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UNRAVELLING THE MUSSA PUZZLE: REAL EXCHANGE RATE VOLATILITY AND REGIME CHANGE IN ASEAN-3, 1967–2024

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ABSTRACT

Evidence for the Mussa Puzzle in Indonesia, Malaysia and Thailand is weak and depends largely on the 1997–1999 Asian financial crisis. Mussa observed that real exchange rates became far more turbulent once the Bretton Woods parities were abandoned, a pattern that has scarcely been tested in Southeast Asia. This paper asks whether moving from pegged to more flexible arrangements changed real exchange rate movements in the three countries between 1967 and 2024. Real rates are constructed from World Bank nominal exchange rates and consumer price indices, and regimes are coded from documented policy chronologies. Annual logarithmic changes in the real exchange rate form the baseline measure, while absolute changes and a five-year rolling standard deviation capture the size of fluctuations; all models include country fixed effects. The baseline regime coefficient is positive but statistically insignificant, and country patterns diverge, with higher average real depreciation under flexible arrangements in Indonesia and Thailand but lower in Malaysia. The alternative measures give larger positive coefficients, significant only at the 10 per cent level for the rolling standard deviation, and these estimates shrink and lose significance once the crisis years are excluded.

Introduction

The postwar monetary order rested on the 1944 Bretton Woods agreement, which fixed the dollar to gold and tied participating currencies to the dollar at declared parities. However, the system began to unravel when the United States suspended dollar convertibility into gold in 1971 amid inflation and slowing economic growth, leading most economies to adopt floating exchange rates by 1973. Mussa (1986) observed that the shift from fixed to floating exchange rates was accompanied by a substantial increase in nominal and real exchange rate volatility, while inflation, consumption, and output showed no comparable changes. This unexpected divergence, known as the Mussa Puzzle, raises the central question of whether exchange rate regime changes systematically influence the behaviour of real exchange rates, and whether the pattern also holds in emerging economies remains an open empirical question.

Recent studies have broadened both the evidence and the explanations. Using 44 countries over 1954–2019, Petracchi (2022) shows that the link between nominal and real exchange rate variability is not confined to the 1973 transition but recurs after other regime changes. Itskhoki and Mukhin (2021, 2025a, 2025b) argue that standard macroeconomic models cannot account for the broader set of Mussa facts and point instead to financial market segmentation and risk-sharing shocks, a view supported by work on limits to arbitrage, currency risk premia and global liquidity (Bacchetta et al., 2024; Chernov & Creal, 2023).

What this literature leaves open is whether the pattern carries over to emerging economies whose regime changes look quite different from the clean break of 1973. Petracchi's sample is dominated by advanced economies with sharply defined breaks, whereas Indonesia, Malaysia and Thailand moved through crawling, basket-managed and hard-peg arrangements, and their most consequential transitions took place during the 1997 Asian financial crisis. This creates a distinct identification problem: in ASEAN-3 a change in real exchange rate behaviour after a regime change may reflect the regime itself or the crisis that accompanied it. Whether regime changes are associated with similar or country-specific patterns across the three economies is likewise unresolved.

Indonesia, Malaysia and Thailand, referred to here as ASEAN-3, offer a useful setting for testing these claims. All three are small open economies that began the sample under fixed or heavily managed arrangements and later moved towards flexibility, and all three were caught by the 1997 Asian financial crisis, which forced a rethink of monetary policy across the region. Yet the evidence on the Mussa Puzzle still comes overwhelmingly from advanced economies or from broad global samples, leaving the Southeast Asian experience largely untested. The omission matters, because financial market depth, central bank credibility and openness to capital differ sharply from the settings that produced Mussa's original result. Agosin and Díaz (2023) document that real rates in developing countries are systematically more volatile than in advanced ones, and that the gap turns on how gross capital inflows and outflows move together, a factor lying entirely outside any regime classification. Work on Southeast Asia, meanwhile, has concentrated on measuring volatility and tracing its effects on trade (Handoyo et al., 2023) or on how volatility spills across borders (Devpura et al., 2021), leaving its structural origins unexamined.

This study examines the relationship between exchange rate regime changes and real exchange rate movements in Indonesia, Malaysia and Thailand (ASEAN-3) over the period 1967–2024. Specifically, it investigates whether the transition from fixed or pegged to more flexible exchange rate arrangements is associated with changes in the direction and magnitude of annual real exchange rate movements, and whether this relationship differs across the three countries, reflecting their distinct exchange rate experiences and institutional settings. The study makes three contributions. First, it provides evidence on the Mussa Puzzle for three Southeast Asian emerging economies examined together as a regional sample, a setting in which regime transitions were gradual, frequently managed and partly coincident with a major financial crisis, unlike the advanced-economy breaks that dominate earlier samples. Second, it separates the role of the regime from that of the crisis by re-estimating the regime effect with the 1997–1999 crisis years excluded, and by comparing a signed measure of real exchange rate movements with absolute and dispersion-based measures of fluctuations. Third, it extends the evidence to 2024 and estimates each country separately, so that country-specific patterns are observed rather than obscured by regional aggregation.

The remainder of this paper is organized as follows. Section two reviews the relevant theory and identifies the gap, section three sets out the data and method, section four presents and discusses the results, and section five concludes.

Literature Review

Monetary Neutrality and the Mussa Puzzle

Monetary neutrality holds that changes in the money supply affect nominal variables such as the price level but not real output or employment in the long run (Friedman, 1956). If nominal arrangements are neutral in this sense, a change in the exchange rate regime should leave real variables, including the real exchange rate, largely unaffected. Mussa (1986) found otherwise for the real exchange rate: its variability rose sharply after the move to floating while other macroeconomic aggregates showed no comparable change. This divergence is the puzzle tested here.

Exchange Rate Regimes and the Real Exchange Rate

In the Mundell–Fleming framework, the exchange rate regime determines how an open economy with mobile capital adjusts to shocks (Krugman et al., 2018). Under a fixed rate the central bank must intervene to defend the parity and gives up monetary autonomy, so shocks are absorbed mainly through prices, reserves and output; under a floating rate the nominal exchange rate itself adjusts to monetary conditions and capital flows. When domestic prices are sticky, nominal adjustment translates into real exchange rate movements in the short run, which is why a move from fixed to floating rates may be expected to change the behaviour of the real exchange rate.

The real exchange rate links these regime effects to relative prices. Purchasing power parity, in the formulation of Cassel (1918), implies that the nominal rate moves to offset inflation differentials, so that the real rate is constant in the long run. In practice transaction costs, trade barriers and non-traded goods produce persistent deviations (Obstfeld & Rogoff, 1996), and Itskhoki (2021) treats the real exchange rate as a general equilibrium variable jointly determined by trade openness, incomplete international risk sharing and the monetary regime in force. Real exchange rate movements therefore reflect the interaction of nominal exchange rate adjustment and relative price developments, both of which are shaped by the exchange rate arrangement; this is the link examined for Indonesia, Malaysia and Thailand.

Exchange Rate Arrangements

An exchange rate arrangement is the mechanism by which a country sets the value of its currency against others (Krugman et al., 2018). Three broad types are usually distinguished. Under a fixed arrangement the authorities announce a rate against a currency or basket and defend it through intervention. Under a floating arrangement the rate is left to supply and demand. A managed float sits between the two, allowing intervention when the authorities judge it necessary. Ilzetzki et al. (2019) warn that what governments announce and what they actually do often diverge, so the regime in force during any period is better identified from observed behaviour than from official statements.

Prior Research

Mussa (1986) provided the foundational empirical evidence for what later became known as the Mussa Puzzle, documenting a substantial increase in real exchange rate volatility following the transition from fixed to floating exchange rates, without comparable structural changes in inflation or real output. Building on this finding, subsequent studies have examined whether the relationship between exchange rate regimes and real exchange rate behavior extends beyond the original historical episode. Using data with 44 countries observed from 1954 onwards, Petracchi (2022) dated regime breaks using the Lavielle–Moulines and CUSUM procedures and measured volatility with a GARCH(1,1) specification. What he found was not confined to the collapse of Bretton Woods. Breaks occurring at other dates and in other countries carried the same signature, which suggests a general relationship rather than a one-off historical accident.

A different reading comes from Itskhoki and Mukhin (2025a), who move the argument towards the microstructure of financial markets. Their objection is that conventional business cycle models are asked to explain a break that shows up in one series and leaves the rest of the macro data undisturbed, and none of them manages it. What does fit is a market split along investor lines, with a risk premium that moves when the regime moves. The theoretical scaffolding comes from Itskhoki and Mukhin (2021), whose dynamic general equilibrium model reproduces the Meese–Rogoff, Backus–Smith, purchasing power parity and uncovered interest parity puzzles together by giving financial shocks the leading role, and from their wedge-accounting exercise, which rules out conventional macro disturbances and leaves risk-sharing shocks as the only candidate consistent with the evidence (Itskhoki & Mukhin, 2025b). Bacchetta et al. (2024) reinforce the point by showing that sharp currency swings can occur without any fundamental disturbance once arbitrage is constrained, while Chernov and Creal (2023) attribute much of the cross-country variation in currency risk premia to yield curve differences and global liquidity conditions.

Turning to developing economies, Agosin and Díaz (2023) confirm that real rates there swing much more widely than in advanced countries. Their explanation turns on gross capital flows. Where inflows and outflows move together, one absorbs the other; where they do not, the currency takes the strain. On policy choice, Sussman and Wyplosz (2024) review the small open economy experience from Bretton Woods to inflation targeting and conclude that fundamentals, central bank credibility and financial integration govern the choice of regime, with the adoption of inflation targets tending to dampen exchange rate variability. For Indonesia, Salaamah and Firmansyah (2020) test neutrality over 1995–2017 and find that money affects real output at both horizons, which counts against the neutrality proposition.

Within Southeast Asia, Handoyo et al. (2023) estimate ASEAN-5 volatility with ARCH and GARCH specifications and relate it to manufacturing commodity exports, while Devpura et al. (2021) use intraday data to show that a country's own disturbances account for most of the movement in its currency, with Indonesia, Thailand and Singapore fairly closely synchronised. Both papers are concerned with measuring volatility and tracing its consequences; neither asks whether the regime is what produces it. Table 1 summarises this body of work.

Table 1. Summary of Prior Research

Study	Data and Coverage	Method	Main Finding
Mussa (1986)	Industrial countries, Bretton Woods and after	Time series analysis of real rates and price ratios	Real rate volatility climbs after the move to floating, with no matching shift in other macro series
Petracchi (2022)	44 countries, 1954–2019	Lavielle–Moulines and CUSUM tests with GARCH (1,1)	The pattern recurs across countries rather than being confined to 1973
Itskhoki & Mukhin (2025a)	United States against the G7, monthly data	General equilibrium model with segmented financial markets	Broadened evidence rejects both RBC and New Keynesian accounts; an endogenous risk premium fits better

Study	Data and Coverage	Method	Main Finding
Itskhoki & Mukhin (2021)	Calibrated open economy	Dynamic general equilibrium model	Financial disturbances reproduce the main currency puzzles without spoiling business cycle moments
Itskhoki & Mukhin (2025b)	Advanced economies, wedge-accounting design	Open economy shock accounting	Conventional macro shocks are inconsistent with disconnect; only risk-sharing shocks fit
Bacchetta et al. (2024) Bank Negara Malaysia. (2005, July 21).	Global currency markets	Exchange rate model with limited CIP arbitrage	Large currency swings can occur with no fundamental disturbance when intermediation is constrained
Chernov & Creal (2023)	Cross-country yield curves	Dynamic term-structure model	Yield curve gaps and global liquidity explain much of the variation in currency risk premia
Agosin & Díaz (2023)	Advanced and developing countries, post-2000	Panel regressions with several estimators	Real rates are more volatile in developing countries, tracking the weak co-movement of gross capital flows
Sussman & Wyplosz (2024)	Small open economies, Bretton Woods to the present	Historical and comparative review	Fundamentals, credibility and financial integration drive regime choice; inflation targets reduce variability
Handoyo et al. (2023)	ASEAN-5, January 2007–March 2019	ARCH/GARCH, ARDL and nonlinear ARDL	Volatility affects manufacturing commodity exports, with asymmetric responses
Devpura et al. (2021)	Five ASEAN countries, intraday data	Variance decomposition and spillover analysis	Own shocks account for most currency volatility; Indonesia, Thailand and Singapore move closely together
Salaamah & Firmansyah (2020)	Indonesia, 1995–2017	Cointegration and error correction	Money affects real output at short and long horizons, weighing against neutrality

Source: Compiled by the authors, 2026

Research Gap

Despite the growing literature on the Mussa Puzzle, the relationship between exchange rate regime changes and real exchange rate behaviour remains insufficiently examined in emerging Southeast Asian economies. This study differs from Petracchi (2022) in three respects. The first is the sample. Petracchi examines 44 countries over 1954–2019, most of them advanced economies with sharply defined regime breaks, whereas this study focuses on Indonesia, Malaysia and Thailand over 1967–2024, which, to the best of our knowledge, have not previously been examined together in this context. Their transitions were gradual and managed rather than clean, and the most consequential of them occurred during the 1997 Asian financial crisis, so the ASEAN-3 experience asks whether the Mussa pattern survives when regime change and financial crisis are difficult to separate. The second is identification. Petracchi dates break endogenously with the Lavielle–Moulines and CUSUM procedures and measures volatility with a GARCH (1,1) model, whereas this study classifies regimes from each country's documented policy chronology and tests whether the estimated regime effect persists once the crisis years are excluded. The third is measurement. The baseline uses the signed annual logarithmic change in the real exchange rate as a measure of real exchange rate movements, complemented by the absolute log change and a five-year rolling standard deviation as measures of the magnitude and dispersion of fluctuations. Furthermore, while previous Southeast Asian studies have examined exchange rate volatility in relation to manufacturing exports (Handoyo et al., 2023) and cross-country spillovers (Devpura et al., 2021), this study examines its relationship with regime change directly and country by country.

Method

Data and Sources

The study draws on annual secondary data for 1967–2024 covering three countries, giving a balanced panel of 174 observations. The choice rests on economic rather than geographical grounds. Indonesia, Malaysia and Thailand are small open economies whose exports combine commodities and manufactures; each began the sample under a fixed or managed arrangement before moving towards flexibility; and each stood at the centre of the 1997 crisis that redirected exchange rate policy across the region. The long window allows the model to observe conditions on both sides of that turning point.

Nominal exchange rates and consumer price indices come from the World Bank's World Development Indicators, drawing on the official exchange rate series (local currency per US dollar, period average) and the consumer price index series (2010 = 100) (World Bank, 2025a, 2025b). These were checked against publications of Bank Indonesia, Bank Negara Malaysia and the Bank of Thailand. The United States serves as the reference partner because the dollar settles most of the region's trade. Table 2 sets out the variables.

Table 2. Variable Definitions and Data Sources

Variable	Definition	Unit	Source
ER	Nominal exchange rate against the US dollar, annual average	LCU per USD	World Bank; central banks
CPI	Consumer price index for the domestic economy and the United States (2010 = 100)	Index	World Bank
RER	Real exchange rate, the nominal rate adjusted by the ratio of foreign to domestic consumer prices	Index	Authors' calculation
DLRER	Annual logarithmic change in the real exchange rate, capturing the direction and magnitude of year-on-year movements. Used as the baseline measure of real exchange rate movements.	Decimal	Authors' calculation
DREGIME	Regime dummy: 0 for fixed and pegged arrangements (hard pegs, basket pegs and managed rates held around a stable reference value); 1 for more flexible arrangements (managed floating and free floating)	Binary (0/1)	Authors' classification

Source: Compiled by the authors, 2026

Classifying Exchange Rate Regimes

The regime dummy follows the policy chronology of each country, cross-checked against observed exchange rate behaviour. Since declared and actual arrangements often part company (Ilzetzki et al., 2019), periods are assigned on the basis of official changes that were accompanied by a visible change in how the rate behaved. Coding rests on a single criterion: whether the authorities held the nominal rate at, or within a narrow range of, a fixed parity or stable reference value. DREGIME takes the value zero where they did, which covers hard pegs, basket pegs and managed rates that tracked a reference currency closely. It takes the value of one where the reference value was itself adjusted routinely or left to the market, which covers both managed floating and free floating. The value one therefore denotes a more flexible arrangement rather than a pure free float, and the binary split separates less flexible from more flexible regimes without implying that arrangements within each group are institutionally identical.

Three rules govern the annual coding and are applied identically to all three countries. First, a year is assigned to the arrangement in force for most of that year, so a change taking effect in the second half of a year is coded from the following year. Malaysia's move to a managed float on 21 July 2005 is therefore coded from 2006, a choice reinforced by Bank Negara Malaysia's own statement that the ringgit was not expected to move significantly from its prevailing level (Bank Negara Malaysia, 2005); Indonesia's devaluation of 15 November 1978, after which the rupiah was managed against a basket of currencies (Woo & Nasution, 1989), is coded from 1979. Second, the crisis episodes of 1997–1998, which de facto schemes classify separately as freely falling (Ilzetzki

et al., 2019), are assigned to the arrangement the authorities adopted on exit: floating for Thailand, which moved to a managed float on 2 July 1997 (International Monetary Fund, 1997a), and for Indonesia, where Bank Indonesia abolished the intervention band on 14 August 1997 (International Monetary Fund, 1997b); and the RM3.80 peg for Malaysia, where the interim float from July 1997 ended with the peg of September 1998. Third, dates are taken from official central bank and IMF announcements. Table 3 summaries the resulting chronology. Two assignments require comment. Indonesia in 1979–1996 is coded one because the rupiah was not held at a stable parity: it "glided gently downward against a basket of currencies" and was devalued again in March 1983 and September 1986 (Woo & Nasution, 1989), although de facto schemes would place such a crawling arrangement in an intermediate category. Malaysia before 1997 is the reverse case: officially a managed float for much of the period, the ringgit tracked the US dollar closely and is therefore coded zero.

Table 3. Exchange Rate Regime Chronology in ASEAN-3

Country	Period	Arrangement in Force	DREGIME
Indonesia	1967–1978	Fixed within an intervention band	0
	1979–1996	Basket-managed rate with a continuous crawl from November 1978	1
	1997–2024	Free float after the band was abolished in August 1997	1
Malaysia	1967–1997	Managed rate tracking the US dollar (crisis float from July 1997 coded with the subsequent peg)	0
	1998–2005	Hard peg at RM3.80 per US dollar	0
	2006–2024	Managed float after the peg was lifted in July 2005	1
Thailand	1967–1996	Basket peg dominated by the US dollar	0
	1997–2024	Managed float after the baht was floated in July 1997	1

Note: Years are coded by the arrangement in force for most of the year; 1997–1998 crisis episodes are coded by the arrangement adopted on exit (see text). Source: Compiled by the authors from central bank publications and IMF announcements (Bank Negara Malaysia, 2005; International Monetary Fund, 1997a, 1997b; Woo & Nasution, 1989), 2026

Model Specification

The model adapts the approach of Mussa (1986) and Petracchi (2022) to the characteristics of ASEAN-3. The real exchange rate is constructed first:

$$\mathrm{RER_t} = \mathrm{ER_t} \times \frac{\mathrm{CPI_{Foreign}}}{\mathrm{CPI_{Domestic}}} \quad (1)$$

where $\mathrm{RER_t}$ is the real rate, $\mathrm{ER_t}$ the nominal rate, $\mathrm{CPI_{Foreign}}$ the United States consumer price index and $\mathrm{CPI_{Domestic}}$ the domestic one. Movement in the real rate is then measured by its log difference:

$$\mathrm{DLRER_t} = \Delta \ln(\mathrm{RER_t}) \quad (2)$$

The annual logarithmic change in the real exchange rate is used as the baseline measure to capture year-on-year real exchange rate movements. This measure reflects both the direction and magnitude of changes in the real exchange rate, allowing the analysis to identify how the exchange rate behaves under different regimes. However, it should be distinguished from conventional volatility measures, as the signed logarithmic change does not directly measure the dispersion or absolute magnitude of fluctuations. Therefore, the baseline specification examines the association between exchange rate regimes and annual real exchange rate movements, while alternative volatility measures are employed in the robustness analysis to assess whether the findings remain consistent when the magnitude and dispersion of movements are considered.

Panel regression is used because it combines the time series and cross-section dimensions, capturing unobserved differences between countries alongside movement over time. The regime dummy enters as the sole regressor so that its effect is identified directly, in keeping with the basic design used to test the Mussa Puzzle. The main model is:

$$\mathrm{DLRER_{it}} = \alpha + \beta \mathrm{DREGIME_{it}} + \mu_{it} \quad (3)$$

where $DLRER_{it}$ represents the annual logarithmic change in the real exchange rate for country i in year t and serves as the baseline measure of real exchange rate movements; α is the constant, β the regression coefficient, $DREGIME_{it}$ the regime dummy and μ_{it} the error term. A positive β indicates a higher average annual real depreciation under more flexible arrangements; because the measure is signed, it does not by itself indicate larger fluctuations, which are examined with the absolute and dispersion-based measures in the robustness analysis. The same specification is estimated separately for each country so that patterns can be compared:

$$DLRER_IND_t = \alpha + \beta DREGIME_IND_t + \mu_t \quad (4)$$

$$DLRER_MYS_t = \alpha + \beta DREGIME_MYS_t + \mu_t \quad (5)$$

$$DLRER_THA_t = \alpha + \beta DREGIME_THA_t + \mu_t \quad (6)$$

Estimation Strategy

Descriptive statistics come first, reporting means, standard deviations and extreme values to convey the shape of the data. Estimation then proceeds by panel regression. Parameters are obtained by ordinary least squares, which minimises the residual sum of squares and yields efficient unbiased estimates provided the classical assumptions hold (Gujarati & Porter, 2009). The general panel form is:

$$Y_{it} = \alpha + \beta X_{it} + e_{it} \quad (7)$$

with Y_{it} the dependent variable, X_{it} the regressor, α the constant, β the coefficient and e_{it} the error term for country *i* in period *t*. Three estimators were considered: the common effect, fixed effect and random effect models. The Chow test compares the first two and the Hausman test the last two. Both pointed to fixed effects, consistent with the expectation that unobserved country characteristics such as central bank credibility and financial market depth correlate with regime choice. Diagnostic tests for normality, multicollinearity, heteroskedasticity and autocorrelation were run to confirm that the estimator satisfies the conditions for best linear unbiased estimation. Two further checks are reported below: alternative volatility measures, and estimation with the crisis years removed.

Results and Discussion

Descriptive Statistics

Table 4 describes real exchange rate movement in the three countries over 1967–2024. Mean changes are small and positive everywhere, indicating a mild tendency towards real depreciation across the period. The striking difference lies in dispersion. Indonesia's standard deviation is more than twice that of Malaysia or Thailand, and its extreme values span a much wider range. These differences indicate that the magnitude of annual real exchange rate movements is not uniform across ASEAN-3. Nevertheless, the descriptive statistics should be interpreted as evidence of variation in annual real exchange rate changes rather than as direct estimates of conditional volatility.

Table 4. Descriptive Statistics for Real Exchange Rate Movement, 1967–2024

Country	N	Mean	Std. Deviation	Minimum	Maximum
Indonesia	58	0.0139	0.1526	−0.4074	0.7911
Malaysia	58	0.0151	0.0670	−0.1837	0.2969
Thailand	58	0.0077	0.0668	−0.1247	0.2151
Pooled panel	174	0.0123	0.1031	−0.4074	0.7911

Source: Authors' calculation, 2026

Panel Estimation Results

Fixed effect estimation of the main model returns a DREGIME coefficient of 0.005854 with a probability of 0.8030 and a constant of 0.009703. The R-squared of 0.001769 means the model accounts for roughly 0.18 per cent of the variation in real rate movement. Table 5 collects the main and country results.

Table 5. Estimated Effect of Regime Change on Real Exchange Rate Movement

Model	Constant (α)	DREGIME coefficient (β)	Fitted value, D = 0	Fitted value, D = 1	Prob.
ASEAN-3 panel (FEM)	0.009703	0.005854	0.009703	0.015557	0.8030
Indonesia	0.010803	0.006877	0.010803	0.017680	0.8678

Model	Constant (α)	DREGIME coefficient (β)	Fitted value, D = 0	Fitted value, D = 1	Prob.
Malaysia	0.017375	−0.004874	0.017375	0.012501	0.7972
Thailand	0.001860	0.012791	0.001860	0.014651	0.4784

Note: Fitted values follow from the estimated equations assuming $E(\mu_{it}) = 0$. Prob. is the p-value of the DREGIME coefficient. Source: Authors' calculation, 2026

Substituting the estimates into the main equation gives:

$$DLRER_{it} = 0.009703 + 0.005854DREGIME_{it} + \mu_{it} \quad (8)$$

The fitted value is 0.009703 under fixed or pegged arrangements and 0.015557 under more flexible ones, implying an average annual real depreciation about 0.6 percentage points higher after the move to flexibility. Because the baseline measure is signed, this difference concerns the average direction of real exchange rate changes rather than the size of fluctuations, which is the dimension the Mussa Puzzle addresses; that dimension is examined with the alternative measures in Table 6. The probability of 0.8030 lies far above conventional thresholds, so the null hypothesis of no regime effect cannot be rejected, and the data provide insufficient evidence that the transition to flexible arrangements systematically changed real exchange rate movements in ASEAN-3. The R-squared of 0.0018 should also be read with caution. A single binary regressor is not expected to account for much of the year-to-year variation in real exchange rates, and the remaining variation may reflect factors outside the model, such as global financial shocks, commodity price swings, international interest rates and capital flows. The low R-squared therefore does not by itself invalidate the estimated relationship; the statistical insignificance of the regime coefficient is the more direct basis for assessing the main hypothesis.

Cross-Country Comparison

The country-specific estimates reveal heterogeneous patterns of real exchange rate movements across ASEAN-3. In Indonesia, the fitted value increases from 0.010803 under the fixed or pegged regime to 0.017680 under the floating regime. Thailand exhibits a similar pattern, with the fitted value rising from 0.001860 to 0.014651. These results indicate that average annual real exchange rate changes became more positive following the transition towards floating arrangements in both countries. Malaysia, however, displays the opposite pattern, with its fitted value declining from 0.017375 to 0.012501. This divergence suggests that the relationship between exchange rate regimes and real exchange rate movements is not uniform across the three economies. Differences in monetary policy frameworks, intervention practices, and the timing of regime transitions may help explain these contrasting patterns. However, since the country-specific estimates are descriptive fitted values from the estimated equations, they should not be interpreted as statistically established regime effects.

Figure 1 shows the pattern. All three currencies were comparatively quiet through the Bretton Woods years and the 1980s before spiking together in 1997–1998, far more sharply in Indonesia than elsewhere. After 2000 the amplitude narrows and the three series move more closely in step, which may reflect more settled policy frameworks and larger reserves across the region.

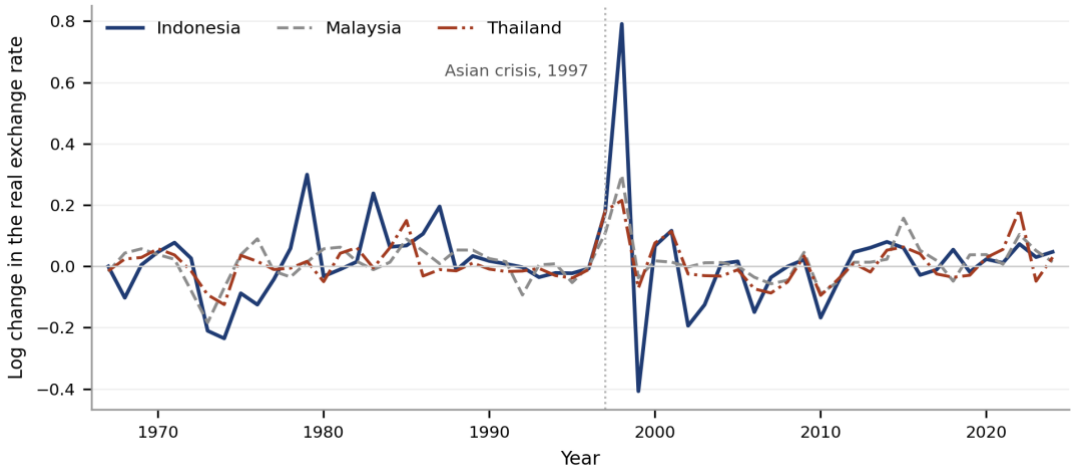


Figure 1. Real Exchange Rate Movement in ASEAN-3, 1967–2024
Source: Authors' calculation, 2026

Institutional context may help explain this divergence. Indonesia abandoned its intervention band in August 1997 amid a banking collapse and political upheaval, so the adjustment proceeded without any real cushion. Thailand faced heavy speculative pressure that ended with the float of the baht in July 1997. Malaysia took a different route, pegging at RM3.80 in 1998 alongside capital controls and lifting the peg only in 2005 once fundamentals had recovered. That sequencing is consistent with the lower average real depreciation recorded for Malaysia under its flexible arrangement, although the country-level differences are not statistically established, and it accords with Sussman and Wyplosz (2024) on the weight of credibility and financial integration in shaping the consequences of regime choice.

Robustness

Because the baseline measure is a signed log change, which captures the direction and average size of annual real exchange rate changes but not the magnitude or dispersion of fluctuations, two alternative measures that correspond more closely to the volatility concept in the Mussa Puzzle were used. The first is the absolute log change, |Δln RER|, which removes direction so that appreciations and depreciations contribute equally to uncertainty. The second is a five-year rolling standard deviation of the log change, a simple approximation to conditional volatility of the kind Petracchi (2022) estimates. Both were regressed on the regime dummy with country fixed effects using the classification in Table 3, and the baseline was re-estimated within the same routine for comparison. Each measure was also re-estimated with the 1997–1999 crisis years excluded. Table 6 reports the results.

Table 6. Robustness Checks Using Alternative Measures of Real Exchange Rate Fluctuations

Dependent variable	Sample	DREGIME coefficient	t	Prob.	R-squared
Δln RER (baseline replication)	Full (N = 174)	0.006246	0.39	0.6982	0.0019
|Δln RER|	Full (N = 174)	0.020239	1.60	0.1117	0.0650
Five-year rolling std. deviation	Full (N = 162)	0.019306	1.79	0.0746	0.1615
|Δln RER|	Excluding 1997–1999 (N = 165)	0.004160	0.52	0.6041	0.0560
Five-year rolling std. deviation	Excluding 1997–1999 (N = 153)	0.012194	1.25	0.2144	0.1530

Note: All models include country fixed effects
Source: Authors' calculation, 2026

The robustness results indicate that the estimated relationship between exchange rate regimes and real exchange rate behaviour varies depending on the measurement approach. The coefficient increases from 0.006246 in the baseline specification to 0.020239 when the absolute log change is employed and 0.019306 when the five-year rolling standard deviation is used. Although these alternative measures produce larger positive coefficients and higher explanatory power, their statistical significance differs. The absolute log change specification remains statistically insignificant ($p = 0.1117$), while the rolling standard deviation specification provides weak evidence of a positive relationship at the ten per cent significance level ($p = 0.0746$), but not at the five per cent level. These findings suggest that the measurement approach influences the estimated magnitude and statistical strength of the relationship, although the overall evidence remains insufficient to establish a robust regime effect.

The sample-exclusion results are the more telling. Dropping 1997–1999 weakens the estimates further. The coefficient on |Δln RER| falls from 0.020239 to 0.004160 with a probability of 0.6041, and the rolling standard deviation falls from 0.019306 to 0.012194 with a probability of 0.2144. These findings indicate that the positive association observed in the full sample is sensitive to the inclusion of the Asian financial crisis period. Because the excluded years also contain Thailand's regime transition, the exclusion reduces the information available to identify a regime effect, which is a further reason for caution. Although this does not establish that the crisis alone drove the observed movements, it suggests that exceptional financial disturbances may have played an important role in shaping real exchange rate behaviour in ASEAN-3, and the robustness results therefore provide limited support for interpreting regime change as the primary source of real exchange rate volatility. This is consistent with the reading of Itskhoki and Mukhin (2025a), for whom the break in volatility

originates in risk premia and market segmentation rather than in the nominal regime, although the present design cannot test that mechanism directly.

Discussion

The Mussa Puzzle predicts that floating exchange rate arrangements are associated with greater real exchange rate volatility than fixed arrangements (Mussa, 1986). The evidence assembled here addresses this prediction in two steps. The baseline estimates in Table 5 concern the signed annual change: the panel DREGIME coefficient of 0.005854 points to a slightly higher average real depreciation under flexible arrangements, but it is statistically insignificant ($p = 0.8030$), and the country estimates diverge, rising in Indonesia (0.010803 to 0.017680) and Thailand (0.001860 to 0.014651) and falling in Malaysia (0.017375 to 0.012501). The prediction about the size of fluctuations is tested more directly by the alternative measures in Table 6. Both the absolute log change and the five-year rolling standard deviation give positive coefficients roughly three times the baseline, in the direction the puzzle predicts, yet only the rolling standard deviation reaches even the 10 per cent level ($p = 0.0746$), and both estimates shrink and become clearly insignificant once 1997–1999 is excluded. Read together, the baseline and robustness results offer at most weak and crisis-dependent support for the Mussa Puzzle in ASEAN-3.

Figure 1 provides complementary evidence on the timing and magnitude of these movements. All three countries experience pronounced increases during the 1997–1998 Asian financial crisis, with Indonesia displaying the largest spike. The series become less dispersed after 2000, although their subsequent movements remain country-specific. Taken together, Tables 5 and 6 and Figure 1 suggest that real exchange rate behaviour in ASEAN-3 may reflect both differences in national exchange rate arrangements and major regional financial disturbances. Nevertheless, the insignificant coefficients indicate that the evidence does not establish a statistically robust relationship between regime changes and real exchange rate movements.

This is less awkward than it first appears. Itskhoki and Mukhin (2025a) emphasise that the break after Bretton Woods showed up in the real exchange rate and nowhere else, which undermines reading the puzzle as direct evidence of nominal rigidity, and they point instead to segmentation and to risk premia that move with the regime. Seen that way, the present result is unsurprising. In economies with relatively shallow financial markets and heavy exposure to global capital, a plausible interpretation is that real rate uncertainty stems less from the regime than from external financial shocks transmitted through risk premia, the channel emphasised by Bacchetta et al. (2024) and Chernov and Creal (2023), although the present design does not test this channel directly. Agosin and Díaz (2023) supply direct evidence for developing countries, tying the higher volatility of their real rates to the behaviour of gross capital flows rather than to any regime classification.

The contrast with Petracchi (2022), who finds a strong general pattern across 44 countries, has two plausible sources. Most of his sample consists of advanced economies with deep financial markets and sharply defined regime breaks, whereas the ASEAN-3 countries have operated various forms of managed floating that blur the distinction between regimes. His design also relies on higher-frequency data, while the annual observations used here smooth away much of the short-run movement that volatility measures are meant to capture.

Policy Implications

Two implications follow for monetary authorities in the region, subject to the caveats above. On this evidence, the choice of exchange rate arrangement does not appear to be decisive for real rate stability, so efforts to stabilise the currency are better directed at fundamentals: inflation control, adequate reserves, a sound current account and credible policy. And because external disturbances appear to be the dominant source of uncertainty, resilience to capital flow reversals is likely to matter more than the label attached to the regime. Macroprudential instruments, capital flow management frameworks and regional arrangements such as the Chiang Mai Initiative Multilateralisation and local currency settlement schemes are likely to prove more effective than reclassifying the regime.

Limitations

Several limitations deserve mention. The baseline specification uses the year-on-year logarithmic change in the real exchange rate to measure annual real exchange rate movements, which is not equivalent to a conditional volatility measure such as the GARCH(1,1) estimates used by Petracchi (2022); the robustness checks in Table 6 show that this choice materially affects the estimated magnitude, so a full conditional measure remains desirable. Annual data limit the model's ability to capture short-run dynamics, and monthly or quarterly observations would offer better

resolution. With a single regressor, the model is exposed to omitted variable bias, since interest rate differentials, commodity prices and global uncertainty indices are left uncontrolled. The regime dummy is also binary and cannot register gradations of intervention within managed floating; some assignments, notably Indonesia's crawling arrangement of 1979–1996, would fall into an intermediate category under de facto schemes. Future work should adopt GARCH-based volatility measures on higher-frequency data, add macroeconomic and financial controls, use de facto or multi-category regime classifications, and apply endogenous break tests so that regime dates are not imposed in advance.

Conclusion

This paper has examined the association between exchange rate regime change and real exchange rate movements in Indonesia, Malaysia and Thailand between 1967 and 2024, using fixed effect estimation on an annual panel. The move to more flexible arrangements is associated with a slightly higher average annual real depreciation, but the association is not statistically significant and the model has very little explanatory power. The robustness analysis provides additional but qualified evidence. Measures of the magnitude of fluctuations produce larger positive coefficients, in the direction the Mussa Puzzle predicts, with the five-year rolling standard deviation showing weak statistical evidence at the 10 per cent significance level. However, the estimates become statistically insignificant when the Asian financial crisis period of 1997–1999 is excluded. These findings indicate that the estimated relationship is sensitive to the measurement approach and to the inclusion of major financial crisis episodes. Therefore, the empirical evidence does not provide conclusive support for the Mussa Puzzle in ASEAN-3.

The results also reveal marked differences within the region. The average annual real depreciation predicted under flexible arrangements is higher in Indonesia and Thailand but lower in Malaysia, although these country-level differences are not statistically established. These differences may reflect the underlying economies, the frameworks their central banks operate and the depth of their financial markets, with Malaysia possibly benefiting from more controlled policy sequencing and steadier reserves.

Theoretically the findings are more consistent with long-run neutrality than with a strong regime effect. An insignificant coefficient is not proof that no effect exists, but the data do not show that regime change reliably moved the real exchange rate in this region, where uncertainty about the real rate appears to owe more to global crises, international interest rates, foreign capital flows and other external shocks. For policy, this suggests that real exchange rate stability depends more on the quality of fundamentals and on resilience to external shocks than on the choice of regime. Further research might employ conditional volatility measures, higher-frequency data, additional controls, alternative regime classifications and a wider set of ASEAN countries to establish how far these findings generalise.

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