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Causality Relation between Real Exchange Series and Emerging Stock Markets: Panel Common Factor Analysis

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This paper investigates the underlying dynamics of real exchange rate series (RER), and the long run causality relationship between RER and the stock market movements for a group of emerging countries during 1988:01–2005:02. The purchasing power parity theory is employed to derive RER series. Employing Bai and Ng methodology (Bai, J. and Ng, S. 2004. A new look at panel testing of stationarity and the PPP hypothesis, in: Don Andrews and James Stock (ed), Identification and inference in econometric models: Essays in Honor of Thomas J. Rothenberg, Cambridge University Press, New York, 426-450) three nonstationary common factors influencing all countries' RER are found. Furthermore, it is observed that these common factors are very vulnerable to financial crises. Subsequently, Toda and Yamamoto Granger causality tests (Toda, H.Y. and Yamamoto, T. 1995. Statistical inferences in vector autoregressions with possibly integrated processes, Journal of Econometrics, 66, 225-50.) are conducted to determine the direction of the causality between stock markets and common factors of RER series. Our test results indicate a bi-directional causality between emerging countries' stock markets and RER. We know that the empirical literature does not provide a consensus on either the direction of the sign of the correlation or the cause. Our causality analysis shed light on this phenomenon. Actually, the relationship between foreign exchange and stock markets is complex. The sign of the correlation is not identifiable since there is more than one underlying dynamic between these markets.

Keywords: *Time Series Panel Data, Common Factors, Real Exchange Rate Series, Purchasing Power Parity, Emerging Stock Market, US Stock Market.*

1. Introduction

Over the past decades, developing countries have liberalized their economies. A large number of restrictions on investment decisions have been abolished. Consequently international capital flows have risen sharply. During the1990s, the composition of debt shifted from bank loans to portfolio investment. Bond and equity issues became the main source of financing (Krueger, 2002). The trends to financial liberalization and the adoption of more flexible exchange rate regimes have increased the interest of researchers in studying the interaction between stock and foreign exchange markets. Economic theory provides two alternative explanations for the relationship between these markets: "flow" and "stock" approaches. Flow approach models claim that real exchange rate movements affect stock prices through their influence on competitiveness and economic activity. By contrast, stock approach models

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claim that stock prices influence real exchange rate determination through their effect on the demand of money (Phylaktis and Ravazzolo, 2005). Flow approach models claim a negative correlation between these two markets, whereas the stock approach suggests a positive correlation.

Unfortunately, the empirical literature does not provide a consensus on either the direction of the correlation or the sign of the cause. Aggarwal (1981) finds that revaluation of the US dollar is positively related to stock market returns. Solnik (1987) inspects the influence of exchange rates, interest rates and variation in inflation expectations on stock prices for monthly data of nine developed countries. He observes a positive but insignificant influence of exchange rates on the US stock market. Roll (1992), considering daily data over the period 1988-1991, also gets a positive relationship between the two markets. However, Soenen and Hennigar (1988) achieve a significantly negative relationship between US exchange and stock markets employing monthly data for the period 1980-1986. On the other hand, Chow, Lee and Solt, (1997), using monthly data for the period 1977-1989, find no relationship for monthly excess stock returns and real exchange rate returns. Ong and Izan (1999) apply the non-linear least square technique and find evidence of a very weak relationship between the markets. They conclude that exchange rate depreciation causes a rise in stock market returns as the appreciation has the opposite effect.

In literature, there is a large number of studies about developed countries, especially the US market. However, emerging countries markets began to get attention with the East Asian financial crises which started in Thailand in July, 1997 and influenced all Asian countries. The flight to quality caused a rise in demand for US equities and bonds while decreasing demands on all emerging countries. Thus, the spread between the emerging and US stock markets increased strongly. Abdalla and Murinde (1997) examine the direction of granger causality between exchange markets and stock prices for India, Korea, Pakistan and the Philippines for the period 1985:01 to 1994:07. They find that exchange rates influence stock prices. Caporale, Pittis and Spagnolo (2002) consider causality between these markets for four East Asian counties employing the GARCH model. Their results state that in the pre-crisis era, stock prices influenced exchange rates negatively in Japan and Korea (in a consistent way with the portfolio approach) and positively in Indonesia and Thailand. However, after the crisis, bi-directional causality between these two financial variables is observed. Muhammed and Rasheed (2005) examine the granger causality relation for four emerging countries using monthly data over the period 1994:01 to 2000:12. They find bi-directional causality between markets for Bangladesh and Sri Lanka but no long-run correlation for Pakistan and India.

In this paper we investigate the underlying dynamics of the real exchange rate series and the long run causality relationship between these and the stock market movements for a group of fifteen emerging countries in Latin America and the Asia and Pacific regions. We also consider the long run effects of the US stock market, representing the world market, on these markets. We examine the period 1988:01 to 2005:02. The RER series is obtained by absolute version purchasing power parity (PPP) theory. Data sets of prices and exchange rates for all countries are taken from IMF statistics data base: International Financial Statistics, (IFS). The emerging stock market indices are obtained from International Financial Corporation (IFC). The Dow Jones Industrial Average is used for the US stock market index.

First of all, we employ the Bai and Ng (2004) common factor methodology that allow us to consistently estimate the common factors, which drive all countries' RER series simultaneously, and country-specific error components. Our results show there are three

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nonstationary common factors influencing the RER of all countries simultaneously. Also, we find that all country-specific idiosyncratic errors are stationary. Hence, we conclude that the long-run variations of the RER series are caused by these three common factors. Indeed, their non-stationarity causes the RER series to deviate from PPP theory. Our variation analysis shows that common factors explain 43 percent of the variation in a panel of RER series whereas country-specific idiosyncratic errors explain 57 percent of the variation. The dynamics of these common factors are further investigated and seen that they are very vulnerable to financial crises.

Thereafter, we proceed with the search of the long-run relationship between stock markets and the RER series. Previous literature usually considered the return of stock prices and the RER series, instead of levels. Therefore, the long-run dynamics were not investigated because of the lack of the technique to deal with non-stationary series. In our study, we employ the Toda and Yamamoto (1995) Granger causality test for non-stationary series. This methodology allows us to determine the direction of the causality between a stock market and the RER series. Since we find out that long-run variations of RER series are derived by common factors, we specifically investigate the long run relation between these factors and stock prices. Our test results indicate that there is a bi-directional causality between emerging countries' stock markets and RER; but there is no causality relation between the US stock market and all the other variables. We know that the empirical literature does not provide a consensus on either the direction of the correlation or the sign of the cause. Our causality analysis shed light on this phenomenon. Actually, the relationship between foreign exchange and emerging stock markets is complex. The sign of the correlation is not identifiable since there is more than one underlying dynamic between these markets.

Our paper is motivated by Phylaktis and Ravazzolo (2005) and Dufrenot and Yehoue (2005). Phylaktis and Ravazzolo (2005) consider the granger causality test and co-integrating relationship between emerging stock markets, the US stock market and the real exchange rate series (RER) for six Pacific Basin countries for [1980, 1998] period. They find a positive relation between emerging countries' stock markets and the RER series. Indeed, they emphasize that the US stock market is the force that triggers this positive relationship. Phylaktis and Ravazzolo search for a co-integrating relationship but their do not provide the common factor analysis. Indeed, they do not investigate the underlying dynamics of the RER series or the interactions of these dynamics to the stock market.

Dufrenot and Yehoue (2005) consider the RER series dynamics of emerging countries by applying the Bai and Ng common factor analysis. They investigate 64 developing countries for [1979, 2000] period and construct three sub-groups, depending on income levels. They find 3 or 4 common factors for all countries and provide that, for the sub-groups, the common factor numbers change between 4 and 7. They declare productivity, terms of trade and openness as the most significant fundamentals to explain the common factors. However, they do not provide a causality analysis. Indeed, they do not consider the emerging stock markets and their influence on the RER series.

According to our knowledge, our paper is the first study in literature applying the common factor analysis to understand the long-run causal relationship between the real exchange rate and stock market movements for emerging markets.

This paper is organized as follows. The theoretical framework for construction of RER series and econometric framework of Bai and Ng (2004) common factor methodology are established in Section 2. Section 3 introduces the data set. The results of empirical tests applied to the RER and discussion of the characteristic common factors are presented in Section 4. The economic theories that explain the relationship between the RER series and stock markets are introduced in Section 5. The Toda and Yamamoto (1995) Granger causality methodology is described and the results of the test on common factors and stock market indices are established in Section 6. Section 7 concludes our study.

2. Theoretical and Econometric Framework

First of all, we want to understand the underlying dynamics of the real exchange rate series. These are obtained by the absolute version purchasing power parity theory. Then the Bai and Ng (2004) common factor methodology is applied to a panel of RER series. This methodology allows us to consistently estimate the common factors driving all countries' RER series simultaneously and the country-specific idiosyncratic components. In this section, we establish the absolute PPP theory and then introduce Bai and Ng's econometric framework.

2.1 Theoretical Framework: Construction of RER Series

In this study we obtain the RER series by applying the absolute version purchasing power parity (PPP) theory. The PPP theory concerns the equilibrium relationship between the exchange rate and prices of two countries. It focuses on the role of prices of goods and services to determine exchange rate movements. The absolute PPP is based on the law of one price (LOP). The law of one price states that identical commodities or goods should have the same price in all markets. If we formulate the LOP for any good i:

$$Pi = E.P^{*}i \qquad (1)$$

where Pi, P*i are the commodity i's price level in domestic currency and foreign currency respectively, and E is the nominal exchange rate defined as the domestic currency price of a unit of foreign currency.

The LOP holds under strict assumptions. First, the financial markets should be perfect. There should be no barriers such as quotas or tariffs to international trade. The goods markets also should be perfectly competitive. The goods have to be homogenous, otherwise there can be price differences because of quality differences in commodities. Furthermore, the prices of goods have to be known by the individual agents of the countries, i.e. there must be perfect information in markets. Moreover, the international delivery of commodities should take place freely, instantaneously and costlessly, i.e. there should not be any transportation costs. In the case that the LOP does not hold, then arbitrage occurs. Arbitrage is when prices of identical goods are not the same in the markets of different countries, then the arbitrageurs (profit-seeking entrepreneurs) import from a market with lower prices and sell in the expensive market. Because of increasing supply, prices will decrease in the expensive market while rising in the cheaper market because of increased demand. This process will go on until prices of the commodity are equalized in both markets.

The LOP refers to one good only. However, if the general price level indices of any two countries are constituted by taking the same basket of goods and giving equal weight to each good, then we can derive the following relationship:

$$P = E.P^{*} \qquad (2)$$

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where P, P* are the general price indices respectively in domestic and foreign countries. E is the nominal exchange rate (the domestic currency price of a unit of foreign currency). Then, we can derive the absolute PPP based on LOP as follows:

$$E = P / P^* \qquad (3)$$

As a consequence, the absolute PPP states that the nominal exchange rate between two currencies is equal to the ratio of the general price levels between two countries. Also it can be interpreted as the general level of prices will be the same in each country, when it is converted to a common currency, i.e. P/SP* =1 whatever the real and monetary disturbances in the economy.

The theory of PPP asserts that the real exchange rate (RER) should be stationary. To demonstrate this claim let us consider the equation (3), the absolute version of PPP. If we consider all the series in their logarithmic form, then equation (3) becomes:

$$e = p - p^* \qquad (4)$$

where p, p* and e represent the natural logarithm of P, P* and E series respectively. Since the real exchange rate is a price-adjusted nominal exchange rate, we can formulate the logarithm of RER in algebraic form by:

$$r = e - (p - p^*) \qquad (5)$$

Considering the definition of RER, we can state that if the absolute PPP holds, then the real exchange rate series should be stationary.

2.2. Econometric Framework: Bai & Ng (2004) Common Factor Methodology

Bai and Ng's (2004) common factor methodology provides a framework to consistently estimate the common factors and the idiosyncratic components by using a panel of data with a large number of time-series observations and cross-section units.

Bai and Ng's model deals with two main problems in the panel data studies. First, a large number of the panel data studies in literature assumed cross-sectional independence which is not realistic for macro-economic data. In their study, the data are assumed to follow a factor structure and cross-section correlation is allowed. Second, as O'Connell (1998) points out, panel data stationarity tests have low power. If the data are mixture of stationary (I(0)) and non-stationary (I(1)) processes, and if the I(0) component is larger, then stationarity tests have low power while the unit root tests are oversized as analyzed in Pantula (1991).[2] Bai and Ng's methodology deals with the size problem because of the mixture components by using a panel of data with large number of time-series observations and cross-section units. They separate panel data into the common factors and idiosyncratic components. After that, the stationary tests can identify the source of non-stationarity.

Bai and Ng (2004) propose the following "Factor Model" can be constructed:

[2] If a series should be differenced 'x' times to make it stationary, it is said to be "*integrated of order x* " and showed as $y_t \sim I(x)$ (Diebold,1998).

$X_{it} = D_{it} + \lambda_i' F_t + e_{it}$ $\quad t = 1,\ldots,T$ (5)

$F_{mt} = \alpha_m F_{mt-1} + u_{mt}$ $\quad m = 1,\ldots,k$ (6)

$e_{it} = \rho_i e_{it-1} + \epsilon_{it}$ $\quad i = 1,\ldots,N$ (7)

where X_{it} is the observed data – in our case RER - and D_{it} is the deterministic component , F_t is a k×1 vector of unobservable common factors, λ_i is a k×1 vector of "loadings" and e_{it} is the idiosyncratic component. Here u_{mt} and ϵ_{it} are iid and mutually independent error terms. The conclusions derived still hold even the u_{mt} and ϵ_{it} are weakly dependent. Factor m and the idiosyncratic error e_{it} are stationary if respectively $\alpha_m < 1$ and $\rho_i < 1$.

The consistent estimation of F_t and e_{it} are obtained by applying "Method of Principal Components" without imposing the stationarity on errors.

Bai and Ng's methodology is composed of three main steps. In this model, the inferences are made on estimated factors and errors. Therefore, first of all, these components are estimated by applying the method of principal components. Second, the stationarity tests are computed on these estimated factors F_{mt} (m = 1,…,k) and errors e_{it} (i = 1,…,N). Finally, depending on the stationarity tests results, the pooled test of stationarity on over-all errors is derived. These steps are explained in the following sub-sections.

2.1.2 Application of Method of Principal Components

First of all, factors and errors are estimated by employing the method of principal components. The estimated values are consistent only if $\rho_i < 1$ in equation (7). Therefore, to guarantee consistent estimation of common factors, the principal components method should be applied to first differenced series. In our study we consider the model (5) with only intercept i.e. $X_{it} = c_i + \lambda_i' F_t + e_{it}$. The model in differenced form is as follows:

$\Delta X_{it} = \lambda_i' \Delta F_t + \Delta e_{it}$ $\quad i = 1,\ldots,N ; t = 2,\ldots,T$ (8)

here, ΔX_{it} is the observed data in first difference, ΔF_t is the k*1 vector of factors in differences and lastly Δe_{it} is the error term in first difference. We can construct the following matrix model:

$\Delta X = \Delta F. \Lambda' + \Delta E$ (9)

such that ΔX and ΔE are the (T-1)*N matrices whose i^{th} column respectively are $(\Delta X_{i2}, \Delta X_{i3}, \ldots, \Delta X_{iT})'$ and $(\Delta e_{i2}, \Delta e_{i3}, \ldots, \Delta e_{iT})'$. Here $\Delta F = (\Delta F_2, \Delta F_3, \ldots, \Delta F_T)'$ is (T-1)*k matrix of factors in differences. The vectors of loadings λ_i's compose the N*k loading matrix $\Lambda = (\lambda_{1,\ldots,}\lambda_N)'$.

According to the principal components method, the estimated ΔF_{tk}'s $\Delta \hat{F} = (\Delta \hat{F}_{t1}, \ldots, \Delta \hat{F}_{tk})'$ are the k eigenvectors corresponding to the first k biggest eigenvalues of the matrix $\Delta X * \Delta X'$. The estimated loading matrix is equal to $\hat{\Lambda} = \Delta X' \Delta \hat{F}$. Lastly, $\Delta \hat{e}_{it} = \Delta X_{it} - \hat{\lambda}_i' \Delta \hat{F}_t$.

After estimating the differenced common factors and the idiosyncratic components, the F_t and e_{it} series can be obtained by applying the following formulas:

$$\hat{F}_{mt} = \sum_{s=2}^{t} \Delta \hat{F}_{ms} \qquad m=1,\ldots,k;\ t=2,\ldots,T \qquad (10)$$

$$\hat{e}_{it} = \sum_{s=2}^{t} \Delta \hat{e}_{is} \qquad i=1,\ldots,N;\ t=2,\ldots,T \qquad (11)$$

As has been explained, after estimating the differenced common factors and the idiosyncratic components, the F_t and e_{it} series can be obtained by applying formulas (10) and (11) respectively.

2.1.3 Stationarity Tests on Estimated Factors and Errors

The next step is to apply stationarity tests on the estimated F_t and e_{it} series. Similarly to Bai and Ng's (2004) study, we also apply Kwiatkowski, Phillips, Schmidt, and Shin's (1992) test (KPSS). In the following sub-sections, the application of stationarity tests is considered.

Application of KPSS Test

The KPSS test is defined as:

$$KPSS= \sum_{t}^{T} (\sum_{r}^{t} x_r)^2 / (T^2 . f_0) \qquad (12)$$

Here x is the demeaned series to be tested and f_0 is the estimate of the long run variance of the series.

According to Bai and Ng's methodology, first stationarity test for the common component F_{mt} for each m=1,…k should be derived. Lets denote the KPSS test statistic for demeaned series F_{mt} as $K_{F,C}(m)$.

The limiting distribution of the stationarity tests of the estimated errors depend on whether F_t is I(0) or I(1). If F_{mt} for each m=1,…k is I(0), then the KPSS test is applied to error series e_{it} for each i=1,…N. Lets denote the test statistic for demeaned error series by $K_{e0,C}(i)$. $K_{e0,C}(i)$ has the same limiting distribution as the KPSS test.

However, if there are some common factors which are not stationary, i.e. F_{mt} is I(1) for some m, then the distribution of the test statistic for the error terms will not be that of KPSS. Let $\bar{k}$ be the set of factors which are not stationary. First of all we regress the estimated errors $\hat{e}_{it}$ on 1 and $\hat{F}_{1t},\ldots,\hat{F}_{\bar{k}t}$ to obtain the residuals of this regression, $\tilde{e}_{it}$. After that we construct the test statistic denoted by $K_{e1,C}(i)$ for each country's residuals. Since $\bar{k}$ factors are non-stationary, stationarity of the residual terms implies the cointegration relationship between X_i and the sub-set of F of dimension $\bar{k}$. Therefore, the limiting distribution of test statistic $K_{e1,C}(i)$ is the same as Shin's (1994) statistic which is developed for testing the cointegrating relationship.

2.1.4 Pooled Test on Estimated Errors

The pooled test is a joint test of stationarity of error terms and can be applied if all the factors are stationary. After obtaining KPSS stationarity test results, we can employ the pooled stationarity test for idiosyncratic components in case F_{mt} is I(0) for each m=1,…,k. As has been indicated in *Corollary 1* by Bai and Ng (2004), the pooled test is:

$$Q=-2\sum_{i=1}^{N} \log q(i)$$

such that q(i) is the p-value of the $K_{e0,C}(i)$ test. If e_{it} is independent across i and F_{mt} is I(0) for each m=1,…,k then the distribution of the statistic is equal to $(Q-2N)/\sqrt{4N}$ which converges to N(0,1). Indeed, the independence of error terms can be relaxed as N and T go to infinity.

3. Data

A sample of fifteen emerging economies is considered in this study. Seven are in the Latin America and Caribbean region (Argentina, Chile, Colombia, Brazil, Mexico, Peru, Venezuela). The rest are from Asia, six being in the East Asia and Pacific region (Indonesia, Korea, Malaysia, Philippines, Taiwan, Thailand), one from Central Asia (Turkey) and the last from South Asia (India).

Our study is composed of two parts. First we make inferences about the underlying dynamics of the RER series applying common factor analysis. After that, the long-run granger causality relationship between the real exchange rate and stock market movements is investigated. Thus, first of all we construct the RER series depending on absolute PPP theory. According to PPP theory, we need the countries' price levels and the nominal exchange rate series to construct the RER series. In this study as a proxy for the world economy, the variables of the US economy are taken into account. Hence, bilateral exchange rates of 16 less developed countries (LDC) and the US and their respective price levels will be considered. Data sets of prices and exchange rates for all countries are taken from IFS over the period 1988:01 to 2005:02. For the price levels of countries, consumer price indexes (series 64) are taken. The exchange rates series coded as (rf) in IFS are used; (rf) refers to period averages of market exchange rates for countries quoting rates in units of national currency per US dollar. The emerging stock market indices are obtained from International Financial Corporation, IFC, Global Index. IFC global stock price indices are denominated in US dollars. The time span is from 1988:01 to 2005:02 for all countries except Indonesia and Peru. For Indonesia, the data span is 1989:12 to 2005:02 and for Peru 1993:09 to 2005:02. The Dow Jones Industrial Average is used as the US stock index (USTOCK) for the period 1988:01 to 2005:02.

4. Empirical Results

First of all, the RER series are achieved by employing the absolute PPP theory as stated in equation (5). Then, the RER series are demeaned and their variances standardized to one to apply the KPSS test (see Table 1).[3] According to the KPSS test results, stationarity hypothesis is rejected for all the countries except Colombia, Peru, and Turkey. The non-statonarity of the RER series implies that in the long run there are deviations from PPP hypothesis. Thus, to identify the source of non-stationarity we establish the common factor analysis.

[3] In this study we use Matlab and write our own codes to apply Bai and Ng's (2004) methodology. However, KPSS tests are computed by using e-views.

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Table 1 KPSS Results For SES

Variable	Test Statistics
Argentina	0.384**
Chile	0.460*
Colombia	0.334
Brazil	0.975*
Mexico	0.513*
Peru	0.281
Venezuela	1.020*
India	1.210*
Indonesia	1.086*
Korea	1.140*
Malaysia	1.327*
Philippines	0.839*
Taiwan	1.468*
Thailand	1.297*
Turkey	0.120
5% CV	0.463
10% CV	0.347

Notes: KPSS critical values are for the case when constant is included. The null hypothesis of KPSS is the stationarity of series. Newey-West Bandwidth is employed. 2)*, ** denote significance at 5% and 10% levels respectively.

First, the common factors and idiosyncratic components are estimated by the method of principal components. However, the number of common factors, k, is unknown. Bai and Ng (2002) propose the following three information criteria:

$$IC_{p1}(k) = \ln(V(k, \hat{F}^{k})) + k\left(\frac{N+T}{NT}\right)\ln\left(\frac{NT}{N+T}\right)$$

$$IC_{p2}(k) = \ln(V(k, \hat{F}^{k})) + k\left(\frac{N+T}{NT}\right)\ln C_{NT}^{2}$$

$$IC_{p3}(k) = \ln(V(k, \hat{F}^{k})) + k\left(\frac{\ln C_{NT}^{2}}{C_{NT}^{2}}\right)$$

here $V(k, \hat{F}^{k}) = (NT)^{-1}\Sigma_i \Sigma_t (\hat{e}_{it})^2$ and C_{NT}^{2} =min{N,T}. We find three common factors, k=3, applying each of the criteria (see Table 2).

Table 2 The Number of Common Factors

Variable	IC1(k)	IC2(k)	IC3(k)
k=1	4.429	4.434	4.421
k=2	4.456	4.466	4.440
k=3	**4.401**	**4.416**	**4.377**
k=4	4.524	4.544	4.491
k=5	4.497	4.522	4.456
k=6	4.601	4.631	4.552
k	3	3	3

Notes: IC: Information Criteria. The appropriate k is decided as 3, which gives the minimum value for each of the criteria

The common factor series are named as F1, F2 and F3. After we identify each of the common factors, the KPSS tests are conducted. KPSS test statistics are presented in Table 3. As a result, we find each of the factors non-stationary.

Table 3 KPSS Results for Common Factors

Variable	Test Statistics
F1	0.762*
F2	0.356**
F3	0.860*
5% CV	0.463
10% CV	0.347

Notes: 1) KPSS critical values are for the case when constant is included. The null hypothesis of KPSS is the stationarity of series. 2)*, ** denote significance at 5% and 10% levels respectively.

Since, all of the common factors are non-stationary, I(1), testing stationarity of idiosyncratic errors terms, e_{it}, is equivalent to controlling the null hypothesis of cointegration between the RER series and the common factors. First of all the residuals ($\hat{e}_{it}$) from projection of e_{it} on 1 and $F1_t$, $F2_t$, and $F3_t$ are obtained. Then, the KPSS test is applied on ($\hat{e}_{it}$) for each i to obtain $K_{e1,C}(i)$ (see Table 4). It is observed that the idiosyncratic errors are stationary for all countries at 5 percent significance level except Mexico. As it is indicated that the KPSS over-rejects the null, therefore these results are strong evidence of the stationarity of error terms.[4]

Table 4 KPSS Results For Idiosyncratic Country Specific Errors

Variable	Test Statistics
Argentina	0.217
Chile	0.248
Colombia	0.374**
Brazil	0.421**
Mexico	0.624*
Peru	0.247
Venezuela	0.281
India	0.353**
Indonesia	0.326
Korea	0.189
Malaysia	0.385**
Philippines	0.144
Taiwan	0.362**
Thailand	0.388**
Turkey	0.396**
5% CV	0.463
10% CV	0.347

Notes: KPSS critical values are for the case when constant is included. The null hypothesis of KPSS is the stationarity of series. Andrews Parzen Kernel is employed as bandwidth. 2)*, ** denote significance at 5% and 10% levels respectively.

[4] Since the common factors are not stationary, the pooled stationarity test of error terms cannot be derived.

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Comments on Common Factor Analysis and Variance Analysis

Our results shows that there are three non-stationary common factors (named as F1, F2 and F3) influencing all countries' RER simultaneously. Also, we find that all country-specific idiosyncratic errors are stationary. Since all common factors are I(1), the stationarity of idiosyncratic components implies the cointegrating relationship between the factors and the RER series. Hence, we conclude that the long-run variations of the RER series are caused by these three common factors. Indeed, their non-stationarity cause the RER series to deviate from PPP theory.

Our variation analysis shows that F1, F2 and F3 explain respectively 24, 11, and 9 percent of the variation in a panel of RER series. Common factors, all together, explain 43 percent of the variation whereas country-specific idiosyncratic errors explain 57 percent of the variation. Indeed, we also analyze the relative importance of the common factors and the idiosyncratic errors for each country separately. The first column in Table 5 presents the ratio of the variation of idiosyncratic errors to the variation of the differenced data, $\text{var}(\Delta\hat{e})/\text{var}(\Delta X)$. The second column of Table 5 exhibits the standard deviation of the common factors to idiosyncratic component, $\sigma(\hat{\lambda}_i^{'}\hat{F}_t)/\sigma(\hat{e}^0)$. In the case of the dominance of an idiosyncratic component, the first column's statistics become very close to 1 and the second one's should be small. The extreme cases are Argentina, Venezuela and India; their $\text{var}(\Delta\hat{e})/\text{var}(\Delta X)$ statistics are 0.87, 0.92 and 0.86 respectively while their $\sigma(\hat{\lambda}_i^{'}\hat{F}_t)/\sigma(\hat{e}^0)$ is around 0.3. Thus, for these three countries the country-specific factors dominate. However, for the rest of the countries average of $\text{var}(\Delta\hat{e})/\text{var}(\Delta X)$ is 0.49 while the average of $\sigma(\hat{\lambda}_i^{'}\hat{F}_t)/\sigma(\hat{e}^0)$ is 2.07. As a result we conclude that common variations play a significant role in explaining the variation of the RER series.

Table 5 Variation Analysis

	$\frac{\text{var}(\Delta\hat{e})}{\text{var}(\Delta X)}$	$\sigma(\hat{\lambda}_i^{'}\hat{F}_t)/\sigma(\hat{e}^0)$
Argentina	**0.871**	**0.312**
Chile	0.342	2.451
Colombia	0.574	1.127
Brazil	0.528	1.280
Mexico	0.781	0.583
Peru	0.594	1.143
Venezuela	**0.921**	**0.300**
India	**0.858**	**0.304**
Indonesia	0.345	2.238
Korea	0.478	2.338
Malaysia	0.303	3.989
Philippines	0.362	2.367
Taiwan	0.730	0.973
Thailand	0.202	5.620
Turkey	0.612	0.810
Average	**0.488**	**2.077**

Notes: KPSS critical values are for the case when constant is included. The null hypothesis of KPSS is the stationarity of series. Andrews Parzen Kernel is employed as bandwidth. 2)*, ** denote significance at 5% and 10% levels respectively.

Moreover, we researched whether these common factors affect countries' RER series positively or negatively. As explained in section 2, the vectors of loadings, λ_i's, provides panel regression coefficient of each factor on country i. Since there is a cointegrating relationship between the RER series and common factors, we can make inferences depending on these coefficients. Table 6 reports the loading matrix. It is observed that F1 has a negative influence on all countries' RER series except three in Latin American: Argentina, Mexico, and Venezuela. F2 has a positive effect on all Latin American countries, India, and Turkey. By contrast, it has a negative influence on all Asia-Pacific countries except Taiwan. F3 has generally negative effects. However, it is has a positive effect on 4 Latin American and 2 Asian countries: Colombia, Brazil, Mexico, Peru, Korea, and the Philippines.

Table 6 Loading Matrix

i:country index	λi1 for F1	λi2 for F2	λi3 for F3
Argentina	0.615	0.368	-5.073
Chile	-5.219	10.252	-1.398
Colombia	-3.764	5.560	6.474
Brazil	-2.114	9.551	0.644
Mexico	0.172	5.171	4.289
Peru	-0.517	0.331	9.096
Venezuela	0.092	2.865	-2.802
India	-1.547	1.549	-5.006
Indonesia	-11.095	-2.864	-1.503
Korea	-10.230	-1.106	0.228
Malaysia	-11.510	-3.128	-1.154
Philippines	-10.792	-1.194	3.558
Taiwan	-7.213	1.408	-1.322
Thailand	-12.622	-1.724	-0.973
Turkey	-1.187	6.551	-5.890

Indeed, we further investigate the dynamics of these common factors. Figures 1 to 3 exhibit common factors F1, F2 and F3 respectively.

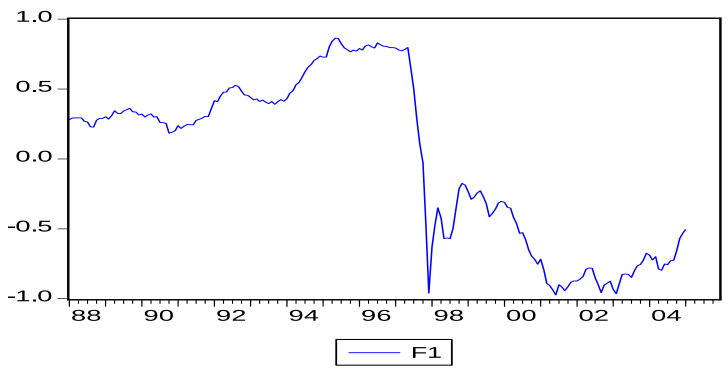

Figure 1. First Common Factor: F1

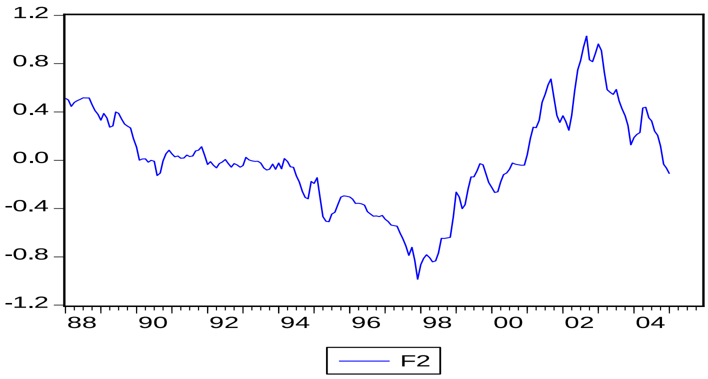

Figure 2. Second Common Factor: F2

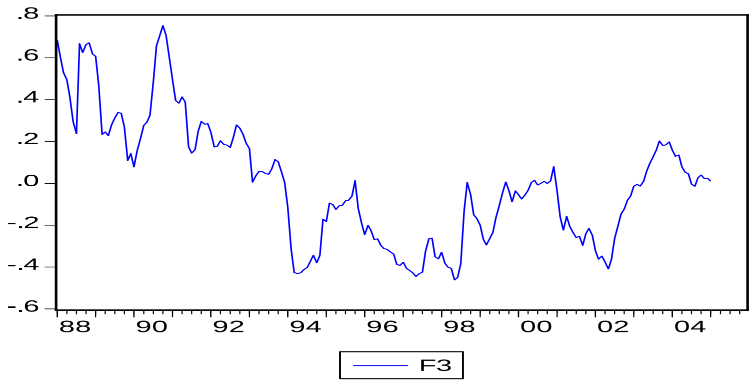

Figure 3. Third Common Factor: F3

Our first observation is that all of the common factors were seriously affected by the 1997 financial crisis which started in Thailand and influenced all emerging countries. The most severe effect is seen on F1. Indeed, the structure of F2 is also changed. Before the crisis, it had a negative trend but afterwards exhibited a positive trend. Moreover, it is observed that F3 is very vulnerable not only to the1997 crisis but also the 1994 Mexico peso crisis and the 2001 Argentina crisis. Thus we conclude that the common factors are very vulnerable to financial crises.

The common factor analysis has provided us a very important insight about the structure of the emerging RER series. We proceed with the search of the long-run relationship between stock markets and the RER series.

5. Theoretical Framework: Relationship between Foreign Exchange and Stock Markets

Economic theory provides two alternative explanations for the relationship between foreign exchange and stock markets: “flow” and “stock” approaches. First, flow approach models claim that real exchange rate movements affect stock prices through their influence on competitiveness and economic activity. By contrast, stock approach models claim that stock prices influence real exchange rate determination through the effects of the demand for money. The relationship between these markets can be formulated as:

$$s_t = \alpha_0 + \alpha_1 r_t + \alpha_2 s_{usa,t} + u_t \qquad (13)$$

where s and susa are the logarithm of domestic stock price and US stock price respectively, r is the logarithm of real exchange rate defined as domestic prices relative to foreign prices multiplied by the nominal exchange rate; and u is a disturbance term. The flow approach claims negative correlation, $\alpha1<0$. On the contrary, the stock approach suggests positive correlation, $\alpha1>0$. In this model susa represents the world capital markets and it could be conduit through which foreign exchange and the local stock markets are linked. $\alpha2$ is expected to be positive ($\alpha2>0$) under both stock and flow approaches.

Phylaktis and Ravazzolo (2005) provide alternative scenarios to illustrate how the flow and stock approaches work. They point out that an appreciation of the domestic currency, a fall in the RER level, will increase demand for domestic goods and thus production levels. A firm's stock price is evaluated depending on its profitability and its profit depends on future demand. Thus, a rise in domestic demand increases the stock price value. Hence, according to the flow approach, a fall in the RER series causes an increase in stock market prices, $\alpha1<0$. On the other hand, stock market movements may influence the RER series. According to the stock approach, the rise in domestic stock prices will increase wealth. This increase in wealth will be distributed by portfolio allocations on domestic and foreign equities, bonds and currency. Especially an increase in demand for the domestic currency will raise the interest rate. Subsequently, a higher interest rate triggers foreign capital. As a result, the domestic currency will be depreciated; that is, an increase in RER level. Hence, according to the stock approach, a rise in stock market prices causes a higher RER level, $\alpha1>0$.

6 Toda & Yamamoto (1995) Granger Causality Test: Methodology and Test Results

Previous literature usually considers the return of stock prices and the RER series, instead of levels. Therefore the long-run dynamics were not investigated because of the lack of the technique to deal with non-stationary series. In our study we employ Toda and Yamamoto's (1995) Granger causality test for non-stationary series. This methodology allows us to determine the direction of the causality between stock markets and the RER series. Since we find out that long-run variations of the RER series are derived by common factors, we specifically investigate the long run relation between these factors and stock prices.

Toda and Yamamoto (1995) claim that the Granger (1969) causality test can be applied to the level of non-stationary series and provide valid estimations as long as the maximal order of the integration of the series (d-max) is added into the model. The model to test the causality will be the following:

$$Xt = c_1 + \sum_{j=1}^{k+d} \alpha_{1j} X_{t-j} + \sum_{j=1}^{k+d} \beta_{1j} Y_{t-j} + \varepsilon_{1t}$$

$$Yt = c_2 + \sum_{j=1}^{k+d} \alpha_{2j} Y_{t-j} + \sum_{j=1}^{k+d} \beta_{2j} X_{t-j} + \varepsilon_{2t} \qquad (14)$$

here c1 and c2 are the constants, k is the optimal order of the vector autoregressive (VAR) model, Y and X are non-stationary series with d-max equal to d, ε_{1t} and ε_{2t} are white noise

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error terms. Y granger causes X if β_{1j}'s for j=1,...,k are not jointly equal to zero. Similarly, X granger causes Y if β_{2j}'s for j=1,...,k are not jointly equal to zero. The tests on coefficients are derived by a standard Wald test.

Test Results

First, we derive the Granger Causality test on emerging market stock markets and common factors: F1, F2 and F3. The emerging stock market indices (ESTOCK) are obtained from International Financial Corporation, IFC. We have constructed a general index (ESTOCKI) giving equal weight to each country's stock price.

$$ESTOCKI_t = \sum_{i=1}^{15} ESTOCK_{it} \qquad (15)$$

ESTOCKI represents all markets of emerging countries. Then, we construct VAR model to test Granger causality. We derive causality tests considering the system composed of ESTOCKI, USTOCK, F1, F2 and F3. The optimal lag of VAR model is found as 2 for each case applying Schwarz Information Criteria (SIC) criteria. Indeed, we know dmax is equal to 1. Therefore, VAR model including 3 lags are derived. Wald tests results are reported in Table 7. Results show that ESTOCKI granger causes F2 and F3 but not F1. Moreover, one common factor, F3, does granger cause ESTOCKI. Thus, our test results indicate that there is a bi-directional causality between emerging countries' stock markets and RER. However, we do not find any causality relationship between USTOCK and all the other variables.

Table 7 Granger Causality Test

Null Hypothesis	F Statistic	Probability	Result
F1 does not Granger Cause ESTOCKI	0.71	0.494	F1 does not Granger Cause ESTOCKI
F2 does not Granger Cause ESTOCKI	0.40	0.671	F2 does not Granger Cause ESTOCKI
F3 does not Granger Cause ESTOCKI	2.67	0.072	F3 does Granger Cause ESTOCKI
USTOCK does not Granger Cause ESTOCKI	0.31	0.731	USTOCK does not Granger Cause ESTOCKI
ESTOCKI does not Granger Cause F1	1.48	0.230	ESTOCKI does not Granger Cause F1
USTOCK does not Granger Cause F1	1.04	0.354	USTOCK does not Granger Cause F1
ESTOCKI does not Granger Cause F2	11.31	0.000	ESTOCKI does Granger Cause F2
USTOCK does not Granger Cause F2	0.29	0.751	USTOCK does not Granger Cause F2
ESTOCKI does not Granger Cause F3	2.52	0.082	ESTOCKI does Granger Cause F3
USTOCK does not Granger Cause F3	0.59	0.55	USTOCK does not Granger Cause F3

We can identify the sign of the correlation between ESTOCKI and RER series, by multiplying the sign of the correlation between ESTOCKI and common factors to the sign of the correlation between common factors and the RER. We have already stated the sign of the correlation with factors and the RER series in Table 6. Table 8 reports the significant coefficients in the VAR models. It is observed that ESTOCKI's first lag has a significant negative effect on both the level of F2 and F3. However, ESTOCKI's second lag has a significant positive effect on the level F2.

Table 8. Optimal Lag Number for VAR Model: SIC Criteria

Lag Number	1	**2**	3	4	5	6	7	12
SIC Value	-13.65	**-14.01**	-13.46	-12.88	-12.28	-11.77	-11.21	9.18

Notes: IC: The appropriate lag number is decided as 2, which gives the minimum value for the SIC.

As a result we conclude that ESTOCKI's first lag influences positively the RER series for Indonesia and Thailand. But, it has a negative influence on Colombia, Brazil, Mexico, and Peru. We cannot identify ESTOCKI's first lag effect on Korea, the Philippines, Taiwan, Turkey, India, Argentina, Chile, and Venezuela; it may be either positive or negative. Furthermore, ESTOCKI's second lag has a positive effect on all Latin American countries, India, and Turkey. But, it has a negative influence on all Asia-Pacific countries except Taiwan.

Furthermore, from Table 8 it is also seen that F3's second lag has a significant positive influence on the level of ESTOCKI. By multiplying the sign of the correlation between F3 and ESTOCKI to the sign of the correlation between F3 and the RER, we obtain the sign of the correlation between RER and ESTOCKI series. For Colombia, Brazil, Mexico, Peru, Korea, and the Philippines the RER series has a positive influence on ESTOCKI. For the rest of the countries, the RER series has negative pressure on ESTOCKI.

7 Conclusions

This study aims to understand the underlying dynamics of real exchange rate series and the long-run causality relationship between the real exchange rate and the stock market movements for a group of emerging countries in Latin America and the Asia and Pacific regions. Firstly, the RER series is obtained by absolute version PPP theory. Then, Bai and Ng's (2004) common factor methodology is employed to analyze the dynamics of the RER series. Our results show that there are three non-stationary, common factors, F1, F2 and F3 influencing all countries' RER series simultaneously. Also, we find that all country-specific idiosyncratic errors are stationary. Since all common factors are I(1), the stationarity of idiosyncratic components implies the cointegrating relationship between the factors and the RER series. Variation analysis shows that common factors explain 43 percent of the variation in a panel of RER series. Moreover, it is observed that these common factors are very vulnerable to financial crises.

Furthermore, we investigate the long-run relationship between stock markets and the RER series. Toda and Yamamoto's (1995) Granger causality tests derived considering the common factors, F1, F2, F3, emerging countries' stock indeces and the US stock indeces. Results show that ESTOCKI granger causes F2 and F3; and F3 does granger cause ESTOCKI. Hence, we conclude that there is a bi-directional causality between emerging countries' stock markets and RER. However; we could not observe any causality relation between the US stock market and all the other variables.

Moreover, we identify the sign of the correlation between ESTOCKI and RER series, by multiplying the sign of the correlation between ESTOCKI and common factors to the sign of the correlation between common factors and the RER. However, we see that for some countries the sign of the correlation is not identifiable. It is found that ESTOCKI's first lag has a significant negative effect on both the level of F2 and F3. But, ESTOCKI's second lag has a significant positive effect on the level F2. Moreover, F3's second lag has a significant positive influence on the level of ESTOCKI.

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We know that the empirical literature does not provide a consensus on either the direction of the sign of the correlation or the causality. Our causality analysis shed light on this phenomenon. Actually, the relationship between foreign exchange markets and stock markets is complex. The sign of the correlation is not identifiable since there is more than one underlying dynamic between these markets. Indeed, there is a bi-directional causality between foreign exchange and emerging stock markets.

In our model we consider the relationship among RER series, emerging stock markets and the US stock market. Even though we find the long run causality relationship between RER and the emerging stock markets, we cannot find any causality relationship between USTOCK and all the other variables. As it is known that the results of the causality tests depend on the variables considered. Therefore, we believe that further studies in this subject are necessary to improve our knowledge on emerging financial markets and their iteractions with world stock market and foreign exchange market. In this paper shed light on the existence of the common factors which derives the RER series, and their complex interactions with emerging stock market.

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