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The Nexus between USD Parity and Trade Balance of BRICS-T Countries

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Amerikan Doları Paritesi ile BRICS-T Ülkelerinin Dış Ticaret Dengesi Arasındaki İlişki

Öz

Zaman serisi modelleri aracılığıyla ticaret dengesi ve döviz kuru pariteleri arasındaki bağlantıya odaklanan önceki birçok çalışmanın aksine, bu çalışmada çoğunlukla BRICS-T ülkeleri için panel veri modelleri uygulanmıştır. Ticaret dengelerinin USD/yerli para birimi paritesine karşı karşılaştırmalı varyansları ortaya çıkarılıp en duyarlı olan ülkeler Brezilya, Türkiye ve Rusya olarak bulunmuştur. Panel EGLS analizine göre aynı paritenin ticaret dengesi üzerinde kısa vadede önemli olmayan bir olumsuz etkisi olmuştur. FMOLS sonucuna göre, uzun vadeli anlamlı etki bulunmuştur. Panel VAR ve VECM genelleştirilmiş etki tepki analizi, USD/yerli para birimi paritesinin BRICS-T'nin ticaret dengesi üzerindeki olumsuz etkisini ortaya çıkarmıştır. J-eğrisi analizlerde kısa süreliğine gözlemlenmiştir.

Anahtar Kelimeler: Döviz Kuru, Ticaret Dengesi, Panel Veri Analizi, j-Eğrisi, Dalgacık Analizi

JEL Kodları: F30, F40, B23

The Nexus between Usd Parity and Trade Balance of BRICS-T Countries

Abstract

Unlike many previous studies that focused on the link between trade balance and exchange rate parities through time series models, panel data models were applied mainly to BRICS-T countries in this study. Comparative variances of trade balances against USD/local currency parity were revealed, and the most sensitive countries were Brazil, Turkey, and Russia. According to the panel EGLS analysis, the same parity had a non-significant negative impact on the trade balance in the short run. A significant long-term effect was found in the FMOLS analysis. Panel VAR and VECM generalized impulse response analysis revealed the negative impact of the USD/domestic currency parity on the trade balance of BRICS-T. The J-curve was observed briefly in the analyses.

Keywords: Exchange Rate, Trade Balance, Panel Data Analysis, j-Curve, Wavelet Analysis

JEL Codes: F30, F40, B23

Araştırma ve Yayın Etiği Beyanı	Bu çalışma bilimsel araştırma ve yayın etiği kurallarına uygun olarak hazırlanmıştır.
Yazarların Makaleye Olan Katkıları	Yazar 1'in makaleye katkısı %55, Yazar 2'nin makaleye katkısı %45'dir.
Çıkar Beyanı	Yazarlar açısından ya da üçüncü taraflar açısından çalışmadan kaynaklı çıkar çatışması bulunmamaktadır.

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1.Introduction

The exchange rate is a critical tool to consider in open economies, as it is a significant driver of countries' investments, trade, and economic policies. Nicita (2013) stated that the exchange rate significantly affects economic growth and relative currency valuations. Since any depreciation/appreciation of foreign currency directly affects the demand for goods, it has become a critical component of a country's economy in terms of foreign trade. From this vantage point, it is not surprising that the exchange rate is a primary subject of study in dozens of articles. Since the 1970s, as the floating exchange rate system evolved, the number of studies on the exchange rate and its effects has increased, and the reviews on this subject continue to this day. Whether caused by macroeconomic shocks or not, exchange volatility has significant implications for foreign trade, the balance of payments, and overall economic growth. Exchange rate parities are critical for exporters engaged in international trade in emerging economies. When exporters use USD-priced raw materials and the local currency depreciates rapidly against the USD, the cost of the raw materials may increase; even exporters may gain a competitive edge with a cheaper currency. Additionally, the rapid appreciation of the USD relative to local currencies can increase overhead costs such as energy costs, resulting in exporters losing their competitive edge. Exchange rate movements are critical for factories and for emerging countries' tourism sectors. Because both goods and services are included in the current account of the balance of payments, service sector exports are also critical to a countries' trade balance. A strong overvaluation of the US dollar against the local currency could significantly impact the tourism sector's revenue.

Moreover, the volatility of exchange rates can have a substantial impact on service sector exports. According to Cheung and Sengupta (2013), currency appreciation had a substantial negative impact on non-financial firms in India. Broll et al. (2020) used panel quantile regression analysis to examine 85 non-financial service firms in India between 2004 and 2015. They discovered that all Indian (non-financial) service sector firms appeared to have a positive correlation between their export performance and changes in the expected exchange rate, but a negative relationship with changes in exchange rate volatility. It can be indicated that many Indian non-financial service firms position themselves against the expected exchange rate, but they are not ready for a volatile market environment. Exchange rate volatility is a vital problem for emerging countries' economies. Some businesses benefit from the low-cost currency in international markets. If exchange volatility increases rapidly, business costs may rise, and firms may even go insolvent. As a result of increased globalization, the BRICS have developed into a significant source of global growth and political influence. The BRICS economies have expanded rapidly, with their share of global GDP increasing from 11% in 1990 to nearly 30% in 2014.The BRICS countries account for more than 40% of the world's population, hold more than US $4 trillion in reserves, and account for more than 17% of global trade (Mminele, 2016). The primary factors contributing to the BRICS's economic expansion were increased factor input and enormous population and resource scales (Radulescu et al., 2014). Many goods are manufactured by companies in emerging economies, which are heavily concentrated in China. Given China's importance as a global manufacturing hub, changes in the USD/Yuan parity significantly impact the global economy. China is critical for emerging economies, but so are Russia, Brazil, India, and South Africa (BRICS). Moreover, Turkey is also a newly emerging country and a potential candidate for the BRICS organization. Given the BRICS-T countries' growing importance in the global economy and having more intense trade relations with developed countries, analyzing the impact of exchange rates on emerging countries' trade balances is critical in today's context. Developing markets are also dynamic and strive to expand their economies through increased exports. In addition, developing countries import a sizable amount of goods and services from abroad. The volatility of emerging countries' currencies against the US dollar can have an asymmetrical effect on emerging countries' trade balances. In other words, price changes can have a different effect on export revenues and import costs. Because the US dollar is the reference currency for international trade pricing, fluctuations in the USD's exchange rate against emerging-market currencies may cause a shift in the price elasticity of demand. The changes could have a direct effect on export revenue. Some emerging economies' trade balances may benefit in the long run from the strengthening dollar; others may not. Because the BRICS-T countries are critical representatives of emerging economies, those countries can be analyzed in this research.

The primary goal of this study is to add to the existing knowledge regarding the effects of exchange rate changes on the trade balances of the BRICS-T (Brazil, Russia, India, China, and the Republic of South Africa, Turkey) panel dataset from 2010 to 2019. Along with panel data analysis, variance decomposition will be used to deduce the trade balance variance of the BRICS-T countries. The unstable economies will be identified, and wavelet analysis will be used to conduct in-depth research on the USD/domestic currency parity and trade balance between 2010 and 2020. As a result of the coronavirus pandemic, abnormal exchange rates and trade balances of unstable economies can be observed. In other words, datasets may contain structural break inconsistencies. Wavelet analysis will also be implemented to observe the abnormal behavior of the unstable economies' USD/domestic currency parities and trade balances during the coronavirus period.

The following is the organization of the research. The second part will include a theoretical framework. The third part will cover literature review and contribution of the research. The fourth section consists of a data description and interpretation. Moreover, the fifth and sixth section will contain a research plan and methodology section consecutively. The article will be completed with a conclusion section that intensely focuses on policy implications.

2. Theoretical Framework

The relationship between the exchange rate and the foreign trade balance is mainly shown in the literature with the Marshall-Lerner condition shown by Marshall (1923), Lerner (1944), and the associated J-Curve effect by Magee (1973).

Marshall-Lerner Condition: The total supply and demand elasticity of exported and imported goods should be greater than 1 for the foreign trade balance changes caused by devaluation to be positive (ex+em> 1). The improvement in the international trade balance after the devaluation may not occur immediately because many studies conclude that the Marshall-Lerner condition is met not in a short time but for a long time. The J-Curve expresses this situation because demand is not more flexible in the short-term than in the long-term.

J-Curve Hypothesis: The J-Curve model, put forward by Stephen Magee (1973), states that, depending on the Marshall-Lerner condition, exports may not increase immediately until the local currency is depreciated in foreign currency (exchange rate transition period) in the short term. Thus, the decrease in the exchange rate increases the foreign trade deficit in the first stage. However, the uncertainty process disappeared due to the import and export segments' adaptation to the new exchange rates (Kenen, 1989). Since the value of the local currency diminished due to the previous import and export agreements, the demand for exported goods augments while the demand for imports decreases. Therefore, the foreign trade balance evolves into a positive process (Krugman et al., 2012). Many studies have focused on the impact of the exchange rate on the trade balance in this context. Any change in the nominal exchange rate is assumed to directly affect a country's foreign trade balance in the literature; it is stated that the country could adhere to the devaluation to help improve the trade balance to gain international competitiveness, thereby limiting imports and contributing to the increase in exports (Himarious, 1989).Some studies (Warner and Kreinin, 1983; Houthakker and Magee, 1969; Li and Wang, 2019) have expanded in the context of the Marshall-Lerner condition and found positive reflections of the long-term devaluation in the country's foreign trade balance. Studies (Wilson, 2001; Wang et al., 2012; Mustafa et al., 2015; Bahmani-Oskooee et al., 2018) found a partial exchange rate effect on the foreign trade balance.

Numerous studies examined the impact of the exchange rate on the trade balance for emerging countries. The relationship between the exchange rate regime and the trade balance was investigated by Gomes and Paz (2005). The period of 1990-1998 was chosen for analysis. The Marshall-Lerner condition and the J-curve phenomenon were tested using the VECM model to evaluate the relationship. The results show that the Marshall-Lerner condition holds true, and that the J-the curve will appear after Brazil's real exchange rate depreciation. Bahmani-Oskooee and Wang (2006) investigated China's trade ties with its 13 trading partners. A time series model was used in the research, and the findings show that the depreciation of the Chinese currency has a positive impact on trade with some nations, including the United States. Nevertheless, not much support was found for the J-curve hypothesis. Using a panel dataset from 2005 to 2009, Chun-Hsuan Wang et al. (2012) investigated the short-run J-Curve hypothesis and the long-run trade balance impact of the real exchange rate between China and its eighteen major trading partners. The inverted J-curve hypothesis between China and its trading partners is supported by empirical evidence. Furthermore, real RMB appreciation has a long-run negative impact on China's trade balance with just three of the eighteen trading partners. In comparison, it has a long-run positive impact on five of the eighteen trading partners. As a result of these contradictory observations, empirical evidence suggests that the real appreciation of the RMB has no overall long-term effect on China's trade balance. Singh (2004) investigated the J-curve hypothesis and the impact of conditional exchange rate fluctuations on India's trade balance. The exchange rate is calculated in terms of the trade and export weighted real effective exchange rate in the research model, based on quarterly data from 1975 to 1996. According to the research, there is no proof of the J-curve's impact on the balance of trade. Chiloane et al. (2014) investigated whether the J-curve effect occurs in the South African manufacturing sector and whether the Marshall Lerner condition exists. Quarterly data from 1995 to 2010 was chosen for the analysis, and vector error correction modeling and impulse response functions were used to achieve the research goals. Overall, the findings indicate that a depreciation in the domestic currency causes a short-term decline in the manufacturing trade balance, accompanied by a long-term recovery. The J-curve is found to occur in the South African manufacturing sector, according to the research. The Marshall–Lerner condition appears to hold in the long run. Using a bound testing approach to cointegration and error-correction modeling for January 1990-June 2005, Bahmani-Oskooee and Kutan (2009) unearthed that Russia is one of the countries with a J-curve tendency among 11 East European economies. Halicioglu (2008) used quarterly time series data from 1985 to 2005 to examine Turkey's bilateral J-curve dynamics with 13 trading partners. The bounds cointegration research methodology and error correction modeling is used to estimate the short and long run impacts of the weakening of the Turkish lira on the trade balance between Turkey and her 13 trading partners. The empirical findings show that while there is no J-curve effect in the short run, the real depreciation of the Turkish lira positively impacts Turkey's trade balance.

3. Literature Review and Contribution of the Research

In the literature, some studies focused on the impact of exchange rate variations on the change in exports of countries. Kamal (2015) employed a variety of econometric techniques to empirically examine whether the devaluation of 33 countries (mainly emerging countries) currencies affected changes in exports of major items over 25 years (1987–2011). Kamal (2015) indicated that the devaluation of currencies results in a decrease in exports rather than an increase. Thus, countries should pursue an appropriate policy of currency appreciation rather than depreciation to promote exports (Kamal, 2015). Vieira and Macdonald (2016) discovered that an increase (decrease) in real effective exchange rate volatility between 2000 and 2011 reduced (increased) export volume using panel data analysis for 106 countries and a subset of emerging economies. Schaling and Kabundi (2014) discovered that for the period 1994–2011, there is strong statistical proof that a weaker real effective exchange rate boosts net exports in the long run. This effect, however, does not hold in the short run. Thus, empirical support identified the J-curve effect in South Africa. Using a panel of 25 years of quarterly data, Chit et al. (2010) found that currency volatility had a detrimental effect on the exports of five emerging East Asian economies (China, Indonesia, Malaysia, Philippines, Thailand). Real exchange rate volatility has been proven to have a major impact on overall Chinese exports, operating at both the extensive and intensive margins of trade (Qiu et al., 2020).

In addition, in the literature, many studies analyze the impact of exchange rates on individual countries' changes in trade balances. Akbostanci (2004) examined the J-curve in Turkish data from 1987 to 2000 using quarterly data. An error correction model was estimated to distinguish between long-run equilibrium and short-run dynamics. The trade balance response to real exchange rate shocks was examined using the generalized impulse response technique. According to the findings, the Turkish lira's depreciation improved the country's trade balance. Thus, the author mentioned that the Marshall Lerner condition holds for Turkish data. It can be indicated that Turkey's trade balance benefited from the Turkish lira's depreciation. In addition, for the period between February 1996 and April 2017, Bhat and Bhat (2021) mentioned that when the currency appreciates, the trade balance of India deteriorates in the short run. It does, however, improve with the depreciation of the currency. In the long run, it was discovered that appreciation deteriorates the trade balance statistically insignificantly, whereas depreciation improves it statistically significantly. The authors mentioned that, in the long run, India's trade balance benefits from rupee depreciation. Alemu and Lee (2014) examined the impact of depreciation on the trade balances of 14 Asian economies and concluded that there is no evidence that depreciation improves trade balances. Nevertheless, when they restricted the analysis to eight Asian countries with relatively large, industrialized, and stable economies, they found that depreciation improved the trade balance of the second group of countries. Arize et al. (2017) discovered that, in the long run, currency depreciation enhances the trade balance of China, Israel, Korea, Malaysia, Pakistan, the Philippines, Russia, and Singapore. Zhang and Macdonald (2014) discovered a significant relationship between real exchange rates and trade balances using panel data from 23 OECD countries and four less developed economies. Additionally, they stated heterogeneity in the relationship between real exchange rates and the trade balance between emerging market economies and OECD countries. According to past research results, there are mixed results regarding the relationship between the exchange rate and the trade balance.

Furthermore, many researchers focused on the long-term relationship between the exchange rate and the trade balance. Arize (1994) used newly developed cointegration methodologies to examine the long-run relationship between the real effective exchange rate and the trade balance in nine Asian economies from 1973Q1 to 1991Q1. The findings imply that a long-run positive "statistical equilibrium" between the trade balance and the real effective exchange rate unfolds in Asia. In addition, Arize et al. (2017) mentioned a statistically significant long-run relationship between the trade balance and the real effective exchange rate for China, Israel, Korea, Malaysia, Pakistan, the Philippines, Russia, and Singapore. Using the ARDL approach, Jadoon and Guang (2019) discovered that the exchange rate had a long-term positive and significant link with Pakistan's trade balance. Iyke and Ho (2017) found evidence of exchange rate fluctuations having a long-term nonlinear effect on Ghana's trade balance. Wang et al. (2012) demonstrated that real RMB appreciation has no overall long-run impact on China's trade balance using a panel dataset from 2005 to 2009. In the case of Nigeria, Igue and Ogunleye (2014) discovered that exchange rate depreciation had a long-term positive impact on the trade balance. In addition, some scholars researched the long-term relationship between trade balances and exchange rates with other countries. For example, the relationship between Laos' trade balance and its real exchange rate with Thailand was analyzed by Kyophilavong et al. (2018). They discovered that the trade balance and the real exchange rate have a cointegrated relationship.

The studies mentioned above mainly concentrated on country-based time series analysis. Many scholars have researched the short and long-term association between exchange rates and the trade balance of emerging countries. However, with panel data analysis, no study has analyzed the BRICS-T countries. Moreover, in the literature, panel cointegration analyses between the exchange rate and the trade balance of emerging countries are not adequate. Panel impulse response analyses of emerging countries regarding the relationship between exchange rates and trade balances are also inadequate. The primary justification for our research is to fill out those gaps. The findings of this research can add new dimensions to future studies in the literature and serve as a foundation for future analysis of the trade balance/exchange rate relationship, particularly for emerging economies.

4. Data Description and Interpretation

In the research, the dependent variable is the trade balance. The main independent variable is USD/domestic currency parity. Five control variables will be used.

Trade Balance: The difference between the monetary value of a country's imports and exports over a given time is referred to as the balance of trade (BOT), also known as the trade balance. A trade surplus is indicated by a positive trade balance, whereas a negative trade balance shows a trade deficit. The BOT is a crucial factor in figuring out a country's current account balance (Corporate Finance Institute). Trade balance data was retrieved from the Trade Map database.

USD/Domestic Currency Parity: This variable shows the value of the local currency against the USD. Since global trade is mainly made in USD, the change in USD against emerging countries' currencies can significantly impact the developing countries' economies. The USD/domestic currency parities were retrieved from the St. Louis Federal Reserve database.

GDP Per Capita: This measure depicts the total value of all goods and services produced by a country each year divided by the number of people. The data was retrieved from the World Bank database.

Gross Capital Formation (Gross Domestic Investment): According to the World bank definition, investments on additions to the economy's fixed assets and net changes in the stock of inventories comprise gross capital formation (gross domestic investment). Land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and similar structures, such as schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings, are all examples of fixed assets (World bank). Fixed asset investments and net changes in inventories can directly influence the export and import processes of countries. Gross capital formation data were collected from the World bank database.

Final Consumption Expenditure (Domestic Demand): According to Eurostat, final consumption expenditure refers to products and services purchased by resident institutional units, such as households and businesses, with their main economic center of interest in that economic region to meet individual or collective requirements. It can be indicated that final consumption expenditure is equivalent to total domestic demand. Some countries can increase their demand for local goods and services or imported goods or services. Changes in final consumption can have an essential role in the shift in the import and export statistics. An increase in total expenditure can lead imported goods and services to increase and vice versa.

Global demand factors directly influence the country's exports. When BRICS-T countries' data are analyzed in the World Bank database, good exports constitute the highest proportion of total exports. Thus, goods exports data were not used for the control variable. Since high technology exports and service sector exports are not significant components of BRICS-T's total exports, those variables were chosen as control variables.

High Technology Exports: That variable shows the aggregate exports of high technology goods and services. Total high technology exports of BRICS-T countries were collected from the World bank database.

Service Sector Exports: That variable indicates the total exports of the service sector. The data were retrieved from the World Bank database.

5. Research Plan

Before implementing econometric methods, the research roadmap will be based on the given research questions step-by-step.

Research Question 1: How do BRICS-T countries' trade balances respond to USD change compared to local currencies? In research question 1, the objective is to determine the most volatile economies. After selecting the most volatile economies, wavelet analysis will be implemented.

Research Question 2: According to wavelet analysis, what is the trend of trade balances and USD/domestic currency parity between 2010-2020 for the most volatile countries in variance decomposition analysis? Are there any abnormal changes during the coronavirus period?

Research Question 3: Do panel data of USD/domestic currencies parities of BRICS-T countries have a crucial influence on the change in the trade balance of the BRICS-T countries panel dataset between 2010-2019?

Research Question 4: Are there long-term relationships between USD/domestic currency parity and trade balance for BRICS-T countries' panel dataset and any countries in BRICS-T?

Research Question 5: Did USD/domestic currency parity have a significant long-term impact on the change in trade balance for BRICS-T countries panel dataset?

Research Question 6: When the research questions 3,4,5 are combined, is there any J-curve trend for BRICS-T countries panel dataset?

Research Question 7: According to panel VAR impulse response analysis and panel VECM generalized impulse response analysis, what is the one standard positive innovation impact of USD/domestic currency parity on the change in trade balance of BRICS-T countries? Is there a J-curve trend for the panel dataset of BRICS-T countries?

In the first stage of the research, variance decomposition of the trade balance of BRICS-T (Brazil, Russia, India, China, South Africa, Turkey) will be implemented. After implementing variance decomposition analysis, wavelet analysis will be used for USD/domestic currency parity and trade balance of the most volatile economies to USD changes against domestic currencies. Moreover, after using wavelet analyses, panel data analysis techniques will be utilized for BRICS-T countries.

6. Methodology

In the methodology section, time series analysis techniques and mainly panel data analysis techniques will be implemented. For time series analysis, variance decomposition analysis and wavelet analysis will be applied. For panel data analysis, panel EGLS, FMOLS, Pedroni cointegration test, Johansen Fisher panel cointegration analysis, and panel impulse response analysis will be implemented for the panel data set of BRICS-T countries. The FMOLS test will be applied in accordance with the results of long-term relationship tests.

6.1. Variance Decomposition Analysis

Variance decomposition analysis is a method that distinguishes the impact of independent variables on dependent variables' variances. The main objective of that section is to determine how USD/domestic currencies parities alone influence trade balance variances of BRICS-T countries.

Moreover, it was found that the trade balance variance of Brazil is the highest. The USD/Brazil Real alone explains the 62,94% variance of Brazil's trade balances between 2010-2020. Moreover, Turkey is in the second rank. The USD/TL parity alone explains the 60,97% variance of Turkey's trade balances between 2010-2020. Russia is in third rank. The USD/Ruble alone explains the 33,50% variance of trade balance of Russia between 2010-2020 (Annex A.1.). Since Brazil, Turkey, Russia, and South Africa's trade balances are highly connected to the USD, wavelet analysis was implemented to find the more detailed volatilities of the USD/domestic currencies parity and trade balance of these four countries.

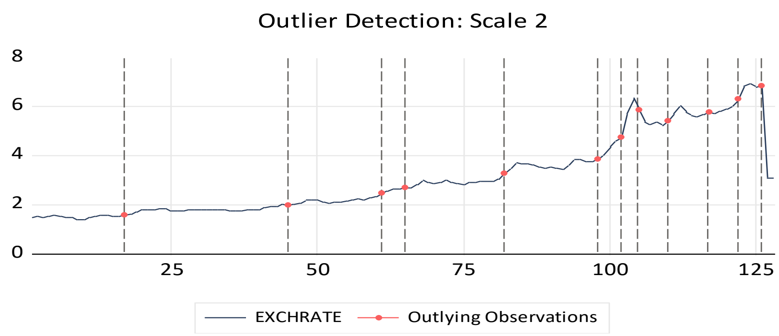
6.2. Wavelet Analyses: Application of Wavelet Outlier Detection and Discrete Wavelet Transform Technique

Brazil, Turkey, Russia, and South Africa's trade balance variances to USD changes were highest compared to other countries. Wavelet analysis will be implemented to analyze those countries' trade balances and exchange rates (USD/domestic currencies). Wavelet analysis can classify data into distinct categories by diagnosing the data shifts caused by various waves. Wavelet outlier detection and discrete wavelet transform techniques were employed in that analysis.

Wavelet outlier analysis can be used to identify data that has undergone an abnormal shift. Discrete wavelet transform techniques can detect standard deviation boundaries, and this analysis can determine whether data changes exceed the standard deviation threshold levels. Since currency values can fluctuate abnormally, an outlier detection method will be used to diagnose changes in the parity between the USD and domestic currencies. Compared to other scales, ideal scales were chosen to diagnose more abnormal volatilities.

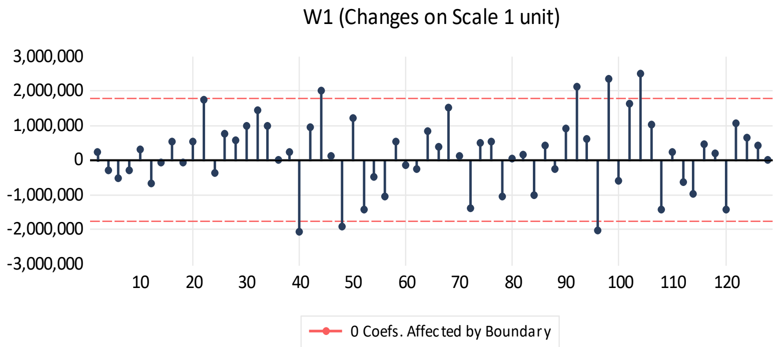
When wavelet outlier detection with scale two (Figure 1) is applied to the USD/TL parity, it becomes clear that the Turkish Lira had been a highly volatile currency between 2010 and 2020. The Turkish Lira has been more volatile in recent years, particularly from 2018 to 2020. Since the Turkish lira interest rate is more than the USD interest rate, the Turkish Lira can lose value rapidly. When the Turkish Lira is compared with other emerging economies' currencies in wavelet analysis, it can be observed that the Turkish Lira is the most volatile. Economic factors led the Turkish Lira to plummet against the USD swiftly, but political decisions also heavily influenced the Turkish Lira. For example, due to the Pastor Brunson Trial (2018) in Turkey, the Trump administration increased the import taxes on some Turkish goods. That political action led the Turkish Lira to depreciate rapidly against the USD in 2018. Moreover, the interest rate volatility in Turkey is high. That circumstance also causes the Turkish Lira to depreciate against the USD Dollar. In addition, the Turkish Lira is a fragile currency in the global economy. When the global economy gets into crisis, the Turkish Lira depreciates against the USD Dollar. The Turkish Lira also strictly depends on the Federal Reserve Bank's monetary policy decisions. For example, when the Federal Reserve Bank increased the interest rate, the Turkish Lira diminished against the USD Dollar. To sum up, systematic risks in the global economy can lead the Turkish Lira to diminish against the major currencies, such as the USD Dollar. Due to economic and political reasons, outlier detection lines (between 2018-2020) became narrower compared to previous periods (2010-2017).

Figure 1. Outlier Detection of USD/TL parity-(2010 to 2020)



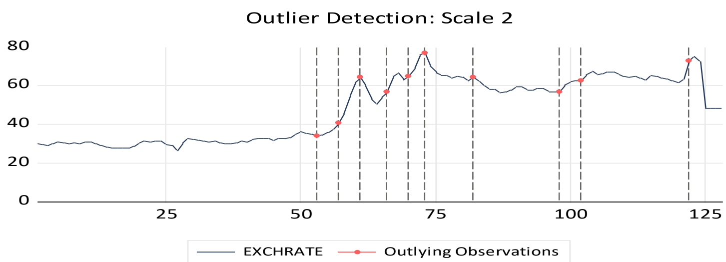
Turkey's trade balance was analyzed using the discrete wavelet transform technique (Figure 2). At the beginning 2010s, there was no intense change in Turkey's trade balance. When the time passes, Turkey's trade balance volatility is in both positive and negative directions. In some periods, the negative changes surpassed the threshold limit, which is the red line. Slight negative trade balance changes are also observable. On the other hand, at some phases, Turkey's trade balance has shifted significantly in favor of the positive direction. Even the increase in Turkey's trade balance can exceed the red line. Moreover, when the coronavirus time was analyzed in the discrete wavelet transform analysis technique, it can be mentioned that the coronavirus period did not strictly influence the trade balance of Turkey.

Figure 2. Discrete Wavelet Transform Analysis on Turkey's Trade Balance-(2010 to 2020)



The wavelet outlier detection methodology with scale three was applied to the USD/Russian Ruble parity (Figure 3). It is possible to conclude that the Russian Ruble is a volatile currency between 2010-2020. In the outlier detection analysis, there was no intense change in USD/Ruble parity until 2014. When Russia did the military intervention in Crimea, the Russian Ruble diminished fast against the USD Dollar, and the distance between outlier detection lines decreased. After the war, at some periods, such as 100, Russian Ruble depreciated against the USD. Moreover, the Russian Ruble does not exhibit high volatility against the USD during the coronavirus period. When the USD/Russian Ruble parity is analyzed for the period between 2010-2020, it is possible to observe that the Russian Ruble's volatility increases at irregular intervals. Although the volatility was not severe, abnormal volatility tends to repeat itself. Due to Russia's military interventions, international sanctions were imposed on Russia. Additionally, volatile global oil prices contribute to the Russian Ruble's depreciation against the US dollar. When the global oil prices fell, the Russian Ruble weakened.

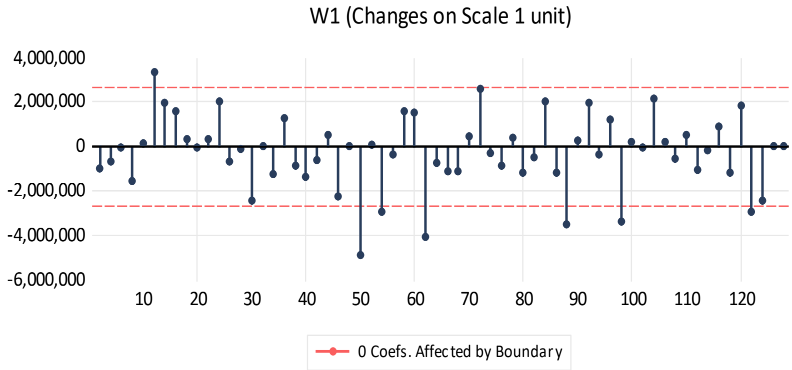
Figure 3. Outlier Detection of USD/Ruble Parity-(2010 to 2020).



Another significant factor contributing to the Ruble's depreciation against the USD is Russia's interest rate policy. Since Russia's interest rates are higher than those in the United

States, the Russian Ruble has depreciated against the USD. According to the outlier detection result, it is probable that similar outlier detection tendencies can be observable in the future.

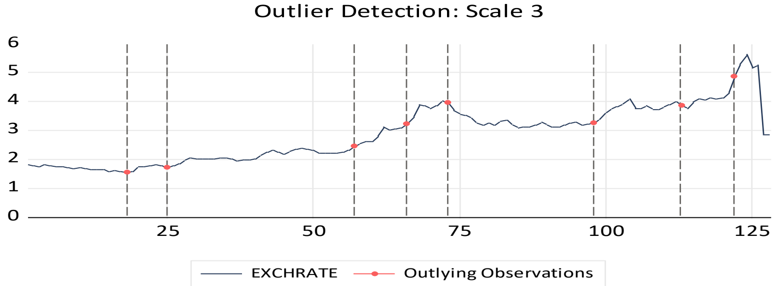
Figure 4. Discrete Wavelet Transform Analysis on Russia's Trade Balance-(2010 to 2020)



When Russia's trade balance is analyzed via the discrete wavelet of transform analysis, it can be mentioned that the volatility of Russia's trade balance change significantly decreased in the negative direction (period 50). Negative trade balance fast changes are also observable at some points after period 50. Moreover, slight positive changes can also be seen in the analysis results. Nonetheless, the positive change exceeds the threshold level (red line). When the analysis result is evaluated in aggregate, similar tendencies in terms of positive and negative changes are observable. Russia's trade balance appears to be improving; however, because negative abnormal changes occur occasionally, Russia's negative trade balance changes outnumber its positive trade balance changes between 2010 and 2020. Furthermore, the coronavirus period has negatively affected Russia's trade balance (Figure 4).

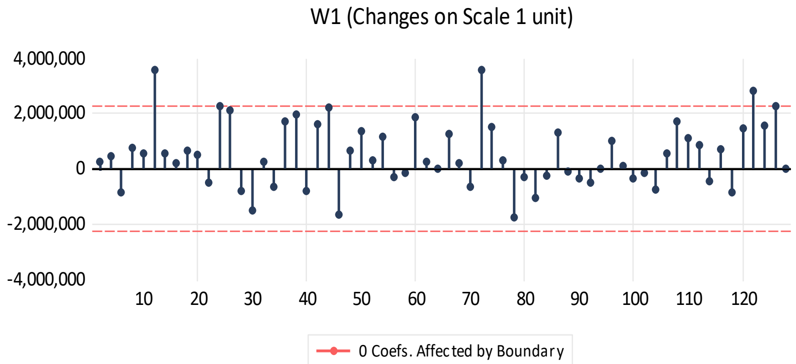
The wavelet outlier detection with scale three was applied to the USD/Real parity (Figure 5). It was observed that the Brazilian Real had been a volatile currency between 2010 and 2020. At the beginning of 2010, the USD/Brazil Real parity is not highly volatile. Between the period 50-75, the USD/Real parity increased fast. After the period of 75, the volatility diminished, and USD/Real parity became more stable. After period 100, outlier detection points are observable, but the distance between outlier detections increased compared to previous outlier detection periods. Because Brazil is a developing country, Brazil Real is susceptible to global market influences. If international market participants lack confidence in emerging economies such as Brazil, they may sell the Reals and convert them to USD. Additionally, because Brazil's interest rate is higher than the US dollar, it is expected that the Brazilian Real will depreciate against the USD. Although Brazil's interest rates had been steadily declining, interest rates were increased in 2021. Increased interest rates may attract investors in the short term, but the Brazilian Real will likely depreciate against the USD in the long run due to that monetary policy.

Figure 5. Outlier Detection of USD/Real Parity- (2010 to 2020)



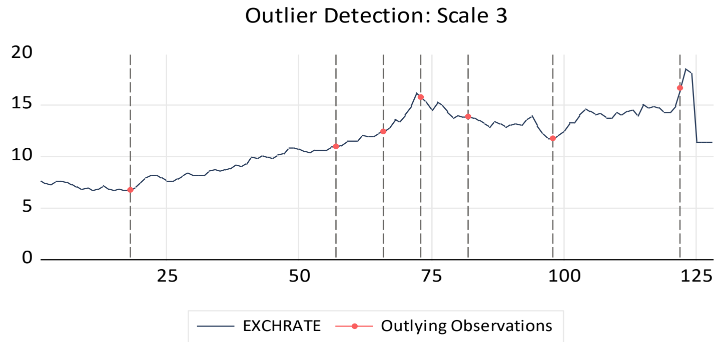
Although Brazil's currency is volatile, the trade balance change is overwhelmingly positive. According to the discrete wavelet transform analysis result, fast positive changes surpassing threshold levels are observable. Moreover, no negative fast outlier changes were diagnosed. When the positive trade balance changes are compared, negative changes succumb to positive changes. Brazil's trade balance change is positive even during the coronavirus period (Figure 6). It can be mentioned that the coronavirus period had not intensely influenced the export-import balance. When the trade balance of Brazil is observed in aggregate similar trade balance changes tendencies are diagnosed. Negative trade balance changes are akin to each other, and positive trade balance changes are alike.

Figure 6. Discrete Wavelet Transform Analysis on Brazil's Trade Balance-(2010 to 2020)



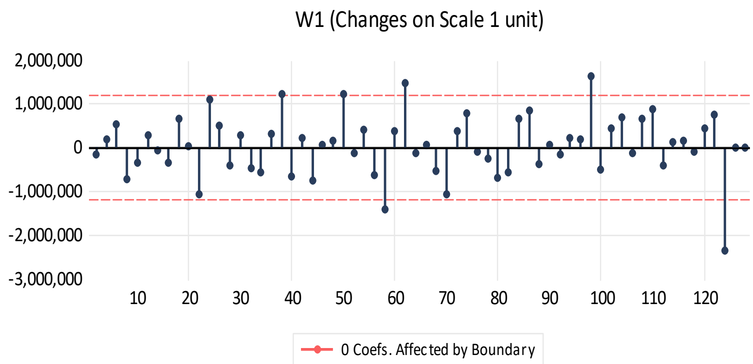
When the wavelet outlier detection technique (Figure 7) is applied to the USD/Rand parity with scale three, the South African Rand is revealed to be a volatile currency for some periods between 2010-2020. At the beginning of the 2010s, USD/Rand parity was not highly volatile. After the detection of the first outlier point, USD embarked to appreciate fast against the Rand until the period of 75. The distance between outlier lines became narrower compared to the first 50 periods, and more intense volatility was observable. After period 100, the space between outlier detection lines increased, which means less volatility is more common for the period 100-125 compared to the periods between 50-75 and 75-100. Although USD appreciated against the Rand between the period of 100-125, intense outlier detection lines were not observed. Due to South Africa's increased reliance on mineral exports, low commodity prices have also weakened the Rand. China's demand for commodities has decreased due to slow economic growth, resulting in lower global commodity prices. Investor confidence is another factor that affects the currency's value. South Africa's government has made changes at the ministerial level that have impacted investor confidence (Deloitte).

Figure 7. Outlier Detection of USD/Rand Parity-(2010 to 2020)



Discrete wavelet transform analysis unearthed that slight positive and negative trade balance changes are observable. In addition, positive fast trade balance changes that surpass the threshold level are detected. Moreover, rapid positive changes that are close to threshold levels are observable. When the negative trade balance changes are analyzed, two abnormal changes exceeding the red line are observed, and two fast negative changes close to the threshold level are detected. In general, slight negative trade balance changes are diagnosed. Furthermore, South Africa's trade balance positive change surpasses the negative changes between 2010-2020. Although positive changes are dominant, during the coronavirus period, the trade balance of South Africa shrank fast (Figure 8).

Figure 8. Discrete Wavelet Transform Analysis on South Africa' Trade Balance-(2010 to 2020)



According to wavelet analysis results, USD/Turkish Lira, USD/Russian Ruble, USD/Brazil Real, and USD/South Africa Rand and trade balance of Brazil, Russia, South Africa, and Turkey have had abnormal volatilities at some periods. When the wavelet analysis results are summarized, the Turkish lira has the most intense volatility, and Brazil most successfully manages trade balance during the coronavirus period. South Africa's trade balance intensely diminished during the coronavirus period.

In this research, the main objective is to combine the balanced datasets of BRICS-T countries' USD/domestic currencies parities and trade balances and evaluate the short-term and long-term relationships between those variables. Moreover, according to outlier detection methodology, fast changes of USD/domestic currencies parities are observable. Thus, the response of the trade balance of BRICS-T countries with exchange rate innovation will also be measured.

6.3. Panel Data Analysis of BRICS-T Countries

Before applying panel EGLS analysis with fixed effect or random effect, the Hausman test will be implemented. If the Hausman test p-value is less than 0.05, the null hypothesis of a random effect is rejected, and a fixed effect will be chosen. Static panel data analysis was applied. To increase the validity of the model five control variables were used. Since static panel data analysis will be used, endogenous variables were not included. An equation for the panel EGLS analysis is given.

$$TRDBLC_{it} = c + a1*EXCHRT_{it} + a2*GDPPC_{it} + a3*GDI + a4*DD + a5*HTE + a6*SE + u_{it}$$

In the equation, $TRBLC_{it}$ represents the trade balance. $EXCHRT_{it}$ represents USD/domestic currency parity. GDPPC is gross domestic product per capita, GDI is gross domestic investment, DD is domestic demand, HTE is total high technology exports and SE is total export of service sector and u_{it} is an idiosyncratic error term.

Table 1: Hausman and Likelihood Ratio Test, Panel EGLS Square Analysis with Wald Test

	Hausman Test (Random Effect)	**Likelihood Ratio (Fixed Effect)**
	Chi-Sq Statistic	
Period Random	0.88	
		Statistic
Cross Section: Fixed		18.31*
Method: Panel EGLS Analysis	**Coefficient**	**t-Statistic**
Variable		
C	1031860	0.31
EXCHANGE RATE	-41479.87	-0.59
GROSS DOMESTIC INVESTMENT	-4.92E-05	-4.52*
DOMESTIC DEMAND	3.09E-05	5.76*
HIGH TECHNOLOGY EXPORTS	0.000177	3.09*
SERVICE SECTOR EXPORTS	-0.000205	-4.04*
Wald Test		**Value**
F-statistic		15.28*
Chi-Square		76.44*

Note: * p-value is less than 0.05 for likelihood ratio test and panel egls analysis and * p-value is 0.00 for Wald test and r-square is 0.9513.

The panel EGLS analysis with cross section fixed and period random effect was applied to measure the impact of USD/BRICS-T's domestic currency parity on the change in the trade balance of BRICS-T countries. Since GDP per capita variable probability is 0.09, variable was removed from the analysis. Gross domestic product per capita variable will be again used for the long-term analysis.

That result shows that appreciation of the USD over BRICS-T currencies non-significantly diminished the BRICS-T countries' trade balance panel dataset between 2010-2019. In terms of economic performance, it can be interpreted that some countries in BRICS-T may not thwart USD appreciation's impact on the trade balance. In other words, those countries may not manage foreign exchange risk well, and that circumstance led their trade balances to shrink. Moreover, the Wald test (Table 1) revealed that variables were truly fit into the model. Since T>N, the Breusch Pagan test (Annex A.2) was chosen to evaluate whether there is a cross-section dependence or not. No cross-section dependence problem was diagnosed.

6.4. The Long-Term Relationship between Exchange Rate and Trade Balance of BRICS-T Countries

Before applying long-term relationship tests such as Pedroni cointegration tests and Johansen Panel cointegration tests, Levin, Lin & Chu t* unit root tests were implemented. According to Levin, Lin & Chu unit root test results, the exchange rate and trade balances are not stationary for I(0). Moreover, the first differences in the exchange rate and trade balances are stationary (Annex A.3). The unit root tests confirm the application of the Pedroni cointegration tests and the Johansen Fisher panel cointegration tests. Pedroni panel cointegration models (2004) allowed researchers to test the null of no cointegration without imposing homogeneity on the cointegrating vector. The justification for applying that analysis derives from that point. The Pedroni cointegration tests were applied to reveal the long-term relationship between exchange rates, trade balance, of the BRICS-T countries.

Table 2. Pedroni Tests for BRICS-T Countries

Cointegration Tests	Statistic
Pedroni Residual Cointegration Test	
Panel PP Statistic (Within Dimension)	-0.16*
Panel ADF Statistic(Within Dimension)	-1.94*
Group PP Statistic (Between Dimension	-2.58*
Group ADF Statistic(Between Dimension)	-3.94*

Note: *indicates p-value is less than 0.05.

The Pedroni cointegration tests (Table 2) showed that there is a long-term relationship between the given variables of BRICS-T. The result indicates that at least one or more countries' trade balances in the BRICS-T panel dataset have a long-term relationship with USD/domestic currency parity. Moreover, since variables are stationary in the same order, Johansen Fisher panel cointegration can be implemented. The innovation in the Johansen Fisher panel cointegration test is that it can measure the long-term relationship between the exchange rate and the trade balance at country-specific levels.

Table 3. Johansen Fisher Panel Cointegration Tests for BRICS-T

Johansen Fisher Panel Cointegration Test	Fisher Stat (from the max-eigen test)
None	42.66*
At most 1	20.21

Note: *indicates p-value is less than 0.05.

The Johansen Fisher Panel Cointegration test (Table 3) revealed a long-term relationship between the exchange rate and the trade balance for the panel dataset of BRICS-T countries. That result also corresponds with the result of the Pedroni test.

Table 4. Johansen Fisher Panel Cointegration Microanalysis Test for BRICS-T

Countries	Max-Eign Test Statistics
South Africa	6.11
India	10.27
Brazil	11.45*
Russia	13.36*
Turkey	22.25*
China	10.95
At most 1 cointegration (BRICS-T)	
South Africa	0.03
India	1.84
Brazil	6.33*
Russia	2.84
Turkey	0.82
China	1.05

Note: *indicates p-value is less than 0.05.

According to the Johansen Fisher panel cointegration test with microanalysis (Table 4), there is a long-term relationship between exchange rates and trade balances for Brazil, Russia, and Turkey. In other words, the Johansen Fisher panel cointegration test results revealed that the trade balances of Brazil, Russia, and Turkey are in disequilibrium with USD movements, but that will be corrected in the long run. Furthermore, it was discovered that several cointegration relationships exist between exchange rates and USD movements in Brazil.

In addition, Kao test[3] was also applied to BRICS-T panel dataset. The Kao test results were also like the results of Johansen Fisher panel cointegration tests and Pedroni tests.

6.5. The Long-Term Impact of Exchange Rate on Trade Balance of BRICS-T

In this section, the main objective is to find the long-term impact of the USD/domestic currency on the change in the trade balance of BRICS-T countries. A FMOLS cointegration regression test will be implemented to reduce the heterogeneity and serial correlation problems to find the long-term impact of USD/domestic currency parity on the change in the trade balance of BRICS-T panel data.

Table 5. FMOLS Method

Variable	Coefficient	t-Statistic
EXCHANGE RATE	-201452.5	-23.16*
GROSS DOMESTIC PRODUCT PER CAPITA	-1399.188	-14.62*
GROSS DOMESTIC INVESTMENT	-5.64E-05	-13.90*
DOMESTIC DEMAND	3.72E-05	17.93*
HIGH TECHNOLOGY EXPORTS	0.000136	5.24*
SERVICE SECTOR EXPORTS	-0.000179	-11.89*
Wald Test	**Value**	
Test Statistic		
F-statistic	181.6181*	
Chi-Square	1089.709*	

Note: *indicates p-value is less than 0.05 and r-square is 0.9539.

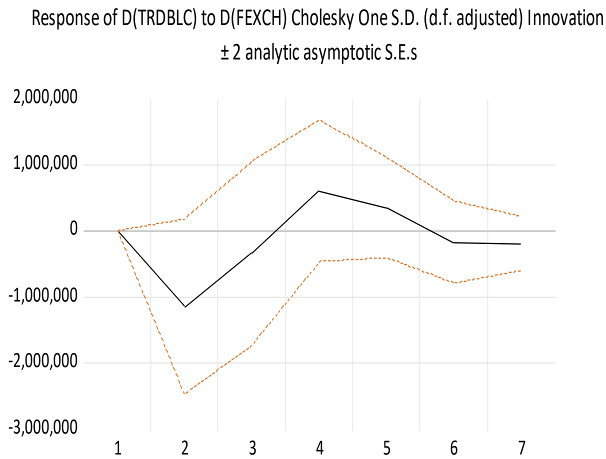
[3] Kao test is available upon request.

According to the Wald test, the coefficients are suitable for the FMOLS model. FMOLS method revealed that the exchange rate has a significant negative long-term impact on the change in trade balances of BRICS-T panel dataset. When short-term (Table 1) and long-term impact (Table 5) results are evaluated, it can be mentioned that the BRICS-T panel dataset does not have a J-curve pattern.

6.6. Panel VAR and VECM Generalized Impulse Response Analysis of BRICS-T Countries

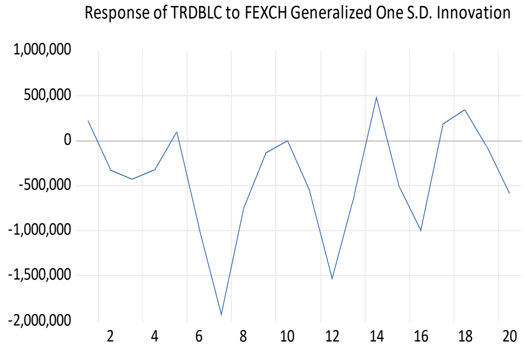
Due to the volatility of developing countries' currencies, the rapid value changes of those currencies against the USD can be observed. The primary objective of that section is to determine whether there is a J-curve trend in a fast USD change against the selected emerging countries' currencies. First, for short-term observation, VAR impulse response analysis will be implemented to investigate the effect of independent variable innovation on the dependent variable's change. One standard deviation of the positive shock to the USD/domestic currency parities will be implemented to determine the response of the BRICS-T countries. The AR polynomial root tests will be implemented before performing panel generalized impulse response analysis. The AR polynomial root test must be used to determine whether the VAR model is stationary or non-stationary. The model is stationary if the dots are contained within the circle; otherwise, it is non-stationary. According to the AR polynomial test (Annex A.4), VAR impulse response analysis with ideal AIC lag length 2 exhibits stationary processes. After determining the stationary process, VAR impulse response analysis (Figure 9) was applied. J-curve was examined for a short period of time. In other words, the J-curve trend was not sustainable, and the trade balance of the BRICS-T panel dataset was reduced again.

Figure 9. VAR Impulse Response Analysis for BRICS-T Countries



In addition to VAR-impulse response analysis, panel generalized impulse response analysis (Figure 10) with VECM will be applied to observe long-term trends. In that method, non-stationary variables (I (0) will be used with AIC based ideal lag length of 5. Since stationary variables together cannot be used for a cointegrated relationship, non-stationary variables will include in the simulation. AR polynomial root test (Annex A.5) was also applied for that model. It was revealed that some dots are outside the circle. That means there is a non-stationary process in VECM-generalized impulse response analysis.

Figure 10. Panel VECM Generalized Impulse Response Analysis for BRICS-T Countries



Panel VECM generalized impulse response analysis result (Figure 10) is like VAR impulse response analysis result (Figure 9). There is a J-curve effect for a short period of time, but the J-curve effect disappears after a short period. The simulation unearthed that trade balance responses are expected to be similar in the long term. When trade balance and USD/domestic parity nexus are evaluated under the volatile parity regime, the BRICS-T panel dataset cannot benefit from cheaper currency to boost trade balance.

7. Conclusion and Discussion

This research is the first to investigate the effect of exchange rates on trade balances for the BRICS-T panel dataset using various econometric techniques. The research findings and policy implications can contribute to the field of knowledge and can be helpful to emerging countries' policymakers. Although many researchers (e.g., Akbostanci, 2004; Wang et al., 2012; Schaling 2014; Arize et al., 2017; Bahmani-Oskooee et al., 2018; Kyophilavong et al., 2018; Jadoon and Guang, 2019; Qui et al., 2020; Bhat and Bhat, 2021) have primarily focused on individual country-level data analysis regarding the relationship between the exchange rate and the trade balance, we mainly focused on a panel dataset of BRICS-T to measure the short-term and long-term nexus between exchange rates and trade balances. For the period between 2010-2019, it was found that USD/domestic currency parity had a non-significant adverse influence on trade balances of the BRICS-T panel dataset. The short-term and long-term panel data analysis results for BRICS-T countries are consistent with the research of Zhang and Macdonald (2014), Kamal (2015), and Chit et al. (2010). Moreover, in the literature, mainly individual country-based impulse response analyses were implemented. Some scholars (e.g., Akbostanci, 2004; Chiloane et al., 2014) applied impulse response analysis to individual countries. Another contribution of this research is the implementation of panel impulse response analysis on the data of BRICS-T. Panel VAR impulse response analysis and panel generalized VECM impulse response analysis revealed that the J-curve effect, in general, was not observed. The J-curve effect occurred for a short period. When trade balance and USD/domestic parity nexus are evaluated under the volatile parity regime, the BRICS-T panel dataset cannot benefit from cheaper currency to boost exports. In other words, resistance points prevent J-curve from occurring in the long run. Remedial economic development policies must be implemented to surpass the resistance points.

Panel data research on the long-term relationship between the exchange rate and the trade balance is limited for emerging countries. Many researchers (e.g., Arize, 1994; Wang et al. (2012); Igue and Ogunleye, 2014; Arize et al., 2017; Kyophilavong et al., 2018; Jadoon and

Guang, 2019) analyzed the long-term relationship between exchange rate and trade balance for individual countries. This article also contributed to the literature with the panel data long-term analysis for selected emerging countries. A long-term relationship between the USD/domestic currency parity and the trade balance was found for the BRICS-T panel dataset. According to FMOLS panel data analysis results, there was evidence of a long-term negative crucial impact of the USD/domestic currency parity on the trade balance of the BRICS-T panel dataset.

When the short-term and long-term impact results are combined, the J-curve effect was not found for the BRICS-T panel dataset. In addition, according to panel VECM and VAR impulse response analyses, the J-Curve effect was also not diagnosed. It can be mentioned that BRICS-T's economic performance is not sustainable against the appreciation of the USD. These emerging economies (except China) must increase their investment in technologies that are primarily focused on high value-added production. By implementing that policy, these emerging countries can strengthen their trade balances. In order to provide more stable equity financing for high-value-added manufacturing and service businesses, such nations may establish a new technology stock market. They can raise their nation's economic growth while growing their foreign exchange reserves if they can increase their exports of high-value-added items via technology stock exchanges. These developing nations' currencies may become more stable for investors and be less affected by behavioral financial shocks as they industrialize through the production of high-value-added goods and the presence of more multinational corporations on international markets. Also, those countries' firms can try to use their currencies for international trade payments. Implementing these economic policies will make these countries' currencies more robust in international financial markets. In other words, their currencies can be more resistant to the USD positive shocks. In addition, as economies in Brazil, India, Turkey and South Africa depend on non-renewable energy, those nations must expand their investments in renewable energy technologies (such as wind, solar, hydro, and geothermal: the most effective ones) in order to eventually lessen their reliance on it. The factories in these nations can boost operational efficiency and lower overhead energy costs by applying such a policy. As a result, those businesses can compete better in domestic and international markets. These nations' trade balances may improve, and their currencies could become more stable on global capital markets if they successfully implement renewable energy policies.

According to variance decomposition analysis, Brazil, Turkey, Russia, and South Africa's trade balance are the most sensitive against USD dollar changes. In addition, according to wavelet analyses, the Turkish Lira is the most fragile currency compared to Brazil, South Africa, and Russia. Also, there are outlier detection points for some periods for Brazil, South Africa, and Russia currencies. Brazil, Turkey, Russia, and South Africa's currencies can all be characterized as unstable. To maintain a more sustainable balance of payments, Brazil, Turkey, Russia, and South Africa should implement a tight import substitution policy with higher-value-added items and absorption reduction. These nations should stop importing unnecessary items and services and produce such goods and services domestically. Newly founded unicorn enterprises may significantly improve the trade balance of certain nations. Entrepreneurs who found new unicorn firms must receive incentives from the governments of Brazil, Russia, Turkey, and South Africa (Unicorn: A company with a value of more than 1 billion dollars). Additionally, these new unicorn businesses can boost exports of goods and services while lowering unemployment. Modifying education policies and developing them based on educating entrepreneurs and R&D specialists is vital for developing such economies to establish value-added manufacturing processes and unicorn firms. The future strength of those nations' currencies and trade balances can be improved by implementing the suggested economic strategies. The Turkish Lira is highly volatile and can depreciate rapidly against the USD. The Turkish government can increase import taxes and transfer additional tax revenue to the central bank. The Turkish central bank can increase its foreign exchange reserves by implementing that fiscal policy and addressing the foreign exchange shortage. In comparison to China, Brazil, India, Russia, South Africa, Turkey has the lowest rate of high-technology exports/manufactured exports, according to World Bank statistics from 2020 (Annex A.6). Turkish officials must lower tax rates and the cost of employer and employee insurance for businesses with the potential to boost high-technology exports. Turkish officials shall support young tech firms with the potential to create high-value-added products and services by covering employer and employee insurance costs on the company's behalf for a certain number of years, such as five. These young tech enterprises can start paying taxes, insurance costs for employers and employees, and other related expenses once they reach maturity. The Turkish government may launch a new technological stock exchange for businesses with the capacity to develop cutting-edge technologies. The regulatory authorities must also permit small and medium-sized tech firms with the ability to develop novel technologies to join the technology stock exchange market. When the companies listed on the technological stock exchange market have employed equity funding effectively, those businesses can be more robust, export more goods, and enhance Turkey's trade balance. The Turkish Lira can be more resilient on international financial markets when Turkey has put economic development policies into practice through exports of technology. India also lacks sufficient international Indian software brands despite having a large infrastructure for the IT workforce. India needs to focus more on the software businesses' brand management to promote service exports. In order to have a more stable economy, Russia shall also refrain from participating in military interventions. Exports of raw materials make up the majority of Russia's economy. Natural resources will likely become less plentiful in the future. Russia must therefore broaden its export markets, especially for high-value-added commodities and services. The South African economy is also heavily reliant on the export of natural resources; as a result, they need to diversify their exports and prioritize industries that are fueled by technology. The majority of Brazil's exports are made up of raw resources and agricultural products. Brazil can also implement similar economic growth methods into practice.

Finally, there is a lack of studies using panel data analysis to examine the connection between trade balances and currency rates in emerging economies. As a result, this study's literature review section strongly emphasizes the outcomes of time series analysis. Each member of the BRICS-T can have their exchange rate-trade balance relationship evaluated separately. Additionally, panel data from other emerging nations can be used to further this study.

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Appendixes:

A.1. Variance Decomposition of Trade Balances-(2010 to 2020)

Countries	Exchange Rate
Brazil	62.94
Turkey	60.97
Russia	33.50
South Africa	19.76
China	9.03
India	2.31

A.2. Cross-Section Dependence Test

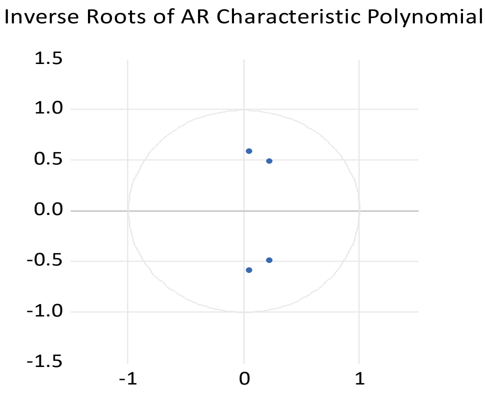
Cross Section Dependence Test	Statistic
Breusch-Pagan LM	17.92

A.3. Unit Root Analyses for BRICS-T Panel Data

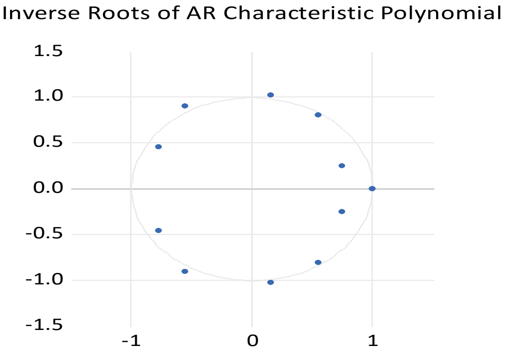
Levin, Lin& Chu t* Unit Root Test	Statistic
EXCHANGE RATE	3.09
D(EXCHANGE RATE)	-3.50*
TRADE BALANCE	-134.43
D(TRADEBALANCE)	-251.08*

Note: *indicates p-value is less than 0.05.

A.4. VAR Impulse Response- AR Roots Polynomial Graph



A.5. VECM Impulse Response- AR Roots Polynomial Graph



A.6. High Technology Exports/Manufacture Exports Rates-2020