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Research Article/Araştırma Makalesi

Do the Exchange Rates Converge Among Fragile Market Economies? New Evidence from LM and RALS-LM Unit Root Tests

Kırılgan Piyasa Ekonomileri Arasında Döviz Kurları Yakınsıyor mu? LM ve RALS-LM Birim Kök Testlerinden Yeni Kanıtlar

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Abstract

Global financial integration causes the economic consequences of economic crises, wars, or pandemics to be felt more in developing countries and triggers high exchange rate volatilities in these economies. In such an integrated financial environment, it is an interesting research domain how and why the exchange rate volatilities of countries are not affected similarly but tend to diverge from each other. This study investigates whether the exchange rate volatilities of fragile market economies converge in the stochastic convergence framework. To answer this question, we analyzed the stochastic behavior of the series using the traditional and structural break unit root tests besides RALS unit root tests, which consider the information of non-normal errors. The discussions regarding the size and power properties of test procedures in the unit root testing literature have formed a crucial part of the implications of the test results. In light of these discussions, we conclude that the stochastic convergence assumption is valid for Brazil, South Africa, India, and Hungary, whereas it is not valid for Argentina, Mexico, and Türkiye. The policy implications of our findings are that fragile market economies have different fragility levels among themselves and countries with high fragility levels show higher volatility than others.

Jel Codes: *F31, C12, C22, G15*
Keywords: *Exchange Rates, Stochastic Convergence, RALS Unit Roots, Fragile Market Economies*

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Öz

Küresel finansal entegrasyon, ekonomik krizlerin, savaşların veya salgın hastalıkların iktisadi etkilerinin gelişmekte olan ülkelerde daha fazla hissedilmesine neden olmakta ve bu ekonomilerde yüksek kur oynaklıklarını tetiklemektedir. Böyle bir finansal ortamda, ülkelerin döviz kuru oynaklıklarının benzer şekilde etkilenmeyip birbirlerinden farklı ayrışma eğilimi sergilemeleri dikkat çeken araştırma konusunu oluşturmaktadır. Bu çalışma, kırılgan piyasa ekonomilerinin döviz kuru oynaklıklarının stokastik yakınsama yaklaşımıyla yakınsayıp yakınsamadıklarını araştırmaktadır. Bu soruyu cevaplamak için, geleneksel ve yapısal kırılmalı birim kök testlerinin yanı sıra kalıntılardaki normal dağılmama bilgisini dikkate alan RALS birim kök testleri kullanılarak serilerin stokastik davranışları analiz edilmiştir. Birim kök testi literatüründeki test prosedürlerinin boyut ve güç özelliklerine ilişkin tartışmalar, test sonuçlarının çıkarımlarının önemli bir bölümünü oluşturmuştur. Bu tartışmaların ışığında, stokastik yakınsama varsayımının Brezilya, Güney Afrika, Hindistan ve Macaristan için geçerli olduğu, Arjantin, Meksika ve Türkiye için geçerli olmadığı sonucuna varılmıştır. Elde edilen bulgulara yönelik politika çıkarımları ise, kırılgan piyasa ekonomilerinin kendi aralarında farklı kırılganlık seviyelerine sahip olduğu ve yüksek kırılganlık düzeyindeki ülkelerin diğerlerine göre daha yüksek oynaklık gösterdiği şeklindedir.

Jel Kodları: *F31, C12, C22, G15*
Anahtar Kelimeler: *Döviz Kuru, Stokastik Yakınsama, RALS Birim Kök Testleri, Kırılgan Piyasa Ekonomileri*

1. Introduction

Increasing global uncertainties and policy mistakes made during and after the Covid-19 epidemic crisis have caused sharp volatility in the currencies of many developing countries. Eventually, as the threat of global inflation became evident by the last quarter of 2021, the expectations that the central banks, especially the FED, could implement tighter monetary policies have emerged as the most significant factor behind the increased volatility in emerging economies. Besides, as the tension between Ukraine-Russia turned into a war, has caused global uncertainties grew even more. The overall impact of these events has not been the same on the volatility of the emerging market currencies; the volatility of some currencies was higher, and some have even negatively diverged. Therefore, analyzing these differences between emerging market economies from a time series perspective can help produce accurate and reliable inferences.

In this study, we used a subsample of emerging market economies whose macroeconomic structures and vulnerabilities are similar to each other to test the presence of convergence or divergence. Our study deals with the volatility in the currencies of Argentina, Brazil, Hungary, India, Mexico, South Africa, and Türkiye. It is important to emphasize that this study only aims to analyze the presence or absence of divergence within a group of countries that shares some common macroeconomic structures and high vulnerability levels but does not aim to discuss the reasons behind the phenomenon in a country-specific manner.

The sample selection was made primarily based on the definition of “Fragile Five” by various credit rating institutions since 2013. Further, the similarity of economic structures and macroeconomic problems has also been taken into account. The Fragile Five was a phrase put forward by a financial analyst at Morgan Stanley in 2013 to describe emerging market economies whose economy is dependent on foreign currency and therefore need to import to grow yet have high external debt stock and are vulnerable to external shocks. After the emergence of this definition, many other financial firms such as S&P Global published their rankings (Kuepper & Clemon, 2021). The countries included in the original Fragile Five definition in 2013 were Brazil, India, Indonesia, South Africa, and Türkiye. In 2016 another list was published by Morgan Stanley that includes Colombia, Indonesia, Mexico, South Africa, and Türkiye. Then, in 2017 Türkiye, Argentina, Pakistan, Egypt, and Qatar were announced as the Fragile Five by S&P Global. The rationale behind the formation of the last listing is that these countries were the most negatively affected by the increases in global interest rates (Kuepper & Clemon, 2021).

The report published by the US Bank Wells Fargo and written by Bryson et al. (2021: 6), like its counterparts, was about identifying the most fragile among 25 emerging market economies. The primary reference to identify the vulnerability levels of the economies was the ability to pay external debts, that is the external debt liability. Argentina, Türkiye, Venezuela, Indonesia, and Chile were identified as the most vulnerable among the 25 emerging market economies discussed. Again, according to the report, Hungary, Malaysia, Saudi Arabia, South Korea, and Thailand were the less fragile ones.

The increasing external debt stock of emerging market economies has accelerated substantially in the last two decades- the amount has increased from 2 trillion USD to 11 trillion USD, excluding China. The relationship between short-term debt stock and central bank reserves is one of the main factors causing the vulnerability. Therefore, the most significant problem for the economies described as fragile is that their reserves are far from meeting their short-term debts. For it causes a debt tolerance problem and increases the probability of bankruptcy (Bryson et al, 2021: 2). Bryson et al. (2021: 5) determined the degree of vulnerability based on the criteria given in Table 1. Accordingly, the first criterion, external debt vulnerability, indicates how resilient economies are to the external debt crisis.

Table 1: Fragile Countries

Countries	External Debt Vulnerability	External Debt Stock	Δ (External Debt/GDP)	Short Term External Debt/Total External Debt	FX Debt/Total External Debt	Debt Service /Total External Debt	Debt Service /Current Account Receipts	FX Reserves /Total External Debt
Türkiye								
Argentina								
Venezuela								
Chile								
Indonesia								
South Africa								
Brazil								
Mexico								
India								
Malaysia								
Hungary								

Note: Red, yellow, and green colors indicate “High Vulnerability”, “Medium Vulnerability, and “Low Vulnerability”, respectively.
Source: Bryson et al. (2021: 5)

Türkiye, Argentina, Venezuela, Chile, and Indonesia are the most vulnerable countries considering the first criterion. Moreover, Türkiye, Argentina, and Venezuela can be seen in the high-risk zone according to most of the criteria in Table 1. Therefore, these three countries differ from other emerging market economies in terms of riskiness and higher vulnerability.

There are two main views in the economics literature explaining why the negative divergence due to the depreciation in the case of a global shock is higher than others for some emerging markets. One explanation is the external debt stock or the insolvency problem, and the other is the monetary hierarchy. These views relate to each other via their arguments.

The problem of the balance of payments in Emerging Market Economies (EMEs)had begun to increase since the beginning of the 2000s. Also, this period coincides with when financial globalization expanded, and financial liberalization discourses gained power.

The expansion of the balance of payments in EMEs has been accompanied by structural changes in the balance of payments. Changes in the balance sheet asset-liability composition of the real sector, which are not caused by capital flows, were also efficacious in this

transformation. The deterioration in debt/assets ratios, the dependence of stock markets on foreign capital, and the increase in foreign direct investment are some results of the transformation process. Therefore, during this period, the balance sheet dollarization of the private sector and its foreign exchange liabilities increased gradually in EMEs. In addition, the net foreign asset (NFA) of EMEs, including China and Russia, remained on the negative, that is the risky side, and increased the vulnerabilities of emerging markets (Akyüz, 2018: 30).

Heterodox economists advocate that uncontrolled capital movements are at the root of these problems. Uncontrolled capital movements, even when considered as a tool to support rapid growth in EMEs, the speculative growth as its consequence has led the external debt to increase and the dollarization of balance sheets. Akyüz (2018: 8) explains how it caused unsustainable indebtedness for EMEs.

Uncontrolled capital movements were the most important reason for the debt burden and the financial crises of the 1990s in EMEs (Stiglitz, 2000: 1079-1080). From the 90s, when capital movements were left uncontrolled, to the present day, the effects of global capital movements on fundamental macroeconomic indicators of EMEs such as growth, employment, and the current account have been more negative rather than positive. More precisely, we can say that global capital movements caused net factor (transferred) from EMEs toward developed countries (Gourinchas & Jeanne, 2007: 3; Prasad et al., 2007: 157).

The relationship between global capital movements and the capital market inflation of EMEs constitutes a remarkable dimension of the discussions about the impacts of global capital movements on EMEs. The capital market inflation requires a different conceptualization from capital bubbles, and it defines as a continuous and increasing net foreign capital inflow to the stock markets and a situation in which the demand for stocks constantly exceeds the supply. Indeed, as stated in Akyüz (2011: 84), the foreign investor concentration in the stock markets of EMEs makes them dependent on the monetary and fiscal policy decisions of large economies. Similarly, Oreiro (2005: 318) argued that global capital movements produce bubbles in financial markets and cause crises.

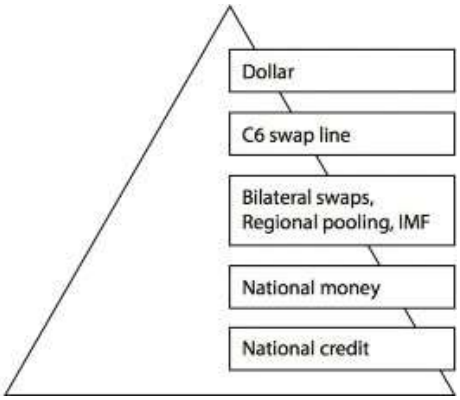
Bonizzi (2013a: 96) argues that foreign capital inflows cause an increase in financial asset prices, which may lead to an increase in financial gains, thereby increasing the demand for consumer goods. That is because the growth of financial wealth may give rise to a process that stimulates the consumer loan demand of the earning agents. Nevertheless, foreign capital inflows and the appreciation of EMEs' currencies have caused a decrease in nominal interest rates in these countries. The decrease in loan rates has particularly affected the growth of consumer loans.

Bonizzi (2015: 116) tested the capital market inflation theory proposed by Toporowski (1999, 2002) for developing countries, the samples of South Korea and Brazil. The results suggest that the participation of foreign investors in Brazilian and South Korean stock markets constitutes the main determinant of capital market inflation.

Another line of literature discusses the existence of the monetary hierarchy regarding the divergence of EMEs currencies in case of global shocks. According to Mehrling (2013: 394), the 'Financial Society' is hierarchical by nature. He refers to the international economic and

monetary system as it has "a core and a periphery on both the expanse border (globalisation) and the dense border (financialization), and also the system dynamics include fluctuations along both of these borders".

Figure 1: The International Hierarchy of Money and Credit



Source: Mehrling (2017: 3)

Figure 1 shows a simplified representation of the hierarchy of money and credit at the international level. The US dollar, which is as global money, is at the top of this hierarchy. The US dollar accepts as government currency within the United States and as private banking currency outside the United States. Other currencies down in the hierarchy are tied up to the USD via public channels (central bank swap lines) and private channels (foreign exchange markets). The promises to pay -the credits- are located at the bottom of the hierarchy. According to Mehrling (2017: 2), everything in between the top (ultimate money) and the bottom (credit) of the pyramid can be seen partly as money when viewed from below and partly as credit when viewed from above.

The source of most discontent related to the global monetary system is the existence of the hierarchy of money. The countries, regions, or groups of economic interests, which are located at the bottom of the international hierarchy of money, consider their secondary positions as an injustice. At the top of the monetary hierarchy are the center countries, and their institutions have a money-creating and money-lending position while the others are in a position of committing to pay the money that is created by the center countries' institutions. In other words, they are in the situation of borrowing. These countries, which are at the bottom of the hierarchy, see it as an injustice that the center countries do not have liquidity problems despite the liquidity restrictions imposed on themselves in difficult times when the global economy slows down and/or goes into crisis (Mehrling, 2013: 397; 2017: 2-3).

The existence of an international money hierarchy could also explain the depreciation and negative divergence of EMEs currencies against global shocks. Terzi (2006: 8), Andrade & Prates (2013: 408-409), and Bonizzi (2015: 115) state that the most important factor in determining the liquidity of any financial asset is its position in the monetary hierarchy. Because of their weakness in functioning as a store of value and a medium of exchange, assets based on EMEs currencies are located at the lower levels of the hierarchy. Therefore, EMEs have to pay higher interest rates than advanced economies to attract foreign investments. If

any EMEs central bank does not set the policy rate at the level desired by the global capital, its currency would suffer sharp depreciation and may diverge negatively from other EMEs.

From the Post-Keynesian Economics point of view, the dominant factor in determining the exchange rate is the portfolio, that is, short-term capital movements. This is where the arguments of international money hierarchy and the external debt stock problem intersect. For example, as stated by Kaltenbrunner (2011: 92; 2015: 428), the preferability of any financial asset based on a currency or the currency itself is related to the position of the currency in the hierarchy, that is, the ability of the country to pay its liabilities in its currency.

Moreover, a large external debt stock also causes negative divergence. Here, we can speak of a Minsky cycle where economic vulnerabilities worsen during periods of global monetary expansion. If an economy has its currency at the bottom of the monetary hierarchy, its collapse would be faster and more severe. The growth phase creates a collapse for these countries themselves; because the rising external debt stock during the growth phase would constitute the basis for the collapse when global liquidity decreases (Kohler, 2019: 5; Oreiro, 2005: 341-342).

This study aims to examine the stochastic characteristics of the volatility of currencies for Fragile Market Economies in the context of the convergence hypothesis. As per our knowledge, there is no prior study on whether exchange rates of the Fragile Market Economies converge. In this context, to investigate the existence of convergence on exchange rates, we use both conventional unit root tests and newly improved unit root tests with structural breaks. These new tests have several advantages over traditional unit root tests in terms of the size and power properties of test procedures. Therefore, this study will contribute to the existing literature in the following aspects. *(i)* The traditional structural breaks unit root tests rely on the location of shifts, but the effects of structural changes, which may occur in the data, can be controlled by trend breaks. Therefore, the newly introduced two-stage transformed LM unit root tests depend on not only where the shifts occur but also on the number of trend breaks. In the conventional unit root process, it has assumed that the residuals of the test regressions used to test for the existence of a unit root process follow a normal distribution. In this context, both the distributions of unit root tests and the critical values of the tests are determined under this assumption. If the residuals of the test regressions follow a non-normal distribution, the ordinary least squares (OLS) estimators lose their efficient estimator properties; however, they retain their unbiased and consistent estimator properties. Hence, the unit root tests based on OLS estimations can be affected by the non-normality of the distribution of the residuals and can even lead to a loss of power in traditional unit root tests. *(ii)* These problems arising from the non-normality distribution of the residuals can be removed or mitigated by using alternative unit root tests. These alternative unit root tests are Residual Augmented Least Squares- Dickey-Fuller (RALS-DF) and Residual Augmented Least Squares–Lagrange Multiplier (RALS-LM) unit root tests based on the RALS procedure. These tests contain information on the non-normality distribution of residuals and help to obtain more efficient estimators and increase the power of tests.

2. Data and Methodology

2.1. Data and Model

In this study, our sample involves the monthly time series data of exchange rates (domestic currency/ US dollar) for emerging fragile market economies from 2010:M1 to 2021:M11. The dataset is obtained from the FRED Economic Data. The emerging fragile market economies comprised the following countries: Argentina, Brazil, Hungary, India, Mexico, South Africa, and Türkiye. The rationale behind the selection is the idea that these countries are to be the most affected by the changes in FED's bond purchase policy, and their currencies would be severely depreciated against the USD. Besides, their economies have some common problems such as a current deficit, external indebtedness, and a potential for an economic crisis.

The convergence hypothesis, which is widely used in the literature, is based on the Solow-Swan growth model. The convergence hypothesis means that the income level differences between the poor and advanced economies decrease over time. In other words, the less developed countries will catch up with the income level of the developed countries over time (Valdés, 2003: 62). There are different approaches in the literature to examine the validity of convergence. These are beta, sigma, stochastic and club convergence. This study investigates whether the stochastic convergence hypothesis holds for relative exchange rate series in fragile market economies.

The studies of Durlauf & Johnson (1995) and Bernard & Durlauf (1996) pioneered the development of the stochastic convergence approach by using unit root tests in time series analysis. The stochastic convergence hypothesis focuses on the time series properties of the interested series and determines whether different economic actors in the time series share a common trend factor. In this context, stochastic convergence implies that the values of the series converge to definite values or fluctuate around. If there is no change in the mean and variance of the series over time, it concludes that there is a convergence between the units examined (Bernard & Durlauf, 1996: 170). In stochastic convergence analysis, a data transformation has required. The following formula has used for this transformation:

$$REX_{it} = \ln(EX_{it}/averageEX_t) = \ln\left(\frac{EX_{it}}{N^{-1}\sum_{j=1}^{N} EX_{jt}}\right) \; i, j=1,2,\ldots N \qquad (1)$$

where EX_{it} the exchange rates of each country at a given time t, and REX_{it} represents the natural logarithm of the ratio exchange rates of each country at time t. Using this approach, we have examined whether the natural logarithm of the transformed series, which is obtained by dividing the interested variable by the average of the country or country group compared, is stationary or not. The stationarity of the series provides evidence supporting the convergence hypothesis, but the evidence against stationarity is counter-evidence convergence since it implies that the impact of a shock would be permanent.

2.2. Econometric Methodology

Changes in monetary policy, economic crises, wars, technological changes, and natural disasters such as earthquakes, floods, fires, and epidemics can alter the structural characteristics of data on economic and financial indicators over time. These permanent

changes in the stochastic behaviour of a series are called structural breaks or structural changes. Traditional unit root tests used in time series analysis do not consider structural breaks that may lead to misleading inferences.

Perron (1989: 1362) noted that if the structural breaks are ignored in the series, this may lead to the not rejected of the null hypothesis of a unit root. He claimed that the shocks that occur in the existence of a structural break in the series are exogenous. He developed a modified DF (Dickey-Fuller) unit root test in which the breakpoints are included exogenously in the model using dummy variables. The exogenous determination of the breakpoint had criticized by researchers in the literature. Perron's test strategy has been found inadequate due to the assumption that the position of the breakpoint is known (Christiano, 1992: 248). However, it has been emphasized that if the breakpoint is not endogenously determined, the unit root null may tend to be overly rejected (Zivot & Andrews, 1992: 252; Perron & Vogelsang, 1992: 316). To overcome these drawbacks, Zivot & Andrews (1992) put forward a novel unit root test that allows determining the location of the shifts endogenously by modifying the equation of the DF test. The endogenous determination of the break date prevents data loss and presents superior properties in comparison with Perron's test (Zivot & Andrews, 1992: 265-266). Lumsdaine & Papell (1997: 217-218) noted that one structural break is not always sufficient when modelling the data-generating process (DGP). They alter this test to allow for two structural breaks, which are determined endogenously. Also, they emphasize that using a structural break test can lead to a loss of information when multiple structural breaks are present.

Even though the DF-type unit root tests, which involve structural breaks, have been extensively used in the literature, the null hypothesis of these tests refers to a unit root process with no structural breaks. Therefore, rejecting the null hypothesis does not necessarily imply stationarity since the alternative hypothesis includes not only the possibility of trend stationarity with a break but also the unit root with a structural break. To overcome all these problems, Lee & Strazicich (2003: 1082) introduce a new unit root test depending on the Lagrange multiplier (LM). It has emphasized that the LM-type unit root tests are more powerful and robust than the DF-type unit root tests with structural breaks (Meng et al., 2013: 538). For this reason, we use the transformed LM-type unit root tests with and without structural breaks instead of the DF-type tests in this study.

Lee et al. (2012: 82) have pointed out that the unit root tests with endogenous structural breaks find the predetermined number of shifts under all conditions and add them to the test equation. They have emphasized that unnecessary breaks added to the test equation lead to a loss of power in the tests as well as they have argued that determining the number of structural breaks should be obtained from the data (Lee et al., 2012: 84). Therefore, the authors proposed a two-stage LM procedure for identifying structural shift(s) and testing for unit roots. It has investigated whether there is any structural break in the series in the first step of the test procedure. Then, the location of the structural break has determined. In the second step, the unit root test has applied to the interested series to investigate whether it is stationary. In the first step, the following equation (2) is estimated in terms of differences:

$$\Delta y_t = \delta' \Delta Z_t + u_t \quad (2)$$

where y_t is the interested variable, so relative P_{it}, $Z_t = [1, t, D_{1t}, \dots, D_{Rt}, DT_{1t}, \dots, DT_{Rt}]'$ a vector of exogeneous variables defined as constant, trend, and structural changes. D_{it} and DT_{it} are dummy variables. These variables indicate the location of the level shifts and trend shifts, respectively. $D_{it} = 1$ for $t \geq TB_i + 1$ and 0 otherwise; $DT_{it} = t - TB_i$ for $t \geq TB_i + 1$ and 0 otherwise, $i = 1,2, \dots, R$. TB_i indicates the location of the breakpoints and R denotes the number of breaks. The two-stage transformed LM unit root test statistic for testing the null hypothesis of the unit root has derived from the following regression:

$$\Delta y_t = \delta' \Delta Z_t + \phi \tilde{S}_{t-1} + e_t \tag{3}$$

where $\tilde{S}_t$ denotes the de-trended y_t series obtained using $\tilde{S}_t = y_t - \tilde{\psi} - \tilde{\delta}' Z_t$. $\tilde{\delta}'$ represents regression coefficients of Δy_t on ΔZ_t in Equation (2) and $\tilde{\psi}$ is given by $\tilde{\psi} = y_t - Z_1 \tilde{\delta}$. The test statistics, τ_{LM}, which is the t-statistics for testing the null hypothesis of the unit root, $\phi = 0$, is obtained from Equation (3). While the test statistic, τ_{LM}, is independent of the nuisance parameter demonstrating the position of the breakpoint in the level-shift model, it has based on the trend break position, λ_i^*, which presents the fraction of subsample in each regime in the trend-shift model, such that $\lambda_1^* = T_{B1} / T$, $\lambda_2^* = (T_{B2} - T_{B1}) / T$, ..., $\lambda_{R+1}^* = (T - T_{BR}) / T$ for $i = 2, \dots, R$. Therefore, Lee et al. (2012: 86) have suggested the following transformation to disappear the dependence on the nuisance parameter:

$$\tilde{S}_t^* = \begin{cases} \frac{T}{TB_1} \tilde{S}_t & for\ t \leq TB_1 \\ \vdots & \\ \frac{T}{TB_2 - T_1} \tilde{S}_t & for\ TB_1 \leq t \leq TB_2 \\ \vdots & \\ \frac{T}{T - TB_R} \tilde{S}_t & for\ TB_R \leq t \leq T \end{cases} \tag{4}$$

Substituting $\tilde{S}_t^*$ instead of $\tilde{S}_t$ in Equation (3), the regression equation can be rearranged as follows:

$$\Delta y_t = \delta' \Delta Z_t + \phi \tilde{S}_{t-1}^* + \sum_{j=1}^{k} d_j \Delta \tilde{S}_{t-j} + e_t \tag{5}$$

where the lagged augmented terms of $\Delta \tilde{S}_{t-j}$ are included to fix the existence of autocorrelation in the error terms. The transformed LM test statistics which is the t-statistics for testing the null hypothesis of the unit root, $\phi = 0$ is defined as τ_{LM}^*. The asymptotic distribution of τ_{LM}^* is has relied only on the number of trend breakpoints in the model. Lee et al. (2012) have produced the critical values of test statistics, which are to be consistent with the number of trend breaks (Lee et al., 2012: 87). Hence, it is noteworthy that the two-stage LM unit root tests correctly specify the structural breakpoints and have better size and power properties than other unit root tests with endogenous breaks.

For the test statistic obtained in the unit root analysis to be a reliable and effective estimator, the residuals of the regression must have a normal distribution. To enhance the performance of traditional DF unit root tests, Im & Schmidt (2008) have proposed the Residual Augmented Least Squares (RALS) procedure (Im & Schmidt, 2008: 220). This process has then been described by Im et al. (2014) and transformed into a two-step RALS-DF process. Im et al. (2014) have pointed out that high-order moments of non-normal distributed residuals include more

information about the nature of non-normality. They argue that using this information about the residuals, it provides a significant power gain for unit root tests (Im et al., 2014: 316). Meng et al. (2014) have developed the Lagrange multiple versions of the RALS-DF unit root test and proposed the Residual Augmented Least Squares-Lagrange Multiplier (RALS-LM) unit root test in level shift models (Meng et al., 2014: 344). The RALS procedure can be easily used in the linear test equation of high moments without requiring a priori knowledge of the nature of the non-normality, such as the density function or any precise functional form of the nonlinearity. Therefore, the RALS-LM unit root test is quite robust to non-normally distributed residuals and some forms of nonlinearity. As with other unit root tests, it has been pointed out that the RALS-LM test loses power unless it accounts for shifts in the trend (Meng et al., 2016: 31). Thus, Meng et al. (2016) have introduced the transformed RALS-LM test by extending the test equation to include trend changes of structural breaks. The main advantage of this new approach is to use all possible information to increase the test power and to free from nuisance parameters that indicate the positions of structural breaks (Meng et al., 2016: 31). The RALS procedure has been obtained by adding the following residual augmented term, $\widehat{w}_t$, to the test equation in Equation (5):

$$\widehat{w}_t = h(\hat{e}_t) - \widehat{K} - \hat{e}_t \widehat{D}_2 \tag{6}$$

where $\hat{e}_t$ denotes the residuals from the regression in Equation (5). To use the knowledge of non-normal residuals, the second and third moments of $\hat{e}_t$ are included in $h(\hat{e}_t) = [\hat{e}_t^2, \hat{e}_t^3]'$, also $\widehat{K} = T^{-1}\sum_{t=1}^{T} h(\hat{e}_t)$ and $\widehat{D}_2 = T^{-1}\sum_{t=1}^{T} h'(\hat{e}_t)$. Thus, allowing $\widehat{m}_j = T^{-1}\sum_{t=1}^{T} \hat{e}_t^j$, the augmented term can be defined as follows:

$$\widehat{w}_t = [\hat{e}_t^2 - \widehat{m}_2, \hat{e}_t^3 - \widehat{m}_3 - 3\widehat{m}_2\hat{e}_t]' \tag{7}$$

The first part of $\widehat{w}_t$ is related to the condition of homoscedasticity, while the second part of $\widehat{w}_t$ contains an additional moment condition based on the nonlinear functions of $\hat{e}_t$ (Meng et al., 2016: 33-34). This part improves efficiency unless $m_4 = 3\sigma^4$. When the error terms are asymmetric, this additional moment condition enhances the efficiency of the estimator of ϕ. In general, if $m_{j+1} = j\sigma^2 m_{j-1}$, the information of higher moments m_{j+1} is not informative. It is known as the redundancy condition, which is only satisfied for the normal distribution. On the other hand, if the distribution of residuals is not normal, the efficiency of the estimators is provided by adding the augmented term, $\widehat{w}_t$. The RALS-LM unit root test statistics are obtained by adding the term in equation (7) to equation (5):

$$\Delta y_t = \delta'\Delta Z_t + \phi\tilde{S}_{t-1}^* + \sum_{j=1}^{k} d_j \Delta\tilde{S}_{t-j} + \widehat{w}_t'\gamma + \varepsilon_t \tag{8}$$

The transformed RALS-LM test statistic with trend break is obtained by the OLS procedure applied to equation (8). $\tau_{RALS-LM}^*$ indicates the corresponding t statistics for $\phi = 0$ and the asymptotic distribution of $\tau_{RALS-LM}^*$ can be given as $\tau_{RALS-}^{*} \quad \rightarrow \rho\tau_{LM}^* + \sqrt{1-\rho^2}\, N(0,1)$. ρ is the correlation between residuals in equation (5) and the residuals in equation (8) and $\rho^2 = E(\hat{e}_t^2)/E(\hat{\varepsilon}_t^2)$. The asymptotic distribution of $\tau_{RALS-LM}^*$ is independent of the nuisance parameter, which indicates the location of breaks. The critical values of the test statistics depend on ρ^2, R and T.

3. Empirical Results

This study aims to examine whether the exchange rates of fragile market economies converge or not. Before analysing the validity of convergence, the descriptive statistics and normality test results for the exchange rates of each country are reported in Table 2.

Table 2: Descriptive Statistics of Exchange Rates

	ARS	BRL	HUF	INR	MXN	TRY	ZAR
Mean	25.575	3.154	258.047	62.274	16.470	3.662	11.885
Median	12.936	3.185	270.160	64.424	17.070	2.920	12.539
Maximum	100.930	5.639	327.110	76.168	24.180	10.520	18.565
Minimum	3.824	1.563	178.290	44.301	11.654	1.420	6.721
Std. Dev.	28.853	1.213	37.741	9.474	3.405	2.212	3.114
Skewness	1.365	0.523	-0.266	-0.551	0.102	1.004	-0.185
Kurtosis	3.509	2.231	1.874	2.158	1.571	2.908	1.854
Jarque-Bera	45.950	10.040	9.243	11.469	12.414	24.061	8.650
Prob.	0.000	0.000	0.010	0.003	0.002	0.000	0.013

Note: ARS, BRL, HUF, INR, MXN, TRY, and ZAR indicate the exchange rates of Argentina, Brazil, Hungary, India, Mexico, South Africa, and Türkiye, respectively.

To check whether the series are normal distribution, we use skewness and kurtosis measures as well as Jarque-Bera normality test findings. According to Table 2, the skewness measure of HUF, INR, and ZAR series are negative. These findings show that the series show a left-tailed distribution. On the other hand, the skewness measure of ARS, BRL, MXN, and TRY series are positive and show a right-tailed distribution. In addition, all series indicate platykurtic distribution except for ARS since the kurtosis values of these series are smaller than 3. The normality test of Jarque-Bera, which represents the null hypothesis of normality, is rejected for all countries. This finding provides evidence for non-Gaussian distributions for exchange rates. It means that, all series have non-normal distribution. This finding provides evidence for non-Gaussian distributions for exchange rates.

In this study, we apply several unit root tests to examine whether the exchange rates converge to the group average in a subsample of emerging fragile market economies. The results of the ADF unit root test, which is one of the traditional unit root tests, and the results of RALS-ADF, which includes information about the non-normal residuals, are reported in Table 3.

Table 3: The Results for ADF and RALS-ADF Unit Root Tests

Countries	ADF		Jarque-Bera	RALS-ADF		ρ^2
ARS	-2.3069	(0)	276.456***	-3.4885**	(0)	0.629
BRL	-3.0558	(0)	4.698*	-3.0851*	(0)	0.940
HUF	-1.8685	(1)	2.975	-2.2965	(0)	0.931
INR	-2.1762	(0)	3.409	-2.2025	(0)	0.946
MXN	-2.4460	(0)	6.368**	-3.1854*	(0)	0.919
TRY	-1.9753	(0)	5.917*	-1.9975	(0)	0.954
ZAR	-1.5512	(0)	0.424	-1.5549	(0)	0.992

Note: ***, **, and * demonstrates the levels of significance at 1%, 5%, and 10%, respectively. The values which are in parentheses indicate the optimal lag length and ρ^2 represents the correlation

coefficient between residuals. We have obtained the critical values of RALS-ADF from the paper of Im et al. (2014: 341).

According to Table 3, the ADF test results indicate the rejection of the null hypothesis for all interested series. As is well known, when the residuals of the test regression do not follow the normal distribution, the RALS unit root tests have more power and perform more robust results than traditional unit root tests. Thus, we use the Jarque-Bera test to determine if the residuals have a normal distribution. The findings demonstrate that the residuals are non-normal for ARS, BRL, MXN, and TRY. According to the RALS-ADF results, we reject the null hypothesis of the unit root hypothesis for the ARS, BRL, and MXN series; on the other hand, the remaining series contains a unit root. When comparing the RALS-ADF and ADF unit root test findings, we have obtained that the relative exchange rates for Hungary, India, South Africa, and Türkiye contain a unit root. It implies the presence of the stochastic convergence hypothesis is not valid for these countries. Nevertheless, the stochastic convergence hypothesis is supported for the relative exchange rates of Argentina, Brazil, and Mexico.

In the existence of structural breaks in the series, the test power of traditional ADF tests decreases and deviates to under-rejecting the unit root null. Therefore, we have extended our analysis by considering the presence of possible structural breaks in the relative exchange rate series. We have applied the transformed LM and RALS-LM unit root proposed by Lee et al. (2012) and Meng et al. (2016), respectively. The results from one and two structural break LM and RALS-LM unit tests are reported in Tables 4 and 5.

Table 4: The Results for LM and RALS-LM Unit Root Tests with One Structural Break

Countries	τ^*_{LM}	$\tau^*_{RALS-LM}$	TB	ρ^2	k
ARS	-4.2798***	-2.7928	2018:06	0.674	6
BRL	-4.2971***	-4.1389***	2012:07	0.917	6
HUF	-4.7764***	-4.7143***	2019:06	0.998	0
INR	-4.4117***	-4.5098***	2013:01	0.971	10
MXN	-2.9145	-3.6325**	2016:02	0.850	9
TRY	-3.3808*	-3.7161**	2012:05	0.943	11
ZAR	-4.1358**	-4.1978***	2013:01	0.963	4

Note: τ^*_{LM} and $\tau^*_{\mathrm{RALS-}}$ demonstrate LM and RALS-LM unit root tests test statistics, respectively. k indicates the optimal lag length and TB represents the estimated breakpoint. When seeking for the breakpoints and the optimum lag lengths, we just write them once to save space since these tests share the same procedure. ***, ** and * demonstrates the levels of significance at 1%, 5% and 10%, respectively.

According to the transformed LM unit root test results, only MXN contains a unit root among all relative exchange rate series, whilst the other six exchange rate series are stationary at level. The RALS-LM unit root results differ from the LM unit root results by including non-normality information of residuals in addition to allowing for level and trend shifts in the test equations. We reject the null hypothesis of unit root for BRL, HUF, INR, and ZAR at the 1% significance level and MXN, TRY at the 5% significance level. Examining the RALS-LM unit root results, only ARS contains a unit root which means that the shocks in the ARS series are permanent. Besides, the rest of the relative exchange rate series are stationary at the level.

That is, the shocks in these series are temporary. In other words, the stochastic convergence hypothesis holds only for the relative exchange rates of Brazil, Hungary, India, South Africa, and Türkiye according to the results of LM and RALS-LM unit roots with only one structural break.

The results obtained by testing the stationarity of long-term macroeconomic series with single structural break unit root tests may be erroneous. In the presence of two structural breaks in such a series, the power of unit root tests would also decrease. Therefore, we look for further evidence of stochastic convergence. We investigate whether there is more than one break by testing the data with unit root tests that allow for two structural breaks.

Table 5: The Results for LM and RALS-LM Unit Root Tests with Two Structural Breaks

Countries	τ^*_{LM}	$\tau^*_{RALS-LM}$	TB1	TB2	ρ^2	k
ARS	-3.3803	-4.1534	2015:10	2016:02	0.651	10
BRL	-4.5559**	-4.6753***	2020:01	2020:07	0.942	5
HUF	-6.0187***	-6.0970***	2018:07	2020:02	0.989	0
INR	-5.6792***	-5.6729***	2012:04	2013:02	0.898	6
MXN	-2.2501	-2.2011	2020:01	2020:04	0.986	9
TRY	-3.1407	-2.8115	2018:06	2018:09	0.978	9
ZAR	-5.7219***	-5.9169***	2013:02	2017:05	0.922	6

Note: τ^*_{LM} and $\tau^*_{\mathrm{RALS-LM}}$ demonstrate LM and RALS-LM unit root tests test statistics, respectively. k indicates the optimal lag length, as well as TB1 and TB2, represent the first and second estimated breakpoints. When seeking for the breakpoints and the optimum lag lengths, we just write them once to save space since these tests share the same procedure. ***, ** and * demonstrates the levels of significance at 1%, 5% and 10%, respectively.

The results obtained by the two-break LM and RALS-LM unit root tests are similar and are reported in Table 5. They failed to reject the null hypothesis of a unit root in 3 out of 7 countries. The null hypothesis is rejected for BRL, HUF, INR, and ZAR series at a 1% significance level. These findings indicate that the stochastic convergence hypothesis is valid for Brazil, Hungary, India, and South Africa.

Overall, the results obtained from the traditional ADF unit root test and RALS-ADF, as well as LM and RALS-LM unit root tests, are all different. The empirical findings of structural break unit root tests with two statistically significant breaks indicate no evidence of stochastic convergence in the context of relative exchange rates in Argentina, Mexico, and Türkiye. Both the impacts of shocks experienced in the economy and the monetary policies implemented can cause permanent changes in the natural logarithm of the relative exchange rate, i.e., fluctuations in a non-stationary manner around a changing mean over time.

4. Conclusion

Financial liberalization, which activates uncontrolled international capital flows, turns toward developing countries that have high interest and growth expectations in the global risk-on periods, which then triggers financial fragility to begin. As a result of increased foreign capital, asset prices, and a credit boom occurs. This process has macroeconomic consequences such

as high growth, high inflation, and an increasing current account deficit in emerging markets. Moreover, foreign capital inflows cause an appreciation of emerging market currencies and encourage banks and companies to undertake more foreign currency liabilities. This leads to liability dollarization as expected. When the global economy is in the risk-off period, this process is reversed, and hence the emerging market's currencies face a sharp depreciation after sudden capital outflows. During this process, increasing speculations toward these currencies could even accelerate the depreciation and lead to bank and company bankruptcies.

Post-Keynesian economics considers the above-mentioned orthodox explanations insufficient and states that this process is related to the global monetary hierarchy. The post-Keynesian argument is that international capital flows are related to the structure of the international monetary system and thus can be explained by the store of value of different currencies. For instance, Kaltenbrunner (2011: 84) argues that the value of a currency is determined by its ability to meet its obligations, more precisely, its ability to meet its obligations through the assets of the same currency.

Since the emerging market's currencies have a low degree of liquidity, global investors steer their assets to more liquid currencies in times of crisis. Emerging market currencies with lower liquidity premiums will increasingly depreciate as a result of the risk aversion behaviour (risk-off mode). Therefore, the perception of risk for the emerging market currency assets causes capital flows to those countries to be unstable and relatively more volatile. This mechanism explains how illiquid currency assets are subject to sudden loss of confidence during a crisis (risk-off mode), and why are considered risky items that should be liquidated in global investment portfolios. In this context, we can argue that portfolio shifts of global institutional investors are one of the key thrusts that shape gross capital flows in today's world. Consequently, it is indeed the position of emerging market economies in the global monetary hierarchy that causes their currencies to be more unstable relative to reserve currencies.

This study examines whether the exchange rate volatilities of fragile market economies have converged over the period 2010:M1-2021:M11 from the perspective of the stochastic convergence approach. The stochastic convergence approach examines whether the natural logarithm of the series obtained by relating the variable of interest to the average of the country or group of countries being compared is stationary. To this end, the existence of the convergence hypothesis for relative exchange rate series is tested using traditional and structural break unit root tests, as well as the RALS extensions of these tests, which have been introduced in the literature as a robust test using the non-normal distribution information in the residuals.

The results of the ADF unit root tests indicate that the convergence hypothesis does not hold in fragile market economies, while the residuals of the test regressions are not normally distributed. Therefore, the RALS-ADF test was applied to incorporate the non-normal distribution information. The results of the RALS-ADF unit root test indicate that the relative exchange rates of Argentina, Brazil, and Mexico converged to the group average over the specified period. However, the series of Hungary, India, South Africa, and Türkiye contain unit roots, which is not consistent with the stochastic convergence hypothesis. As discussed in

detail, ignoring structural breaks in the unit root test can lead to severe magnitude bias and loss of power. We, therefore, tested the validity of the stochastic convergence hypothesis for relative exchange rates using one- and two-structural break-transformed LM and RALS-LM unit root tests. According to the results of the LM unit root test with one structural break, all countries except Mexico converge to the group average, whereas the RALS-LM result shows that all countries except Argentina converge to the group average. On the other hand, the results of the two-break LM and the RALS-LM, which are considered to give better results in terms of power, overlap. The RALS-LM unit root test is more robust to non-normal residuals and some forms of nonlinearity. The results of the RALS-LM unit root test show that the stochastic convergence hypothesis is not valid for Argentina, Mexico, and Türkiye, while it is valid for Brazil, Hungary, India, and South Africa.

Based on these explanations, the findings of our study confirm that emerging market economies have different degrees of vulnerability within, and currencies with higher vulnerability exhibit higher volatility relative to others. The high volatility of the currencies, as a consequence, positions these markets at the bottom of the global monetary hierarchy. Therefore, attempts to reduce the macro-financial vulnerabilities of these economies using the standard orthodox monetary policy prescriptions do not possibly work. Indeed, post-Keynesian and structuralist economists have long doubted the stabilizing ability of flexible exchange rate regimes for such economies. They argue accordingly that the position of these in the global monetary hierarchy causes balance sheet dollarization and the inability to implement policies against the conjuncture. The studies by Kohler & Stockhammer (2022), Drumond & De Jesus (2016), Bonizzi (2013b), Harvey (2007), and Oreiro (2005) can be valuable references for interested readers.

Finally, our policy recommendation based on the empirical findings of this study is in accordance with the post-Keynesian (PKE) literature and implies that countries with highly volatile currencies such as Türkiye, Argentina, and Mexico should consider the exchange rate as a policy variable and the central banks should focus on exchange rate stability besides financial stability.

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Çıkar Beyanı: Yazarlar arasında çıkar çatışması yoktur.

Etik Beyanı: Bu çalışmanın tüm hazırlanma süreçlerinde etik kurallara uyulduğunu yazarlar beyan eder. Aksi bir durumun tespiti halinde Fiscaoeconomia Dergisinin hiçbir sorumluluğu olmayıp, tüm sorumluluk çalışmanın yazarlarına aittir.

Yazar Katkısı: Yazarların katkısı aşağıdaki gibidir;

Giriş: 1. yazar

Literatür: 1. yazar

Veri ve Metodoloji: 2. Yazar ve 3. Yazar

Bulgular: 2. Yazar ve 3. Yazar

Sonuç: 1. Yazar, 2. Yazar ve 3. Yazar

1. yazarın katkı oranı: %45; 2. yazarın katkı oranı: %27 ve 3. yazarın katkı oranı: %28'dir.

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Author Contributions: author contributions are below;

Introduction: 1st author

Literature: 1st author

Data and Methodology: 2nd author and 3rd author

Empirical Results: 2nd author and 3rd author

Conclusion: 1st author, 2nd author and 3rd author

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