

Exchange Rates and Portfolio Rebalancing: Evidence from Emerging Economies

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Abstract

This paper tests the portfolio rebalancing model of Hau and Rey (2006) based on a sample of 23 emerging economies for the period of 1994-2010. We find that the exchange rate returns in emerging economies are significantly and positively correlated with excess emerging stock market returns vis-à-vis the United States, indicating that portfolio rebalancing does not characterize the exchange rate movements for emerging economies. Our findings are strongly supported at daily and monthly frequencies, and are robust to cross-market correlations, different stock market capitalizations, alternative exchange rate systems, capital controls and financial crises.

Keywords: exchange rates, equity returns, portfolio rebalancing, emerging markets

1. Introduction

Recent exchange rate theories have advanced beyond the scope of traditional macroeconomic theory. In their seminal work, Hau and Rey (2006) suggest a dynamic relationship between exchange rates and stock market returns under incomplete foreign exchange risk trading. Focusing on short- and medium-run fluctuations, the authors show that exchange rates are significantly impacted by portfolio rebalancing following equity market innovations. In their model, investors hold equity risk and currency risk as a bundle. If a portfolio of domestic and international equity investments is optimally allocated, then a positive shock to foreign stock markets increases the risk of the portfolio. Investors sell part of their foreign portfolio holdings to reduce the exposure to currency risk, triggering order flows in the foreign exchange markets and driving down the exchange rate for the foreign currency. Therefore, portfolio rebalancing induces foreign currency depreciation following positive shocks in foreign equity markets, causing a negative correlation between exchange rates and stock market returns. This framework, based on the micro-foundation of foreign exchange markets, suggests that stronger equity markets should be associated with weaker currencies.

This paper extends Hau and Rey's (2006) analysis for a sample of 23 emerging market currencies across Asia, Latin America, Europe and Africa over the period 1994–2010. Our undertaking is motivated by notable dissimilarities between emerging and developed countries' currencies. First, emerging currencies constitute a substantial part of the currency trade, but hedging instruments in many of the emerging countries are limited and foreign purchases of stocks are often unhedged (Remsperger, 2007; Saxena & Villar, 2008). Therefore, portfolio rebalancing should be an essential tool for managing currency risk in emerging market investments. Second, emerging economies often depart from the declared currency regime and may prevent the free movement of exchange rates (Calvo & Reinhart, 2002; Edwards, 2007). Many emerging economies also impose capital controls to reduce pressure on their exchange rates (Edwards, 2007; Edwards & Rignonbon, 2009; Baba & Kokenyne, 2011; Magud *et al.*, 2011). Therefore, the correlation structure between exchange rates and stock market returns predicted by Hau and Rey (2006) may be distorted in emerging economies. Third, emerging market currencies are more exposed to financial contagion and crises, resulting from inflation, currency attacks, systemic or financial distresses, and sovereign debt defaults (Reinhart, 2010), raising the question of how these shocks impacts the correlation between exchange rates and equity market returns. Fourth, emerging economies are on a more accelerated tempo of capital market development and integration into the world economy, thus being an excellent laboratory to study whether these factors affect the correlation structure suggested by Hau and Rey (2006).

This study contributes to the understanding of the correlation structure between exchange rates and equity market returns, a central issue for international diversification and risk management (Campbell *et al.*, 2010). We find that portfolio rebalancing does not characterize the exchange rate dynamics of emerging economies, as indicated by the positive and significant correlation between exchange rate returns and excess emerging stock market returns vis-à-vis the United States, at daily and monthly frequencies. Our results take into account cross-market correlations and are robust to emerging economies with different stock market capitalizations, alternative exchange rate systems, capital controls and financial crises.

This research is organized as follows: Section 2 reviews the literature on the correlation between exchange rates and stock market returns for emerging economies. Section 3 describes the methodology and data. Section 4 reports the results and Section 5 concludes the paper.

2. Literature Review

In the last decade, the share of emerging market currencies in global foreign exchange market turnover has increased to about 20% (Bank for International Settlements, 2010). Large investors, such as pension funds in the United States and other developed economies have made emerging markets the main beneficiaries of their international diversification (Note 1).

In contrast to developed countries, many emerging market currencies are subject to foreign exchange convertibility restrictions and capital controls imposed by local authorities. Emerging market currencies are often thinly traded and associated with high inflation and volatility. However, the offer for derivative products for risk management in emerging market currencies is limited. For example, traditional forward contracts are not available for many Latin American and Asian currencies, such as Brazil, Chile, China, Columbia, India, Indonesia, Korea, Malaysia, Peru and Taiwan. These currencies trade in non-deliverable forward markets, where 60–80% of the estimated trading volume relates to speculation (Lipscomb, 2005). Given the growing importance of capital flows to emerging economies and lack of alternative hedging instruments, portfolio rebalancing should be an essential tool for managing currency risk in emerging market investments. Hau and Rey (2006) find that portfolio rebalancing characterizes the exchange rate dynamics for 17 developed countries. Chaban (2009) finds that the portfolio rebalancing model does not hold for commodity currencies of Australia, Canada and New Zealand, suggesting that commodities prices, offsetting the fluctuations in exchange rates, may play a similar role to the terms of trade in risk sharing between commodity exporting and importing countries. Several issues arise when testing Hau and Rey (2006) model for emerging market currencies.

2.1 Currency Regimes and Capital Controls

Although portfolio rebalancing by international investors induces selling in the foreign exchange markets, substantial capital inflows generate upward pressure on emerging currencies. According to International Monetary Fund (IMF), the net capital flows, including portfolio flows and direct investments, account for about 3% of gross domestic product (GDP) for emerging economies, compared to about 2% of GDP for developed economies during 2002-2010 (IMF, 2011a, Figure 4.2). For the same period, the net portfolio equity flows to emerging economies account for about 1% of GDP, compared to about 0.5% of GDP for developed economies (IMF, 2011a, Figure 4.4). Substantial net equity inflows offset the exchange rate movements induced by portfolio rebalancing and may create positive correlations between exchange rates and stock market returns.

Capital controls and central bank interventions in the foreign exchange markets in 2000s aim to alleviate the upward pressure on emerging currencies by curbing speculative inflows (Edwards, 2007; Edwards & Rigobon, 2009; Ostry *et al.*, 2010; IMF, 2011b). The effect of such actions on exchange rates remains an open question. While early studies suggest that capital controls and central bank interventions have short-term effects on exchange rates (Magud *et al.*, 2011), recent research indicates that these actions are ineffective in changing the trend for emerging currencies (Binici *et al.*, 2009; Rincon & Toro, 2010; Baba & Kokenyne, 2011; Concha & Galindo, 2011; Magud *et al.*, 2011) (Note 2). Therefore, in contrast to developed economies, the correlation structure between exchange rates and excess emerging stock market returns is affected by several factors including the magnitude of net equity inflows to emerging economies, the impact of capital controls and central bank interventions on the foreign exchange markets, and the significance of portfolio rebalancing by international investors. A negative correlation indicates that portfolio rebalancing characterizes the exchange rate dynamics for emerging market currencies. A positive correlation suggests that other factors, such as substantial capital inflows, influence the exchange rates for emerging economies.

2.2 Financial Crises and Contagion

Emerging economies and their currencies are more prone to boom and bust cycles (e.g., 1994 Mexican Tequila crisis, 1997 Asian flu and 1998 Russian default). As pointed out by Longin and Solnik (2001), Ang and Bekaert (2002), and Forbes and Rigobon (2002), the correlation structures for the boom and bust periods may differ due to higher volatilities during bear markets. Specifically, when foreign capital pushes into emerging markets during a boom period, portfolio rebalancing based on currency risk may be important for international investors, inducing negative correlations between exchange rates and emerging stock markets returns. During crisis periods, investors pull out or freeze their foreign investments amid dramatic downturns in the currency or stock markets, inducing positive correlations between exchange rates and stock markets returns.

The correlation structure for emerging market currencies can also be affected by contagion, that is, crises in the foreign exchange or equity markets in one country can spread to other countries. Investors suffering losses in one country may sell assets in other countries, triggering forced equity portfolio rebalancing (Forbes, 2004, Kaminsky *et al.*, 2004). Contagion effects are pronounced across countries within a region (Calvo & Reinhart, 1996; Froot *et al.*, 2001, Bekaert *et al.*, 2005b) and are related to such fundamental economic variables as interest rates, exchange rates, and equity market volatilities (Bae *et al.*, 2003). Therefore, we expect cross-market correlations in our sample due to regional interdependence.

2.3 Financial Market Developments and Integration

Hau and Rey (2006) conjecture that the negative correlation structure should be more evident during periods of increasing equity market integration and for countries with higher degrees of capital market development. Since the mid-1990s, many emerging market countries have relaxed or removed restrictions on capital flows and opened their capital markets to international investors. The financial economics literature suggests that correlations between emerging and developed markets have increased in the last decades, and financial liberalization and integration reduce the cost of capital, spur growth, and offer significant diversification benefits to international investors (Bekaert & Harvey, 1995, 1997, 2000; Henry, 2000; Bekaert *et al.*, 2005a; Carrieri *et al.*, 2007). In the process of integrating into world financial markets, international investors in emerging markets gain better access to liquidity, information flow, and risk management tools. We expect that, for our sample of emerging markets, the correlation between exchange rates and stock markets returns should be increasingly significant over time following the path of financial integration, and the correlations should be more significant for countries with greater capital market development, as measured by the ratio of stock market capitalization to GDP.

2.4 Equity Flows and Exchange Rates

A number of studies on cross-border capital flows focus on contemporaneous correlations between equity flows and equity returns in developed and emerging markets (Tesar & Werner, 1994, 1995; Brennan & Cao, 1997). The evidence indicates that international investors engage in positive feedback trading in foreign equity markets, that is, buying subsequent to positive returns and selling subsequent to negative returns (Bohn & Tesar, 1996; Edelen & Warner, 2001; Froot *et al.*, 2001; Kim & Wei, 2002; Griffin *et al.*, 2004, 2007; Richards, 2005; Froot & Ramadorai, 2008). Therefore, positive feedback trading may induce positive correlations between equity market returns and exchange rates.

Previous studies on equity flows and exchange rates in emerging markets focus on the period around currency crises. Bailey *et al.* (2000) document a significant relation between the depreciation of Mexican peso and the price decline of Latin American mutual funds and American Depositary Receipts during 1994 Mexican peso crisis. Choe *et al.* (1999) find strong evidence of positive feedback trading by foreign investors in Korean equity markets before the 1997 Asian currency crisis, and show that herding disappeared during the crisis. Swanson and Lin (2003) find positive feedback trading for seven emerging Asian countries around the Asian currency crisis. These findings suggest that financial crises may be an important factor when assessing the correlation between exchange rates and equity market returns for emerging economies.

Fewer studies, however, have examined the dynamics between equity flows and exchanges rates over longer periods. Brooks *et al.* (2004) find that higher portfolio flows to US stocks are associated with appreciation of the US dollar against the euro and Japanese yen. Siourounis (2004) reports that the net equity flows to the United States from Japan, Germany, Switzerland and the United Kingdom are associated with US dollar appreciation. Hau and Rey (2006) predict that higher equity flows are associated with stronger currencies and provide significant supporting evidence based on US equity flows to 17 developed economies. Our tests, covering a

16-year period, contribute to the literature on the relationship between US equity flows and exchange rates for emerging economies.

3. Methodology and Data

3.1 Methodology

We test the correlation between the exchange rate returns and the equity return differentials for emerging and US stock markets by focusing on Hau and Rey (2006) model:

$$-FXR_{i,t} = \alpha_i + \beta_i MSCI_Excess_{i,t} + \varepsilon_{i,t} \quad (1)$$

where, $FXR_{i,t}$ is the exchange rate return calculated as the log difference of the spot exchange rates, which are in foreign currency units per US dollar. Following Hau and Rey (2006), we multiply $FXR_{i,t}$ by -1 when calculating the correlations and performing regression analyses. $MSCI_Excess_{i,t}$ is the difference between the emerging market and US market MSCI returns, measured in the respective local currencies, i refers to the emerging economies in our sample, α_i is the intercept, β_i is the estimated coefficient, and $\varepsilon_{i,t}$ is the error term. A negative β_i indicates that a stronger emerging stock market is associated with depreciation of the emerging currency, as predicted by Hau and Rey (2006). A positive β_i indicates that a stronger emerging stock market is associated with appreciation of the emerging currency. It is well known that stock market returns and changes in exchange rates are stationary variables and OLS regressions can be applied to Equation 1. We perform this regression for each country in our sample and compute Newey-West (1987) standard errors to account for heteroskedasticity and autocorrelation. We correct for the correlations of the error terms across countries using seemingly unrelated regression (SUR) system to ensure that cross-market correlations do not affect our results.

3.2 Data

Our sample includes 21 countries in the MSCI Emerging Markets Index: Brazil, Chile, China, Colombia, the Czech Republic, Egypt, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Morocco, Peru, the Philippines, Poland, Russia, South Africa, Taiwan, Thailand, and Turkey. To this initial sample, we add Hong Kong and Singapore. These newly industrialized countries play an important role in the regional economy (Frankel & Poonawala, 2010). The final sample consists of 23 countries from a variety of geographical locations (Asia, Latin America, emerging Europe and Africa) and at different stages of financial market development. Our sample covers a variety of exchange rate systems, including independent floating (Brazil, Chile, Mexico, the Philippines, Poland, South Africa, South Korea and Turkey), managed floating (Columbia, the Czech Republic, Hungary, India, Indonesia, Malaysia, Peru, Russia, Singapore, Taiwan and Thailand) and pegged system (China, Egypt, Hong Kong and Morocco) (Note 3).

Spot exchange rates and the MSCI series are obtained from Datastream for the period January 1994 to November 2010. The spot exchange rates are WM/Reuters closing middle rates quoted against the US dollar. The MSCI series are in US dollars for the United States and in local currencies for the 23 countries studied.

Crisis data are obtained from Reinhart (2010). The crises index is the sum of seven dummy variables that take the value of one if in a given year the country confronts a currency crisis, inflation crisis, stock market crash, domestic sovereign debt, external sovereign debt crisis, or banking crisis, and zero otherwise. Table 1 reports the average of the yearly crisis index over the period 1994–2010.

Capital flow data (TIC) are obtained from the Board of Governors Federal Reserve System and are available on a monthly basis. Using these data, we calculate the net increase in foreign stock ownership by US residents, defined as net US purchases of foreign equities minus net foreign purchases of US equities. Following Hau and Rey (2006), we normalize net foreign stock ownership as the proportion of the average absolute level of increase in net foreign ownership by US residents over the previous 12 months.

Table 1 provides a summary of the data. The average daily foreign exchange returns vary between -0.0010 and 0.0010, with the lowest in the Czech Republic and Singapore and the highest in Turkey. The MSCI daily excess emerging stock markets returns, relative to the United States, vary between -0.0030 and 0.0024, with the lowest average values in China and the highest values in Brazil. Stock market capitalization to GDP, obtained from the World Bank, varies from 0.0090 for South Korea to 3.1530 for Hong Kong. The average yearly crisis index, varying between 1.76 and 0.18, has the highest value for Turkey and the lowest value for Taiwan.

Table 1. Summary statistics

Country	Dates	Currency regime	FXR Mean	FXR SD	MSCI Excess Mean	MSCI Excess SD	MCap/ GDP	Crisis
Brazil	Jul-94	Independent	0.0001	0.0099	0.0024	0.0234	0.328	1.18
Chile	Dec-93	Independent	0.0000	0.0058	0.0003	0.0127	0.947	0.35
China	Dec-93	Peg	0.0000	0.0062	-0.0003	0.0223	0.270	0.88
Colombia	Dec-93	Managed	0.0002	0.0062	0.0005	0.0167	0.160	1.12
Czech	Dec-94	Managed	-0.0001	0.0075	0.0001	0.0175	0.213	n/a
Egypt	Dec-94	Peg	0.0001	0.0036	0.0004	0.0202	0.256	0.24
Hong Kong	Dec-93	Currency Board	0.0000	0.0003	0.0001	0.0183	3.153	n/a
Hungary	Dec-93	Target Zone	0.0001	0.0078	0.0004	0.0203	0.182	0.88
India	Dec-93	Managed	0.0001	0.0033	0.0002	0.0190	0.342	0.71
Indonesia	Dec-93	Managed	0.0003	0.0156	0.0001	0.0219	0.239	1.59
Malaysia	Dec-93	Managed	0.0000	0.0080	0.0000	0.0185	1.822	0.65
Mexico	Dec-93	Independent	0.0003	0.0098	0.0005	0.0130	0.279	1.18
Morocco	Dec-94	Peg	0.0000	0.0049	0.0001	0.0146	0.279	0.24
Peru	Dec-93	Managed	0.0001	0.0030	0.0005	0.0180	0.218	0.65
Philippines	Dec-93	Independent	0.0001	0.0060	0.0001	0.0190	0.556	0.88
Poland	Jan-95	Independent	0.0000	0.0078	0.0004	0.0219	0.117	0.88
Russia	Mar-96	Managed	0.0005	0.0186	0.0003	0.0312	0.215	1.76
Singapore	Dec-93	Managed	-0.0001	0.0036	-0.0001	0.0157	1.562	0.47
South Africa	Dec-93	Independent	0.0002	0.0096	0.0002	0.0152	1.528	0.53
Korea	Dec-93	Independent	0.0001	0.0094	0.0000	0.0217	0.009	0.76
Taiwan	Dec-93	Managed	0.0000	0.0028	-0.0001	0.0201	1.015	0.18
Thailand	Dec-93	Managed	0.0000	0.0060	-0.0001	0.0213	0.556	0.82
Turkey	Dec-93	Independent	0.0010	0.0140	0.0012	0.0282	0.260	1.76

Notes: Dates indicate the starting date for the data in our sample. Currency regime is the exchange rate system, based on Bekaert and Hodrick (2009). Independent refers to independent floating. Managed refers to managed floating. *FXR* is the daily exchange rate return calculated as the log difference of the spot exchange rates, which are in foreign currency units per U.S. dollar. *MSCI_Excess* is the excess emerging stock market return calculated as the difference between the emerging market and US market MSCI returns. MCap/GDP is the ratio of the country's stock market capitalization to GDP. Crisis is the average index of the country's crisis index, based on Reinhart (2010). Crisis data for the Czech Republic and Hong Kong are unavailable.

4. Empirical Findings

4.1 Correlations between Exchange Rates and Excess Equity Market Returns in Emerging Economies

Table 2 presents the daily and monthly correlations of exchange rate returns and excess emerging stock market returns. Of the 23 countries analyzed, the daily correlation is positive for 20 countries, with 16 countries significant at 1% level and Czech Republic and Morocco significant at 5% and 10% levels, respectively. Chile, China and Egypt have negative daily correlations, which is significant for Egypt at 10% level. For monthly data, we find that 15 countries show positive correlations, and 11 countries have positive and significant correlations. Notably, none of the countries in our sample has a significantly negative correlation as predicted by Hau and Rey (2006). These findings are supported at regional levels with significant and positive daily correlations for eight countries in Asia, four countries in Latin America and seven countries in emerging Europe and Africa. Based on the results for the total sample, we find strong statistical evidence that the portfolio rebalancing model does not hold for emerging economies.

Table 2. Correlations of Exchange Rate Returns and Excess Emerging Stock Market Returns

Country	All Sample		1994–2002		2003–2010	
	Daily	Monthly	Daily	Monthly	Daily	Monthly
Higher market capitalization						
Brazil	0.1040***	-0.0076	0.0193	-0.0880	0.2248***	0.1011
Chile	-0.0233	-0.0795	-0.0136	0.1133	-0.0966***	-0.1980
Hong Kong	0.0101	0.0469	-0.0152	0.2060**	0.0381	0.0480
India	0.1473***	0.2481***	0.0235	0.1797*	0.2418***	0.2327**
Malaysia	0.1060***	0.1479**	0.1159***	0.1885*	0.0532**	-0.3291***
Mexico	0.0605***	0.1550**	0.0531**	0.2209**	0.0586**	-0.1234
Philippines	0.1158***	0.2008***	0.1089***	0.2559***	0.1426***	-0.1340
Singapore	0.1016***	0.1802***	0.1305***	0.2804***	0.0418*	-0.1230
South Africa	0.0137	-0.0829	-0.0079	0.1508	-0.0514**	-0.2451**
Taiwan	0.1864***	0.1914***	0.1885***	0.2150**	0.1790***	0.0879
Thailand	0.1448***	0.0295	0.1678***	-0.037	0.0942***	0.2110**
Lower market capitalization						
China	-0.0181	0.1355*	-0.0277	0.1467	0.0858***	0.1594
Colombia	0.0505***	-0.0024	0.0119	-0.0558	0.0713***	-0.0748
Czech	0.0360**	-0.0040	0.0183	0.0734	-0.0270	-0.2139*
Egypt	-0.0265*	-0.1195	0.0336	-0.1139	-0.0490**	-0.1754
Hungary	0.1181***	0.0617	0.0043	-0.0496	0.1562***	0.0691
Indonesia	0.1859***	-0.0144	0.1885***	-0.0818	0.3087***	0.2783**
Morocco	0.0294*	-0.1173	0.1243***	0.1470	-0.0868***	-0.3175
Peru	0.0473***	0.1797***	0.0273	0.2311**	0.0750***	0.1674
Poland	0.1179***	0.1315*	0.0668***	0.2068**	0.1543***	0.0473
Russia	0.1696***	0.4676***	0.1775***	0.5004***	0.2274***	0.2692**
South Korea	0.2466***	0.1062	0.2312***	0.1998**	0.2234***	-0.1739
Turkey	0.1237***	0.1581**	0.0538***	0.1510	0.4141***	0.3525***

Notes: This table reports the Pearson correlations of exchange rate returns on excess emerging stock market returns relative to the U.S. stock market returns. The subsample 2003–2010 excludes the data for 2008. *, **, and *** denote significance at 10%, 5%, and 1% levels, respectively.

4.2 Financial Market Development and Integration

To investigate whether the correlations change over time, we divide the sample into two sub-periods, 1994–2002 and 2003–2010. The period 1994–2002 marks the beginning of market openness for emerging economies. This period experiences a large number of financial crises, leading to credit freezes, stock market reforms and capital controls (Bekaert & Harvey, 2003). The period 2003–2010, from which we exclude 2008, is characterized by financial market openness and integration with the financial systems around the world functioning smoothly, except for 2008. Moreover, technological progress leads the integration, allowing better access to emerging stock markets and currency trading. Table 2 reports the results. At the daily level, 12 countries show significant correlations for 1994–2002, while 21 countries exhibit significant correlations for 2003–2010. We note that nine countries, including Brazil, Chile, China, Colombia, Egypt, Hungary, India, Peru and South Africa, have insignificant daily correlations during 1994–2002 and highly significant correlations during 2003–2010 when the degree of financial market integration is higher. The monthly correlations reveal fewer significant changes for the two sub-periods, with 11 countries showing significant correlations during 1994–2002 and eight countries showing significant correlations during 2003–2010. Analyzing separately the countries with higher (lower) market capitalizations indicates that the number of countries with significant correlations is similar for the two subsamples. Across geographical regions, ten countries have shown insignificant daily correlations for 1994–2002 and significant correlations for 2003–2010, including two countries in Asia (China and India), four countries in Latin America (Brazil, Chile, Colombia and Peru), and four countries in emerging Europe and Africa (the Czech Republic, Egypt, Hungary and South Africa). Overall, the results are consistent with Hau and Rey (2006) indicating that financial market development and integration affect the correlation between exchange rates and equity market returns.

4.3 Currency Regimes, Capital Controls and Financial Crises

Table 3 reports the country regressions of exchange rate returns on excess emerging stock market returns, tabulated by alternative exchange rate systems. The results show that, for countries with a pegged exchange rate system, including China, Egypt, Hong Kong and Morocco, the estimated coefficients are insignificant supporting the prediction of Hau and Rey (2006) that the portfolio rebalancing model may not hold for pegged exchange rate systems. For countries with declared independent floating and managed floating systems, the estimated coefficients are positive and significant for 16 of the 18 countries based on daily data, and positive and significant for eight countries (13 countries positive) based on monthly data. These results do not support the portfolio rebalancing model of Hau and Rey (2006). None of the countries in our sample exhibits a significantly negative coefficient. Among the countries with a declared independent floating system, Chile is the only country with a negative coefficient.

Several countries in our sample impose controls on foreign capital inflows and outflows during various periods of this study, including Brazil, Chile, China, Colombia, the Czech Republic, India, Indonesia, Korea, Malaysia, Peru and Thailand (Note 4). Controls on capital outflows in Malaysia, Thailand and South Africa have been gradually relaxed in our sample period. Across geographical regions, many Asian countries impose strict rules for capital controls while Latin American countries introduce capital controls periodically during our sample period. Table 3 indicates that the estimated coefficients for countries with capital controls are predominantly positive and significant based on daily data, except for Chile and China. Based on monthly data, the estimated coefficients are generally insignificant for countries with capital controls. Overall, these results are consistent with the literature that controlling capital flows are less successful in easing the upward pressure on exchange rates (Baba & Kokenyne, 2011, Magud *et al.*, 2011), indicating that capital controls have a limited impact on the correlation between the exchange rate returns and excess emerging stock market returns regardless of geographical locations.

To test whether financial crises affect the correlation between exchange rate returns and excess emerging stock market returns, we obtain a subsample of daily observations from which we eliminate all the years when a country confronted with a crisis. Crisis data for the Czech Republic and Hong Kong are unavailable. The last two columns of Table 3 report the results. We find that 19 of the 21 countries analyzed show positive relationship between exchange rate returns and excess emerging stock market returns, and 17 countries with significantly positive regression coefficients. The results are similar across regions of Asia, Latin America, emerging Europe and Africa.

Overall, Tables 3 confirms the evidence reported in Table 2 that the portfolio rebalancing model does not hold for our sample of emerging economies. Our results are robust to alternative exchange rate systems, capital controls, and financial crises.

Table 3. Regressions of Exchange Rate Returns on Excess Emerging Stock Market Returns

Independent Floating						
	Daily	(t-stat) N	Monthly	(t-stat) N	Non-Crisis	(t-stat) N
Brazil	0.0582**	(2.35) 4265	-0.0059	(-0.05) 196	0.1634***	(8.74) 1785
Chile	-0.0108	(-0.93) 4394	-0.0424	(-0.91) 202	-0.0358***	(-3.57) 3088
Mexico	0.0457*	(1.71) 4394	0.1145	(1.53) 202	0.0262*	(1.67) 2046
Philippines	0.0356***	(3.54) 4394	0.0710***	(2.65) 202	0.0256***	(4.96) 2047
Poland	0.0472***	(5.48) 4132	0.0625*	(1.73) 189	0.0893***	(5.04) 1785
South Africa	0.0085	(0.54) 4394	-0.0685	(-0.92) 202	0.0085	(0.54) 4394
South Korea	0.1038***	(7.02) 4394	0.0588	(1.00) 202	0.0731***	(7.24) 2045
Turkey	0.0615***	(3.66) 4394	0.0729**	(2.18) 202	0.1596***	(10.68) 1524
Managed Floating						
	Daily	(t-stat) N	Monthly	(t-stat) N	Non-Crisis	(t-stat) N
Colombia	0.0185**	(2.49) 4394	-0.0009	(-0.03) 202	0.0241**	(2.45) 1785
Czech	0.0154	(1.40) 4134	-0.0021	(-0.05) 190	n/a	n/a
Hungary	0.0462***	(5.09) 4134	0.0288	(0.72) 190	0.0217**	(2.34) 1565
India	0.0251***	(6.78) 4394	0.0570***	(3.33) 202	0.0363***	(5.63) 2307
Indonesia	0.1251***	(4.83) 4394	-0.0118	(-0.09) 202	0.0900***	(8.07) 1525
Malaysia	0.0435***	(3.67) 4394	0.0675	(1.49) 202	0.0083	(1.48) 2308
Peru	0.0081**	(2.20) 4394	0.0310**	(2.03) 202	0.0059*	(1.72) 2046
Russia	0.1004***	(2.59) 3826	0.1911*	(1.78) 175	0.0218***	(5.96) 1785
Singapore	0.0218***	(4.25) 4394	0.0584**	(2.29) 202	0.0119**	(2.29) 2566
Taiwan	0.0268***	(7.69) 4394	0.0441**	(2.31) 202	0.0268***	(7.69) 4394
Thailand	0.0395***	(3.53) 4394	0.0094	(0.22) 202	0.0222***	(5.30) 2308
Pegged system						
	Daily	(t-stat) N	Monthly	(t-stat) N	Non-Crisis	(t-stat) N
China	-0.0049	(0.86) 4394	0.0435	(1.03) 202	0.0017***	(2.82) 1262
Egypt	-0.0047	(-0.79) 4134	-0.0220	(-0.63) 190	-0.0047	(-0.79) 4134
Hong Kong	0.0001	(0.47) 4394	0.0009	(0.90) 202	n/a	n/a
Morocco	0.0098	(1.43) 4134	-0.0403	(-1.45) 190	0.0098	(1.43) 4134

Notes: This table reports the regression coefficients for exchange rate returns on excess emerging stock market returns relative to US stock market returns. The data are for daily and monthly frequency. The subsample Non-Crisis contains daily observations excluding all the years when a country confronted with a crisis, based on Reinhart (2010). Crisis data for the Czech Republic and Hong Kong are unavailable. The exchange rate system is based on Bekaert and Hodrick (2009). The t-statistics are in parentheses. N is the number of observations. *, **, and *** denote significance at 10%, 5%, and 1% levels, respectively.

4.4 Cross-market Correlations

To test whether cross-market correlations affect our results, we re-estimate Equation 1 using the SUR system. The data starts from March 1996, the starting date for Russia in our sample. The number of observations is 3090 at daily frequency for each country in the regression system. Our SUR system consists of 32 countries including 23 emerging economies and nine developed economies of Australia, Canada, Denmark, the euro zone, Japan, Norway, Sweden, Switzerland, and the United Kingdom (Note 5). The explanatory variable is the excess foreign stock market return, calculated for each country, as the difference between the foreign market and US market MSCI returns. The SUR estimators gain efficiency by jointly estimating 32 equations in the system and correcting for the correlations of the error terms across 32 countries. Table 5 reports the results. The estimated coefficients for the Euro zone, Japan, Switzerland and UK are negative and significant at 1% level, confirming that the portfolio rebalancing model holds for developed economies (Hau & Rey, 2006). The estimated coefficients for Australia and Canada are positive and significant at 1% level, confirming that the portfolio rebalancing model does not hold for commodity currencies (Chaban, 2009). The estimated coefficients are positive and significant for 18 of the 23 emerging economies, with 15 countries significant at 1% level and two countries significant at 5% and 10% levels, respectively. Chile and Egypt show negative coefficients with 10% level of significance. Across geographical regions, the estimated coefficients are positive for nine emerging economies in Asia, four in Latin America and five in emerging Europe. Overall, Table 4 confirms that the portfolio rebalancing model does not hold for our sample of emerging economies.

Table 4. SUR of Exchange Rate Returns on Excess Foreign Stock Market Returns

Developed Countries	Coefficient	SE	z	P > z	χ^2	Adj. R ²
Australia	0.1075***	0.009861	10.91	0	119.01***	0.0688
Canada	0.0247***	0.006480	3.82	0	14.58***	0.0199
Denmark	0.0027***	0.000917	3.01	0.003	9.06***	0.0005
Euro	-0.0103***	0.000796	-13.00	0	168.97***	0.0007
Japan	-0.0328***	0.007113	-4.61	0	21.27***	0.0143
Norway	0.0525***	0.004406	11.93	0	142.33***	0.0455
Sweden	0.0574***	0.003721	15.45	0	238.55***	0.0346
Switzerland	-0.0778***	0.004021	-19.36	0	374.86***	0.0374
UK	-0.0187***	0.005970	-3.15	0.002	9.91***	-0.0077
EM—Asia	Coefficient	SE	z	P > z	χ^2	Adj. R ²
China	0.0003	0.000540	0.59	0.556	0.35	0.0005
Hong Kong	-0.0001	0.000286	-0.13	0.895	0.02	-0.0001
India	0.0282***	0.002417	11.7	0	136.93***	0.0373
Indonesia	0.0816***	0.006372	12.82	0	164.28***	0.0507
Malaysia	0.0175***	0.004470	3.92	0	15.34***	-0.0004
Philippines	0.0383***	0.003607	10.63	0	112.94***	0.0182
Singapore	0.0043**	0.002228	1.97	0.049	3.88**	0.0024
South Korea	0.0702***	0.004758	14.77	0	218.21***	0.0566
Taiwan	0.0226***	0.001958	11.57	0	133.79***	0.0345
Thailand	0.0160***	0.003132	5.14	0	26.39***	0.0118
EM—Latin America	Coefficient	SE	z	P > z	χ^2	Adj. R ²
Brazil	0.0162	0.011149	1.46	0.145	2.13	0.0049
Chile	-0.0133*	0.007718	-1.73	0.084	2.99*	0.0012
Colombia	0.0279***	0.006154	4.54	0	20.6***	0.0032
Mexico	0.0125**	0.007350	1.71	0.087	2.93*	0.0037
Peru	0.0018	0.002784	0.68	0.498	0.46	0.0011
EM—EMEA	Coefficient	SE	z	P > z	χ^2	Adj. R ²
Czech	-0.0057	0.003563	-1.61	0.107	2.59	-0.0012
Egypt	-0.0064*	0.003348	-1.94	0.053	3.75*	0.001
Hungary	0.0189***	0.004071	4.66	0	21.74***	0.0106
Morocco	0.0031*	0.001778	1.77	0.077	3.13*	0.0002
Poland	0.0199***	0.004860	4.11	0	16.90***	0.0087
Russia	0.0221***	0.003089	7.18	0	51.59***	0.0298
South Africa	-0.0430***	0.009512	-4.53	0	20.48***	-0.0025
Turkey	0.0573***	0.008279	6.92	0	47.91***	0.0253

Notes: This table reports the results for the seemingly unrelated regression (SUR) systems of daily exchange rate returns on daily excess foreign stock market returns relative to US stock market returns. *, **, and *** denote significance at 10%, 5%, and 1% levels, respectively.

4.5 Equity Flows and Exchange Rates

Table 5 reports the correlations of monthly exchange rate returns and net increase in foreign stock ownership by US residents (or net foreign equity inflows). The net foreign equity inflows are calculated as net US purchases of foreign equities minus net purchases of US equities by foreigners, normalized as a proportion of the average absolute level of increase in net foreign stock ownership by US residents over the previous 12 months. For the overall sample, eight countries have negative correlations and 15 countries have positive correlations, suggesting that higher equity flows are associated with stronger currencies. The sub-period results indicate that 13 countries have positive correlations for 1994-2002 and 18 countries have positive correlations for 2003-2010. Overall, the evidence supports the prediction of Hau and Rey (2006) that equity flows are positively correlated with exchange rates and is consistent with the literature on capital flows to emerging economies.

Table 5. Correlations of Exchange Rate Returns and Net Foreign Equity Inflows

Country	All Sample	1994–2002	2003–2010
Brazil	0.0683	0.0436	0.1240
Chile	0.0356	-0.0963	0.1050
China	-0.0143	-0.0061	-0.1362
Colombia	0.0096	-0.0283	0.0791
Czech	-0.1062	-0.1942	0.0668
Egypt	0.0025	-0.0054	0.0056
Hong Kong	0.0931	0.0275	0.1396
Hungary	0.0156	0.0228	0.0443
India	0.0924	0.0895	0.2048
Indonesia	-0.0099	-0.0254	0.0853
Malaysia	0.0703	0.0657	0.1098
Mexico	-0.0605	-0.0193	-0.1277
Morocco	-0.0584	-0.0600	-0.0708
Peru	-0.0551	0.0012	-0.2881
Philippines	0.0489	0.0369	0.0777
Poland	0.0066	0.0141	0.0034
Russia	-0.0032	0.0181	-0.0470
Singapore	-0.0367	-0.1464	0.1474
South Africa	0.1082	0.0545	0.2078
South Korea	0.0579	0.0356	0.1798
Taiwan	0.0558	0.0507	0.0702
Thailand	0.1014	0.1030	0.0978
Turkey	0.0180	-0.0288	0.1187

Notes: This table reports the Pearson correlations of monthly exchange rate returns and net US purchases of foreign equities minus net purchases of US equities by foreigners, normalized as a proportion of the average absolute level of increase in net foreign stock ownership by US residents over the previous 12 months.

5. Conclusion

This paper tests the portfolio rebalancing model of Hau and Rey (2006) for a sample of 23 emerging economies at different stages of capital market development and from diverse geographical regions. We find significant and positive correlations between the exchange rate returns and excess emerging stock market returns relative to the United States, indicating that positive shocks in emerging equity markets are associated with appreciation of the emerging market currencies. This result suggests that the portfolio-rebalancing perspective of foreign exchange markets does not hold for our sample of emerging economies. Our findings take into account cross-market correlations and are robust to emerging economies with different stock market capitalizations, alternative exchange rate systems, capital controls and financial crises. We also find that, consistent with previous research, higher equity flows are associated with stronger currencies for our sample of emerging economies.

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Notes

Note 1. For instance, in the period 2006-2007, the California Public Employees' Retirement System had about 90% of the increased exposure to foreign securities in emerging market currencies.

Note 2. See Edwards (2007) & Magud *et al.* (2011) for extensive reviews of capital controls and exchange rates in emerging economies.

Note 3. See Bekaert & Hodrick (2009) for exchange rate systems in our sample of emerging economies. We include Hungary in the sample of managed floating currencies as the Hungarian forint maintains a target zone to the euro but remains floating against the US dollar for our sample period.

Note 4. See, e.g., Magud *et al.* (2011) and IMF (2011b) for surveys on various measures of capital controls imposed in these countries.

Note 5. The euro zone is treated as one country.