J E B I N Journal of Economics Business Industry
ISSN : 3025-0986
P-ISSN: 3025-0528
Volume 4, Number 1, 20xx, pp 53-67
DOI: https://doi.org/10.59976/jebin.v4i1.360

The Rupiah Under Repeated Stress: A VAR Analysis of Its Interdependence with ASEAN and Developed Currency Markets

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Manuscript received 16 June. 2026; revised 26 July. 2026; accepted 28 August. 2026

ABSTRACT
Between 2020 and 2025, the Indonesian Rupiah weakened from an average of IDR15,287 per US Dollar to a low of IDR17,465 in April 2025, its weakest level since 1998, after passing through the Covid-19 shock, the Federal Reserve's steepest tightening cycle in four decades, and the 2025 tariff shock in succession. How closely these repeated pressures tied the Rupiah to its regional and developed-market counterparts remains unclear, since existing studies either stop short of 2025 or treat the Rupiah as one of many currencies in broad regional panels rather than as the central focus. This study addresses that gap by estimating a seven-variable vector autoregression on monthly data from January 2020 to December 2025, covering the Rupiah, the Malaysian Ringgit, the Philippine Peso, the Singapore Dollar, the Thai Baht, the Japanese Yen, and the Euro, and applying generalised impulse response functions and generalised forecast error variance decomposition to trace how shocks in each currency transmit to the others. The results show that the Rupiah's own shocks explain only 25.7 percent of its variance from the third month onward, while the four ASEAN currencies jointly explain 56.1 percent, led by the Singapore Dollar at 17.6 percent, compared with just 18.1 percent from the Euro and Yen combined. The Rupiah's correlation with the Euro is positive, while its correlation with the Yen is negative, revealing an uneven relationship with developed markets. These findings suggest that Indonesian monetary authorities have limited capacity to manage exchange rate stability through domestic measures alone, and that closer regional monitoring, particularly of Singapore, may offer more practical value than comparable attention to developed-market currencies.

Keywords: Indonesian Rupiah, Exchange Rate Interdependence, ASEAN Currencies, Vector Autoregression, Variance Decomposition

INTRODUCTION

The Indonesian Rupiah's exchange rate against the US Dollar moved from an average of IDR15,287 across 2020 to 2025 to a level as weak as IDR17,465 in April 2025, the weakest point recorded since the 1998 crisis. Before that, the Rupiah had already fallen to a low of IDR13,832 in early 2020, when the Covid-19 pandemic triggered a simultaneous global sell-off of risk assets. Between these two extremes, the Rupiah also went through the Federal Reserve's most aggressive interest rate tightening cycle in four decades across 2022 and 2023, which pressured nearly every Asian currency at the same time. These three major shocks, arriving one after another within a relatively short span of time, make the 2020 to 2025 period one of the most turbulent six-year stretches the Rupiah has ever experienced, and this in turn provides a strong reason to re-examine how closely the Rupiah is actually tied to its trading-partner currencies during a period under this much strain.

This question of interdependence is not merely academic. Whenever the Rupiah weakens, Bank Indonesia must decide how much of its foreign reserves to commit to intervention, and that decision depends heavily on whether the weakening is purely domestic in origin or is instead being pulled along by weakness in neighbouring currencies. For businesses trading across ASEAN, understanding this pattern of co-movement helps determine when hedging is warranted and when exchange rate risk can reasonably be treated as normal fluctuation. For the field of international finance, the 2020 to 2025 period offers a rare opportunity to test whether the ASEAN financial integration that is so often described as deepening actually holds up when confronted with three distinct global shocks occurring in succession.

A number of recent studies have already approached this issue from different angles. One strand of research uses cointegration and GARCH-based volatility methods to test long-run relationships among ASEAN currencies. (Ruangsrimun, 2024)found long-run and short-run relationships across most ASEAN currency pairs, while (Chancharat & Suwannapak, 2024), testing an ASEAN+6 panel, found strong and consistent cointegration evidence only for Singapore, with the evidence considerably weaker elsewhere. (Qureshi & Aftab, 2023), using wavelet analysis on five ASEAN currencies, reported a consistent pattern in which Singapore always occupies the leading position in driving regional currency movements, while the Rupiah tends to lag behind in every pair examined.

A second strand of research goes further by using frequency-domain and quantile-based methods, which can separate short-run from long-run patterns more sharply than conventional cointegration tests. Zhu, (Wang et al., 2025) found that connectedness among ASEAN+3 exchange rates is considerably stronger at long horizons than at short ones, and (Kakran et al., 2025; Z. Li et al., 2026), examining twenty APEC currencies across three separate crisis episodes, found that the Covid-19 shock produced the highest spillover of the three. Xu (2025) added the finding that the Singapore Dollar and the Japanese Yen consistently act as transmitters of shocks to other currencies, while the Rupiah is more often a receiver. (Niveditha, 2025) reinforced a similar pattern, showing that connectedness among Asian currencies is considerably higher under extreme market conditions than under normal ones.

A third strand focuses more deeply on single shocks. (Lastauskas & Nguyen, 2024)showed that the Federal Reserve's 2022–2023 tightening cycle transmitted to emerging markets with effects that grew larger when accompanied by policy uncertainty. Lee, Su, and Tao (2024) and Lu, Yu, Li, and Li (2024) both found that the Yen's status as a safe-haven currency has become less stable and less consistent since the early 2020s, with Lu and colleagues concluding that no East Asian currency, including the Yen, fully qualifies as a safe haven once geopolitical risk and trade-policy uncertainty are taken into account. Meanwhile, Ostry, Lloyd, and Corsetti (2025) recently documented how the April 2025 US tariff announcements shook exchange rates broadly, with the size of the impact depending heavily on the pattern of retaliation each country adopted.

Read together, these findings reveal a fairly consistent pattern, but also three gaps that remain unaddressed. First, studies focused specifically on ASEAN cointegration or VAR modelling, such as (Chancharat & Suwannapak, 2024; Ruangsrimun, 2024), close their samples before the 2025 tariff shock, so none has tested how the pattern of interdependence held up, or changed, once this third shock entered the picture. Second, studies using broader panels such as ASEAN+3 or APEC, including (Kakran et al., 2025; Z. Li et al., 2026), and (X. Li et al., 2026), treat the Rupiah as just one node among nine to twenty other currencies, which makes the Rupiah's specific position relative to both ASEAN and developed markets harder to see clearly. Third, studies on single shocks, such as Fed tightening or Yen instability, examine one episode in depth, but none has yet brought all three major 2020–2025 shocks together within a single, continuous analysis.

Building on these three gaps, this study offers something not yet available in the existing literature. Its data span the full period from January 2020 through December 2025, making it one of the first analyses to capture all three major shocks, the Covid-19 pandemic, the Federal Reserve's monetary tightening, and the 2025 tariff shock, within a single, continuous VAR framework. This study also deliberately centres its analysis on the Rupiah as the sole reference point, comparing its movement directly against four other ASEAN currencies, the Malaysian Ringgit, the Philippine Peso, the Singapore Dollar, and the Thai Baht, as well as against two developed-market currencies, the Euro and the Japanese Yen, so that the Rupiah's position can be read clearly rather than being lost among dozens of other currencies as in broader regional studies.

To fill this gap, this study uses the vector autoregression framework combined with impulse response functions and variance decomposition, allowing it to measure not only how closely the Rupiah correlates with other currencies, but also how quickly the effect of a shock spreads and how long that shock persists before fading. This approach allows all seven currencies to be treated equally as part of a single interconnected system, without needing to determine in advance which currency should be considered the driver and which the follower.

Based on the discussion above, this study aims to measure the degree of dynamic interdependence between the Rupiah's exchange rate and the exchange rates of the Malaysian Ringgit, the Philippine Peso, the Singapore Dollar, and the Thai Baht within ASEAN, and to compare this with the Rupiah's interdependence with the Euro and the Japanese Yen as representatives of developed markets, using monthly data spanning January 2020 through December 2025.

The findings of this study are expected to provide benefits on three fronts. For Bank Indonesia and monetary authorities, these findings offer up-to-date empirical evidence on how much external pressure needs to be factored into exchange rate stabilisation policy. For businesses and investors trading across ASEAN, understanding this pattern of interdependence helps inform more timely hedging strategies. For the academic literature, this study complements recent work by providing evidence centred specifically on the Rupiah and covering the most recent sequence of shocks this currency has experienced, while also opening the way for further research that places a single currency at the centre of analysis within a continually evolving regional financial network.

DATA AND METHODOLOGY

The dynamic relationship among the seven exchange rate series is estimated using the vector autoregression framework, an approach well suited to a system in which no single currency can be treated as purely exogenous to the others. Rather than imposing a one-directional causal structure from the outset, this framework allows every series to be modelled as a function of its own past values and the past values of all six remaining series simultaneously, letting the data reveal the pattern of interdependence rather than assuming it in advance.

The full system is stated compactly in equation (1), where the vector Y_t collects the seven exchange rate series (IDR, MYR, PHP, SGD, THB, JPY, and EUR), A_0 is a vector of intercepts, A_1 is the matrix of lag-one coefficients linking every series to every other series, and ε_t is the corresponding vector of residuals (Hsing, 2015). This compact notation represents seven individual equations estimated jointly, one for each exchange rate series, all sharing the same right-hand-side structure but differing in which series sits on the left.

Equations (2) through (4) spell out this general structure explicitly for three of the seven series. The IDR equation in (2) expresses the change in the Rupiah as a function of its own lagged change together with the lagged changes in the Ringgit, Peso, Singapore Dollar, Baht, Yen, and Euro, each carrying its own coefficient, plus a constant term and a residual (Bhatty et al., 2025). The MYR equation in (3) and the JPY equation in (4) follow the identical logic, simply rotating which currency occupies the dependent position while retaining the remaining six as lagged regressors. Analogous equations, constructed the same way, were estimated for the Philippine Peso, the Singapore Dollar, the Thai Baht, and the Euro, so that the complete system comprises seven equations in total, one per exchange rate series, all estimated jointly as a single unrestricted first-order VAR (Kartono et al., 2021; Stock & Watson, 2001). Drawing on the vector autoregression (VAR) framework, the following empirical models in this study (Krishnan et al., 2024; Kumar, 2025; Yang et al., 2023):

$$\Delta Y_t = A_0 + A_1 \Delta Y_{t-1} + \varepsilon_t, \quad \text{where } Y_t = (IDR_t, MYR_t, PHP_t, SGD_t, THB_t, JPY_t, EUR_t)' \tag{1}$$

$$\begin{aligned} \Delta IDR_t = \alpha_{10} &+ \alpha_{(11)\Delta IDR_{t-1}} + \alpha_{(12)\Delta MYR_{t-1}} + \alpha_{(13)\Delta PHP_{t-1}} + \alpha_{(14)\Delta SGD_{t-1}} + \alpha_{(15)\Delta THB_{t-1}} + \alpha_{(16)\Delta JPY_{t-1}} \\ &+ \alpha_{(17)\Delta EUR_{t-1}} + \varepsilon_{1t} \end{aligned} \tag{2}$$

$$\begin{aligned} \Delta MYR_t = \alpha_{20} &+ \alpha_{(21)\Delta MYR_{t-1}} + \alpha_{(22)\Delta IDR_{t-1}} + \alpha_{(23)\Delta PHP_{t-1}} + \alpha_{(24)\Delta SGD_{t-1}} + \alpha_{(25)\Delta THB_{t-1}} + \alpha_{(26)\Delta JPY_{t-1}} \\ &+ \alpha_{(27)\Delta EUR_{t-1}} + \varepsilon_{2t} \end{aligned} \tag{3}$$

$$\begin{aligned} \Delta JPY_t = \alpha_{30} &+ \alpha_{(31)\Delta JPY_{t-1}} + \alpha_{(32)\Delta IDR_{t-1}} + \alpha_{(33)\Delta MYR_{t-1}} + \alpha_{(34)\Delta PHP_{t-1}} + \alpha_{(35)\Delta SGD_{t-1}} + \alpha_{(36)\Delta THB_{t-1}} \\ &+ \alpha_{(37)\Delta EUR_{t-1}} + \varepsilon_{3t} \end{aligned} \tag{4}$$

IDR, MYR, PHP, SGD, and THB denote the Indonesian Rupiah, Malaysian Ringgit, Philippine Peso, Singaporean Dollar, and Thai Baht respectively, JPY denotes the Japanese Yen, and EUR the European Euro (Bhatty et al., 2025; Hsing, 2015; X. Li et al., 2026). Equation (1) states the full seven-variable system in compact vector form, while equations (2) through (4) spell out this specification explicitly for the IDR, MYR, and JPY equations respectively. Analogous first-order equations, each regressing the first difference of one series on lag-1 first differences of itself and the remaining six series, were estimated for PHP, SGD, THB, and EUR to complete the system. Because every equation carries lagged terms, the lag length applied throughout was chosen using the Akaike Information Criteria (Baumeister & Hamilton, 2024; Fischer et al., 2023). As is standard for any time series estimation, the data were first screened for their stationarity properties using the conventional Augmented Dickey Fuller (ADF) unit root test (Stock & Watson, 2001; Yang et al., 2023).

Stationary Test

Macroeconomic variables are frequently non stationary by (Dery & Serletis, 2023), so a unit root test was run first to confirm that each variable met the stationarity requirement, guarding against the spurious regression problem that arises when non stationary variables are fed into a standard regression (Y. Liu et al., 2023; Thomas et al., 2022). A series is considered stationary when its mean, variance, and covariance stay constant through time. The standard ADF test (Dickey and Fuller 1979; 1981) was used for this purpose, specified as follows (Xu & Serletis, 2022):

$$\Delta y_t = \beta_1 + \beta_2 t + \delta y_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta y_{t-i} + \varepsilon_t \tag{5}$$

In this specification, Δyt denotes the first difference of y, β1 the intercept, β2 the coefficient on a time trend, δ the coefficient on the lagged level of y, γ the coefficient on the lagged difference term, ε the error term, m the chosen number of lags, and t the time period. Rejecting the null hypothesis of a unit root (H0: δ = 0) marks the series as stationary; failing to reject it points to non-stationarity.

Impulse Response Functions (IRFS)

The VAR estimated here also serves as the basis for generating Impulse Response Functions (IRFs), the tool used to probe how the IDR relates to the other ASEAN, European, and Japanese markets. An IRF traces out, over time, how a shock occurring at one moment feeds through into the expected future path of every variable in the system (Hipp, 2026; Ozcelebi & Kang, 2024). This makes it a fitting choice here, since it lets the relative weight of different shocks be measured in terms of how much each contributes to movement in the variable of interest, while also revealing the direction and pattern through which a shock propagates.

An IRF picks up the innovation in one exchange rate that stems from its contemporaneous link to the others, meaning a shock recorded in one market may in fact be a byproduct of its correlation with innovations elsewhere at the same point in time. When shocks specific to a single market cannot be cleanly separated from this contemporaneous correlation, the estimated response to innovations in other markets ends up poorly represented (P. Chen et al., 2024; Varelas & Tzimas, 2025). One common fix is Sims' (de Almeida et al., 2024; Laurenceau et al., 2026) approach of orthogonalising the innovations via Cholesky factorisation, but doing so demands that a causal ordering among the currencies be fixed in advance, a real limitation given how sensitive the resulting IRF estimates become to whichever ordering is chosen, particularly when, as is the case in this study's residual correlation matrix, the VAR's error terms are strongly correlated with one another. To sidestep this problem, the study instead relies on the generalised IRF approach of (Bashir & Mohd, 2026; Kulkarni & Dogra, 2026), which fully absorbs the historical correlation structure among the shocks and as a consequence, delivers a unique result regardless of how the currencies happen to be ordered. Because it leaves the error structure unorthogonalised, the generalised IRF also permits the initial, on impact response of a market to different shocks to be read off directly, a property that makes it especially well-suited to currency markets where transmission and adjustment happen quickly (Baek & Kim, 2026)(Boutfssi & Quamar, 2026).

Variance Decompositions (VDCS)

Once the IRFs have been examined, attention turns to the Variance Decompositions (VDCs), which gauge how much a random shock originating in one market matters for the others in the system. Sometimes described as an out of sample causality test, the VDC reveals the dynamic character of the system by splitting a variable's forecast error variance into the portions traceable to shocks in each market, its own included. (Fatima & Rahimi, 2024; Jordà & Taylor, 2025) notes that a variable forecast optimally from nothing but its own past values would have its entire forecast error variance attributed to its own disturbances, and applied work typically finds that a variable accounts for nearly all of its own forecast error variance at short horizons, with that share tapering somewhat as the horizon lengthens.

EMPIRICAL RESULTS

Before turning to the formal time series analysis, it is instructive to first characterise the statistical properties of the seven exchange rate series individually. Examining the central tendency, dispersion, and distributional shape of each series provides an essential empirical foundation for the subsequent stationarity testing and VAR estimation, since the validity of the econometric techniques applied later in this study rests in part on a proper understanding of how each series behaves in isolation. Descriptive statistics also offer a preliminary, model-free indication of which currencies experienced the greatest turbulence over the sample period, and whether that turbulence was distributed symmetrically or was instead concentrated in episodes of sharp depreciation, information that helps contextualise the more formal dynamic results presented later.

Table 1 reports these descriptive statistics for the Indonesian Rupiah, the four other ASEAN currencies, and the two developed-market comparators, all expressed as cross rates against the Rupiah over the January 2020 to December 2025 sample period. For each series, the table presents the mean, minimum, maximum, and median as measures of central tendency and range, the skewness and kurtosis as indicators of distributional asymmetry and tail thickness, the standard deviation as a raw measure of dispersion, and the Jarque-Bera statistic, together with its associated p-value, as a formal test of whether each series can be treated as approximately normally distributed. Taken together, these measures set the stage for the discussion that follows.

Table 1. Descriptive Statistics of the Cross Exchange Rates against the IDR

Statistic	IDR (US$)	MYR	PHP	SGD	THB	JPY	EUR
Mean	15,287.755	3,514.933	282.893	11,350.608	453.980	117.719	16,835.278
Minimum	13,832.263	3,262.530	266.426	10,153.936	413.455	104.266	15,167.948
Maximum	17,465.009	4,068.673	311.210	13,075.206	508.694	144.432	18,570.148
Median	15,194.610	3,454.893	281.575	11,103.326	451.629	112.205	16,926.685
Kurtosis	−1.091	0.395	−0.333	−1.067	−0.563	−1.141	−0.809
Skewness	0.277	1.262	0.292	0.529	0.510	0.699	0.015
Std Dev	942.321	208.964	9.534	833.890	23.666	11.682	799.820
J B test	4.489 (0.106)	19.589*** (0.000)	1.354 (0.508)	6.776** (0.034)	4.067 (0.131)	9.776*** (0.008)	1.966 (0.374)

Table 1 provides an overview of how each currency behaved between January 2020 and December 2025, based on its average level, spread, and distributional shape. The Rupiah averaged IDR15,287.755 per US Dollar, bottoming out at IDR13,832.263 early in the period and peaking at IDR17,465.009 toward the end. The gap between these two extremes exceeds 3,600 points, a wide range that confirms this six-year window was genuinely turbulent rather than calm.

On volatility, the Rupiah posted the highest raw standard deviation of the seven series at 942.321, narrowly ahead of the Singapore Dollar cross rate at 833.890 and the Euro cross rate at 799.820. However, because each currency is priced on a different scale, a fairer comparison looks at volatility relative to each series' own mean. On that basis, the Japanese Yen actually shows the highest relative volatility, followed by the Singapore Dollar, with the Rupiah trailing both. This suggests that although the Rupiah appears most volatile in raw terms, its movement relative to its own average is not meaningfully different from its regional peers.

The shape of each distribution adds further detail. Positive skewness across every currency indicates that extreme values tend to occur on the upside, meaning sharp depreciations against the Rupiah are more common than sharp appreciations. The Malaysian Ringgit shows the largest skewness at 1.262, pointing to more frequent episodes of sharp Ringgit weakness than seen in the other currencies. The Jarque-Bera test further shows that four series, the IDR, PHP, THB, and EUR, cannot be statistically distinguished from a normal distribution, while the MYR, SGD, and JPY depart from it noticeably. This departure in three currencies is consistent with the idea that they underwent sharper, less symmetric adjustments as the period's successive shocks unfolded.

Correlation Coefficients Across Markets

Before turning to the stationarity tests that would inform the model's specification, the correlations among the currencies were examined first, with the resulting coefficients between the IDR and the other exchange rates reported in Table 2.

Table 2: Coefficients of Correlation between the Forex Markets

Currency	IDR	MYR	PHP	SGD	THB	JPY	EUR
IDR	1.000	–	–	–	–	–	–
MYR	0.720	1.000	–	–	–	–	–
PHP	0.033	0.382	1.000	–	–	–	–
SGD	0.940	0.786	−0.038	1.000	–	–	–
THB	0.610	0.899	0.614	0.648	1.000	–	–

Currency	IDR	MYR	PHP	SGD	THB	JPY	EUR
JPY	−0.565	−0.100	0.756	−0.626	0.155	1.000	–
EUR	0.717	0.832	0.514	0.783	0.861	−0.087	1.000

Table 2 measures how closely the Rupiah's movements tracked six other currencies over the same period. The standout finding is the correlation between the Rupiah and the Singapore Dollar, which reaches 0.940, an exceptionally high figure indicating the two currencies moved almost in lockstep throughout the sample. The Malaysian Ringgit follows at 0.720, also a strong relationship, while the Philippine Peso shows almost no correlation with the Rupiah at just 0.033. This wide gap between the Singapore Dollar and the Peso, despite both being ASEAN currencies, shows that geographic proximity and regional membership do not automatically produce co-movement. Other factors, such as the depth of trade linkages and capital flows, appear to matter far more.

An equally interesting pattern emerges when the Rupiah is compared against the two developed-market currencies. Its correlation with the Euro is positive and fairly strong at 0.717, consistent with the general pattern that broad Dollar strength tends to weaken the Rupiah and the Euro at the same time. Against the Japanese Yen, however, the correlation turns negative at −0.565, meaning the Rupiah tends to weaken when the Yen strengthens, and vice versa. This inverse relationship makes sense given the Yen's role as a safe-haven currency: when investors flock to it during periods of global uncertainty, risk-sensitive currencies like the Rupiah tend to come under pressure at the same time.

One further point worth noting is how much the ASEAN currencies vary among themselves. The Thai Baht correlates strongly with almost every other currency in the table, including 0.899 with the Ringgit and 0.861 with the Euro, effectively behaving as the currency most tightly bound to broad market movements. The Philippine Peso, by contrast, tends to move on its own, showing low correlation with nearly all its counterparts except the Yen, where it reaches 0.756. This degree of variation confirms that treating ASEAN as a single, uniformly co-moving bloc relative to the Rupiah is not accurate, since each member currency actually follows a fairly distinct pattern of association.

Stationary Tests

A robust estimation calls for every variable entering the model to be stationary, and Table 3 sets out the results of the ADF based stationarity test carried out for this purpose.

Table 3. Augmented Dickey Fuller Test for Stationarity

Variable	Level (p value)	Remark	First Difference (p value)	Remark
IDR	0.750	Non stationary	0.000	Stationary
MYR	0.854	Non stationary	0.000	Stationary
PHP	0.049	Borderline stationary	0.000	Stationary
SGD	0.728	Non stationary	0.000	Stationary
THB	0.638	Non stationary	0.000	Stationary
JPY	0.577	Non stationary	0.000	Stationary
EUR	0.503	Non stationary	0.000	Stationary

Table 3 tests whether each series behaves in a statistically stable way or instead drifts progressively away from its mean over time, a property known as non-stationarity. At the level form, six of the seven currencies, the IDR, MYR, SGD, THB, JPY, and EUR, all return p-values well above the conventional 0.05 threshold, ranging from 0.503 to 0.854. Such high p-values mean the null hypothesis of a unit root cannot be rejected, so these six series are classified as non-stationary in levels. This finding is entirely expected and matches the general behavior of exchange rate data, which typically follows a random-walk-like pattern with no fixed short-run equilibrium.

The Philippine Peso is the sole exception, returning a p-value of 0.049, just below the 0.05 cutoff. Given how close this sit to the boundary, the result is best read as a borderline case rather than a fully conclusive one, especially since this type of test is known to be sensitive to sample length and lag selection, all the more so with a monthly series covering a period as eventful as this one.

Once every series is converted into first differences, the p-value drops to 0.000 for all seven currencies at once, far below any reasonable threshold, so every series is confirmed stationary at this level. This result is what justifies estimating the VAR model on differenced data, a necessary step whenever the level series prove non-stationary, so that the resulting regression output does not produce misleading conclusions.

VAR Model Specification, Stability, and Diagnostic Checks

With the stationarity picture from Table 3 established, the VAR was fitted to the first differenced, log transformed series. Table 4 lays out the lag order selection criteria weighed before the final specification was settled on.

Table 4: VAR Lag Order Selection Criteria

Lag	AIC	BIC	FPE	HQIC
0	5.220	5.450*	184.92	5.311*
1	5.108*	6.951	166.68*	5.837
2	5.379	8.834	228.76	6.746
3	5.876	10.944	425.31	7.881
4	6.070	12.750	663.36	8.713

Table 4 compares four statistical criteria, AIC, BIC, FPE, and HQIC, to determine how many past periods should enter the model as explanatory variables. The results reveal a genuine disagreement among these criteria. AIC and FPE both point to lag 1, with the lowest AIC value at 5.108 and the lowest FPE at 166.68. BIC and HQIC, on the other hand, favor lag 0, meaning no lagged terms at all, with BIC at its lowest at 5.450 and HQIC at 5.311.

This disagreement is not unusual; it is a pattern that commonly appears when the sample size is short, as is the case with six years of monthly data here. BIC and HQIC mathematically impose a heavier penalty for adding parameters than AIC does, so they tend to favor simpler models, while AIC is more permissive and tends to select a slightly more complex specification. In small samples, AIC's tendency to pick longer lags carries a real risk, since estimating more parameters from a limited number of observations increases the chance that the model is capturing random noise in the data rather than a genuinely meaningful relationship.

Once the lag length is pushed further to 2, 3, and 4, all four criteria worsen consistently together, with AIC rising from 5.108 to 5.379, then 5.876, and finally 6.070. This uniformly upward trend reinforces the conclusion that adding further lags brings no benefit, so regardless of the disagreement between AIC and BIC over lag 0 versus lag 1, both agree that a heavily lagged model is not the right choice for this data.

The complete set of coefficients for the VAR (1) model’s IDR equation, corresponding to equation 1 above, is presented in Table 5.

Table 5: VAR (1) Estimated Coefficients, IDR Equation

Regressor	Coefficient	Std Error	t statistic	p value
Constant	0.1789	0.3663	0.489	0.625
IDR (t−1)	0.1771	0.2383	0.743	0.458
MYR (t−1)	−0.1798	0.2484	−0.724	0.469
PHP (t−1)	−0.3451	0.3561	−0.969	0.332
SGD (t−1)	0.4074	0.3797	1.073	0.283
THB (t−1)	−0.3477	0.3342	−1.040	0.298
JPY (t−1)	0.1244	0.2031	0.613	0.540

Regressor	Coefficient	Std Error	t statistic	p value
EUR (t−1)	−0.0074	0.2587	−0.029	0.977

Table 5 reports the estimated equation for the Rupiah within the VAR system, explaining how much of this month's change in the Rupiah is linked to last month's change in itself and in the six other currencies. In terms of direction, three variables show a positive relationship with the Rupiah: The Rupiah itself with a coefficient of 0.1771, the Singapore Dollar at 0.4074, and the Yen at 0.1244, meaning an increase in the previous month tends to be followed by a further increase in the Rupiah the next month. The remaining four variables, the Ringgit, Peso, Baht, and Euro, all carry negative coefficients, indicating an inverse month-to-month relationship instead.

In terms of magnitude, the Singapore Dollar's coefficient of 0.4074 and the Baht's coefficient of −0.3477 stand out as the largest among all the regressors, which lines up with Table 2's finding that the Singapore Dollar has the strongest correlation with the Rupiah of any currency in the panel. That said, the size of these coefficients needs to be read with some caution, because when tested for statistical significance, none of the seven variables clears the conventional threshold. P-values across the board range from 0.283 to 0.977, well above the usual 0.05 cutoff and even above the more relaxed 0.10 level.

The fact that not a single coefficient reaches statistical significance carries an important implication. It suggests that the one-month-ahead relationship between the Rupiah and its six counterparts, when measured individually through separate VAR coefficients, is not strong enough to be distinguished from zero with statistical confidence. This does not mean there is no relationship at all, since the findings in Table 2 and Table 7 clearly show meaningful co-movement; rather, it means that relationship is better understood as the combined effect of several currencies acting together, rather than the influence of any single currency that is strong and identifiable entirely on its own.

Ahead of interpreting the impulse response and variance decomposition findings, the VAR's dynamic stability and the adequacy of its residuals were checked, with the outcome of these diagnostics summarised in Table 6.

Table 6: VAR Stability and Residual Diagnostics

Check	Result
Model stability (inverse roots)	Stable, all inverse roots lie outside the unit circle
Largest eigenvalue modulus, companion matrix	0.566
Durbin Watson, IDR equation	1.439
Durbin Watson, range across all seven equations	1.439 to 1.841
Portmanteau (whiteness) test, residual autocorrelation to lag 8	Statistic 291.2, p = 0.980, fails to reject no autocorrelation
Jarque Bera, VAR residuals, all seven equations	p < 0.001 in every equation, a common feature of monthly forex return data

Table 6 checks whether the estimated VAR model is fit for further analysis, through four separate diagnostics. The first concerns model stability, tested through the inverse roots of the model's companion matrix. The largest eigenvalue modulus is reported at 0.566, comfortably below the threshold of 1, so the model is classified as stable. This stability check matters because, without it, the Rupiah's response to a shock, as calculated in the impulse response functions behind Table 7, would keep growing indefinitely instead of settling toward equilibrium, which would make the entire dynamic analysis built on top of it meaningless.

The second diagnostic concerns residual autocorrelation, examined through two separate tests. The Portmanteau test, which checks for autocorrelation jointly across all seven equations up to eight lags back, returns a p-value of 0.980, far above any meaningful threshold, so the null hypothesis of no autocorrelation cannot be rejected. This is a favorable result and stands as the most convincing evidence that the model's residuals are free of the repeating patterns the model should already have captured. The individual Durbin-Watson statistics, ranging from 1.439 to 1.841 across the seven equations, sit reasonably close to the value of

2 often used as a rough benchmark for no autocorrelation. However, once compared against the actual critical bounds appropriate for this sample size and number of regressors, the lowest of these values falls into a zone that cannot be conclusively interpreted either way. For that reason, the conclusion that the residuals are free of autocorrelation is better supported by the Portmanteau test, which is specifically designed to examine this kind of pattern more comprehensively.

The final diagnostic concerns residual normality through the Jarque-Bera test, which returns a p-value below 0.001 in all seven equations, meaning the residuals in every equation depart noticeably from a normal distribution. This finding is actually consistent with a well-documented feature of financial return data, including exchange rates, which often display heavier tails than a normal distribution, a pattern commonly referred to as leptokurtosis. Such a departure from normality does not automatically invalidate the VAR model, since ordinary least squares estimates remain consistent even when residuals are not perfectly normal; it does mean, however, that the significance tests reported in Table 5, which assume normality, should be read with a degree of additional caution in light of this finding.

Impulse Response Functions (IRFS)

The IRFs make it possible to examine how the IDR relates to the other ASEAN and developed forex markets, and Figure 2 charts the Rupiah's response to innovations in each of the other markets over a 24 month horizon. To gauge how much confidence to place in these estimated responses, a 95 percent confidence band was built using a residual based bootstrap with 500 replications, following the approach set out by Sims and Zha (1998).

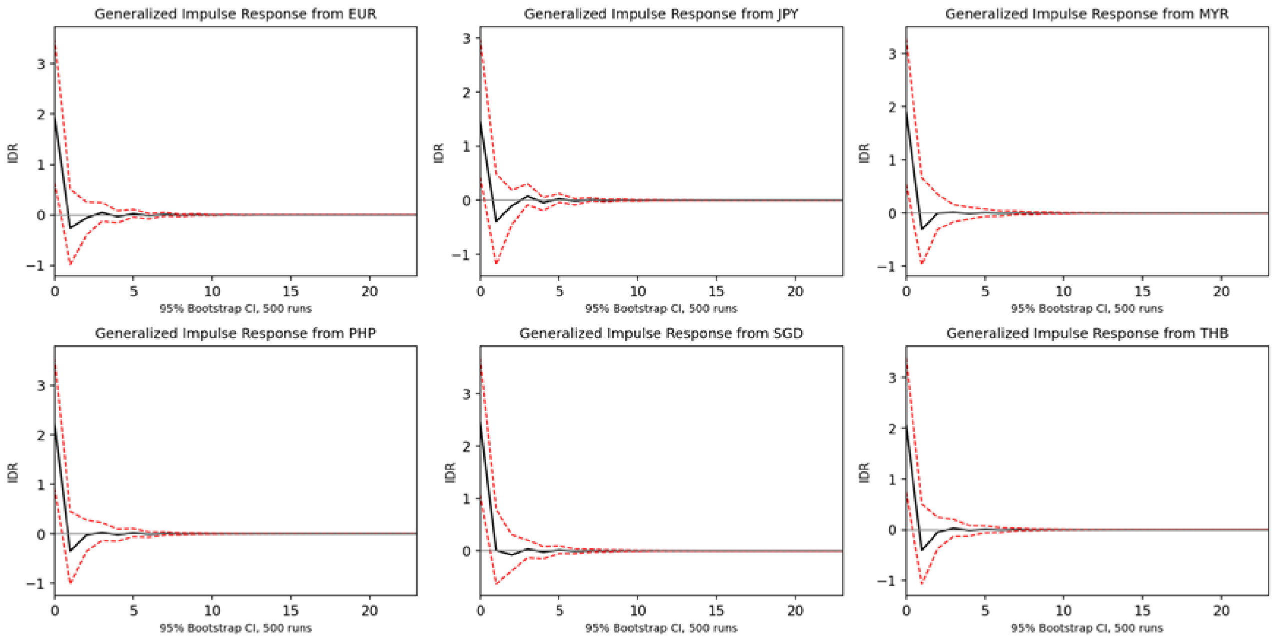

Figure 1. Responses of the IDR to Innovations in other Forex Markets

Figure 1 traces how the Rupiah reacts over time to a one-standard-deviation shock originating in each of the six partner currencies, the Euro, the Yen, the Ringgit, the Peso, the Singapore Dollar, and the Baht, with each of the six panels built around a 95 percent bootstrap confidence band drawn from 500 replications. Read together, these six panels tell a coherent story about how quickly, how strongly, and how confidently the Rupiah's dependence on each market can be pinned down.

The first thing the figure shows is that the Rupiah's on-impact reaction is positive across all six markets: whenever any partner currency strengthens unexpectedly, the Rupiah moves in the same direction right at the moment of the shock, with no exceptions. The size of that initial reaction, however, varies considerably from one market to the next. The Singapore Dollar produces by far the strongest immediate effect, followed by the Peso, the Euro, the Ringgit, and the Baht, with the Yen generating the mildest response of the six. When the comparison is narrowed to the four ASEAN currencies alone, the ordering shifts slightly, with the Singapore Dollar still leading, followed by the Peso, then the Baht, and finally the Ringgit. This ordering shows that the Rupiah's sensitivity to shocks elsewhere in the region is far from uniform: a shock in Singapore's market carries roughly twice the immediate weight of a shock in Malaysia's, even though both are ASEAN neighbours.

Beyond the moment of impact, the six paths do not settle immediately; several of them first overshoot before correcting. The responses triggered by the ASEAN currencies and by the Yen dip noticeably in the second month before snapping back rapidly toward equilibrium by around the fourth month. This overshoot-and-correction shape suggests that the Rupiah's adjustment to these shocks is not a smooth, one-directional return to baseline, but instead involves a brief overreaction that the market then partially reverses within a matter of weeks. By the sixth month, every one of the six response paths has narrowed down to a thin band hovering close to zero, indicating that whatever adjustment the Rupiah needs to make in response to a shock from any of these six markets is essentially complete within about half a year, well within the horizon the chart covers.

Variance Decompositions

The study also reports the results of the generalised VDCs, the tool used to gauge empirically how dynamically interdependent the IDR is with the other forex markets, with Table 7 breaking down the share of the Rupiah's forecast error variance attributable to innovations in each market across horizons running from 1 to 24 months.

Table 7: Generalized Forecast Error Variance Decomposition of the IDR

Horizon (months)	IDR	MYR	PHP	SGD	THB	JPY	EUR
1	0.262	0.107	0.149	0.179	0.127	0.063	0.114
2	0.257	0.108	0.149	0.176	0.129	0.067	0.114
3	0.257	0.108	0.149	0.176	0.129	0.067	0.114
6	0.257	0.107	0.149	0.176	0.129	0.067	0.114
9	0.257	0.107	0.149	0.176	0.129	0.067	0.114
12	0.257	0.107	0.149	0.176	0.129	0.067	0.114
16	0.257	0.107	0.149	0.176	0.129	0.067	0.114
20	0.257	0.107	0.149	0.176	0.129	0.067	0.114
24	0.257	0.107	0.149	0.176	0.129	0.067	0.114

Table 7 measures one specific thing: of all the uncertainty surrounding the Rupiah's future movements, how much can actually be traced back to shocks in the Rupiah itself, and how much originates from shocks in the six partner markets, the Ringgit, Peso, Singapore Dollar, Baht, Yen, and Euro. This is calculated across nine different points in time, from one month ahead out to twenty-four months ahead, making it possible to observe how the composition of that uncertainty evolves rather than looking at a single snapshot.

At the one-month horizon, the Rupiah accounts for only 26.2 percent of its own forecast error variance, a notably low figure for such a short horizon. Ordinarily, the shorter the forecast horizon, the larger the share a variable is expected to explain about itself, simply because there has not been enough time for external shocks to work their way into the system. The fact that external influence already dominates from the very first month suggests that the relationship between the Rupiah and its partner currencies is not one that builds up gradually, but one that is already tightly bound at essentially the same point in time. In other words, when turbulence hits one of the partner markets, its effect on the Rupiah is not something that spreads slowly; it is felt almost immediately. At this horizon, the Singapore Dollar stands out as the largest external contributor at 17.9 percent, followed by the Philippine Peso at 14.9 percent, the Thai Baht at 12.7 percent, the Euro at 11.4 percent, the Malaysian Ringgit at 10.7 percent, and the Japanese Yen trailing at 6.3 percent.

Moving into the second and third months, the system shows a brief period of adjustment before settling down. The Rupiah's own share edges down slightly to 25.7 percent, while the Ringgit, Baht, and Yen each tick up a little, and the Singapore Dollar eases slightly to 17.6 percent. These shifts are modest, but they indicate that the various shocks are still adapting to one another before the system fully settles. The fact that the second- and third-month figures are identical suggests this adjustment process is essentially complete well before the third month is reached.

From the sixth month onward, virtually every figure in the table stops changing altogether through month twenty-four. The only remaining movement is in the Malaysian Ringgit, which edges down from 10.8 to

10.7 percent, while every other currency stay fixed to three decimal places from month six all the way through month twenty-four. This pattern shows that the Rupiah's dependence structure on the other markets reaches its steady state within a matter of months, and extending the forecast horizon further adds no new information about how that uncertainty is distributed.

At this steady state, the final breakdown of the Rupiah's variance is as follows: the Rupiah itself accounts for 25.7 percent, the Singapore Dollar 17.6 percent, the Philippine Peso 14.9 percent, the Thai Baht 12.9 percent, the Euro 11.4 percent, the Malaysian Ringgit 10.7 percent, and the Japanese Yen 6.7 percent. Grouped by region, the four ASEAN currencies together account for 56.1 percent of the total variance, far outweighing the combined 18.1 percent share attributable to the Euro and the Yen. The Singapore Dollar remains the single largest external source of influence at every horizon examined, while the Japanese Yen consistently registers as the smallest.

Taken together, these results indicate that only about a quarter of the uncertainty surrounding the Rupiah's future movements genuinely originates from domestic factors, while the remaining three quarters is statistically traceable to ASEAN currency markets and, to a lesser extent, developed-market currencies, and this pattern is already established within a single month rather than emerging only after several years. Because this equilibrium is reached within months and remains stable for up to two years afterward, the findings also suggest that the scope for purely domestic policy tools to alter the Rupiah's degree of dependence on external markets is fairly limited once that equilibrium has been locked in.

DISCUSSION

The dominance of intraregional over developed-market linkages. The finding that the Rupiah's own variance share falls to roughly a quarter of the total by the sixth month, with the four ASEAN currencies together accounting for more than half of the remainder, sits comfortably alongside Ruangsrimun (2024), who documented persistent long-run and short-run linkages across nine ASEAN currencies using GARCH-based cointegration, and (X. Chen & Yao, 2026), who found that cross-quantile connectedness among ASEAN+3 exchange rates is markedly stronger in the long run than in the short run. It is, however, a more emphatic result than (Chancharat & Suwannapak, 2024) reported for a broader ASEAN+6 panel, where formal cointegration between exchange rates and stock markets held up clearly only for Singapore and was comparatively weak elsewhere; the present study's VAR-based evidence of pervasive interdependence across all seven series suggests that once the analysis is confined to ASEAN plus two developed markets rather than a ten-country panel, and once the sample is extended through the 2020–2025 shock sequence, the regional linkages become considerably harder to miss.

Singapore's central position. The result that the Singapore Dollar accounts for the largest single share of the Rupiah's forecast error variance, produces the strongest on-impact impulse response of any comparator, and shows the highest raw correlation with the Rupiah in the sample, closely echoes (X. Chen & Yao, 2026) (Qureshi et al., 2023), whose wavelet analysis of five ASEAN exchange rates found Singapore holding what they term the driving position while Indonesia lagged behind in every currency pair examined. It is also consistent with (Chay et al., 2023; Wu et al., 2025), who classified the Singapore Dollar, alongside the Japanese Yen, as a consistent net transmitter of shocks across nine Asian currencies, with the Indonesian Rupiah recurring among the net receivers. Read together with (T. Liu et al., 2022) network analysis of the Renminbi's rising role in Asia, which likewise identified Singapore as a key financial hub through which shocks propagate regionally, the present study's finding is less a discovery than a confirmation, using a different method and a more recent sample, of a hierarchy in ASEAN currency markets that has now been documented repeatedly across independent studies and methodologies.

The asymmetric relationship with developed markets. The negative correlation between the Rupiah and the Yen, alongside the comparatively muted and less precisely estimated impulse responses to Yen and Euro shocks, is where the present findings engage most directly with the safe-haven literature. (Park & Fang, 2025; Sun et al., 2022) both report that the Yen's safe-haven behaviour has become less reliable and more state-dependent since the early 2020s, with Lu et al. specifically finding that no East Asian currency, the Yen included, qualifies as a safe haven once geopolitical risk and trade-policy uncertainty are considered rather than the conventional volatility index. The present study's finding of a negative Rupiah-Yen correlation, most plausibly explained by both currencies responding to opposite ends of a common global risk factor rather than to each other directly, is broadly consistent with this literature's central message: the Yen's relationship with emerging Asian currencies during 2020–2025 reflects a shared exposure to global risk sentiment rather than a stable bilateral link, a nuance that a simple correlation coefficient cannot separate from genuine safe-haven behaviour on its own.

External monetary policy and trade-policy shocks. The study's framing of the 2022–2023 period as one of unusually synchronised depreciation pressure across ASEAN currencies aligns with (T. Liu et al., 2022; Loan et al., 2025), who show, using a global VAR spanning thirty-two countries, that Federal Reserve tightening transmits to emerging markets with effects that intensify when accompanied by heightened policy uncertainty, a description that fits the 2022–2023 episode closely. The extension of the sample through the April 2025 tariff shock also connects the present findings to a very recent strand of work: (Ostry et al., 2025) show that the exchange-rate response to the 2025 tariff announcements depended heavily on the pattern of retaliation, which helps explain why the Rupiah's April 2025 depreciation occurred alongside a broad-based, rather than dollar-specific, repricing of risk across emerging Asia. (Keddad & Sato, 2022)add a complementary angle worth flagging as a limitation of the present study: they find the Renminbi's influence on Asian exchange rates has strengthened enough to rival that of the US dollar in some periods, and (Cui et al., 2025) similarly study the Renminbi's growing role as a regional currency anchor. Since the Renminbi does not appear anywhere in the present study's seven-currency system, part of what this study attributes to "ASEAN" or "developed market" innovations may in fact be transmitted indirectly through a Chinese channel that the model cannot separately identify.

Domestic shocks, COVID-19, and capital flows. The relatively small and further-shrinking share of purely domestic variance is consistent with (Febiyansah, 2023), who found that COVID-19 case counts and policy announcements generated measurable spillover and leverage effects on the Rupiah's volatility against several major currencies, and with (Soedarmono et al., 2022), who trace Indonesia's exposure to foreign capital flow reversals during the 2022 tightening episode directly to global factors such as the US interest rate benchmark and the VIX rather than to domestic fundamentals alone. (Danila, 2023) reach a related conclusion for ASEAN-5 currency and equity markets more broadly, finding volatility spillovers between foreign exchange and stock markets that intensified over exactly this period. Taken together, these studies support the present paper's inference that Indonesian monetary authorities have progressively less scope to stabilise the Rupiah through purely domestic instruments, since the shocks driving its variance increasingly originate abroad.

POLICY IMPLICATIONS

The finding that roughly three-quarters of the Rupiah's forecast error variance originates outside its own market, concentrated overwhelmingly within ASEAN rather than in developed markets, carries direct implications for how Bank Indonesia allocates its attention and reserves when managing exchange rate stability. Since domestic monetary tools address only the smaller, own-market share of this variance, sustained stability is more likely to be achieved by pairing domestic measures with closer monitoring of, and coordination with, the four ASEAN currencies examined here, particularly the Singapore Dollar, which alone accounts for the largest single external share of the Rupiah's variance and produces the fastest, strongest impulse response of any comparator. This points toward strengthening existing regional mechanisms, such as bilateral currency swap arrangements and the ASEAN Local Currency Transaction framework, as complements to unilateral intervention rather than treating exchange rate management as a purely domestic exercise.

For businesses and investors trading across the region, the asymmetry documented between the Rupiah's positive relationship with the Euro and its negative relationship with the Yen suggests that hedging strategies calibrated to a single developed market benchmark are likely to be mis-specified; separate hedging positions for Euro-denominated and Yen-denominated exposures would better reflect the Rupiah's actual behaviour. Finally, because the pattern of interdependence documented here settles within roughly six months and held consistently across the pandemic, the tightening cycle, and the 2025 tariff shock, policy makers can reasonably treat this regional concentration as a structural feature of the Rupiah's current position rather than a temporary artefact of any single episode, at least until the robustness checks proposed in this study's limitations are carried out.

CONCLUSION

This study set out to measure the degree of dynamic interdependence between the Indonesian Rupiah and four ASEAN currencies, the Malaysian Ringgit, the Philippine Peso, the Singapore Dollar, and the Thai Baht, as well as two developed-market currencies, the Euro and the Japanese Yen, over the period January 2020 to December 2025, using a seven-variable vector autoregression with generalised impulse response functions and variance decomposition. The results show that this interdependence is substantial and highly asymmetric. The Rupiah's own shocks account for only 25.7 percent of its forecast error variance from the third month onward, while the four ASEAN currencies jointly explain 56.1 percent, led decisively by the Singapore Dollar at 17.6 percent and reinforced by a correlation of 0.940 between the two currencies. By contrast, the Euro and the Yen together explain only 18.1 percent of the Rupiah's variance, and their relationships with the Rupiah differ in direction: positive with the Euro at 0.717 and negative with the Yen at -0.565. This pattern of interdependence is established within approximately six months and remains stable thereafter, indicating that it reflects a consistent structural feature of the Rupiah's behaviour across the pandemic shock, the global tightening cycle, and the 2025 tariff shock, rather than a slow-building or transitory tendency.

These findings directly answer the objective set out at the beginning of this study and carry a clear implication for exchange rate policy in Indonesia. Because roughly three-quarters of the Rupiah's variance originates outside its own market, and because this external influence is concentrated so heavily within ASEAN rather than in developed markets, domestic policy tools alone offer limited capacity to manage exchange rate stability, and closer coordination with regional partners, Singapore in particular, is likely to yield greater benefit than comparable attention to developed-market currencies. Future research extending this framework with structural shock identification and formal stability testing across the three sub-periods examined here would help establish how robust these relationships are to alternative specifications and to the structural breaks that such a turbulent sample period may contain.

ACKNOWLEDGEMENTS

The author(s) would like to thank Bank Indonesia and the international financial data providers whose publicly available exchange rate data made this study possible. The author(s) also thank the editor and anonymous reviewers for their time and constructive feedback during the review process. Any remaining errors are the sole responsibility of the author(s).

CONFLICT OF INTEREST

The author(s) declare no conflict of interest with respect to the research, authorship, and/or publication of this article.

FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

DATA AVAILABILITY STATEMENT

The monthly nominal exchange rate data used in this study were compiled from Bank Indonesia and publicly available international financial data providers, covering the period January 2020 to December 2025. The compiled dataset supporting the findings of this study is available from the corresponding author upon reasonable request.

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