DEPARTMENT OF
DATA SCIENCE

Temporal Dynamics and Volatility Analysis of the PHP–USD Exchange Rate

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Abstract

This study analyzes the behavior, volatility, and structural shifts of the PHP–USD exchange rate from 2018 to 2025. The exchange rate is treated as a dynamic indicator of broader macroeconomic conditions rather than an isolated variable. The analysis integrates inflation and interest rate differentials between the Philippines and the United States, along with trade balance measures, oil prices, and Overseas Filipino Worker (OFW) remittances. Daily USD–PHP closing prices serve as the primary dataset, while monthly macroeconomic indicators are temporally aligned through resampling and feature engineering.

Descriptive statistics, rolling-window measures, and visual time-series techniques are employed to examine trends, volatility patterns, and co-movements without imposing strict econometric assumptions. The results identify distinct phases of exchange rate behavior marked by stability, heightened volatility, and sharp directional changes. Comparative inflation analysis reveals higher variance, faster mean reversion, and weaker persistence in Philippine inflation relative to the smoother and more stable U.S. inflation process. Overall, the findings underscore the sensitivity of the PHP–USD exchange rate to relative macroeconomic pressures and structural dynamics, offering insights relevant to macroeconomic monitoring and risk analysis.

1 Introduction

1.1 Background and Significance

The PHP–USD exchange rate is a preeminent macroeconomic indicator for the Philippines, a small, open economy heavily reliant on remittances and imports. Fluctuations in the exchange rate directly affect domestic inflation—particularly through the cost of imported commodities such as oil—fiscal stability via US dollar–denominated debt servicing, and the welfare of remittance-receiving households.

Given these critical implications, understanding exchange rate dynamics requires moving beyond a univariate time-series perspective. Classical currency valuation theories, notably

Purchasing Power Parity (PPP) and Interest Rate Parity (IRP), posit that exchange rates are fundamentally influenced by cross-country differentials in inflation and interest rates. Consistent with these frameworks, this study incorporates Philippine inflation, US inflation, and the US Federal Funds Rate (DFF) to examine their relationship with the PHP–USD exchange rate.

The 2018–2025 period is particularly salient, as it encompasses extreme macro-financial shocks, including the COVID-19 pandemic (2020) and the aggressive US Federal Reserve interest rate tightening cycle (2022–2023). These events generated pronounced monetary policy divergence, significantly shaping capital flows and exchange rate volatility. Using a multivariate exploratory data analysis (EDA), this study investigates co-movement patterns and volatility dynamics among these variables, providing empirical insights relevant to exchange rate policy and financial risk management.

1.2 Statement of the Problem

From 2018 to 2025, the USD–PHP exchange rate experienced significant fluctuations driven by major global and domestic events, including the COVID-19 pandemic, shifts in interest rates and inflation, oil price instability, and geopolitical tensions such as the Russia–Ukraine war. These events likely affected currency behavior, but the extent, patterns, and timing of their influence remain unclear. This project aims to conduct exploratory data analysis (EDA) to examine how the USD–PHP exchange rate behaved during this period, identify potential seasonal trends, measure changes in volatility before and after the pandemic, and assess whether major events or macroeconomic factors contributed to notable movements in the exchange rate. Understanding these patterns can provide insights into currency sensitivity to shocks and support more informed economic analysis.

2 Methodology

2.1 Primary Datasets

This research employs the USD–PHP exchange rate as its primary time-series dataset. We sourced the USD–PHP exchange rate dataset from Investing.com (2025). To maintain a parsimonious model and ensure data stationarity, we extracted only the Daily Closing Price, omitting the auxiliary Open, High, and Low (OHL) metrics. The rationale for this selection is twofold: first, the closing price represents the aggregate daily market consensus; and second, it minimizes volatility bias inherent in intraday trading. This allows for a more robust correlation analysis with secondary datasets that lack high-frequency, intraday granularity.

2.2 Secondary Datasets

To provide a comprehensive analysis of the USD-PHP exchange rate, this study integrates a primary exchange rate dataset with four distinct categories of secondary macroeconomic variables. These variables represent the fundamental drivers of currency valuation, encompassing both financial flows and real-economy demands.

First, the study incorporates **Interest Rates and Inflation Rates** from both the United States and the Philippines. These are utilized to capture the **'interest rate differential'** and **'purchasing power parity'** effects, which dictate capital allocation and investment flows between the two nations.

Second, to account for the structural supply-demand dynamics of the Philippine economy, the study integrates **Merchandise Trade Statistics**—specifically the total value of **Merchandise Imports and Exports** for the Philippines. In the Philippine context, the **Merchandise Trade Balance** is a critical determinant of currency value; a widening trade deficit in physical goods necessitates a higher demand for US Dollars to settle international payments, typically leading to Peso depreciation. By focusing on merchandise trade, the analysis captures the direct impact of the physical economy on foreign exchange requirements.

Furthermore, as the Philippines is a net energy importer, international **Oil Prices (Crude and Brent)** are included to reflect the cost-push inflationary pressures and the subsequent drain on foreign exchange reserves required for fuel procurement. Finally, **OFW Remittances** are integrated as a primary supply-side factor. As a significant contributor to the Philippine GDP, these remittances represent a consistent inflow of US Dollars, acting as a key stabilizer for the local currency against external shocks. By combining these datasets, the model can effectively distinguish between short-term financial speculation and the fundamental commercial requirements of the Philippine economy.

2.3 Data Cleaning and Preprocessing

Data preparation

- Datasets were loaded using `pd.read_csv()`, validated with `df.info()` and `df.describe()`, and checked for missing values via `df.isna().sum()`.
- Variables were standardized, datetime fields were created using `pd.to_datetime()`, and datasets were merged through index-based joins.

Feature engineering

- Interest rate and inflation differentials were computed to capture relative monetary conditions and purchasing power, reducing multicollinearity and aligning with interest parity and PPP theories.
- The Philippine trade balance was included to represent real-sector foreign exchange flows and macroeconomic shocks.

Analytical rationale

- These steps produce a concise, economically grounded dataset that captures financial, price-level, and real economic drivers of USD–PHP movements for exploratory data analysis.

2.4 Methods

- The study utilized an **exploratory data analysis** approach on multi-source time-series datasets, incorporating data cleaning, type conversion, temporal indexing, and alignment through resampling and merging procedures.

- **Descriptive and exploratory techniques** were applied, including missing-data assessment, feature engineering, rolling-window statistics, and decomposition methods to isolate trend, seasonal, and irregular components.

- **Visual time-series analytics** (e.g., line plots and comparative trend charts) were employed to detect temporal patterns, co-movements, and structural variations without enforcing a predefined econometric model.

3 Results

3.1 The USD–PHP exchange rate during the pandemic period

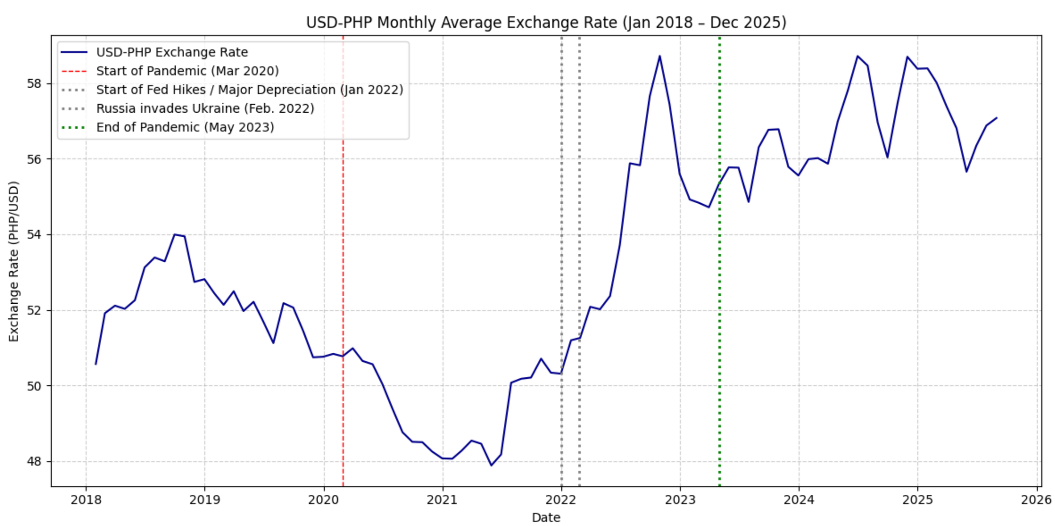

Figure 1: Philippine Peso (PHP) Exchange Rate Against the US Dollar (USD): Impacts of Global Events (2018–2025)

Between Q1 2020 and Q4 2021, the PHP exhibited notable strength, bottoming out near 48.00 PHP/USD. However, the onset of aggressive US Federal Reserve tightening in January 2022, compounded by heightened geopolitical risk from the Russia-Ukraine conflict, triggered a sharp reversal. By late 2022, the Peso reached historic lows near 59.00 PHP/USD. While a brief recovery followed in early 2023, the exchange rate has since stabilized within a volatile range of 54.00 to 58.00 PHP/USD, reflecting persistent inflationary pressures and a widened trade deficit.

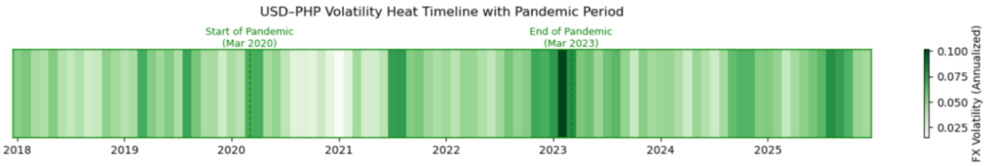

Figure 2: USD-PHP FX Volatility: Heat Timeline Highlighting Start to End of Pandemic

The Philippine Peso (PHP) exhibited pronounced volatility from 2018 to 2025, as reflected in the green-shaded FX timeline. Darker green shades correspond to periods of higher month-to-month exchange rate swings, while lighter green indicates calmer, more stable periods. From 2018 to 2019, the Peso remained relatively stable, with light to medium shades signaling a low-volatility environment. In mid-2021, volatility surged sharply, marking the first major peak of the period, likely driven by domestic inflationary pressures and heightened global uncertainty during the pandemic recovery phase. After this initial peak, volatility eased somewhat but remained above pre-2020 levels, reflecting lingering economic uncertainty. Toward the end of 2022, the Peso experienced a second, more intense spike in volatility, coinciding with aggressive U.S. Federal Reserve interest rate hikes and surges in global inflation. Just before the end of the pandemic period in May 2023, volatility reached an extreme rate of 0.1, reflecting a combination of residual pandemic effects, trade imbalances, and speculative FX activity. In 2024, volatility moderated but began to rise slightly toward year-end, indicating renewed external and domestic FX pressures, highlighting the Peso's continued sensitivity to both global shocks and structural economic factors.

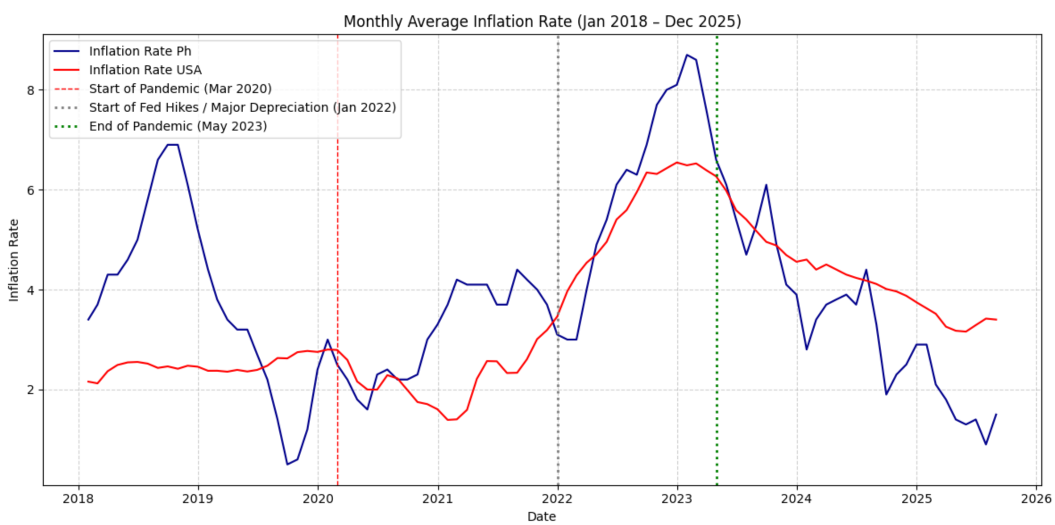

Figure 3: Comparative Inflation of Philippines and USA Response to Global Economic Shocks (2018-2025)

The graph shows that the Philippines (PH) inflation series has a much wider spread of values than the United States (US) series. This means PH inflation fluctuates more around its average, indicating higher variance and standard deviation, while US inflation remains more tightly clustered. PH inflation is also more volatile, as shown by its jagged line and frequent sharp month-to-month changes. In contrast, the US line is smoother and more gradual, reflecting lower short-term volatility. Additionally, the US series shows stronger trend persistence, where increases or decreases last longer, implying higher autocorrelation, while the PH series changes direction more frequently.

In terms of peaks and troughs, PH inflation has sharp, short-lived highs and lows followed by quick reversals, which indicates fast mean reversion. The US series displays broader peaks and slower declines, meaning deviations from the average persist longer. The PH series also tends to reach turning points earlier than the US series, suggesting a lead–lag pattern where PH adjusts faster. Moreover, the PH line has steeper slopes, showing that changes occur more rapidly, while the US series changes more gradually. Overall, the graph shows that PH behaves as a high-volatility, fast-moving process, whereas US behaves as a more stable, low-volatility, and persistent process over time.

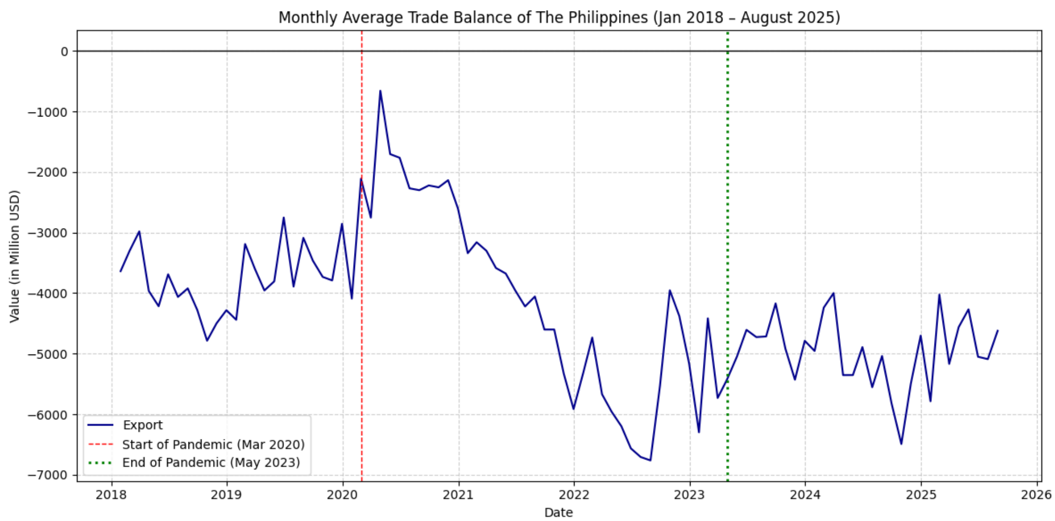

Figure 4: Trade Deficit and Pandemic Impact on Philippine Goods Flow (2018–2025)

The sustained **trade deficit** shown in Figure 4, characterized by a worsening trend from 2021 to 2023, is fundamentally explained by the divergent patterns in exports and imports visible in Graph 12. The latter shows that, while **Exports** (blue line) displayed only moderate growth after the initial pandemic dip in early 2020, **Imports** (green line) experienced a robust, significant, and persistent recovery, consistently maintaining a value substantially higher than exports throughout the period. This dominant import growth necessitates a constant outflow of US Dollars, which is structurally reflected in the persistent and volatile trade deficits of Figure 3. Global commodity costs compound this pressure: Graph 16 reveals a **high negative correlation** between the **Trade Balance** and **Price Crude** (Crude Oil) and **Price Brent** (Brent Oil) (values around -0.83), indicating that when global oil prices rise (as seen in the peak in Graph 8), the trade balance deteriorates sharply. Since the Philippines is a net energy importer, higher oil prices directly increase the cost of its already high import bill, requiring more foreign currency to settle payments and worsening the trade deficit, a key factor that puts downward pressure on the Peso. Ultimately, the trade balance's **high negative correlation** with the **Price USD-PHP** (around -0.61 in Graph 16) confirms that the worsening deficit strongly drives the depreciation (increase in the value) of the Peso.

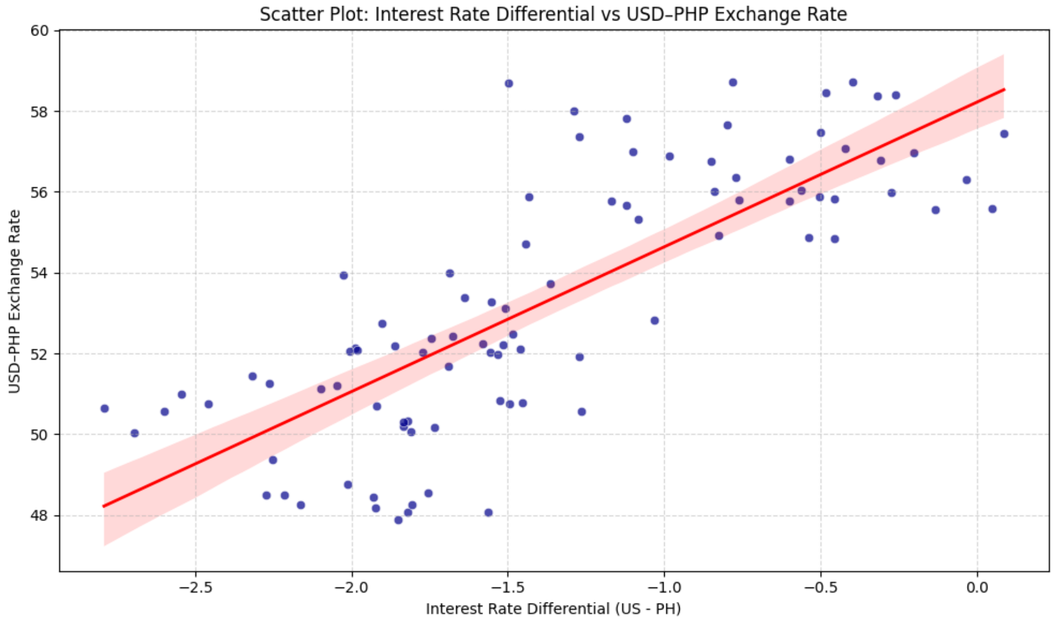

Figure 5: Correlation between US-PH Interest Rate Differences and the Peso's Value

The scatter plot in Figure 5 visually confirms a **strong, positive linear correlation** between the Interest Rate Differential (US Rate minus PH Rate) on the horizontal axis and the USD-PHP Exchange Rate on the vertical axis. This key feature, represented by the upward-sloping regression line and tightly clustered data points, is statistically supported by Graph 16 (Heatmap), which shows a **strong positive correlation** between the **Interest Differential** and the **Price USD-PHP** (a value around +0.65). This relationship implies that as the Interest Rate Differential moves to the right (becoming less negative, meaning the US interest rate is declining relative to the Philippine rate), the USD-PHP Exchange Rate tends to increase, causing the Philippine Peso to depreciate. Conversely, when the Interest Differential becomes more negative (as the US rate rises relative to the PH rate), the Peso tends to appreciate. The overall tightness of the data in Figure 4, reinforced by the high correlation coefficient in Graph 16, suggests that the divergence in interest rates between the two countries is a **significant and reliable predictor** of the movements in the USD-PHP exchange rate, directly supporting the principles of Interest Rate Parity theory.

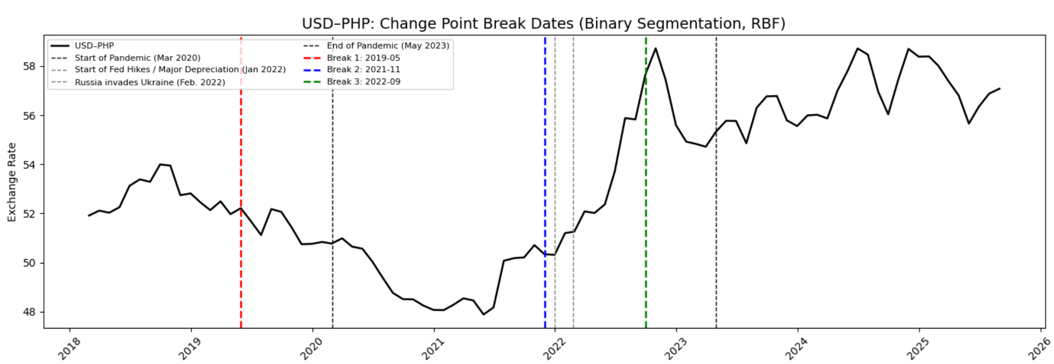

Figure 6: USD-PHP Exchange Rate Volatility: Pinpointing Dates of Major Trend Changes

The structural **Change Point Break Dates** identified in Figure 6 serve as markers for fundamental shifts in the USD-PHP exchange rate's behavior, which are comprehensively supported by corresponding movements in underlying macroeconomic drivers (Graphs 9, 10, 11, 13, 16, 17, and 19). The overall narrative of the exchange rate shifting from initial stability to **significant depreciation** is directly tied to changes in cross-country differentials (Graph 19). The **strong positive correlation** between the **Interest Differential** and the **Price USD-PHP** (around +0.65 in Graph 16, and visually confirmed in Figure 5 and Graph 17) confirms that shifts in interest rate policy are the primary structural mechanism driving the Peso's value.

This mechanism is evident in two major phases:

1. **Break 2 (Nov 2021) and the Depreciation Phase:** This break precedes the **Start of Fed Hikes (Jan 2022)** and marks the end of the Peso's post-pandemic strength. It coincides with the **Interest Differential (Graph 9)** nearing its least negative point and the **Inflation Differential (Graph 10)** beginning its sharp spike. Crucially, the **Multivariate Change Point Detection (Graph 19)** highlights this as the beginning of a sustained macro regime change (blue-to-pink transition in late 2021/early 2022) across the Exchange Rate, Interest Differential, and Inflation Differential. This shift was fueled by the strong negative correlation between the **Trade Balance** and the **Price USD-PHP** (-0.61 in Graph 16), as the **Trade Balance (Graph 13)** was already rapidly deteriorating.

2. **Break 3 (Sep 2022) and Maximum Pressure:** This break coincides with the height of the **Russia-Ukraine invasion (Feb 2022)**, which propelled oil prices to their peak (Graph 8). The **Trade Balance (Graph 13)** reached its lowest point shortly after, driven by the strong negative correlation with rising oil costs (Graph 16). The resulting deficit created maximum demand for US Dollars, coinciding with the Peso's lowest value. This peak pressure occurred despite **OFW Remittances (Graph 11)** maintaining a stable, cyclical inflow, underscoring that the external pressures from trade and monetary policy vastly outweighed the stabilizing effect of remittances on the foreign currency supply.

In summary, the statistically identified breaks in Figure 5 are not isolated events but rather the result of a **synchronized regime change** across the Interest Rate Differential, the Trade Balance, and the Inflation Differential, all acting consistently with their high correlation coefficients in Graph 16 to push the Peso into its deepest depreciation phase.

4 Validation

The validation of findings was conducted using a rigorous exploratory data analysis framework to ensure data quality, analytical accuracy, and methodological soundness. Data preprocessing procedures were validated through systematic completeness checks, descriptive statistical profiling, and consistency assessments to confirm numerical integrity and temporal alignment. Distributional characteristics were examined using both graphical and statistical techniques to identify outliers, assess dispersion, and confirm economic plausibility.

Relationships among variables were explored using correlation analysis, and the observed associations were directionally and theoretically consistent with established exchange rate and macroeconomic theory. Time-series visualizations further supported the validity of observed trends by confirming temporal continuity, structural shifts, and periods of heightened volatility. Additional inspection of variability and clustering patterns provided preliminary evidence relevant to exchange rate volatility behavior. Extreme observations were evaluated within their historical context and retained when indicative of genuine market shocks rather than data anomalies. The stability of relationships across time intervals further reinforced the reliability of the analytical results. Overall, the consistency of findings across multiple exploratory techniques confirms the robustness of the dataset and its suitability for advanced volatility analysis.

5 Limitations, Ethics, and Responsible Use

5.1 Limitations

- **Frequency:** Aggregation to monthly data loses high-frequency volatility (daily clustering) that is critical for short-term risk management.
- **Model Scope:** The OLS model in the analysis is simplified (excluding the DFF and other critical variables like trade balance/remittances) and assumes linear relationships.
- **Causality vs. Correlation:** The OLS provides correlation and association, but does not definitively prove causation, especially without formal co-integration testing.

5.2 Ethics and Responsible Use

Maintain the same ethical standards regarding transparency and the explicit disclaimer that the results are purely **exploratory and academic**, and not a basis for financial investment decisions

6 Conclusion and Actionable Recommendations

6.1 Conclusion

This exploratory analysis confirms that the USD–PHP exchange rate is a dynamic indicator highly sensitive to structural and global macroeconomic shifts. The findings establish three key relationships driving the currency's behavior:

1. **High External Sensitivity:** The Peso's trajectory shifted sharply in response to major external events, notably the Start of Fed Hikes (Jan 2022), when the U.S. Federal Reserve signaled a major policy tightening [1], which triggered a sustained depreciation to historic highs.
2. **Structural Predictors:** The analysis validates key theoretical drivers:

- A strong, positive linear correlation exists between the Interest Rate Differential (US minus PH) and the USD–PHP exchange rate, confirming its predictive reliability consistent with Interest Rate Parity.
- The persistent and structurally large trade deficit acts as an ongoing depreciation pressure, requiring high US Dollar demand for imports.

3. **Domestic Volatility: Philippine inflation** is fundamentally a **high-volatility, fast-moving process** with high variance and fast mean reversion, contrasting with the more stable U.S. inflation. This intrinsic instability contributes to the high volatility observed in the Peso.

In conclusion, the results underscore the need for policymakers to manage the structural pressures of the trade deficit and anticipate the swift, powerful impact of U.S. monetary policy divergence for effective macroeconomic monitoring and currency risk management.

6.2 Actionable Recommendations

- **Adopt a multifaceted policy response** - Address both short-term financial stability and long-term structural resilience to reduce external vulnerability.
- **Implement Proactive Differential Management (BSP)** - Actively use monetary policy tools to maintain favorable interest rate differentials relative to U.S. rate hikes, mitigating interest rate parity (IRP)–driven peso depreciation.
- **Apply Strategic Commodity Hedging** - Introduce targeted hedging mechanisms for oil imports to protect the economy and foreign exchange reserves from cost-push inflation and external price volatility.
- **Introduce targeted hedging mechanisms for oil imports to protect the economy and foreign exchange reserves from cost-push inflation and external price volatility.** - Promote long-term, high-quality Foreign Direct Investment to generate sustainable USD inflows and counter persistent trade balance pressures.

References

[1] TheStreet. A timeline of the fed's 2022–2023 rate hikes, 2025.

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[3] Ronald J. Balvers and Brendan McDonald. Designing a global digital currency. *Journal of International Money and Finance*, 111:102317, 2021.

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[7] Investing.com. Crude oil wti futures historical prices, 2025.

[8] Investing.com. Oil brent historical data, 2025.

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[10] John B. Taylor. Low inflation, pass-through, and the pricing power of firms. *European Economic Review*, 44(7):1389–1408, 2000.

[11] World Trade Organization. Wto stats, 2025.

Appendix

Appendix A: Graphs

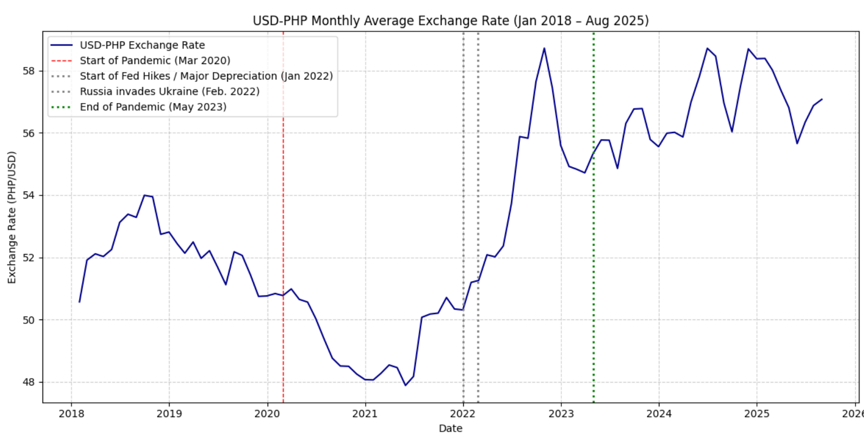

Figure 7: USD-PHP Monthly Average Exchange Rate (Jan 2018 - Aug 2025)

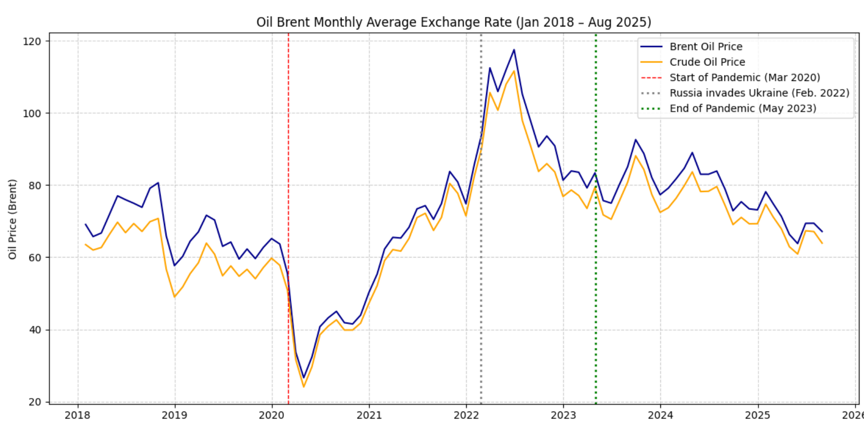

Figure 8: RMonthly Average Oil Price (Jan 2018 - Aug 2025)

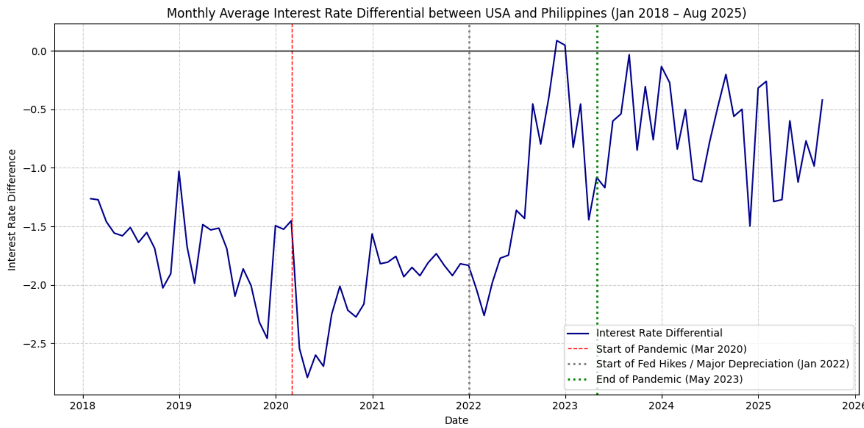

Figure 9: Monthly Average Interest Rate Differential between USA and Philippines (Jan 2018 - Aug 2025)

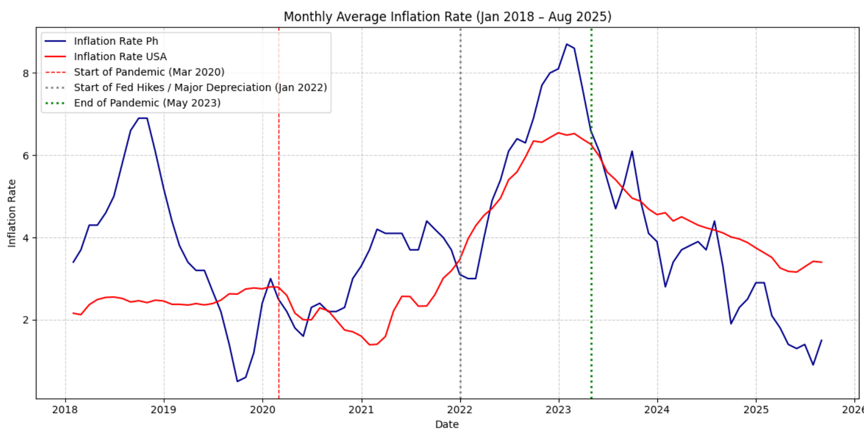

Figure 10: Monthly Average Inflation Rate (Jan 2018 - Aug 2025)

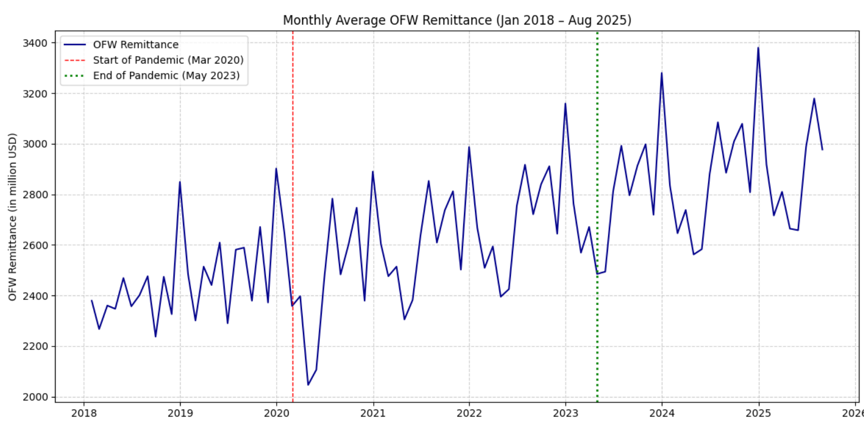

Figure 11: Monthly Average of OFW Remittance (Jan 2018 - Aug 2025)

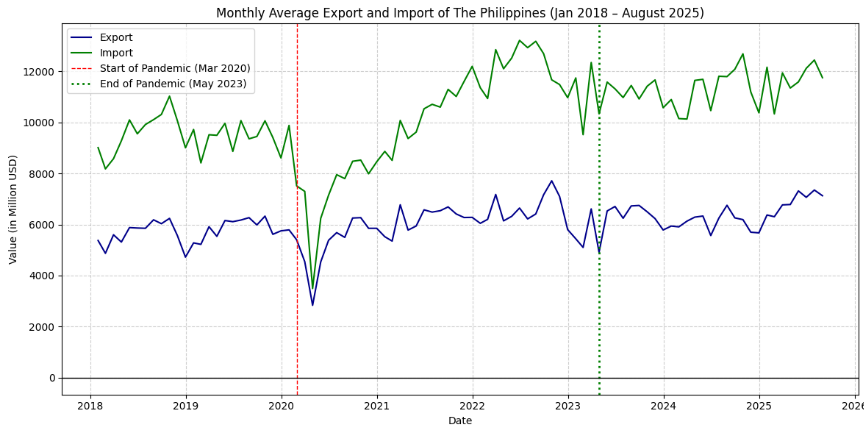

Figure 12: Monthly Average Export and Import of The Philippines (Jan 2018 - August 2025)

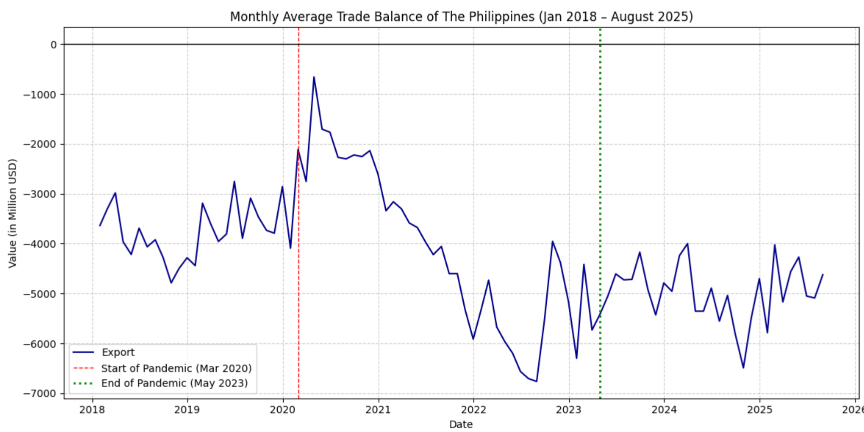

Figure 13: Monthly Average Trade Balance of The Philippines (Jan 2018 - August 2025)

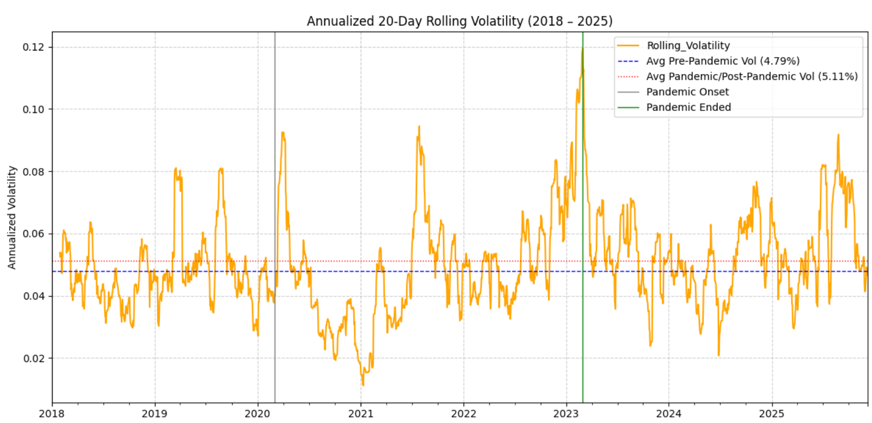

Figure 14: Annualized 20-Day Rolling Volatility (2018-2025)

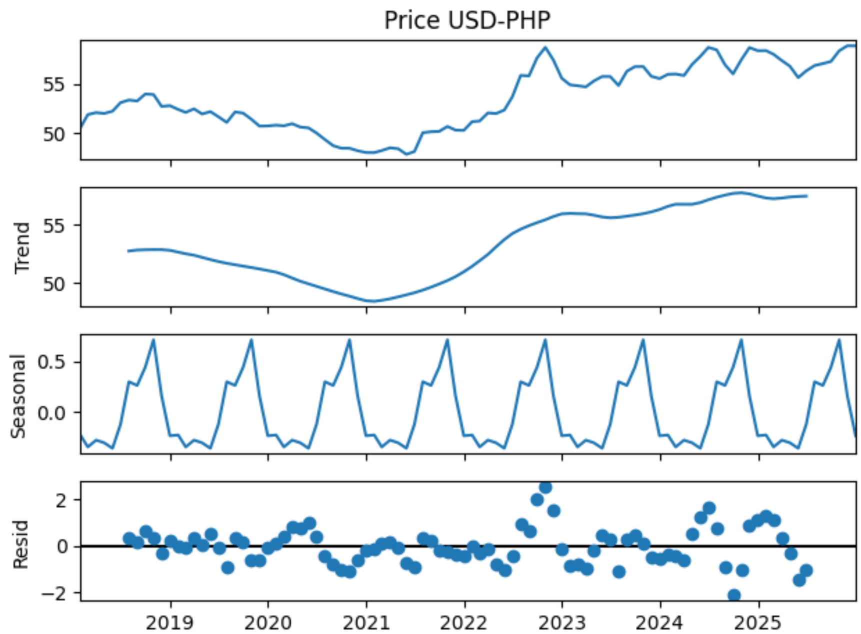

Figure 15: USD-PHP Seasonal Pattern

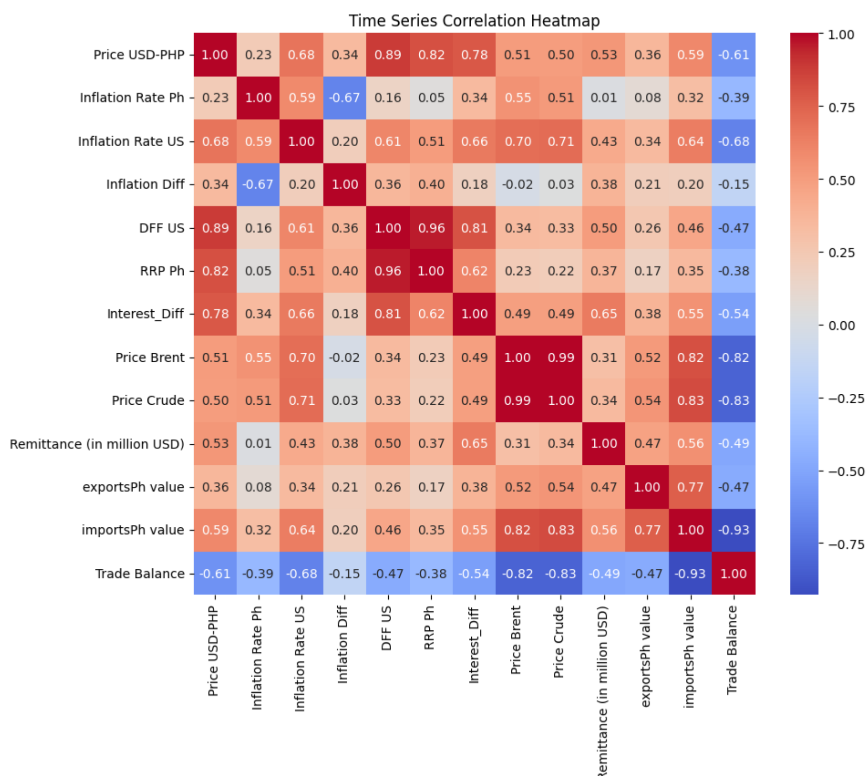

Figure 16: Time Series Correlation Heatmap

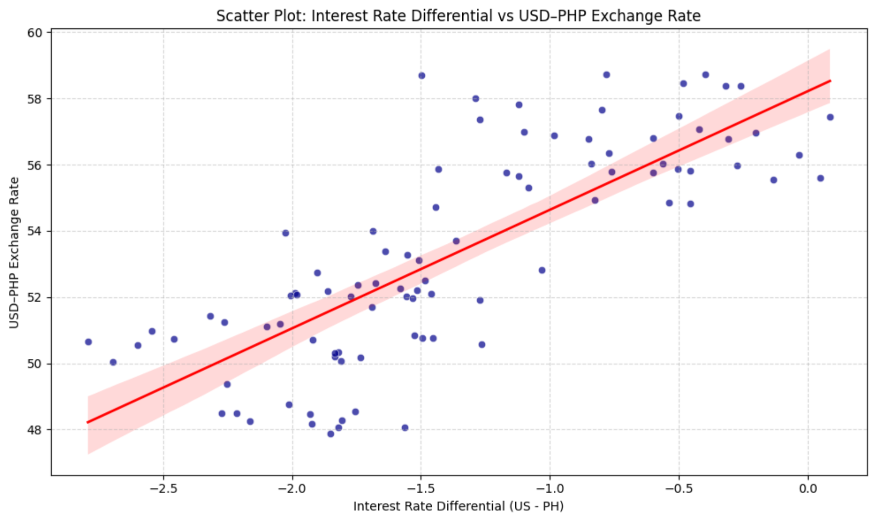

Figure 17: Scatter Plot: Interest Rate Differential vs USD-PHP Exchange Rate

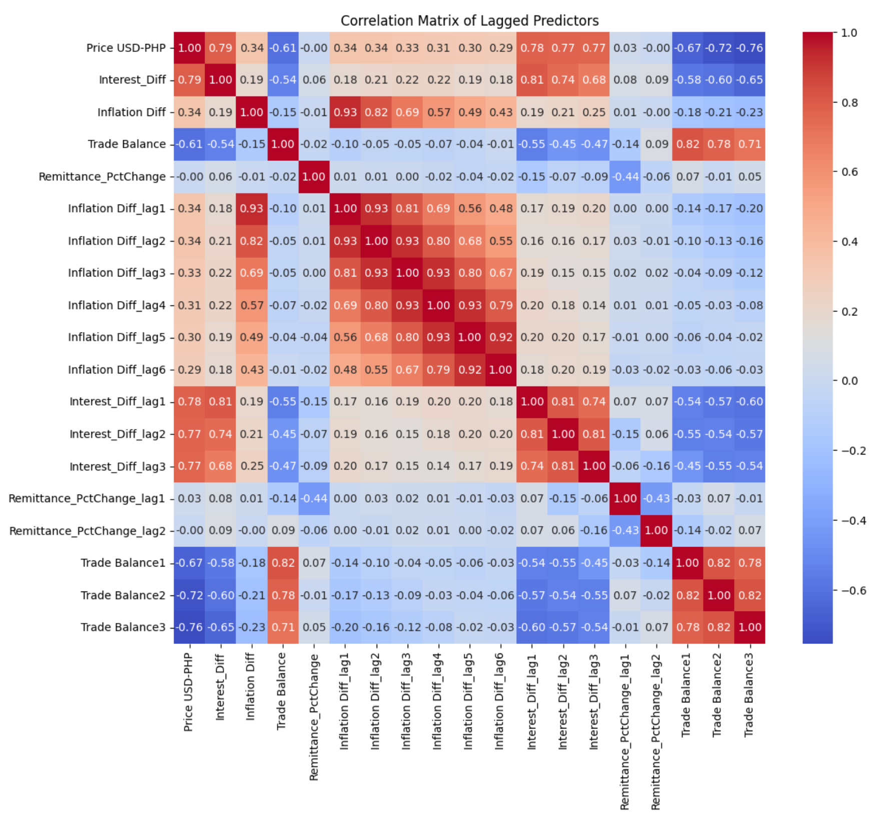

Figure 18: Correlation Matrix of Lagged Predictors

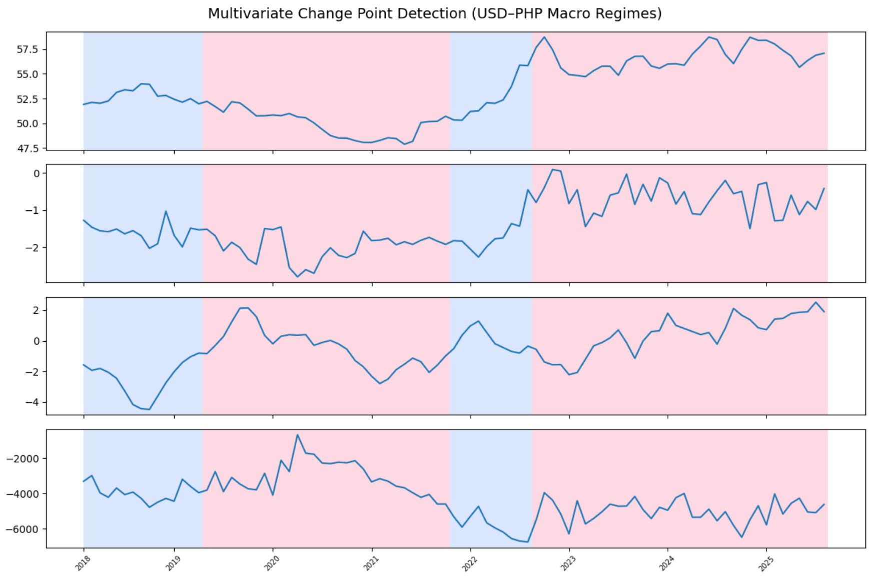

Figure 19: Multivariate Change Point Detection (USD-PHP Macro Regimes)

Panels (top to bottom): USD–PHP exchange rate; interest differential; inflation differential; trade balance.

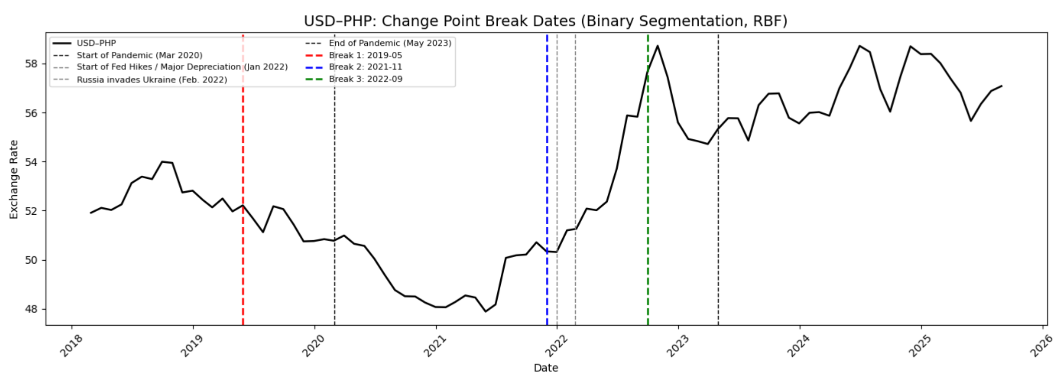

Figure 20: USD-PHP Change Point Break Dates

*Description.*The same as with Graph 13, but showcasing the exact dates overlaid on top of USD-PHP exchange rate.

Appendix B: Tables

	Price USD-PHP	Inflation Rate Ph	Inflation Rate US	DFF US	RRP Ph	Price Brent	Price Crude	Remittance (in million USD)	importsPh value	exportsPh value	Trade Balance	Interest_Diff	Inflation Diff
count	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00
mean	53.31	3.93	3.51	2.50	3.87	72.70	67.83	2650.29	10340.85	6052.62	-4288.23	-1.37	-0.42
std	3.19	1.90	1.43	1.98	1.48	16.92	16.34	262.05	1682.15	709.23	1226.90	0.70	1.57
min	47.88	0.50	1.39	0.05	1.65	26.63	24.08	2046.00	3492.85	2834.01	-6763.80	-2.79	-4.48
25%	50.75	2.48	2.39	0.18	2.55	64.38	58.29	2468.00	9396.29	5678.71	-5109.63	-1.85	-1.54
50%	52.61	3.70	3.08	2.19	3.79	73.62	69.28	2641.00	10416.69	6164.63	-4280.45	-1.50	-0.26
75%	55.99	4.93	4.51	4.37	5.34	82.27	77.44	2837.00	11611.73	6430.42	-3628.61	-0.79	0.67
max	58.72	8.70	6.55	5.33	6.45	117.50	111.61	3380.00	13209.44	7711.12	-658.84	0.09	2.52

Table 1: Statistical Summary

Variable	VIF
Inflation Diff_lag1	3.078586
Inflation Diff_lag3	4.424949
Inflation Diff_lag6	2.145788
Interest_Diff_lag1	2.802129
Remittance_PctChange_lag1	1.268338
Remittance_PctChange_lag2	1.278783
Trade Balance1	2.727005

Table 2: VIF Results

```
                            OLS Regression Results
==============================================================================
Dep. Variable:          Price USD-PHP   R-squared:                       0.756
Model:                            OLS   Adj. R-squared:                  0.734
Method:                 Least Squares   F-statistic:                     34.12
Date:                Tue, 16 Dec 2025   Prob (F-statistic):           3.94e-21
Time:                        23:45:17   Log-Likelihood:                -161.36
No. Observations:                  85   AIC:                             338.7
Df Residuals:                      77   BIC:                             358.3
Df Model:                           7
Covariance Type:            nonrobust
=============================================================================================
                                coef    std err          t      P>|t|      [0.025      0.975]
---------------------------------------------------------------------------------------------
const                        52.8051      1.089     48.483      0.000      50.636      54.974
Inflation Diff_lag1           0.2058      0.205      1.003      0.319      -0.203       0.614
Inflation Diff_lag3           0.2056      0.246      0.836      0.406      -0.284       0.695
Inflation Diff_lag6           0.1418      0.169      0.838      0.404      -0.195       0.478
Interest_Diff_lag1            2.4724      0.317      7.809      0.000       1.842       3.103
Remittance_PctChange_lag1    -2.4751      2.076     -1.192      0.237      -6.609       1.659
Remittance_PctChange_lag2    -4.2994      2.092     -2.055      0.043      -8.465      -0.134
Trade Balance1               -0.0010      0.000     -5.496      0.000      -0.001      -0.001
==============================================================================
Omnibus:                        6.407   Durbin-Watson:                   0.716
Prob(Omnibus):                  0.041   Jarque-Bera (JB):                2.867
Skew:                           0.134   Prob(JB):                        0.238
Kurtosis:                       2.141   Cond. No.                     6.14e+04
==============================================================================
```

Table 3: OLS Results from Lagged Data

Feature	Value
Interest_Diff	0.3108884195065292
Inflation Diff	-0.07880959222737609
Trade Balance	0.17144659551268504
Remittance_PctChange	0.31662598863907643
Inflation Diff_lag1	0.11697514681253736
Inflation Diff_lag2	0.13814244776313753
Inflation Diff_lag3	0.11442137795981194
Inflation Diff_lag4	0.14077298772411243
Inflation Diff_lag5	0.1580236208931001
Inflation Diff_lag6	0.09513466548521504
Interest_Diff_lag1	0.3835118875841736
Interest_Diff_lag2	0.48530411670759377
Interest_Diff_lag3	0.7886609430772837
Remittance_PctChange_lag1	0.35219419329234275
Remittance_PctChange_lag2	0.1514719350206769
Trade Balance1	-0.2826396960736699
Trade Balance2	-0.47902484969760517
Trade Balance3	-0.736591931940964

Table 4: Ridge Regression of all Lagged Features

Appendix C: Python Mathematical Calculations

```
main_monthly['Trade Balance'] = main_monthly['exportsPh value'] - main_monthly['importsPh value']
```

Figure 21: Trade Balance = Exports - Imports

1.

```
main_monthly['Interest_Diff'] = main_monthly["DFF US"] - main_monthly["RRP Ph"]
```

Figure 22: Interest Rate Differential = Interest Rate USA - Interest Rate Philippines

2.

```
main_monthly["Inflation Diff"] = main_monthly['Inflation Rate US'] - main_monthly['Inflation Rate Ph']
```

Figure 23: Inflation Differential = Inflation USA - Inflation Philippines

3.

Appendix D: Long Interpretation of Figures

Interpretation

`Interest_Diff`: +0.311
`Interest_Diff_lag1`: +0.384
`Interest_Diff_lag2`: +0.485
`Interest_Diff_lag3`: +0.789

Higher US–PH interest rate differentials cause the peso to weaken (USD–PHP rises), not only immediately but increasingly over the next 3 months. This is exactly what monetary theory predicts, if US rates increase relative to PH, the capital flows to the US, and peso depreciates. The effect strengthens over time because interest rate changes take time to influence global capital flows.

`Inflation Diff`: -0.079 (slightly negative)
`Inflation Diff_lag1`: +0.117
`Inflation Diff_lag2`: +0.138
`Inflation Diff_lag3`: +0.114
`Inflation Diff_lag4`: +0.141
`Inflation Diff_lag5`: +0.158
`Inflation Diff_lag6`: +0.095

Immediate inflation effect is weak or slightly negative, likely due to noise. After 1–6 months, higher PH inflation relative to US inflation leads to peso depreciation (USD–PHP goes up). This aligns with Purchasing Power Parity (PPP) that if PH prices rise faster than US prices → peso loses purchasing power, peso depreciates, and the persistence (lags up to 6 months) shows that Inflation shocks affect the exchange rate slowly but steadily.

Figure 24: Long Interpretation I - Ridge Regression Results

`Trade Balance`: +0.171 (current)
`Trade Balance1`: –0.283
`Trade Balance2`: –0.479
`Trade Balance3`: –0.737

A more negative (worse) trade balance today → peso weakens (USD–PHP up). The effect strengthens dramatically over the next 3 months. Trade deficits mean the Philippines must buy more USD to pay for imports. This creates Persistent FX demand → peso depreciation pressure. The increasing negative magnitude from lag1 to lag3 shows Trade shocks (like oil price spikes or supply chain disruptions) influence the exchange rate with a delay.

`Remittance_PctChange`: +0.317 (current)
`Remittance_PctChange_lag1`: +0.352
`Remittance_PctChange_lag2`: +0.151

These positive coefficients mean something counterintuitive at first (remittances ↑ should strengthen peso ↓ USD–PHP). But Ridge shrinks coefficients heavily, and the relationship may be tangled with other variables.

Economic interpretation that still aligns with theory remittances provide FX inflows → support peso → usually peso appreciates. But in your data, remittances may rise during crises (OFW emergency remittances), which coincide with peso depreciation periods (COVID, oil shocks). So the model likely picks up co-movements, not pure causality. Remittances matter, but the effect is small and mixed due to crisis periods.

Overall:

The Ridge regression shows that the US–PH interest rate differential is the most influential driver of USD–PHP movements, with positive and increasing impacts across multiple lags. Higher US rates relative to PH consistently lead to peso depreciation, reflecting delayed capital flow adjustments. Inflation differentials also contribute to peso weakening, in line with purchasing power parity, with effects materializing gradually over 1–6 months. Trade balance deficits exert strong depreciation pressure with a 1–3 month lag, consistent with foreign currency demand to finance imports. Remittances show weaker and mixed effects, likely because remittance surges often coincide with crisis periods when the peso is already depreciating.

Figure 25: Long Interpretation II - Ridge Regression Results