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The impact of capital flows and monetary policy on exchange rate vulnerability: an empirical overview of the Fragile Five countries

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Abstract

This study investigates how exchange rate dynamics in the Fragile Five economies are shaped by key macroeconomic and financial indicators, namely foreign direct investment inflows, the balance of trade in goods and services, the current account position, inflationary pressures, policy interest rates, and the level of foreign exchange reserves. Despite extensive research on exchange rate behaviour in emerging markets, empirical evidence focusing on financially vulnerable economies such as the Fragile Five remains relatively limited. This study examines the relationship between these variables using panel regression analysis for the period 1990–2023. The main objective is to identify the macroeconomic determinants influencing exchange rate movements in the Fragile Five economies. The results indicate that foreign direct investment and the net trade balance have a statistically significant positive effect on exchange rates, whereas the current account balance, inflation, and policy interest rates have significant negative effects. Foreign exchange reserves do not show a statistically significant effect. The findings provide empirical evidence on exchange rate vulnerability in emerging economies and offer insights for policymakers and investors.

Keywords: exchange rate dynamics, panel regression, the Fragile Five countries, monetary policy, capital flows

JEL: C23, F31, G15

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1. Introduction

Developing nations, particularly those with unstable economies, exhibit heightened susceptibility to fluctuations in the global financial system. This vulnerability is primarily linked to exchange rate volatility, external debt, and variations in capital flows (Arellano 2008). In 2013, global investors and economic analysts coined the term 'the Fragile Five' to characterize the macroeconomic vulnerabilities of emerging market economies. The Fragile Five comprises five nations that face distinct economic challenges and exhibit susceptibility to global financial instability. The countries include Brazil, Indonesia, India, Turkey, and South Africa. The Fragile Five countries share several common characteristics that contribute to their vulnerability: significant current account deficits, elevated inflation rates, unstable growth patterns, reliance on external resources, and adverse domestic political conditions (Umit 2016; Yildirim 2016).

One distinguishing characteristic of the Fragile Five countries is the significant magnitude of their external debt. These countries primarily borrow in foreign currencies, which could make it very difficult to repay if their own currency loses value. In developing countries, unstable currency rates make the economy less stable by making the external debt load worse (Eichengreen, Gupta 2015). The economies of the Fragile Five countries have become dependent on external financing, placing them at heightened risk. The current account deficit reflects a situation in which a country's expenditures on imports exceed its export revenues. In the case of the Fragile Five economies, persistent current account imbalances largely stem from structurally higher import demand relative to export capacity. This puts the economy at risk since financing the current account deficit requires borrowing from other countries or getting money from other countries. Still, global financial concerns and changes in capital flows have made these countries more dependent on foreign investment (Stiglitz 2003). The Fragile Five countries have seen their inflation rates rise at regular periods. High inflation has caused prices of goods and services to rise quickly, making life more expensive. Also, the fact that currencies have lost value in many nations has made imports more expensive, which has made inflation worse. Changes in currency rates have made investors less confident and caused money to leave the country (Şen et al. 2020). Most of the Fragile Five countries had faster growth rates in the early 2000s, but these rates started to go down in the middle of the 2010s. This situation has sparked concerns about the sustainability of the nations' development programmes, which depend on economic growth. Slowing growth, together with fundamental problems including high unemployment and low investment, has made the economy more vulnerable (Wu, Wu 2021). Political instability and civil unrest are major factors that make the Fragile Five countries even more economically vulnerable. These countries have seen changes in government policy, protests by people, and civil unrest. As a result of this domestic instability, foreign investment has gone down, the business climate has deteriorated, and economic growth has slowed down (Acemoglu, Robinson 2013; Akın 2019).

Exchange rate movements are widely regarded as a key reflection of macroeconomic stability, particularly in developing economies, where external conditions play a decisive role. According to the theory of optimum currency areas proposed by Mundell (1961), economies with a high degree of openness tend to be more exposed to exchange rate fluctuations, as trade-related channels directly transmit external shocks into domestic markets. In emerging market contexts, persistent trade imbalances intensify structural fragilities by amplifying exchange rate volatility. Consequently,

exchange rate levels reflect the interaction between external competitiveness, capital flows, and macroeconomic policy credibility, thereby providing important signals regarding a country's external trade position and long-term economic prospects (Obstfeld, Rogoff 1994). The exchange rate also indicates the appeal of foreign investment. Exchange rate volatility introduces significant uncertainty, representing a crucial risk factor for foreign direct investment. Investors might decrease capital flows owing to apprehensions that exchange rate volatility could adversely affect potential returns (Chakrabarti 2001). The exchange rate can also serve as a general indicator of the effectiveness of economic management, although it is influenced by multiple domestic and external factors and should be interpreted alongside other macroeconomic indicators. The literature reveals a lack of consensus concerning the interaction between the exchange rate and the aforementioned factors.

This study analyses the role of independent variables in influencing exchange rate levels in the Fragile Five countries, focusing on economic and financial stability. Although previous studies have examined the relationship between macroeconomic indicators and exchange rates, relatively limited attention has been given to the combined effects of these variables in financially fragile emerging economies such as the Fragile Five. Moreover, existing studies often focus on individual countries or shorter time horizons, leaving a gap in long-term comparative empirical evidence. Accordingly, the central research question of this study is as follows: Which macroeconomic factors systematically influence exchange rate movements in the Fragile Five economies? The main objective of this study is to examine the impact of selected macroeconomic variables – namely foreign direct investment inflows, net trade balance in goods and services, the current account balance, inflation rate, policy interest rates, and foreign exchange reserves – on exchange rate dynamics in the Fragile Five countries. Although FDI serves as the primary indicator of capital inflows in the empirical model, net trade balance and current account balance also reflect indirect effects of international capital movements, ensuring consistency with the overall conceptual scope of the study.

A comprehensive understanding of exchange rate dynamics is crucial for mitigating instability risks in fragile economies, fostering sustainable economic growth, facilitating investment planning, and enhancing economic integration. Prior research has analysed the influence of foreign direct investment, net trade balance in goods and services, current account balance, inflation rate, and policy rate on exchange rates, highlighting that these variables are critical for comprehending the financial fragility of these nations (Benazic, Kersan-Skabic 2016; Chen et al. 2021; Fuchs 2022; Phuc, Duc 2021; Raksong, Sombatthira 2021; Raza, Afshan 2017; Yuan 2011).

This study contributes to the existing literature in several ways. First, it provides a comprehensive empirical analysis of exchange rate dynamics in the Fragile Five economies using a long-term dataset covering the period 1990–2023. Second, it jointly examines the roles of key macroeconomic indicators associated with capital flows and monetary policy. Third, the study offers updated empirical evidence on exchange rate vulnerability in emerging economies that are highly sensitive to international financial conditions. The period 1990–2023 was selected not only to capture major episodes of financial globalization, capital flow volatility, and macroeconomic adjustments, but also because reliable and comparable data for all selected macroeconomic indicators – such as foreign direct investment, trade balances, current account, inflation, policy rates, and foreign exchange reserves – are available for the Fragile Five countries throughout this timeframe.

2. Literature review

Exchange rate dynamics are one of the fundamental research areas of open economy macroeconomics and are considered an important determinant in terms of countries' foreign trade balances, capital movements, and monetary policy transmission mechanisms. The theoretical literature on exchange rate determination is generally structured around purchasing power parity, interest rate parity, and portfolio balance approaches. According to these theories, price differences between countries, interest rates, and international capital movements are among the key determinants of the exchange rate. However, it is emphasized that, particularly in developing economies, exchange rate movements cannot be explained solely by macroeconomic fundamentals, and that financial vulnerabilities and international capital flows also play an important role.

In the literature, the relationship between the exchange rate and inflation is mostly addressed within the framework of the purchasing power parity approach. According to this approach, differences in price levels between countries determine the direction of the exchange rate in the long term. National studies conducted on the Fragile Five countries show that this hypothesis is valid to a certain extent. Çeviş and Ceylan (2015), Umit (2016), Çil and Yıldırım-Tıraşoğlu (2018), Coşkun (2020), and Kardaşlar (2023) have concluded in their analyses, conducted using different periods and methods, that the purchasing power parity hypothesis is valid in at least some of the Fragile Five countries. These findings are generally interpreted as meaning that local currencies lose value during periods of high inflation. The theoretical foundations of this relationship are largely based on the Purchasing Power Parity framework developed by Rogoff (1996) and further discussed by Taylor and Taylor (2004), who argue that exchange rates tend to converge to relative price levels in the long run despite short-run deviations. However, some studies in the international literature show that the relationship between exchange rates and inflation can vary depending on the country and the period analysed. While Raza and Afshan (2017), Andriyani et al. (2020), Phuc and Duc (2021), and Chen et al. (2021) found a significant relationship between the two variables in different country groups, some studies reveal that this relationship may be weak in short-term dynamics. This situation indicates that exchange rate movements cannot be explained solely by price differences and that other macroeconomic variables must also be taken into account.

Another important factor affecting the exchange rate is monetary policy indicators. According to the interest rate parity approach, interest rate differentials between countries can influence international capital flows and thus be decisive for the exchange rate. Numerous studies in the literature examine the relationship between the policy interest rate and the exchange rate. Yuan (2011), Raza and Afshan (2017), Phuc and Duc (2021), and Fuchs (2022) have demonstrated that interest rates have a significant impact on the exchange rate. Moreover, Bahmani-Oskooee and Kara (2000), in their study on Turkey, provide evidence supporting the exchange rate overshooting hypothesis, suggesting that monetary shocks and interest rate adjustments can lead to temporary but substantial exchange rate fluctuations. However, some studies emphasize that the impact of interest rates on the exchange rate may vary depending on factors such as financial risk perception and capital movements. This situation indicates that the impact of monetary policy instruments on the exchange rate may be limited, particularly in economies with high financial fragility.

The current account balance, one of the indicators representing macroeconomic imbalances, also occupies an important place in the exchange rate literature. Theoretically, countries with high current

account deficits may become more dependent on external financing, which can create pressure for depreciation on their local currencies. Obstfeld and Rogoff (2005), Edwards (2002), and Bouraoui (2019) have demonstrated that current account deficits are associated with exchange rate depreciation. In contrast, some studies show that deterioration in the current account balance can increase not only the level of the exchange rate but also its volatility. Das (2016) and Kuncoro and Fafurida (2023) indicate that current account deficits increase exchange rate volatility, while Jawaid and Raza (2013) and Şit and Karadağ (2019) conclude that an increase in the current account deficit leads to an appreciation of the exchange rate. These differing findings indicate that the relationship between the current account balance and the exchange rate may vary depending on country characteristics and the methods used. In addition, Coudert, Couharde and Mignon (2008) emphasize that external balance indicators such as terms of trade can significantly influence real exchange rates, particularly in commodity-exporting economies.

Capital flows also play an important role in determining exchange rate dynamics. In particular, foreign direct investment can have a decisive impact on foreign exchange markets because it is a long-term capital flow. Benazic and Kersan-Skabic (2016), Kartal, Kılıç-Depren and Depren (2018), and Raksong and Sombatthira (2021) have determined that foreign direct investment has a positive effect on exchange rates. Furthermore, Kiyota and Urata (2004), Albuquerque, Loayza and Servén (2005), and Vergil and Çeştepe (1997) have revealed a unidirectional causality relationship from foreign direct investment to the real effective exchange rate. Earlier studies by Cushman (1985) and Froot and Stein (1991) also indicate that exchange rate movements and exchange rate uncertainty play a significant role in shaping foreign direct investment decisions. Similarly, Blonigen (2005), in a comprehensive review of the FDI literature, identifies exchange rates among the key determinants of foreign direct investment flows. However, some studies indicate that there may be a reciprocal interaction between the exchange rate and capital flows, and that this situation may lead to endogeneity problems in empirical analyses.

Foreign exchange reserves are also one of the important policy tools used to ensure exchange rate stability. However, the literature presents differing findings regarding the impact of reserves on the exchange rate. While Petreski (2012) states that the effect of foreign exchange reserves on exchange rate volatility is limited, Law (2019) argues that reserve accumulation can increase exchange rate volatility. In contrast, Hansen and Morales (2021) and Kuncoro and Fafurida (2023) state that foreign exchange reserves can support exchange rate stability, especially during periods of intense financial turbulence. In a study conducted on Turkey, Tümtürk (2019) concluded that foreign exchange reserves are not sufficiently effective in limiting exchange rate movements.

Following the 2008 Global Financial Crisis, a major turning point in the global financial system, there has been a significant increase in the number of studies examining exchange rate dynamics in developing countries. Post-crisis global liquidity conditions, the direction of international capital flows, and global risk perception are among the key factors determining exchange rate movements in developing economies (Forbes, Warnock 2012; Ahmed, Zlate 2014). In this context, the global financial cycle approach developed reveals that changes in international capital movements and global risk appetite have a strong impact on financial conditions and exchange rate dynamics in developing countries (Rey 2015; Bruno, Shin 2015). Therefore, recent empirical studies emphasize that exchange rate movements should be assessed not only in terms of domestic macroeconomic fundamentals, but also in conjunction with global financial conditions and international capital flows (Obstfeld, Ostry, Qureshi 2019).

The Fragile Five countries, which are characterized by high financial vulnerabilities and sensitivity to international capital flows, have become an important area of research in the foreign exchange literature. These countries exhibit a more fragile structure against exchange rate fluctuations due to characteristics such as high current account deficits, external financing dependence, and sensitivity to capital flows. Therefore, examining exchange rate dynamics in these economies yields important results for both academic literature and economic policy. This study aims to contribute to the literature by analysing the effects of key macroeconomic variables such as inflation, policy interest rates, current account balance, foreign direct investment, foreign exchange reserves, and trade balance on exchange rates in the Fragile Five countries using panel data methods.

Based on the theoretical framework and the empirical findings discussed above, the following testable hypotheses are formulated:

H1: Foreign direct investment inflows have a statistically significant positive effect on exchange rates.

H2: Net trade balance has a statistically significant positive effect on exchange rates.

H3: Current account balance has a statistically significant negative effect on exchange rates.

H4: Inflation has a statistically significant negative effect on exchange rates.

H5: Policy interest rates have a statistically significant negative effect on exchange rates.

H6: Foreign exchange reserves have a statistically significant effect on exchange rates.

3. Data and methodological framework

3.1. Variable definition and data description

This research examines the macroeconomic factors that affect exchange rates in the Fragile Five countries using panel data analysis. Indicators with empirically established effects on exchange rates, as documented in the literature and grounded in theoretical models, were selected for their relevance to the economic structures of the Fragile Five countries. The selection process for data involved key criteria such as the reliability of data sources, the timeliness and accessibility of the data, and the prevalent use of the variables in empirical analyses.

The primary factor influencing the exchange rate, the dependent variable of the study, is foreign direct investment (FDI). Capital flow theory posits that substantial FDI inflows often bolster the currency by augmenting demand for the local currency (Alfaro et al. 2004). The current account deficit is another indicator regarded as a primary predictor of exchange rates. The balance of payments theory posits that currencies of nations exhibiting current account deficits are likely to deteriorate over the long term (Edwards 2002). The Fragile Five nations are typically recognized for possessing substantial current account deficits, which are regarded as a risk factor that heightens exchange rate volatility or adversely affects the exchange rate's value. Consequently, the current account deficit constitutes an essential variable for understanding the macroeconomic determinants of exchange rate dynamics (Çiftci 2014).

The policy interest rate is a key determinant in deciding exchange rates, and according to interest rate parity theory, it also affects capital flows. According to Taylor (1993), central banks frequently employ policy rates to mitigate exchange rate volatility in emerging markets like the Fragile Five

countries. When imports outweigh exports, a country's currency may be under pressure due to the trade imbalance, which is calculated as the net trade in goods and services (Obstfeld, Rogoff 1995). Recent empirical studies show that uncovered interest parity often fails in the short run due to market shocks and monetary policy reactions, but the relationship tends to be stronger over longer horizons, consistent with theoretical predictions (Chinn, Meredith 2004; Chinn, Quayyum 2012). The International Fisher Effect further suggests that expected differences in inflation and nominal interest rates between countries are reflected in long-term exchange rate movements, implying that higher nominal interest rates tend to be associated with future currency depreciation. Many studies have shown that countries with large external deficits tend to experience pressure on their currency rates, especially in the case of the five most vulnerable economies (Calvo, Leiderman, Reinhart 1993).

The theory of purchasing power parity elucidates the relationship between exchange rates and inflation. This theory posits that elevated inflation rates may result in the depreciation of the local currency. Inflation rates serve as a crucial macroeconomic indicator in developing countries, significantly influencing economic stability and exchange rates (Fischer 1993). Foreign exchange reserves serve as a tool to safeguard a nation's currency value and enhance its resilience to external shocks. The level of reserves is indicated to significantly influence the mitigation of exchange rate fluctuations (Flood, Marion 1999).

This study empirically examines the determinants of exchange rate movements in the Fragile Five economies – Brazil, Indonesia, South Africa, India, and Turkey – over the period from 1990 to 2023. The set of variables employed in the empirical analysis is summarized in Table 1.

The dependent variable (EXC) represents the nominal bilateral exchange rate of the local currency against the US dollar (USD/local currency). All series, including the dependent and independent variables, are expressed in natural logarithms to reduce the potential effects of exponential growth and outliers and to obtain more consistent model results. This approach allows for a more interpretable estimation of coefficients and aligns with standard practice in empirical studies of exchange rate determinants in emerging market economies.

3.2. Econometric methodology and empirical findings

Equation (1) shows the model that will be used to empirically examine the influence of the factors specific to the Fragile Five countries on the exchange rate.

$$EXC_{it} = \beta_0 + \beta_1 FDI_{it} + \beta_2 CAB_{it} + \beta_3 INF_{it} + \beta_4 RES_{it} + \beta_5 NTD_{it} + \beta_6 INT_{it} + \varepsilon_{it} \quad (1)$$

Table 2 presents the pairwise correlation coefficients for the variables used in the study. Overall, it can be observed that the majority of the correlation coefficients between the variables are low to moderate.

The results of the correlation analysis indicate that the dependent variable EXC has a positive relationship with the variables NTD (0.29) and CAB (0.23), and a negative relationship with the variables INF (-0.30) and INT (-0.37). This finding shows that there are no strong linear correlations among the explanatory variables included in the model, and therefore, there is no serious multicollinearity issue. According to the results in the table, a relatively higher correlation coefficient is observed between

the current account balance and the net trade balance. This is due to the net trade balance being an important component of the current account balance. In the study, a Variance Inflation Factor (VIF) analysis was also conducted to more accurately assess the issue of multicollinearity among the variables.

In the panel data analysis model to be estimated, the issue of multicollinearity, arising from the strong correlation among independent variables, must be addressed first (Gujarati 2003). VIF is a widely used diagnostic tool for detecting potential multicollinearity among explanatory variables. It measures the extent to which the variance of an estimated regression coefficient is inflated due to linear relationships with other independent variables in the model. In this study, the VIF test is employed to assess the presence and severity of multicollinearity among the independent variables. During the application of the VIF method, the model is constructed by sequentially assigning all independent variables as a dependent variables. The other variables are treated as independent variables, and the models are evaluated according to the R_i^2 value, calculated by the formula $[1/(1 - R_i^2)]$ (O'brien 2007). The results of the VIF analysis that was carried out during the course of the investigation are presented in Table 3.

According to the VIF analysis, a critical value greater than 5 indicates the presence of multicollinearity. Analysing the results from the Table 3, it is observed that the calculated VIF values of the variables in the model are all less than 5. It can be concluded that the model to be estimated does not exhibit multicollinearity issues.

The assumption of independence among the countries in the panel suggests that a shock to any specific unit affects all units uniformly, indicating that a macroeconomic shock in one country does not produce spillover effects on others. Nevertheless, the growing interdependence among nations in the contemporary global economy significantly restricts the validity of this assumption. A realistic perspective recognizes that a shock to one cross-sectional unit can differentially affect others (Mercan 2014). A notable challenge in panel data analysis is the existence of cross-sectional dependence among the series that constitute the panel. It is crucial to initially assess the variables for cross-sectional dependence. The results indicate that the choice between first- or second-generation unit root tests is necessary for evaluating the stationarity of the variables.

Drawing on both the time dimension (T) and the cross-sectional dimension (N) of panel data, the empirical literature has developed a variety of testing procedures to detect cross-sectional dependence. In cases where the temporal dimension exceeds the cross-sectional dimension ($T > N$), the Breusch-Pagan (1980) Lagrange Multiplier (LM) test is commonly regarded as the most appropriate approach, and its formal specification is given in Equation (2).

$$LM = T\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}^2 \tag{2}$$

The temporal dimension (T) and the cross-sectional dimension (N) are not necessarily identical; in certain instances, N may surpass T, whereas in others, both dimensions may be equivalent. In these instances, the CDLM test formulated by Pesaran (2004) may be utilized. The CDLM test adheres to a standard normal distribution and is calculated as demonstrated in Equation (3):

$$CD_{lm} = \sqrt{\frac{1}{N(N-1)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\left(T\hat{\rho}_{ij}^2 - 1\right) \tag{3}$$

In panel data settings, conventional cross-sectional dependence tests such as the Breusch-Pagan (1980) LM and the Pesaran (2004) CD tests may produce biased outcomes when individual cross--sectional means differ from zero despite a zero group mean. To mitigate this limitation, Pesaran, Ullah and Yamagata (2008) refined the test statistic by introducing adjustments for both the mean and variance, thereby proposing the bias-adjusted LM_{adj} test, which is formalized in Equation (4).

$$LM_{adj} = \sqrt{\frac{2}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} T\hat{\rho}_{ij} \frac{(T-k)\hat{\rho}_{ij}^2 \mu_{Tij}}{\sqrt{u_{Tij}^2}} \tag{4}$$

The cross-sectional dependence test introduced by Pesaran (2015) aims to identify dependence in panel data sets characterized by a significant time dimension (T) and a considerable number of cross--sectional units (N). This test offers a more comprehensive and flexible framework for application compared to the conventional Pesaran (2004) CD test (Pesaran 2015).

$$\hat{\rho}_N = \frac{2}{N(N-1)} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij} \tag{5}$$

Here, $\hat{\rho}_{ij}$ is calculated as follows:

$$\hat{\rho}_{ij} = \hat{\rho}_{ji} = \frac{\sum_{T=1}^{T} e_{it} e_{jt}}{\left(\sum_{t=1}^{T} e_{it}^2\right)^{1/2} \left(\sum_{t=1}^{T} e_{jt}^2\right)^{1/2}} \tag{6}$$

The CD test developed by Pesaran (2004) is essentially a scaled version of $\hat{\rho}_N$ and can be expressed as follows:

$$CD = \left[\frac{TN(N-1)}{2}\right]^{1/2} \hat{\rho}_N \tag{7}$$

Assessing whether slope coefficients are homogeneous or heterogeneous is a critical step in panel data analysis, as this distinction directly affects the reliability of unit root, cointegration, and causality tests. Assuming coefficient homogeneity may obscure country-specific dynamics and lead to misleading inferences (Nazlioglu, Lebe, Kayhan 2011). To account for potential heterogeneity, Pesaran and Yamagata (2008) proposed the Delta ($\tilde{\Delta}$) test as an extension of Swamy's (1970) framework for examining slope coefficient homogeneity within cointegration models. Under the null hypothesis (H0), slope coefficients are assumed to be homogeneous across cross-sectional units, whereas the alternative hypothesis (H1) allows for heterogeneity. The test is based on two related statistics, $\tilde{\Delta}$ and the adjusted $\tilde{\Delta}_{adj}$, which are designed for large-sample and small-sample settings, respectively, and are computed following the methodology outlined in Pesaran, Ullah and Yamagata (2008).

$$\tilde{\Delta} = \sqrt{N}\left(\frac{N^{-1}\tilde{S} - k}{\sqrt{2k}}\right) \tag{8}$$

$$\tilde{\Delta}_{adj} = \sqrt{N}\left(\frac{N^{-1}\tilde{S} - E\left(\tilde{z}_{iT}\right)}{\sqrt{\mathrm{Var}\left(\tilde{z}_{iT}\right)}}\right) \tag{9}$$

where N refers to the total number of cross-sectional units, S denotes the Swamy's test statistic, and k indicates the number of explanatory variables.

This study acknowledges the potential influence of common shocks on the Fragile Five countries. We assess cross-sectional dependence utilizing the bias-adjusted LM_{adj} test, as formulated by Pesaran, Ullah and Yamagata (2008), alongside the CD test introduced by Pesaran (2015). The results are displayed in Table 4, Panel A. Table 4, Panel B displays the findings of the Pesaran and Yamagata (2008) homogeneity test, which evaluates the homogeneity of the cointegration coefficients.

The findings obtained from the Pesaran et al. (2008) LM_{adj} and Pesaran CD (2015) tests reveal that the p-values associated with the variables are below the 0.05 significance level, leading to the rejection of the null hypothesis that assumes the absence of cross-sectional dependence. This outcome provides clear evidence of cross-sectional dependence among the variables included in the analysis. Similarly, the homogeneity test results reported in Table 4, Panel B, yield p-values lower than 0.05, resulting in a strong rejection of the null hypothesis and indicating that the slope coefficients in the cointegration equations are heterogeneous. These results collectively suggest that both cross-sectional dependence and slope heterogeneity characterize the series employed in the model. Therefore, to maintain the robustness and reliability of the empirical framework, it is necessary to adopt econometric techniques that explicitly account for cross-sectional dependence in subsequent stages of the analysis.

Once cross-sectional dependence among the Fragile Five economies is established, the next step involves examining the stationarity properties of the variables. In this context, panel unit root tests are commonly classified into two categories based on whether they incorporate cross-sectional dependence. Tests that ignore such dependence are referred to as first-generation panel unit root tests, whereas those that explicitly accommodate cross-sectional interactions are classified as second-generation panel unit root tests.

The findings indicate that the panel exhibits statistically significant dependence across cross--sectional units (countries). Subsequently, the CADF test, as developed by Pesaran (2007), is utilized to investigate the existence of a unit root. In this unit root test, the CADF statistics assess the stationarity of each country's series individually, whereas the CIPS test, which extends the CADF test by incorporating cross-sectional averages, evaluates stationarity across the panel by considering the overall average of all countries.

The CADF test is formulated as shown in Equation (10) (Pesaran 2007):

$$\Delta y_{it} = a_i + \beta_i y_{i,t-1} + \gamma_i f_t + \varepsilon_{it}, i = 1,\ldots,N; t = 1,\ldots,T \tag{10}$$

where: $a_i = \left(1 - \varnothing_i\right)\mu_i$, $\beta_i = -\left(1 - \varnothing_i\right)$ and $\Delta y_{it} = y_{it} - y_{i,t-1}$.

For $\varnothing_i = 1$

$$H_0\colon \beta_i = 0 \text{ for all } i \tag{11}$$

$$H_1: \beta_i < 0, i = 1, 2, \ldots, N_1, \beta_i = 0, i = N_1 + 1, N_1 + 2, \ldots, N \tag{12}$$

When doing the CADF test, the existence of a unit root is considered to be the null hypothesis. The CIPS statistics is obtained by calculating the simple arithmetic average of individual CADF statistics. The CIPS statistics were formulated by Pesaran (2007) in the following manner:

$$CIPS(N, T) = t - bar = N^{-1} \sum_{i=1}^{N} t_i(N, T) \tag{13}$$

The CIPS test statistic lacks a normal distribution; therefore, critical values are derived and presented in tabular form by Pesaran (2007) through simulation methods. If the calculated CADF value exceeds the critical value established by Pesaran, the null hypothesis H0 is rejected, indicating that the relevant series is stationary. This study employs the Pesaran CADF panel unit root test on the series of the Fragile Five countries, with results presented in Table 5. Furthermore, to corroborate the findings of the Pesaran CADF (2007) unit root test, the MADF test, a second-generation SUR-based panel unit root test, was employed, with the results of both tests presented in Table 5.

Based on the Pesaran CADF results reported in Table 5, stationarity is confirmed, as the CIPS (t-bar) statistics exceed the corresponding critical values at the 10%, 5%, and 1% significance levels, together with statistically significant Z[t-bar] probability values. The MADF test outcomes further support this finding, with the test statistic surpassing the 5% critical threshold. Overall, both the Pesaran CADF (2007) and MADF tests indicate that the variables are stationary in levels, suggesting that the series are integrated of order zero, I(0).

Given the stationarity of the variables, panel regression techniques are employed to estimate the specified model. An F-test rejects the validity of the pooled classical model, indicating the need for panel-specific estimators. To determine the appropriate estimation approach, the Hausman (1978) specification test is applied, and the null hypothesis is rejected, favouring the fixed effects estimator over the random effects alternative. In addition, diagnostic tests reveal the presence of heteroskedasticity, serial correlation, and cross-sectional dependence within the panel structure. Accordingly, these econometric issues impose limitations on standard panel estimators. The diagnostic test results related to the underlying panel data assumptions are reported in Table 6.

The results shown in Table 6 indicate that the fixed effects model is influenced by heteroskedasticity, autocorrelation, and cross-sectional dependence, as suggested by the assumptions of the panel data model. Due to the potential bias of the fixed effects estimator in the presence of certain issues, the parameter estimates for the variables in the constructed model were derived using the robust estimator introduced by Driscoll and Kraay (1998).

The estimation results of Driscoll and Kraay (1998) indicate that the model's F-statistic is statistically significant, and the independent variables significantly explain the dependent variable. The R^2 value, representing the model's explanatory power, was determined to be 55.55%. Assuming the presence of heteroskedasticity, autocorrelation, and cross-sectional dependence, the t-statistics derived from robust standard errors demonstrate that foreign direct investment (lnFDI) and the net trade balance of goods and services (NTD) exert a statistically significant and positive influence on the exchange rate (EXC). Additionally, the estimation results from Driscoll and Kraay presented in Table 7 indicate that the current account balance (CAB), inflation rate (INF), and policy interest rate (INT) exert a statistically

significant negative impact on the exchange rate (EXC). Furthermore, the evaluation of t-statistics derived from robust standard errors indicates that the effect of reserves (RES) on the exchange rate (EXC) lacks statistical significance.

4. Conclusions

The Fragile Five are emerging market economies that are highly vulnerable to global economic uncertainty. They frequently face structural challenges, including external debt, current account imbalances, exchange rate fluctuations, inflation, and low growth. While their economies have recovered and reformed over time, they remain vulnerable to global economic shocks and financial volatility. In this context, the economic structures of the Fragile Five can be seen as an important case study for understanding the vulnerabilities of emerging market economies.

This study explores the relationship between exchange rates and a set of macroeconomic variables – namely foreign direct investment, the net trade balance in goods and services, the current account balance, inflation, the policy interest rate, and foreign exchange reserves – in the Fragile Five economies. The empirical findings reveal that foreign direct investment inflows and the net trade balance have a statistically significant positive effect on exchange rates, thereby supporting H1 and H2. In contrast, the current account balance, inflation rate, and policy interest rate exert statistically significant negative effects on exchange rates, confirming H3, H4, and H5. However, foreign exchange reserves do not have a statistically significant influence on exchange rate movements, indicating that H6 is not supported. Overall, these results highlight the importance of key macroeconomic variables in shaping exchange rate dynamics in the Fragile Five economies, while suggesting that the stabilizing role of foreign exchange reserves may be limited under certain conditions.

When these findings are compared with the results of previous studies in the literature, the following conclusions can be drawn: While foreign direct investments generate foreign exchange inflows, the resulting profits can be repatriated to the investors' home countries, potentially offsetting some of the inflows. Additionally, investments in labour-intensive sectors due to cheap labour may increase the demand for foreign exchange because of import dependency in terms of resources (Blonigen 2005; Cushman 1985; Froot, Stein 1991). These scenarios illustrate the beneficial effect of foreign direct investments on exchange rates. This result aligns with findings reported in the literature (Benazic, Kersan-Skabic 2016; Kartal, Kılıç-Depren, Depren 2018; Raksong, Sombatthira 2021). The positive effect of net goods and services trade on the exchange rate is attributable to heightened demand for foreign exchange resulting from imports. This phenomenon, particularly evident in countries with a trade surplus, contributes to the depreciation of the local currency. This trend is particularly pronounced in contexts characterized by significant import dependency for exports, including industrial inputs and energy. This finding aligns with existing literature (Bahmani-Oskooee, Kara 2000; Coudert, Couharde, Mignon 2008).

However, the negative relationship between the current account balance and the exchange rate is consistent with previous studies (Bouraoui 2019; Edwards 2002; Obstfeld, Rogoff 2005), which show that the local currency depreciates in countries with external deficits. The negative effect of the inflation rate on the exchange rate is consistent with previous studies (Çeviş, Ceylan 2015; Coşkun 2020; Kardaşlar 2023; Çil, Yıldırım-Tıraşoğlu 2018; Rogoff 1996; Taylor, Taylor 2004; Umit 2016). The negative effect of the policy rate on the exchange rate is consistent with studies (Dekle, Hsiao, Wang 2002;

Chen et al. 2021), which indicate that foreign investors shift to local currency assets, and the exchange rate decreases when interest rates increase. Finally, the insignificant effect of foreign exchange reserves on the exchange rate is consistent with the literature (Aizenman, Marion 2004; Calvo, Leiderman, Reinhart 1993), which suggests that the effect of reserves on the exchange rate may be limited from time to time, despite their function of preventing speculative attacks. This situation can also be explained by the fact that central banks, especially in these countries, generally direct reserves to external debt payments rather than creating a buffer against exchange rate fluctuations.

In order to provide guidance to policymakers, potential investors, and scholars, it is important to draw several conclusions from the results of the study. Accordingly, policymakers should pay attention to combating inflation to stabilize exchange rates. This is because price stability will limit the depreciation of the national currency and support economic stability. In addition, encouraging foreign direct investment, especially investment incentives for highly competitive sectors of countries, will contribute to exchange rate stability by increasing long-term foreign capital inflows to these countries. Furthermore, efforts should be made to improve foreign trade by implementing more export-oriented growth strategies to address the threat of current account deficits.

From the standpoint of investors, exchange rate dynamics constitute a critical component of investment decision-making processes. In this context, particular attention should be paid to the role of interest rate and inflation developments in shaping exchange rate movements, especially in the Fragile Five economies. Furthermore, the empirically observed positive association between foreign direct investment and exchange rates underscores the importance of effectively managing exchange rate expectations in these countries.

One limitation of this study is its empirical specification, which predominantly concentrates on domestic macroeconomic variables. While this methodology enables the isolation of country-specific fundamentals, it is important to acknowledge that exchange rate dynamics in emerging market economies are also shaped by global financial conditions. Specifically, factors such as US interest rates, global risk indicators (e.g. VIX), and commodity price movements may significantly affect exchange rate fluctuations. Future research could enhance the current analysis by incorporating these global variables to offer a more comprehensive understanding of exchange rate dynamics in the Fragile Five economies.

For future research, examining the effects of exchange rate volatility on financial markets across different time horizons – particularly during periods of economic and financial crises – would allow for more robust and comprehensive insights. Additionally, further investigations should explore the interaction between exchange rate movements and fundamental macroeconomic indicators associated with economic stability. Expanding the set of variables and employing alternative analytical methodologies in subsequent studies would enhance the depth of analysis and provide more informative guidance for both policymakers and investors. The findings demonstrate that FDI inflows increase demand for foreign currency, while increases in the net trade balance may exert depreciation pressure on the domestic currency. Inflation and high policy rates reduce currency value, reflecting both short-term market responses and structural economic pressures. These insights provide actionable guidance for policymakers aiming to stabilize exchange rates and for investors evaluating currency risk in emerging markets.

Overall, the findings of this study provide important insights into the macroeconomic determinants of exchange rate dynamics in financially vulnerable emerging economies. By focusing

on the Fragile Five countries and employing a long-term empirical framework, the study contributes to the literature on exchange rate vulnerability in emerging markets. The results highlight the importance of macroeconomic stability, particularly with regard to inflation control, sustainable capital inflows, and prudent monetary policy implementation, in mitigating exchange rate instability.

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Appendix

Table 1
Definitions and descriptive information of variables

Variable	Definition	Data source	Period
EXC	Exchange rate	Eikon, Datastream	1990–2023
FDI	Foreign direct investments	Eikon, Datastream	1990–2023
CAB	Current account balance	Eikon, Datastream	1990–2023
INF	Inflation rate	Eikon, Datastream	1990–2023
RES	Reserves	Eikon, Datastream	1990–2023
NTD	Net trade	Eikon, Datastream	1990–2023
INT	Interest rates	Eikon, Datastream	1990–2023

Table 2
Pairwise correlation matrix of the variables

	EXC	CAB	NTD	FDI	RES	INT	INF
EXC	1.00						
CAB	0.23	1.00					
NTD	0.29	0.57	1.00				
FDI	0.15	-0.35	-0.32	1.00			
RES	0.07	0.12	-0.09	0.31	1.00		
INT	-0.37	0.04	-0.05	-0.34	-0.18	1.00	
INF	-0.30	0.09	0.10	-0.14	-0.07	-0.09	1.00

Note: the table reports pairwise correlation coefficients among the variables used in the empirical analysis.

Table 3
Empirical evidence on multicollinearity: VIF statistics

Variable	VIF	1 / VIF
CAB	3.07	0.325254
NTD	2.89	0.345588
FDI	1.50	0.668844
RES	1.31	0.761186
INT	1.21	0.823462
INF	1.04	0.957004
Mean VIF	1.84	

Table 4
Panel data diagnostics: dependence across cross-sections and slope homogeneity

Variables	LM_{adj} test (Pesaran, Ullah, Yamagata 2008)	CD (Pesaran 2015)
Panel A: evidence on cross-sectional dependence		
EXC	58.55 (0.000)	16.258 (0.000)
FDI	27.75 (0.000)	13.696 (0.000)
CAB	9.222 (0.000)	3.771 (0.000)
INF	7.85 (0.000)	6.480 (0.000)
RES	28.78 (0.000)	4.901 (0.000)
NTD	14.21 (0.000)	4.667 (0.000)
INT	27.14 (0.000)	6.354 (0.000)
Panel B: homogeneity test of Pesaran and Yamagata (2008)		
Δ	3.758 (0.000)	
Δ_{adj}	4.297 (0.000)	

Note: figures in brackets represent p-values of test statistics.

Table 5
Stationarity assessment based on unit root tests

Variables	CADF			MADF	
	t-bar	Z[t-bar]	Prob.	Test statistic	Critical value (5% significance level)
EXC	-3.325	-3.674	0.000	135.562	25.463
FDI	-2.728	-2.927	0.000	32.699	25.463
CAB	-2.849	-2.542	0.000	50.101	25.463
INF	-2.812	-2.962	0.000	77.921	25.463
RES	-3.936	-5.128	0.000	129.681	25.463
NTD	-2.748	-2.935	0.000	58.306	25.463
INT	-2.133	-2.609	0.000	35.207	25.463

Note: the Pesaran CADF test has statistical significance levels of 90% (cv10), 95% (cv5), and 99% (cv1), with corresponding critical values of -2.210, -2.330, and -2.550, respectively.

Table 6
Diagnostic tests for panel data

Panel A: unit and/or time effects test		
Model I	Test statistic	Prob.
F test	231.22	0.000
Panel B: Hausman test		
Model I	Test statistic	Prob.
Hausman test	67.68	0.000
Panel C: heteroskedasticity test		
Model I	Test statistic	Prob.
Modified Wald test	3148.80	0.000
Panel D: autocorrelation test		
Model I	Test statistic	Prob.
Modified Bhargava, Franzini, Narendranathan (1982) D-W	0.6717	< 2
Baltagi-Wu (1999) LBI	0.8334	< 2
Panel E: evidence on dependence across cross-sections		
Model I	Test statistic	Prob.
Breusch-Pagan LM	24.407	0.000

Table 7
Driscoll-Kraay panel regression estimation results

Variables	Coefficient	Driscoll-Kraay standard error	t-statistic	Prob.
FDI	0.4322831*	0.0966581	4.47	0.000
CAB	-0.4079155*	0.1313863	-3.10	0.004
INF	-0.2547122*	0.0828031	-3.08	0.004
RES	-4.25e-12	2.96e-12	-1.44	0.160
NTD	0.5855686*	0.2050706	2.86	0.006
INT	-2.79152**	1.27739	-2.19	0.010
Dependent variable	EXC			
Method	Panel fixed effects estimator			
Period	1990–2023			
Number of cross--sections (country)	5			
Total observations	170			
F-test	9.37			
Prob. > F	0.000			
R^2	0.5555			

Note: the symbols * and ** correspond to significance levels of 1% and 5%, respectively.

Wpływ polityki pieniężnej i przepływów kapitału na zmienność kursu walutowego: empiryczna analiza sytuacji krajów Kruchej Piątki

Streszczenie

Grupa krajów tzw. Kruchej Piątki (The Fragile Five) obejmuje pięć kluczowych rynków wschodzących: Brazylię, Indie, Indonezję, Republikę Południowej Afryki i Turcję. Gospodarki rynków wschodzących są szczególnie wrażliwe na globalne zawirowania finansowe ze względu na ich strukturalne cechy, takie jak: utrzymująca się nierównowaga na rachunku obrotów bieżących, presja inflacyjna, wysoka wrażliwość na szoki zewnętrzne oraz rosnący popyt na finansowanie zewnętrzne. W związku z tym kurs walutowy (EXC), jako „łącznik" pomiędzy wewnętrznym położeniem kraju a jego otoczeniem, odgrywa kluczową rolę w kształtowaniu stabilności makroekonomicznej i kondycji finansowej.

Literatura przedmiotu zawiera wiele informacji na temat czynników determinujących zmiany kursów walutowych w gospodarkach rynków wschodzących. Liczne badania podkreślają znaczenie zróżnicowania stóp inflacji i polityki stóp procentowych oraz wskazują na rolę sald na rachunkach obrotów bieżących, bezpośrednich inwestycji zagranicznych i rezerw walutowych. Badania empiryczne dają jednak wynik niejednoznaczny, szczególnie jeśli chodzi o kierunek wpływu poszczególnych czynników na kurs walutowy w gospodarkach wschodzących. Niektóre badania podkreślają stabilizującą rolę napływu kapitału, inne z kolei zwracają uwagę na destabilizujący wpływ nierównowagi zewnętrznej i presji inflacyjnej. Dlatego ze względu na podobieństwo strukturalne krajów Kruchej Piątki i ich znaczny udział w światowym obrocie towarowym warto się przyjrzeć typowemu dla tej grupy krajów mechanizmowi kształtowania kursu walutowego.

Podstawowe pytanie badawcze brzmi: które czynniki makroekonomiczne w sposób systemowy i systematyczny wpływają na zmienność kursów walutowych w krajach Kruchej Piątki? Celem badania jest określenie kierunku i skali wpływu na kurs walutowy następujących zmiennych: bezpośrednich inwestycji zagranicznych (FDI), obrotów netto towarami i usługami (NTD), sald na rachunkach obrotów bieżących (CAB), stóp inflacji (INF), stóp procentowych (INT) i rezerw walutowych (RES).

Analiza empiryczna zakłada weryfikację kilku hipotez. Po pierwsze, oczekuje się, że inwestycje zagraniczne będą wywierać pozytywny wpływ na kurs walutowy. Do kraju napływają bowiem obce waluty i rośnie popyt na krajowe aktywa. Po drugie, zakłada się, że pogorszenie sald na rachunkach obrotów bieżących spowoduje deprecjację waluty krajowej, co jest zgodne z klasyczną teorią bilansu płatniczego. Po trzecie, oczekuje się, że wyższa inflacja osłabi walutę krajową poprzez mechanizm parytetu siły nabywczej. Po czwarte, zakłada się, że stopy procentowe wpływają na kurs walutowy za pośrednictwem przepływu kapitału i parytetu stóp procentowych. Po piąte, oczekuje się, że dynamika handlu netto wpłynie na kurs walutowy w wyniku zmiany popytu na waluty obce. Wreszcie zakłada się, że rezerwy dewizowe, generalnie rzecz biorąc, stabilizują ruchy kursu walutowego, chociaż ich skuteczność w gospodarkach wschodzących może być ograniczona ze względu na ich strukturalną niestabilność. Hipotezy te wynikają zarówno z teoretycznych modeli, jak i wcześniejszych, empirycznych ustaleń, które biorą pod uwagę strukturalną nierównowagę w krajach Kruchej Piątki. Do przeprowadzenia empirycznej weryfikacji hipotez w odniesieniu do Brazylii, Indonezji, Indii, Turcji i RPA wykorzystano model regresji panelowej oraz dane panelowe za przeszło

dwudziestoletni okres od 1990 do 2023 r. Dane pochodzą z Refinitiv Eikon i Datastream, co zapewnia ich spójność i wiarygodność w różnych krajach i okresach.

Wyniki analizy empirycznej pokazują, że bezpośrednie inwestycje zagraniczne oraz saldo obrotów netto towarów i usług wywierają pozytywny i statystycznie istotny wpływ na poziom kursu walutowego. Z kolei saldo na rachunku obrotów bieżących, stopa inflacji i stopa procentowa wywierają statystycznie istotny negatywny wpływ na kurs walutowy. Wyniki te są zgodne z oczekiwaniami teoretycznymi i podkreślają negatywną rolę deficytów zewnętrznych, presji inflacyjnej i restrykcyjnych reguł monetarnych. Z kolei rezerwy walutowe nie wykazują statystycznie istotnego wpływu na wahania kursu walutowego, co sugeruje, że ich zdolność stabilizująca może być ograniczona w przypadku utrzymującej się nierównowagi zewnętrznej w gospodarkach wschodzących. Ogólnie rzecz biorąc, model wyjaśnia około 56% zmienności kursu walutowego w krajach Kruchej Piątki, co można uznać za wynik zadowalający.

Słowa kluczowe: dynamika kursów walutowych, regresja panelowa, Krucha Piątka, polityka pieniężna, przepływy kapitałowe