620
Skew	0.731211	0.0759	-2.521337	1.9409	1.3413
Range	0.006820	516 trillion	0.224033	0.0590	0.0314

Note: Statistics for February 1, 1989 through February 1, 2015.

TABLE 2
Descriptive Statistics for South Korea

Statistic	Exchange Rate	Money Supply	Productivity	Interest	Inflation
Mean	0.001026	237 trillion	0.005637	0.0352	0.0032
Median	0.000948	259 trillion	0.004690	0.0300	0.0030
Std Deviation	0.000220	153 trillion	0.022709	0.0202	0.0046
Minimum	0.000590	27 trillion	-0.107143	0.0100	-0.0060
Maximum	0.001501	602 trillion	0.072702	0.0800	0.0252
Standard Error	0.000012	8 trillion	0.001284	0.0011	0.0002
Kurtosis	-0.912078	-1.0710	3.278551	-0.7593	3.3351
Skew	0.518935	0.3065	-0.631566	0.6252	1.0787
Range	0.000911	574 trillion	0.179845	0.0700	0.0313

Note: Statistics for February 1, 1989 through February 1, 2015.

Testing hypotheses

An auto-regression analysis was used to test all hypotheses. For Hypothesis 1, the Japanese money supply had no significant effect on the U.S.-Japan exchange rate between February 1, 1989 and February 1, 2015 (alpha = 0.05; p-value = 0.3152). Therefore, we reject the alternate hypothesis. Hypothesis 2 showed that Japanese productivity did not have a significant effect on the U.S.-Japan exchange rate between February 1, 1989 and February 1, 2015 (alpha = 0.05; p-value = 0.7848). Therefore, we reject the alternate hypothesis.

Hypothesis 3 showed that Japanese interest rates had no significant impact on the U.S.-Japan exchange rate between February 1, 1989 and February 1, 2015 (alpha = 0.05; p-value = 0.7054). Therefore we reject the alternate hypothesis. Hypothesis 4 showed that Japanese inflation did not have a significant effect on the U.S.-Japan exchange rate between February 1, 1989 and February 1, 2015 (alpha = 0.05; p-value = 0.4552). Therefore we reject the alternate hypothesis.

The results suggest that no macroeconomic variable within the sticky-price monetary theory had a significant impact on Japanese exchange rates between February 1, 1989 and February 1, 2015. The r-squared for the Japanese model indicates the variables explained 96.48 percent of the impact on exchange rates; however, no macroeconomic variable was significant. The analysis indicates the sticky-price monetary model may not be appropriate for determining U.S./Japanese exchange rates.

Hypothesis 5 showed that South Korean money supply had a significant effect on the U.S.-South Korea exchange rate between February 1, 1989 and February 1, 2015 (alpha = 0.05; p-value = <0.0001). Therefore, the null hypothesis was rejected. Hypothesis 6 showed that South Korean productivity did not have a significant effect on the U.S.-South Korea exchange rate between February 1, 1989 and February 1, 2015 (alpha = 0.05; p-value = 0.6889). Therefore we reject the alternate hypothesis.

Hypothesis 7 showed that South Korean interest rates had no significant effect on the U.S.-South Korea exchange rate between February 1, 1989 and February 1, 2015 (alpha = 0.05; p-value = 0.8931). Therefore we reject the alternate hypothesis. Hypothesis 8 showed that South Korean inflation had a significant effect on the U.S.-South Korea exchange rate between February 1, 1989 and February 1, 2015 (alpha = 0.05; p-value = 0.0003). The null hypothesis was rejected.

The results suggest that money supply and inflation were the only macroeconomic variables within the sticky-price monetary theory to have a significant impact on South Korean exchange rates between February 1, 1989 and February 1, 2015. The r-squared for the South Korean model indicates the variables explained 96.34 percent of the impact on exchange rates. The analysis indicates the sticky-price monetary model may not be appropriate for determining U.S./South Korean exchange rates in that only money supply and inflation signified an impact.

SUMMARY

The analysis indicated that some economic variables have a substantial relationship with rates of exchange rates. However, the variables had varying significance and impacts. Inflation and money supply had a significant effect on U.S./South Korean exchange rates between February 1, 1989 and February 1, 2015. The model suggests that a 1% increase in the money supply rate differential would yield the exchange rate to rise by 0.0003%. The model also proposed that a 1% growth in the inflation differential would yield the exchange rate to increase by 0.002%. The autoregressive model that accounted for serial correlation also suggested that one lag period was sufficient for South Korea.

Money supply and productivity

The test results suggest money supply had an effect on the South Korean exchange rates but not the Japanese exchange rate. Given that the variable used within the analysis was a differential of the log money supply between the foreign nation and the U.S., the data show that differentials in log money supply between the United States and the foreign country affected rates of exchange differently between Japan and South Korea. The analysis indicates that a 1% increase in the log money supply differential between the United States and South Korea causes the respective exchange rate to increase by a relatively small percentage. For the purpose of the study, this variable may be a causal factor in a potential difference between market classifications.

The productivity index did not influence the Japanese nor South Korean exchange rates. Given that the variable used within the analysis was a differential of the productivity index between the foreign nation and the U.S., the

data show that differentials in the index between the U.S. and the foreign nation do not significantly affect rates of exchange. These findings somewhat differ from the literature regarding a gross domestic product analysis. However, as indicated previously, the data used in this analysis was the percent change in the production index and not a pure gross domestic product. For the purpose of the study, this variable did not show to be a causal factor in potential difference between market classifications.

Interest and inflation

Interest rates did not have a significant influence on the Japanese nor South Korean exchange rate. Given that the variable used within the analysis was a differential of interest rates between the foreign country and the U.S., the data show that differentials in interest between the U.S. and the foreign nation do significantly affect rates of exchange. As with productivity, for the purpose of the study, interest rates did not show to be a causal factor in potential difference between market classifications.

The test results suggest inflation did not influence Japanese, but did have a significant influence on South Korean exchange rates. Given that the variable used within the analysis was a differential of inflation between the foreign nation and the U.S., the data show that differentials in inflation between the U.S. and the foreign nation significantly affect rates of exchange differently possible based on market classification. For the purpose of the study, inflation did show to be a possible causal factor in the difference between market classifications.

Recommendations for research

The study found that inflation and money supply related to Japan and South Korea differently. However, the level of impact was minimal, such that the study suggest there may not be a significant difference in how the sticky-price monetary model predicts the exchange rate movements with respect to market classification. Therefore, firms may be able to use forecasting techniques similarly between developed and emerging market economies. The analysis found within this study directly fulfilled the purpose of its intended research.

The lack of high frequency data is a limitation of this study; therefore, additional research is recommended when more data become available. In addition, another method for determining an exact impact of market classification would be to incorporate a control variable for market classification. However, to perform this analysis, one would have to research an economy that has transitioned from being an emerging market economy to a developed market economy, with available data ranging throughout the periods. A second recommendation for future research would be to expand the analysis with respect to business cycle. It may be interesting to investigate how monetary variables influence differently the rates of exchange by market classification contingent on whether the economy is in a recession or expansion.

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