

Original Article

Modelling the Effects of Currency Exchange Rate Volatility on Philippine Balance of Trade Using Granger Causality Test

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Abstract

Background: Trade contributes to a nation's economic development, and the exchange rate indicates a country's trade competitiveness. This study investigates the potential for a bidirectional causal relationship between exchange rate volatility and trade balance in the Philippines.

Methods: The study uses the Granger Causality Test to determine and ascertain whether there is a two-way causative relationship between exchange rate volatility and the balance of trade in the Philippines using the time series analysis considering the period from 1990–2023.

Results: The findings indicate that the balance of trade can influence and be a factor in the change and movement of exchange rate volatility due to factors such as the export-import of the country that reflects the demand and supply of currency, indicating that shifts in the trade balance can contribute to fluctuations in exchange rates. Exchange rate changes may be necessary to restore equilibrium in trade flows in response to shifts in the balance of trade, including improvements or deteriorations.

Conclusion: The study, therefore, recommends utilizing trade-related tactics to improve the trade balance by enhancing exports while cutting down unproductive and unprocessed imports, attracting more foreign investments and more exportation for exchange rate stability.

Keywords

exchange rate volatility, balance of trade, granger causality test

INTRODUCTION

Exchange rate is the cost of a unit of foreign currency in terms of the local currency [Bangko Sentral ng Pilipinas \(n.d.-a\)](#). The peso-dollar currency exchange rate volatility (ERV) is a dynamic and integral aspect of the global financial landscape, affecting countries, businesses, and individuals. Peso-dollar ERV is specifically examined in the study because the United States is a dominant trading partner and strongly impacts the Philippine economy. Fluctuations in said exchange rates can have far-reaching consequences on trade, investment, financial markets, and the overall economic stability of nations. Understanding the drivers, impacts, and effective risk management strategies associated with currency ERV is crucial for businesses, policymakers, and investors in the complex and interconnected global economic landscape. In the context of the Philippines, it strongly relies on its trading sector activities as a driver of economic growth, and the effect of currency fluctuations becomes more particularly pronounced.

ERV may cause market uncertainty, volatility in traders' profits, increased risk, inflation unpredictability, an unfavorable trade balance, and effects on production and transaction costs (Juhro & Phan, 2018). Trade transactions involving various countries or regions typically require a currency conversion. Whether or not demand for traded products is sensitive to fluctuations in exchange rates has long been recognized as a significant problem in international transmission and adjustment. Exchange rate fluctuation is one such aspect that has varied effects on a nation's economic growth. This study determines whether there is a causal relationship between changes in the currency exchange rate fluctuations in the Philippine balance of trade (BOT), focusing on the time frame of 1990-2023. The Granger Causality Test is commonly used to analyze the cause-and-effect relationship between time series data. This study will explain how ERV and BOT changes cause the other and vice versa.

ERV makes it more difficult and expensive for businesses in developing countries to trade with other countries. ERV can lead to unexpected changes in the cost of goods and services, making it difficult for businesses to plan and budget (Palamalai & Kalaivani, 2013). Additionally, ERV can make it more difficult for businesses to obtain financing and insurance, as they further increase trade costs. It also suggests that ERV will likely increase, leading to even greater challenges for developing countries. The global economy is becoming increasingly interconnected, and financial markets are becoming more volatile (Kim, 2017). Among the factors that affect the currency exchange rate is the value of imports, which are deducted from the value of exports to calculate the BOT. Moreover, Naz and Broqueza (2022) in their findings, stated that "If exports are more than imports, there is a favorable BOT or trade surplus; thus, demand for own currency increases."

In contrast, if imports outpace exports, there is a negative trade balance or trade deficit, lowering domestic currency demand. Ouattara (2023) on the impact of ERV on international trade in developing countries reveals that ERV significantly impacts international trade dynamics by altering the relative pricing of goods and services. According to Yeboah (2023), when a domestic currency depreciates, it can make exports more competitive and imports more expensive, potentially improving the trade balance.

Exchange rate fluctuations impact both imports and exports. It is assumed that a nominal depreciation or appreciation of the exchange rate will impact the real exchange rate, which will, in turn, impact a nation's trade balance. The changes in export and import patterns can affect the country's BOT. A trade surplus occurs when exports exceed imports, while a trade deficit arises when imports surpass exports. A persistent trade imbalance can influence foreign exchange's supply and demand dynamics, potentially leading to further exchange rate fluctuations. It is important to note that the impact of exchange rates on trade is most pronounced in countries with floating exchange rate regimes, where the market determines the value of a currency relative to others. In cases where one or both currencies are fixed or pegged to another currency, the exchange rate is not as responsive to trade imbalances, and the effects on trade may be less pronounced (Lioudis, 2024).

Various scholars have examined the effect of ERV on trade and its variants. Dada (2017) examined the causal relationship between ERV and trade balance in Sub-Saharan African Countries adopting the statistical framework of Panel Vector Autoregressive (PVAR) methodology, which found that there is unidirectional causality with trade balance causing ERV. Another study emphasizes that trade balance is positively impacted by real domestic income. In contrast, the trade balance is negatively impacted, both short- and long-term, by real exchange rates and their volatility (Olomola & Dada, 2017) in their study on the effect of ERV on the trade balance in Nigeria utilizing the Generalized Autoregressive Conditional Heteroscedasticity (GARCH 1, 1) model.

However, several studies from different countries have found no causal connection between ERV and BOT. ERV had a negative influence on Uganda's trade balance, according to empirical data from 1990 to 2015, yet this impact was not statistically significant. In addition, the Granger Causality Test revealed that trade balance was positively connected with ERV rather than the other way around. This is consistent with the observation that the nation's trade balance has not improved despite the country experiencing predominant currency depreciation year after year (Immaculate & Kwadzo, 2018). Furthermore, the study by Ali and Hasan (2018) found that, out of the emerging nations they studied, Indonesia had a statistically significant unidirectional causal relationship of BOT to ERV, while Bangladesh and Mexico had a unidirectional causal relationship between the exchange rate and the BOT. From the exchange rate to the trade balance, Indonesia is causative. Nonetheless, there is no causative relationship between the variables in Malaysia, whereas there is a two-way causal relationship

between ERV and trade balance in South Africa. Bangladesh is not suffering ERV, which could impact the nation's trade balance.

Results from existing studies of other rising economies are conflicting, and some studies have primarily focused on the impact of currency ERV on their export performance in other countries, FDI, trade openness, and some other variables in a short time. There may be a research gap in analyzing co-integration and understanding the specific dynamics between ERV and the BOT in the Philippines through modeling its effects and by employing the Granger Causality Test to determine the two-way causality effect of two variables focusing only on the ERV and BOT in the Philippine economy which could be a methodological gap as some studies are employing the Generalized Autoregressive Conditional Heteroscedasticity. Nevertheless, it aims to contribute by applying and validating the Granger Causality Test in this specific context utilizing the time series analysis of the data from 1990-2023 through Multivariate Time series Analysis of Vector Autoregression (VAR).

Specifically, the research objectives include analyzing historical trends and patterns of ERV in the Philippines, assessing and modeling the causal relationship between exchange rate fluctuations and the BOT in the Philippines to explore the coping mechanisms and strategies employed by Philippine traders to mitigate its impact on the economy and lastly, evaluating the effectiveness of government policies and interventions in stabilizing exchange rates and promoting the country's economic growth (Estorosos et al., 2023).

Conceptual Framework

This study is anchored on the theory of J-curve (Davies, 1962), which helps understand the relationship between two variables. However, care must be taken when it is used for prediction purposes. He also asserted a sudden reversal in fortunes after a long period of economic growth. Economics demonstrates how currency depreciation significantly worsens trade imbalances, followed by a significant improvement (Kenton, 2024). This theory would relate to describing the relationship between a country's trade balance and its ERV. According to this theory, a country's trade balance will initially worsen after a currency devaluation but will eventually improve over time (Bahmani-Oskooee & Ratha, 2004). However, as highlighted by Huchet-Bourdon and Korinek (2012), the J-curve effect occurs after currency depreciation: initially, a trade balance declines due to higher import prices. Immediate orders raise import values, but later, businesses adjust by reducing imports and potentially increasing local production. This lag in adjusting traded quantities compared to prices creates a J-shaped curve, ultimately leading to a trade balance improvement in the long term. Previous research discovered that the renowned J-curve theory expresses that local currency depreciation makes foreign goods more expensive for locals and domestic goods less expensive for foreigners, implying an increase in exports and a decrease in imports, resulting in trade balance improvements. Economists (Ahmad & Khan, 2018) believe that currency devaluation provides favorable competitive advantages in international trade. As mentioned by Dogru et al. (2019), the J-Curve states that under specific conditions, a nation's trade deficit will likely deteriorate initially following a devaluation of its currency. A sudden change in exchange rates would result in ERV. Volatility in the exchange rate is a risk uncertainty in international trade driven by macroeconomic factors such as inflation, interest rates, the balance of payments, and the import-export of an economy. Moreover, BOT is a factor of volatility in the exchange rate because when a country experiences a trade deficit, it will decrease demand for its currency, causing the exchange rate to decline. This condition will impact the demand and supply of currencies, causing sudden fluctuations in exchange rates.

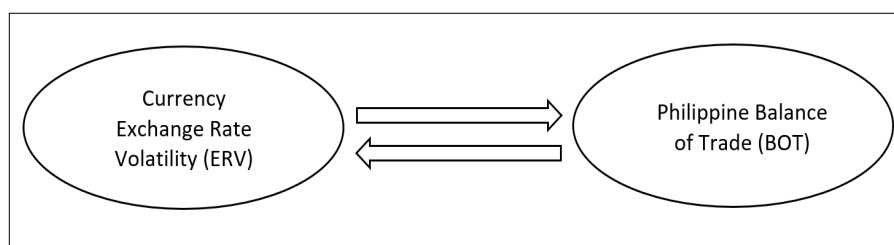


Figure 1. Conceptual Framework

This study centers on modeling the effect of currency ERV of peso-dollar on the BOT in the Philippines using the Granger Causality Test, the ideal approach for the study on the impact determination between ERV and trade balance. According to [Haansende and Nyambe \(2020\)](#), testing for Granger Causality was ideal for studying the impact determination between ERV and trade balance. The results of this study indicate that the volatility of exchange rates in the SACU region can be used to predict trade balance. It is possible to know what will happen to the trade balance with what happens to the exchange rate. For instance, the trade balance will decrease if the exchange rate rises or devalues due to volatility.

The J-Curve theory assists researchers in determining how changes in the BOT are primarily driven by macroeconomic adjustments such as currency volatility, before quantity changes become prominent. The researchers assumed that the effects of changes in currency on a country's trade balance are not immediate but occur gradually. By analyzing the long- and short-run coefficients of the real exchange rate in the econometric analysis, empirical testing for the J-Curve indirectly tests the approaches of elasticities and Marshall-Lerner Condition ([Rose, 1991](#)) which the J-Curve is the only approach that allows tracing the effect of real exchange rate depreciation on trade balance over time ([Abbas Ali et al., 2014](#)). The factors that lead to ERV are inflation, export-import which affects supply demand of currencies, interest rates, and foreign investments.

Figure 1 shows a significant connection between ERV and the Philippine trade balance, whether both variables show a cause-and-effect relationship towards one another, which may provide helpful information for projecting the future behavior of the other variable. The following aspects were defined:

Exchange Rate Volatility - refers to the degree of fluctuations or variation in the exchange rate of a currency over a specific period. According to [Latief and Lefen \(2018\)](#), if risk-averse traders face a higher transaction risk and higher cost due to ERV, they will decrease the trade volume.

Balance of Trade - refers to the numerical representation of the difference between a country's exports and imports of goods and services during a specified period. The trade balance is a key gauge for understanding how currency exchange rate fluctuations affect economies. According to [Lioudis \(2024\)](#) a trade surplus, with more exports than imports, shows high demand for a country's goods, boosting demand for its currency. This often leads to price increases and currency appreciation, following supply and demand rules. Conversely, a trade deficit, where imports exceed exports, signals lower demand for the country's currency, causing prices to drop and the currency to depreciate.

To determine if a causal influence is present, the Granger Causality Test is employed against the following null hypotheses:

Ho1: Exchange rate volatility does not Granger cause Philippine balance of trade.

Ho2: The Philippine balance of trade does not Granger cause exchange rate volatility.

METHODS

The study utilized the causal-comparative research design to identify the cause-effect nature and correlations among the variables. According to [Harappa \(2021\)](#), causal-comparative research can help determine the consequences and causes of existing differences by retrospectively studying cause and effect to investigate a specific question after the effects have occurred and attempting to determine whether or not a variable influences another variable. The study employed a quantitative approach to comprehensively investigate the impact of currency exchange rates on Philippine trade, which allows a deeper understanding of the relationship between ERV and BOT.

Data mining was used in this study to gather secondary data from various sources ([Rios et al., 2013](#)). According to [Pastrana et al. \(2019\)](#), data mining is a process that attempts to discover and explain behavioral patterns in massive data sets. For this study, the annual Philippine balance of trade data (in current US dollars) from 1990–2023 was retrieved from the World Bank's World Development Indicators (WDI) database. The Philippine Peso-US Dollar exchange rate data, from which exchange rate volatility was calculated as the standard deviation of monthly log returns, was sourced from the Bangko Sentral ng Pilipinas (BSP). This raw exchange rate data is the "Philippine Peso Reference Exchange Rate (PHP per US\$)," available in the [BSP's \(n.d.-b\)](#) Statistics Exchange Rate.

The study utilizes an econometric model to forecast future economic developments (Hymans, n.d.). The model measures past relationships among such variables and then tries to forecast how changes in some variables will affect the future course of others. It allows us to explore and forecast the effect of ERV and Philippine trade balance. The particular econometric model used is the Granger Causality Test, a statistical concept used to determine whether a one-time series can predict the future values of another time series. It assesses the extent to which historical values of one variable provide helpful information for projecting the future behavior of the other variable (Padav, 2021). A p-value equal to or below a predetermined significance threshold (typically 0.05000) denotes statistical significance, signifying enough evidence against the null hypothesis based on the observed data.

Furthermore, the Augmented Dickey-Fuller (ADF) is employed to attest the stationarity of the data before proceeding and utilizing the Granger Causality Test. Before integrating the data into examining its Granger causality effect, stationary testing is necessary, which can be processed through the Augmented Dickey-Fuller Test utilizing Jeffreys's Amazing Statistics Program (JASP). This statistical software is helpful in the determination of the variable stability. This test is necessary to prevent non-stationary regressors from invalidating several common empirical results. The study's two variables, exchange rate volatility (ERV) and Philippine Balance of Trade (BOT), are processed to attest to its stationarity. The processed data resulting in a p-value lower than 0.05000 means the run data is interpreted as stationary, or the null hypothesis was rejected, thus concluding the data is stationary. However, differencing was applied to transform the data series if the data is non-stationary. Once stationarity of the data is achieved, granger causality testing follows through the Gretl software, specifically the Vector Auto Regression, a Multivariate Time Series analysis model that describes relationships between variables based on past values and the values of other variables.

RESULTS

This part presents all the information gathered, which data are tabulated, analyzed, and interpreted to obtain the objective of the study, which is to determine if the two variables, ERV and BOT of the Philippines, have a causal effect towards each other considering the period from 1990 to 2023 using the Granger Causality Test.

Figures 2a and 2b displayed the raw time series for exchange rate volatility (ERV) and the balance of trade (BOT). Preliminary analysis, including unit root tests, indicated that ERV and BOT were non-stationary, necessitating differencing for subsequent econometric analysis.

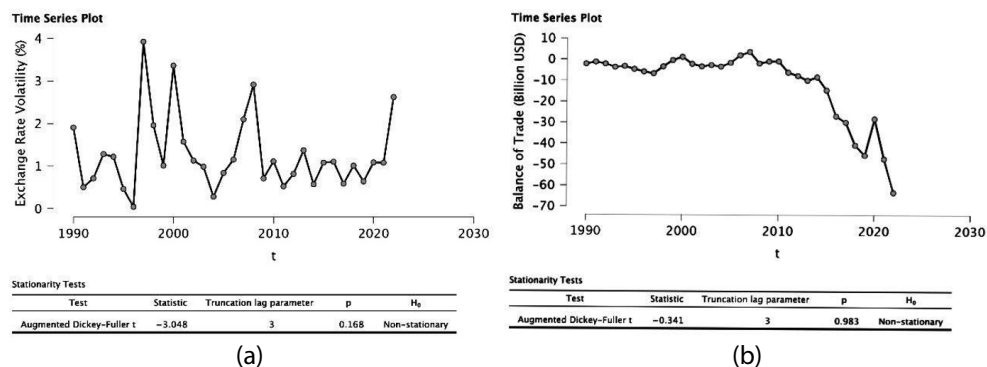


Figure 2. Non-stationary Data Set

Following the first differencing, the Balance of Trade (BOT) series achieved stationarity, as indicated by a p-value of 0.021 below the 0.05 significance level (Figure 3a). This result led to rejecting the null hypothesis of non-stationarity for BOT. However, Exchange Rate Volatility (ERV) remained non-stationary with a p-value of 0.085 (Figure 3b), thus necessitating a second differencing for the ERV series.

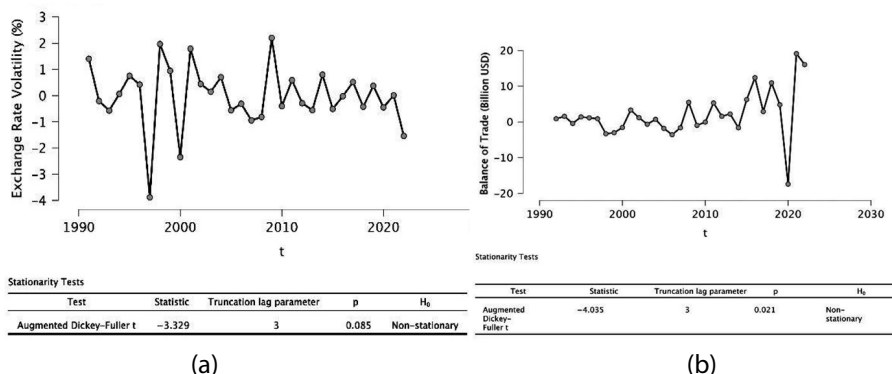


Figure 3. First Differencing of BOT and ERV

Figure 4 illustrates that a p-value of 0.010 was achieved after the second differencing for the ERV series, signifying the rejection of the null hypothesis of non-stationarity and confirming its stationarity. With both variables now stationary, the dataset was suitable for Granger causality testing.

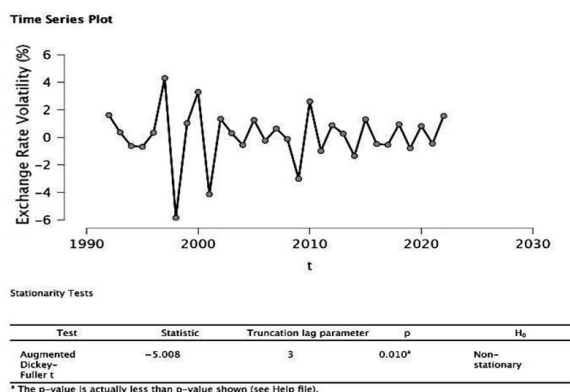


Figure 4. Second Differencing of ERV

The table presents the Granger causality result of ERV to BOT; the p-value of ERV to BOT is greater than 0.0500, and the decision of the null hypothesis was not rejected, implying that no causality is running from ERV to BOT. It indicates that ERV does not Granger cause the BOT in the Philippine economy. The empirical study shows that this one key factor of exchange rate movements can have offsetting effects on imports and exports. When a country's currency depreciates, its exports become cheaper for foreign buyers, thus increasing exports. Conversely, imports become more expensive, which can reduce the demand for imported goods. This dynamic can help stabilize the BOT despite exchange rate fluctuations.

The findings are consistent with [Rahman and Uddin \(2019\)](#) study on the impact of ERV on trade balance: empirical evidence from Uganda: 1990-2015, which found that ERV harms Uganda's trade balance, but this impact is not statistically significant. In line with the study of [Rahman and Uddin \(2019\)](#), factors such as trade openness, economic variety, and institutional strength have a greater impact on the trade balance in developing countries than just changes in exchange rates. This aligns with the idea that the relationship between exchange rate instability and trade balance can differ depending on the circumstances. Even though there is a long-term relationship between the variables, the researchers found that using the Granger Causality Test did not demonstrate that the exchange rate caused the trade balance, which is consistent with the outcome in the Philippines that the exchange rate does not precede the behavior of the trade balance.

Table 1. Presents the Granger Causality Result (ERV-BOT)

NULL HYPOTHESIS	LAGS	F-statistics	Probability	Decision
ERV does not granger cause BOT	1	0.20711	0.081420	Do not Reject
ERV does not granger cause BOT	2	1.4115	0.528405	Do not Reject
ERV does not granger cause BOT	3	3.0034	0.195422	Do not Reject
ERV does not granger cause BOT	4	1.2077	0.236548	Do not Reject
ERV does not granger cause BOT	5	2.5493	0.141933	Do not Reject

According to [Olomola and Dada \(2017\)](#), the need for exports in the Philippines persists despite ERV due to several reasons, such as to generate foreign exchange earnings, which is essential for stabilizing the balance of payments, supporting imports, and promoting economic growth. Key sectors such as electronic products, other manufactures, woodcrafts, furniture, coconut oil, and fruits enable the country to tap into international markets, diversify revenue sources, and capitalize on its strengths. Exporting also fosters job creation, technology transfer, and overall economic development by promoting innovation and competitiveness globally. The country's dependence on exports is crucial for driving economic growth, enhancing trade relationships, and maintaining its position in the global economy. Thus, it is consistent with the idea that the trade balance in the Philippine economy will not improve even in the face of a preponderant currency depreciation, and the volatility of exchange rates does not directly affect the BOT's behavior. ERV tends to increase during economic uncertainty, geopolitical instability, or financial crises, leading to high volatility.

On the other hand, average ERV may occur during periods of relative economic stability and predictable market conditions. Medium ERV falls between these extremes, reflecting fluctuations that are more pronounced than average but not as extreme as during times of crisis or significant economic events. These volatility-level shifts highlight the dynamic nature of exchange rates and their sensitivity to global economic conditions and events ([Latief and Lefen, 2018](#)).

Table 2 provides information on the result of the causality of BOT toward ERV. The test confirms a unidirectional relationship between BOT and ERV as the p-values are lower than the Alpha value of 0.0500. In the succeeding observation, there is still an impact. Hence, this means that the Philippine BOT statistically significantly impacts ERV on ERV in the long run.

The study shows that BOT can influence ERV by affecting foreign exchange supply and demand. A country with a trade surplus will have a greater demand for its goods and services, which may cause its currency to appreciate and demand to grow. On the other hand, a country with a trade deficit will have less demand for its goods and services, which might cause the currency to depreciate and demand to fall. The volatility of the exchange rate impacts trade flows slightly and in the short-run towards trade flows, unlike the fact that BOT has a variation in the rapid fluctuations of the exchange rates because this will go with the supply and demand of the domestic currency. Thus, when the BOT in the Philippines goes with a trade surplus or deficit, it will affect the demand for the peso currency, resulting in its changes fluctuating rapidly from time to time.

Table 2. Presents the Granger Causality Result (BOT-ERV)

NULL HYPOTHESIS	LAGS	F-statistics	Probability	Decision
BOT does not granger cause ERV	1	5.7725	0.008187	Reject
BOT does not granger cause ERV	2	9.7879	0.000075	Reject
BOT does not granger cause ERV	3	0.62077	0.000620	Reject
BOT does not granger cause ERV	4	3.175	0.000380	Reject
BOT does not granger cause ERV	5	0.038494	0.004102	Reject

DISCUSSIONS

[Olomola and Dada \(2017\)](#) also found that changes in a country's trade balance can influence ERV, not vice versa. If a country's trade balance improves (exports increase or imports decrease), it can lead to more foreign investment and a more stable exchange rate, making it volatile. The link between trade imbalances and ERV is complex, with some believing that substantial imbalances may result in more variable rates due to uncertainty about future trade flows ([Ozturk, 2006](#)). This result is in tune with the findings in the study of ERV and international trade in Nigeria focusing on the period of 1986-2018, which discovered that the exchange rate has a positive and considerable impact on its trade flows in the short run, but a negative and insignificant effect in the long run. ERV does not create aggregate trade volatility, but a uni-causal relationship exists between ERV and trade volatility ([Ikechi & Anthony, 2020](#)). Furthermore, the researcher's findings are consistent with earlier empirical findings of [Yaya and Lu \(2012\)](#), who found that the effective exchange rate is affected by the trade balance, and they have discovered that positive trade performance shocks cause China's exchange rate to rise. Furthermore, the study ([Olomola & Dada, 2017](#)) shows causality from the trade balance causing ERV.

The Granger Causality Tests indicate no evidence to support the hypothesis that ERV causes changes in BOT. However, the causality test suggests that BOT does Granger cause ERV, indicating a unidirectional relationship between BOT and ERV. This implies that while changes in BOT may influence ERV, fluctuations in ERV do not directly impact BOT in the Philippine economy. ERV may not have a significant negative impact on world trade. Hence, the researchers suggest that it is not a significant policy concern for promoting global trade.

On the other hand, the fluctuations in the nation's trade balance have a long-term effect on ERV in the Philippines. These results are consistent with fundamental economic theories, showing that changes in the trade balance influence demand for the Philippine peso, which in turn impacts volatility in exchange rates. This highlights the importance of monitoring and managing the nation's trade balance by promoting export diversification, enhancing import substitution, and strengthening trade agreements.

CONCLUSION

The Granger Causality Tests found no evidence that Exchange Rate Volatility (ERV) causes changes in the Balance of Trade (BOT); however, BOT does Granger cause ERV, suggesting a unidirectional relationship. This implies that while the nation's trade balance influences ERV, ERV fluctuations do not directly impact BOT in the Philippine economy. Consistent with economic theories, changes in the trade balance affect demand for the Philippine peso, which in turn impacts exchange rate volatility. This highlights the importance of managing the nation's trade balance to support currency stability and attract foreign investments. The application of the Granger Causality Test on short-term impacts of ERV and BOT emphasizes the need for further comprehensive analysis, considering their long-term relationship. Utilizing VAR and multivariate time series analysis over an extended period can validate these findings and offer a longitudinal perspective on their relationship. Understanding that BOT changes can impact ERV in the long run enables policymakers to anticipate and manage economic risks better, ultimately contributing to the Philippines' economic resilience.

Author Contributions

C. Sarsaba, I. G. Diano, & J. Daro: Writing – Original Draft, Writing – Review & Editing; **C. Gonzaga & K. I.Pasulojan:** Investigation, Data Curation, Visualization, Writing – Review & Editing; **M. J. Teodosio & J. Estorosos:** Supervision, Conceptualization, Formal Analysis, Validation

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Ethical Approval

Not applicable.

Competing interest

The authors declare no conflicts of interest.

Data Availability

Data will be made available by the corresponding author on request.

Declaration of Artificial Intelligence Use

In this work, the author did not use generative AI or AI-assisted technologies in the preparation, analysis, or writing process.

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