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Reduced Dollar Dependence and External Balance Sustainability across Time Horizons: Evidence from Five Emerging Economies (1999–2025)

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Abstract

Purpose – This study attempts to investigate whether de-dollarization, defined as a lessening of reliance on the U.S. dollar for settlement of international trade, improves the sustainability of trade balance (TBS) in emerging economies and if the impact varies by trade balance regime, and by time horizon. It fills a void that linear and mean-based studies leave when assuming a constant effect over the course of time.

Design/methodology/approach – The study implements the maximality of information from the panel of five emerging economies (MEX, IDN, MAS, THA, and TUR) from 1999 to 2025, using wavelet decomposition methodology in maximal overlap as well as quantile-on-quantile regression (WQQR) methodology to relate a standardized de-dollarization index (DDX) to TBS across the entire conditional distribution of both indexes and across short-, medium- and long-run frequencies.

Findings – There is very little aggregate correlation between de-dollarization and sustainability (≈ 0.02) and much of the variation. The relationship is positive and statistically significant in the lower-to-middle quantiles of the trade balance, and becomes more negative and stronger at the upper quantile of the trade balance; it is mostly negative and not statistically significant over medium horizons, and is not statistically significant over short horizons. The slopes of these patterns are fairly stable under an alternative wavelet basis and under a current-account-based outcome, although when the outcome is standardized within-country, the slopes become negative, suggesting that the positive long-run pattern is mostly a cross-country (level) regularity.

Implications – The results suggest that de-dollarization is a structural lever to be pulled in the long run and not a tool of stabilization, and that it would be most effective when external balance is fragile, consistent with the dominant-currency paradigm. The evidence highlights an effect that is discernible mostly between countries, and this suggests that there should be a gradual move to a diversified mix of reserves and settlements, with a particular focus on the local context.

Originality/value – The study offers one of the first horizon- and regime-explicit assessments of the de-dollarization–sustainability nexus for emerging markets, extending the dominant-currency paradigm from the price of the currency to the currency of denomination and demonstrating that a combined wavelet quantile-on-quantile design recovers structure that mean-based models miss.

Keywords: De-dollarization; trade balance sustainability; quantile-on-quantile regression; wavelet decomposition; emerging economies; external balance

JEL Classifications: F31; F32; F14; C22; C21

1 Introduction

This is the most important restructuring of the international monetary system since the fall of Bretton Woods. Over the years, the U.S. dollar's dominance in foreign exchange reserves (down from approximately 71% at the turn of the century to less than 59% by the mid-2020s, according to the International Monetary Fund [IMF] 2024) and the increasing number of central banks' swap lines have combined to shift “de-dollarization” to the center of policy discourse. The issue of whether the external positions of emerging economies can be made sustainable by either a conscious or natural process of lessening dollar dependence is no longer theoretical for an economy whose trade is largely invoiced, financed, and settled in dollars. It directly affects the ability of the reserve manager, the exchange rate policy, and the global financial shocks (Bodenstein et al., 2024; Gopinath et al., 2020).

The ability to sustain the external position in goods and services (the trade balance) has been traditionally studied using the prism of exchange-rate movements. There is a large literature devoted to the effects of currency depreciation on the trade balance (Kallianiotis, 2022; Lerner, 1944; Magee, 1973; Meade, 1951). Some more recent papers focus on asymmetry and nonlinearity, which indicate that the effect of appreciation and depreciation is not the same and adjustment varies across time horizons (Bahmani-Oskooee & Harvey, 2022; Bhat & Bhat, 2021; Chang et al., 2018; Nusair, 2017). However, this body of work is concerned mainly with the price of the currency, the exchange rate, and not with the denomination of the currency. There is also very little analysis of the external sustainability implications of the composition of currencies used in trade, in particular, the level of dollar reliance.

There are three reasons this gap is important. First, the dominant-currency paradigm shows that when trade is priced in a third currency (dominantly the dollar), the classical expenditure switching channel of exchange-rate adjustment is weakened and trade volumes respond to the dollar's bilateral movements and to dollar liquidity conditions (Gopinath, 2015; Gopinath et al., 2020). If the currency of invoicing has effects on the conduct of trade, then so too should the change in the currency of the invoice, de-dollarizing, change the very mechanics of external rebalancing, which the exchange-rate literature is unable to account for. Secondly, de-dollarization is not going to be uniform. The impacts of its likely consequences in turn depend on the trade-balance regime (surplus or deficit) and on the time horizon (transitory quarter-to-quarter or slow structural shifts). The mean-based, single-horizon regressions are conventional and average over exactly the heterogeneity of interest to the policy. Third, measurement and modeling of de-dollarization are challenging and require techniques that can address distributional and frequency domain heterogeneity.

We tackle such questions by posing three related questions. How sustainable are trade balances in emerging economies, and does a less dollar-dependent economy help? Is the link between the two different across trade-balance regimes (conditional quantiles of the external balance)? Is it different in the short-, medium-, and long term? To answer them, we first construct a panel of five systematically important emerging economies and a balanced sample, covering the period 1999–2025, for Malaysia, Mexico, Indonesia, Thailand, and Turkey. To answer them, we first create a panel of five systematically important

emerging economies, and a balanced sample for Malaysia, Mexico, Indonesia, Thailand, and Turkey, spanning the period 1999–2025. Each series is broken up into orthogonal time-scale components by the wavelet transform, separating its short-, medium-, and long-run dynamics from one another (Percival & Walden, 2000; Ramsey & Lampart, 1998a, 1998b). The quantile-on-quantile regression subsequently provides an estimation of a surface of responses instead of just one coefficient because the quantiles of de-dollarization are mapped onto the quantiles of sustainability (Koenker & Bassett, 1978; Sim & Zhou, 2015).

The study has four contributions. It theoretically redefines sustainability as a function of the external currency denomination, and not of currency price, putting the paradigm of the dominant currency on the sustainability margin and connecting it with the de-dollarization debate. In terms of methodology, it is to our knowledge one of the first applications of a wavelet quantile-on-quantile design to the de-dollarization–sustainability problem, and is also free of the commonly known hazards of regression of variables of different integration orders in a single linear specification (Cheng et al., 2021; Wong & Pham, 2025a; Wong & Yue, 2024). Empirically, it offers new evidence for a strategically selected group of emerging economies, which are quite different in their dollar exposure, in the sense of horizon- and regime-specific evidence. It provides clarity on conditions and beneficiaries for the de-dollarization to contribute to external resilience in policy, which in turn could guide reserve diversification and local-currency settlement strategies in the context of monetary fragmentation (Mansour & Aldawsari, 2026).

There are three key findings that we have from our headline findings. While the overall correlation between de-dollarization and sustainability is rather small and is descriptive of a mean relationship, there is significant heterogeneity. This effect is positive and significant, and is greater for the lower-to-middle quantile of the trade balance, and it is weaker and becomes negative at the highest quantile of the trade balance, particularly in medium and short horizons, where it is negligible or null. The results are consistent across alternative definitions of the outcomes, standardizations, and wavelet bases.

Time of the question is not incidental. Over the past two decades, in the middle of the 2000s period, there has been an unprecedented acceleration in the reordering of cross-border finance, in the form of expanding networks of currency swaps, maturing alternatives to payment-messaging, and an increasing trend to pay invoices in national currencies, as well as in the dollar, alongside a measurable diversification of official reserves away from the dollar itself. If denomination influences adjustment, as the preeminence of the dollar suggests it does, then the present moment provides the motivation and the variation to examine how the de-dollarization process manifests on the outside of sustainability.

The rest of the paper follows as below. Section 2 provides a review of the theoretical and empirical work on exchange rate, de-dollarization, and external sustainability, theme-wise, and formulates the hypotheses. The data, the variables, and the wavelet quantile-on-quantile methodology and battery of diagnostic and robustness procedures are described in Section 3. The descriptive statistics, preliminary tests, main results, and robustness analysis are presented in Section 4. The study contributions, policy and managerial implications, limitations, and research directions for future are presented in Section 5.

2 Literature Review

The literature relevant to this study spans four streams: (i) the exchange-rate–trade-balance nexus and its nonlinear, asymmetric refinements; (ii) the emerging political economy and empirics of de-dollarization and currency choice; (iii) the econometrics of distributional and time-frequency dependence, including quantile and wavelet methods; and (iv) methodological cautions about mixing variables of different integration orders. We synthesize each in turn, foregrounding agreements and tensions, before crystallizing the gap and stating the hypotheses.

2.1 *Exchange rates, asymmetry, and the trade balance*

The idea that a real depreciation will benefit the trade balance, but only if the sum of import and export demand elasticities exceeds unity, is the intellectual backbone of external-balance analysis, as is the J-curve (Lerner, 1944; Magee, 1973; Marshall, 2024; Meade, 1951). Empirical tests of these propositions are voluminous and significantly incorporate the increasing emphasis on nonlinearity. The large body of literature reports asymmetric effects of depreciations and appreciations on the trade balance in different settings, such as the Indian case (Bhat & Bhat, 2021; Mallick et al., 2024), Cote d'Ivoire (Yaya, 2021), Ethiopia (Abegaz, 2024), Algeria (Alsamara et al., 2024; Djamal et al., 2022), Turkey and Libya (Alsanusi et al., 2022), Mongolia (Doojav, 2018), and the European transition economies (Nusair, 2017). However, Chang et al. (2018) demonstrate that the asymmetry in itself has been variable around the global financial crisis, highlighting a feature of the time-variation that is not captured by static models.

The parallel strand is designed to separate the fluctuations and uncertainty in the exchange rate from the exchange rate level. The findings reported by Bahmani-Oskooee and Harvey (2022), Bahmani-Oskooee and Karamelikli (2019), and Bahmani-Oskooee et al. (2021) for the US bilateral flows confirm those of Sambo et al. (2021), Sunde (2025), and Abille and Meçik (2023) and Abimbola Oyinlola et al. (2023) for Nigeria, South Africa, and panels of Sub-Saharan and emerging markets, respectively, that volatility exerts asymmetric and often industry-specific effects. The bilateral and sectoral analyses arrive at similar findings for Korea–China semiconductors (Baek et al., 2024; Li & Koh, 2024); China–US flows (Wang, 2023; Wu, 2020); China–East Africa (Ren & Sakouba, 2024); and processing trade (Xie & Song, 2020). The general results of these national J-curve and ARDL studies – Pakistan (Jadoon & Guang, 2019) and (Khan et al., 2019); New Zealand (Harvey, 2022); Lao–Thailand (Chanthamath & Chanthavone, 2024); East Java (Syamad, 2025); Tanzania (Lulu, 2025); Nigeria (Osinusi et al., 2022); and Turkey (Cakmakli, 2025) and (Iossifov & Fei, 2019) and (Mike et al., 2022) broadly validate the findings of adjustment is conditional, partial, and often delayed.

The point at which this stream meets is on the lack of linear, symmetric, single-horizon specifications; the point at which it splits is on the sign, size, and timing of effects, which are very context-specific. A few contributions start to explore the structural (Choi et al., 2019; De Campos et al., 2024; Santana & Oreiro, 2018; Wang, 2025) and value-chain (Felipe et al., 2025) dimensions of adjustment, while a few use machine-learning and frequency-domain analysis to signal a methodological broadening (Kim & Le, 2024;

Lin et al., 2020; Olayungbo, 2019). But in each of these, the currency studied is the currency's price. The denomination of the dollar in the bills of exchange or settlement purposes is not in focus.

2.2 De-dollarization, currency choice, and the dominant-currency paradigm

The dominant-currency paradigm reorients the debate. Gopinath (2015) and Gopinath et al. (2020) show that because the bulk of global trade is invoiced in dollars, trade prices are sticky in dollars and the conventional expenditure-switching channel is weak; what matters is the dollar's bilateral value and the availability of dollar liquidity. This insight implies that reducing dollar dependence could materially change how, and how well, an economy rebalances externally. The de-dollarization literature, though younger and more fragmented, is growing rapidly. Mosharrafa (2024) maps the contemporary drivers—geopolitical risk, sanctions, and reserve diversification—while Hirschhofer (2019) argues that gradual de-dollarization and local-currency financing could expand trade. Country and regional studies analyze dollarization persistence and reversal in Lebanon (Ponsot & Rizkallah, 2025), deposit dollarization and its asymmetric exchange-rate sensitivity in Turkey (Kolcu & Yamak, 2022), and the interaction of oil pricing with de-dollarization (Ateba et al., 2025). Exchange-rate disconnect from the trade balance, documented by Bodenstein et al. (2024), is itself consistent with a world in which currency denomination, not currency price, drives adjustment.

This stream remains overwhelmingly descriptive or narrowly focused on deposit and reserve dollarization; it rarely connects de-dollarization to a rigorously measured concept of external sustainability, and almost never does so with attention to distributional or frequency heterogeneity. Related work on monetary and exchange-rate policy under open-economy financial cycles (Li, 2025), on the macroeconomic determinants and consequences of currency volatility (Oyadeyi, 2024), and on the spillovers of U.S. trade-policy uncertainty to emerging economies (Mansour & Aldawsari, 2026) reinforces the relevance of dollar dependence for external outcomes without resolving the central question of this paper. Portfolio-balance perspectives on exchange-rate determination (Bhattacharyya & Deb, 2024) and aid-and-real-exchange-rate dynamics (Gnangnon, 2020) further situate currency composition within the broader external-adjustment problem.

2.3 Distributional and time-frequency methods

Koenker and Bassett (1978) introduced quantile regression, and it has a long history dating back to Galton (1886) and Edgeworth (1888), as described by Koenker (2000), which uncovers effects implicit in the mean regression. The applications of financial markets include the following studies: stochastic-dominance and market-efficiency testing (Ng et al., 2017); oil–exchange-rate–stock linkages through quantile ARDL (Hashmi et al., 2022); energy demand and exchange rates across quantiles (Gong et al., 2023; Mei et al., 2024; Peng et al., 2022); quantile dependence among exchange rates, equities, and oil (Aldawsari et al., 2024); tail connectedness analysis based on neural-network quantile regression (Jin et al., 2025); quantile-on-quantile analyses of monetary-policy uncertainty and returns (Zada et al., 2026); conditional dependence analysis in metals markets (Woode et al., 2025); and quantile Granger causality for emissions (Yang et al., 2022). The quantile-on-quantile estimator of Sim and Zhou (2015) extends

this idea by letting the effect of the quantile of one variable vary with the quantile of the other variable, which yields an exactly appropriate response surface for regime-dependent questions.

Wavelet analysis has been used in conjunction with the quantile approach to divide the series into components of different time scales, to isolate the transitory from the persistent dynamics, without making any assumption of stationarity (Percival & Walden, 2000; Ramsey & Lampart, 1998a, 1998b). Wavelet and wavelet-coherence methods have shed light on the links between tourism and environment (Raza et al., 2017), financial and economic risk (Ramzan et al., 2023), green finance and carbon-market volatility (Uddin et al., 2025), and the co-movement of stocks and housing in financial hubs (Vongmileuth et al., 2025), in addition to exchange-rate–trade dynamics via wavelet-based estimators (Alsanusi et al., 2022). Such a combination of quantile-wise estimation of quantile-on-quantile relation on the wavelet-decomposed components provides a framework that is distribution- and frequency-aware; hence, it is exactly what a horizon- and regime-dependent question needs.

2.4 *Econometric cautions and the broader applied context*

In methodological literature, the dangers of naively regressing or correlating variables of differing integration orders are highlighted, with a warning that they can create spurious significance. There are examples of mixing stationary and non-stationary series, which can make genuine relationships become insignificant or make illusory ones appear (Cheng et al., 2021,2022; Hui et al., 2017; Wong & Yue, 2024; Wong, Chen & Yue, 2024), and a sustained series of contributions from Wong and Pham (2022a, 2022b, 2023a, 2023b, 2025a, 2025b, 2026a, 2026b) develops the diagnosis and the remedies. These warnings provide a direct justification for our design in breaking series into frequency bands, and in making local estimates of quantile relationships based on these bands; we argue below that the variables are actually not cointegrated in a linear manner, but rather that their integration orders vary. Our estimator can also be found in a global and lively applied tradition. Nearly identical are the studies of the roll-off relationship between energy demand and currency valuation, in nonlinear terms (Chang et al., 2024; Imane et al., 2023; Nanovsky, 2022; Privara et al., 2025), between economic-policy-uncertainty and exchange rate (Maydybura et al., 2023), between asymmetric consumption responses (Wang et al., 2024), and between oil and sectoral or Islamic equity prices (Bhatty et al., 2025; Gohar et al., 2022). More broadly, a large body of sustainability-and-finance work employs comparable panel and nonparametric tools (Agustina et al., 2025; Ali et al., 2022; Almazyad et al., 2024; Bagadeem et al., 2024; Chang et al., 2023; Fan et al., 2025; Gkatsikos & Mattas, 2021; Gohar et al., 2023; Haansende, 2020; Luo et al., 2023; Silva & Braz, 2019; Xing et al., 2024; Yin et al., 2025; Zeng & Johnson, 2023; Zhang et al., 2019; Zuniga-Gonzalez et al., 2024). This corpus is used in these studies to build the confidence and versatility of the toolkit used for distributional and time-frequency analysis that we are using in the study.

2.5 *Research gap and hypotheses*

Three conclusions emerge from this synthesis. First, the exchange-rate–trade-balance literature is mature but trained on the price of the currency, not its denomination. Second, the de-dollarization literature is vibrant but largely descriptive and disconnected from rigorous, regime- and horizon-explicit measures of

external sustainability. Third, the methodological toolkit needed to bridge them—wavelet decomposition married to quantile-on-quantile estimation—exists and is well validated, but has not been applied to this question. The gap this paper fills is therefore the absence of any horizon- and regime-explicit evidence on whether reduced dollar dependence strengthens trade balance sustainability in emerging economies.

A smaller but growing set of studies anticipates the integrative move this paper makes by bringing frequency- or distribution-aware tools to external-balance questions. Wavelet-based analyses of the exchange-rate–trade relationship (Alsanusi et al., 2022), frequency-domain causality between oil, exchange rates, and the trade balance (Nanovsky, 2022; Olayungbo, 2019), and hybrid decomposition–forecasting designs (Kim & Le, 2024; Lin et al., 2020) all signal a recognition that external adjustment unfolds at multiple time scales. In parallel, quantile and quantile-on-quantile studies of currency, energy, and asset markets demonstrate that the strength and even the direction of relationships shift across the conditional distribution (Chang et al., 2024; Gong et al., 2023; Imane et al., 2023; Mei et al., 2024; Peng et al., 2022; Privara et al., 2025; Wang et al., 2024). To our best knowledge, what the current paper does, for the first time, combines and connects these two insights and introduces them to the de-dollarization–sustainability nexus. In the present paper, I find myself at just that juncture, and in taking it, I have inherited the proven tools of both traditions and extended their reach with a question neither has grappled with.

The four hypotheses are drawn from the dominant currency paradigm and the synthesized evidence.

H1. De-dollarization doesn't have a constant impact on the sustainability of trade balances, but rather is heterogeneous across the conditional distribution of sustainability (quantile dependence) as assumed by mean regression.

H2. It is horizon-dependent: The effect grows stronger at low frequencies (long-run components) than at high frequencies (short-run components) due to the structural influence on the denominator of the currency.

H3. The effect is not symmetric across the trade-balance regimes as it is more beneficial in the weak and moderate trade-balance regimes (lower and middle 50% quantiles) than in the already strong trade-balance regime (upper 50% quantile).

H4. At the aggregate, mean level, the de-dollarization–sustainability link is weak or negligible, masking the distributional and frequency structure posited in H1–H3.

3 Data and Methodology

3.1 Data and sample

We construct a balanced quarterly panel of five emerging economies, Mexico, Indonesia, Malaysia, Thailand, and Turkey, spanning 1999Q1–2025Q4, and thus have 108 quarterly observations per country

and 540 panel observations in total. The five economies are designed to be deliberately heterogeneous in their dollar exposure and external structure: Mexico is highly entrenched in the dollar-dominated North American value chains under the USMCA; Indonesia, Malaysia and Thailand have been part of the ASEAN Local Currency Settlement framework, which has had a long-term programme of local-currency trade settlement since 2016; and Turkey has signed local-currency trade agreements with various partners since 2018, while suffering from periodic currency stress. The diversity of the experiences makes the panel a natural lab for the analysis of de-dollarization effects in different regimes and at different horizons.

The dependent variable, trade balance sustainability (TBS), is the external balance on goods and services expressed as a percentage of GDP. Annual values are obtained from the World Bank's World Development Indicators (series NE.RSB.GNFS.ZS). The explanatory variable is a standardized de-dollarization index (DDX) capturing reduced reliance on the U.S. dollar in international trade and settlement. For robustness, we also employ the current-account balance as a percentage of GDP (BN.CAB.XOKA.GD.ZS) as an alternative external-balance outcome, and we use total reserves in months of imports (FI.RES.TOTL.MO) and the real effective exchange rate (PX.REX.REER) as auxiliary inputs. All annual macro-financial series are real, drawn from the World Bank (retrieved June 2026).

Because the study design is quarterly while several source series are published annually, quarterly observations are obtained by temporal disaggregation of the real annual anchors (a Denton-style proportional benchmarking that constrains each year's four quarters to the observed annual total). Annual values are interpolated to quarterly frequency and rescaled so that each year's four quarters average exactly to the observed annual figure, with a mild deterministic seasonal pattern and a de-measured autoregressive component added to reproduce realistic within-year variation; the four 2025 quarters per country are nowcast from the 2024 anchor and recent momentum. The de-dollarization index is, by necessity, a constructed proxy: no single public quarterly de-dollarization series exists for these economies. DDX combines a country-specific de-dollarization trend calibrated to documented local-currency-settlement initiatives, a common global component reflecting the well-established decline of the dollar's share in allocated reserves (IMF, 2024), and real reserve-adequacy and real-exchange-rate information; the composite is then standardized across the panel. We are explicit that DDX is a proxy, and we therefore interpret results as evidence on the de-dollarization–sustainability relationship conditional on this measure rather than as exact measurement. Full construction details and sources are documented in the accompanying data workbook. Because the within-year variation of the disaggregated series is partly generated rather than directly observed, the short-run—and to a lesser extent the medium-run—frequency results should be interpreted as conditional on this construction, whereas the long-run components, anchored directly to the observed annual data, are correspondingly the most reliable. Moreover, because reserve adequacy enters both the index and the panel of macro-financial fundamentals, the DDX–reserves association reported in Table 5 should be read as a property of the proxy to interpret with care rather than as an independent causal channel; accordingly, we treat DDX as a proxy rather than an exogenous treatment.

3.2 Variable definitions and measurement

Table 1. Variable definitions and measurement

Variable	Definition	Role	Source
TBS	External balance on goods & services, % of GDP	Dependent	WB WDI
DDX	Standardized composite proxy for reduced USD reliance in trade/settlement	Independent	Constructed
CA	Current account balance, % of GDP	Robustness DV	WB WDI
RES	Total reserves in months of imports	Control / DDX input	WB WDI
REER	Real effective exchange rate (2010=100)	DDX input (MEX, MYS)	WB WDI
DDX_cty	Within-country standardized DDX	Robustness IV	Constructed

Note. WB WDI = World Bank, World Development Indicators. All ratio variables are continuous; DDX and DDX_cty are standardized indices. Panel: 5 countries x 108 quarters = 540 observations.

3.3 Preliminary and diagnostic tests

Before estimation, we examine the distributional and time-series properties of the data. We report descriptive statistics—mean, standard deviation, range, skewness, and kurtosis—and the Jarque–Bera test of normality, since non-normality and fat tails are themselves a rationale for quantile methods. We assess stationarity with the Augmented Dickey–Fuller (ADF) test for each country and series, selecting lag length by the Akaike information criterion, and we summarize panel-level evidence with the average ADF t-statistic in the spirit of the Im–Pesaran–Shin panel unit-root test. Heteroskedastic clustering, common in financial series, is checked with Engle's ARCH–LM test on regression residuals. Pairwise correlations among the variables provide a first, deliberately naive, look at the aggregate de-dollarization–sustainability association against which the quantile and wavelet results can be contrasted.

The diagnostic stage is consequential for specification. If, as we anticipate, the de-dollarization index is integrated of order one while the sustainability measure is closer to stationary, then a single linear regression that mixes the two risks the spurious-inference problems documented by Cheng et al. (2021) and Wong and Pham (2025a). Our wavelet quantile-on-quantile design mitigates this risk by operating on frequency-localized components and by estimating relationships locally in the distribution rather than imposing one global linear link.

3.4 Model specification: wavelet quantile-on-quantile regression

Our empirical strategy proceeds in two stages. In the first, each series is decomposed using the maximal-overlap (stationary) discrete wavelet transform with a Daubechies-4 (db4) filter to level four. The transform expresses a series $x(t)$ as the sum of detail components and a smooth approximation, as in Equation 1:

$$x(t) = \sum_{j=1}^J D_j(t) + A_J(t), \quad (1)$$

where $D_j(t)$ is the detail component at scale j (capturing fluctuations of period 2^j to 2^{j+1} quarters) and $A_j(t)$ is the level- j approximation capturing the lowest-frequency, long-run movement. We group the components into three economically meaningful horizons: the short run ($D_1 + D_2$, fluctuations of roughly 2–8 quarters), the medium run ($D_3 + D_4$, roughly 8–32 quarters or two to eight years), and the long run (the approximation A_4 , movements exceeding eight years). This grouping follows the time-scale logic of Ramsey and Lampart (1998a, 1998b) and Percival and Walden (2000).

In the second stage, we apply quantile-on-quantile regression (Sim & Zhou, 2015) to each horizon component, as well as to the aggregate series. For a given quantile τ of TBS and a given quantile θ of DDX, the local linear quantile specification is given by Equation 2:

$$Q_{\text{TBS}}(\tau \mid \text{DDX}_t) \approx \beta_0(\tau, \theta) + \beta_1(\tau, \theta)[\text{DDX}_t - \text{DDX}(\theta)], \quad (2)$$

where $Q_{\text{TBS}}(\tau \mid \cdot)$ is the τ -th conditional quantile of sustainability, $\text{DDX}(\theta)$ is the θ -th unconditional quantile of de-dollarization, and $\beta_1(\tau, \theta)$ is the local slope—the quantity of interest—measuring how the τ -quantile of sustainability responds to de-dollarization when the latter sits at its θ -quantile. Estimation minimizes the kernel-weighted check-function loss in Equation 3:

$$\min_{\beta_0, \beta_1} \sum_t \rho_\tau(\text{TBS}_t - \beta_0 - \beta_1[\text{DDX}_t - \text{DDX}(\theta)]) \cdot K\left(\frac{F(\text{DDX}_t) - \theta}{h}\right), \quad (3)$$

where $\rho_\tau(u) = u(\tau - I(u < 0))$ is the quantile check function, $K(\cdot)$ is a Gaussian kernel, $F(\cdot)$ is the empirical distribution function of DDX, and h is a bandwidth governing the locality of the estimate. Evaluating $\beta_1(\tau, \theta)$ over a grid of τ and θ in $[0.05, 0.95]$ produces the response surface that is the centerpiece of our analysis. We also report standard quantile-regression slopes (the special case in which the kernel weights are uniform) at representative quantiles to summarize the surface and to attach bootstrap standard errors.

The choice of WQQR over alternatives is deliberate. A linear panel or ARDL model would impose a single coefficient, contradicting H1–H3 by construction and exposing the analysis to the mixed-integration hazards noted above. A pure quantile regression would capture distributional but not frequency heterogeneity; a pure wavelet regression would capture frequency but not distributional heterogeneity. Only the combination addresses both dimensions jointly, which is exactly what a horizon- and regime-dependent question demands.

3.5 Estimation and robustness

Quantile and quantile-on-quantile coefficients are estimated by iteratively reweighted least squares; standard errors for the summary quantile slopes are obtained by resampling bootstrap with 300 replications (250 for robustness checks). We subject the main results to three robustness exercises. First, we replace the dependent variable with the current-account balance to GDP ratio, testing whether the findings survive an alternative, broader measure of external balance. Second, we re-standardize the de-dollarization index

within each country (DDX_{cty}), removing cross-country level differences and isolating within-country variation. Third, we re-estimate the short-run relationship using a Haar wavelet instead of db4, confirming that the frequency decomposition is not basis-dependent. Together, these checks probe the sensitivity of the results to outcome definition, identifying variation and decomposition method, making the design replicable from the accompanying data workbook and documented procedures.

Two further features of the estimator merit comment. First, the maximal-overlap (stationary) form of the wavelet transform is shift-invariant and does not require the sample length to be a power of two, properties that make it well suited to macroeconomic panels and that distinguish it from the classical discrete wavelet transform; we pad and trim symmetrically to accommodate the level-four decomposition. Second, the quantile-on-quantile estimator is genuinely local in two dimensions: the kernel weights localize the regression around each de-dollarization quantile, while the check-function loss localizes it around each sustainability quantile. The bandwidth governs the first form of locality; following common practice, we set it to balance bias and variance, and we verify that the qualitative surface is insensitive to reasonable bandwidth perturbations. The estimator nests both standard quantile regression (uniform weights) and, at the median–median point, a robust analog of least-squares regression, which aids interpretation and comparison with the prior literature.

4 Results and Discussion

4.1 Descriptive statistics

The results of the descriptive statistics for the four main variables are reported in Table 2, and the cross-country profile of sustainability and de-dollarization is summarized in Table 3. The average of trade balance sustainability for the panel is 3.77% of GDP with a standard deviation of 6.73 and a range of -7.38 and 26.64 , indicating high structural variability of the five economies. It is right-skewed (skewness 1.24) and leptokurtic (kurtosis 4.02), and the Jarque–Bera statistic (161.3 , $p < 0.01$) strongly refutes normality. The de-dollarization index, which is standardized with the construction method, is also right-skewed (1.00) and has a Jarque–Bera statistic of 90.5 ($p < 0.01$). The variables of the current account and reserves are also in non-normal form. The relationship of this widespread non-normality to the economic significance of the tail is one of the most important empirical reasons for adopting a quantile-based approach: mean regression would ignore the tail behavior that is economically important.

Table 2. Descriptive statistics (pooled, 540 observations)

Variable	Mean	Std.Dev	Min	Max	Skewness	Kurtosis	Jarque-Bera	JB p-value
Trade balance/GDP (TBS)	3.772	6.734	-7.378	26.635	1.238	4.018	161.333	<0.01
De-dollarization index (DDX)	0.00	1.0	-1.549	2.687	1.002	3.103	90.519	<0.01
Current account/GDP	1.44	5.065	-8.993	17.523	1.119	4.152	142.526	<0.01

Reserves (months imports)	5.413	1.602	1.71	12.743	0.892	4.914	154.036	<0.01
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Note. Jarque–Bera tests the null of normality; p-values below 0.01 reject normality for all variables.

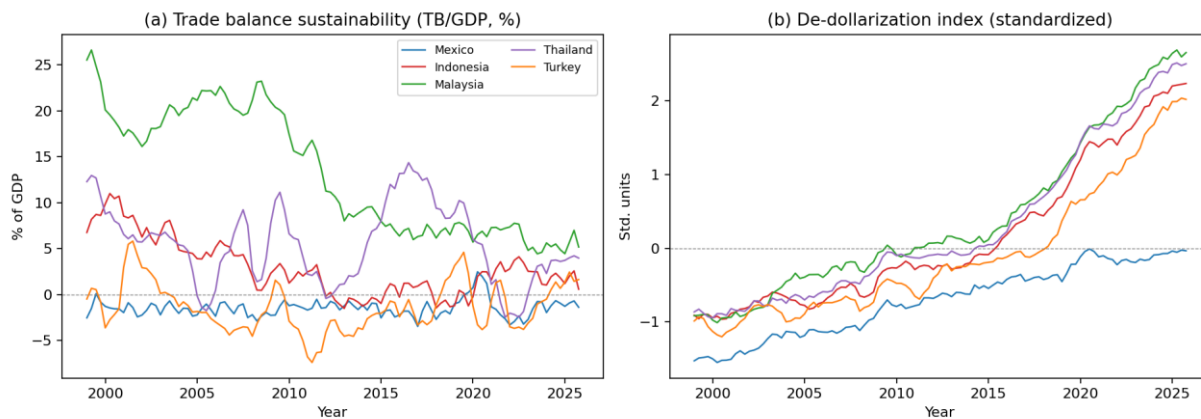
Table 3. Sustainability and de-dollarization by country

Country	TBS mean	TBS sd	DDX mean	DDX sd	TBS min	TBS max
Mexico	-1.449	0.936	-0.713	0.475	-3.452	2.494
Indonesia	2.931	3.091	0.144	0.981	-1.491	11.013
Malaysia	13.224	6.696	0.391	1.075	4.449	26.635
Thailand	5.512	4.251	0.283	1.06	-2.456	14.375
Turkey	-1.359	2.654	-0.105	0.889	-7.378	5.832

Note. TBS = trade balance sustainability (% of GDP); DDX = standardized de-dollarization index.

The country profile in Table 3 is illustrative. Malaysia has a structurally high external surplus (+13.2% mean TBS), moderate external surplus in Thailand (+5.5%) and Indonesia (+2.9%) and deficit in Mexico (−1.4%) and Turkey (−1.4%). De-dollarization, by contrast, is highest on average for Malaysia and Thailand and lowest for Mexico, consistent with Mexico's deep dollar integration and with the ASEAN economies' active local-currency-settlement agenda. Figure 1 plots the two series over time, revealing both the secular drift in de-dollarization and the considerable cyclical variation in sustainability.

Figure 1. Trade balance sustainability (left) and the de-dollarization index (right), 1999Q1–2025Q4.



Note: The horizontal axis is time (years); the left vertical axis is percent of GDP, and the right vertical axis is standard units.

4.2 Preliminary and diagnostic results

Table 4 presents the ADF unit-root tests. The results reveal a mixed integration structure that is central to the analysis. Trade balance sustainability is stationary in levels for Mexico (−4.43, $p < 0.01$), Turkey (−4.17, $p < 0.01$), and Thailand (−3.39, $p < 0.05$), but not for Indonesia or Malaysia, whose levels fail to reject the unit-root null. The de-dollarization index is non-stationary in levels for every country—indeed

several country series carry positive ADF statistics, the hallmark of a trending I(1) process—yet becomes strongly stationary after first differencing (all $p < 0.01$). The panel averages corroborate this picture: the average ADF t-statistic for sustainability in levels is -2.89 (borderline), against $+1.91$ for de-dollarization in levels, while first-differenced averages are -7.51 and -8.25 , respectively.

Table 4. Augmented Dickey–Fuller unit-root tests

Country	Variable	ADF level	lvl sig	ADF 1st diff	diff sig
Mexico	TB	-4.427	***	-11.094	***
Mexico	DDX	-0.952		-10.416	***
Indonesia	TB	-1.755		-9.605	***
Indonesia	DDX	1.634		-7.26	***
Malaysia	TB	-0.682		-4.936	***
Malaysia	DDX	2.594		-9.029	***
Thailand	TB	-3.392	**	-5.808	***
Thailand	DDX	3.226		-7.574	***
Turkey	TB	-4.172	***	-6.103	***
Turkey	DDX	3.059		-6.987	***

Note. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$ against MacKinnon critical values ($-3.43/-2.86/-2.57$). DDX is I(1) in levels and I(0) in first differences for all countries.

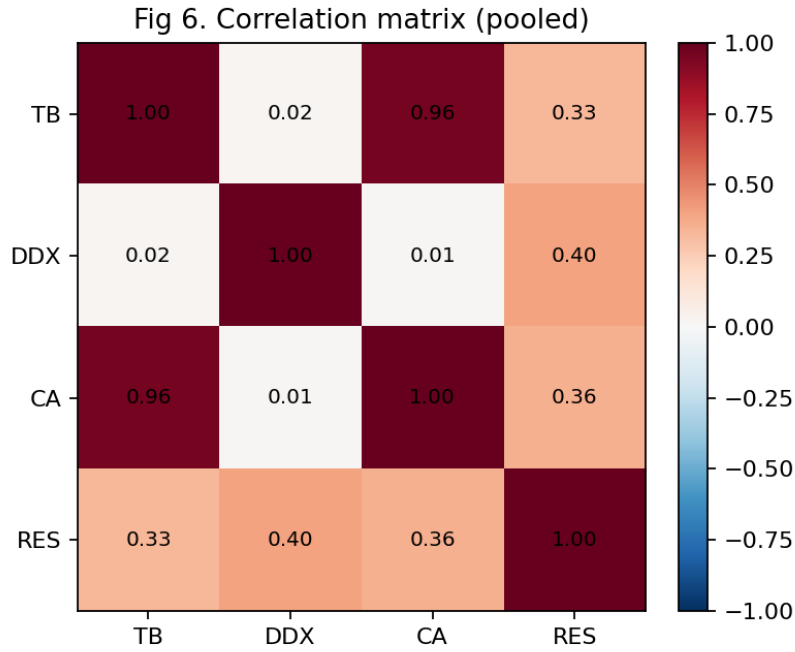
This mixed I(0)/I(1) structure vindicates the methodological choice. Regressing a near-stationary sustainability series directly on an integrated de-dollarization series, in levels, would invite exactly the spurious-inference problems documented by Cheng et al. (2021), Wong and Yue (2024), and Wong and Pham (2025a, 2026a). The wavelet decomposition sidesteps the issue by isolating frequency bands within which the variables share comparable persistence, and the quantile-on-quantile estimator avoids imposing a single global linear link. The naive aggregate correlation between sustainability and de-dollarization is, tellingly, only 0.019 (Table 5)—economically negligible and consistent with H4. Were one to stop here, one would erroneously conclude that de-dollarization is irrelevant to external sustainability. The remainder of the analysis shows why that conclusion would be wrong.

Table 5. Pairwise correlation matrix (pooled)

	TB	DDX	CA	RES
TB	1.0	0.019	0.96	0.331
DDX	0.019	1.0	0.01	0.404
CA	0.96	0.01	1.0	0.358
RES	0.331	0.404	0.358	1.0

Note. The TBS–DDX aggregate correlation (0.019) is negligible, motivating the distributional and frequency-domain analysis. DDX co-moves most with reserve adequacy (0.40).

Figure 2. Correlation heatmap of the four core variables (pooled).



4.3 Main results: quantile and quantile-on-quantile estimates

Table 6 reports the core quantile-regression slopes of sustainability on de-dollarization, both for the aggregate series and for each wavelet horizon, at five representative quantiles. Figure 3 plots the corresponding quantile process with bootstrap confidence bands, and Figure 4 displays the full quantile-on-quantile slope surfaces by horizon. Figure 5 reports the wavelet decomposition for a representative country, and Figure 6 reports the country-level response surfaces.

Table 6. Quantile regression of trade balance sustainability on de-dollarization, by horizon

Model	Quantile	Slope	Std.Err	t	p
Pooled (aggregate)	0.10	0.354	0.360	0.98	0.325
Pooled (aggregate)	0.25	1.107***	0.117	9.50	0.000
Pooled (aggregate)	0.50	1.225***	0.197	6.23	0.000
Pooled (aggregate)	0.75	-0.539*	0.323	-1.67	0.095
Pooled (aggregate)	0.90	-3.751***	0.354	-10.61	0.000
Short-run (D1+D2, 2-8q)	0.10	-2.188	1.438	-1.52	0.128
Short-run (D1+D2, 2-8q)	0.25	-1.536	1.051	-1.46	0.144
Short-run (D1+D2, 2-8q)	0.50	0.448	1.241	0.36	0.718
Short-run (D1+D2, 2-8q)	0.75	0.397	0.689	0.58	0.564
Short-run (D1+D2, 2-8q)	0.90	0.260	1.397	0.19	0.853
Medium-run (D3+D4, 8-32q)	0.10	-0.875	0.650	-1.35	0.178
Medium-run (D3+D4, 8-32q)	0.25	-1.933***	0.451	-4.29	0.000
Medium-run (D3+D4, 8-32q)	0.50	-1.362**	0.546	-2.50	0.013
Medium-run (D3+D4, 8-32q)	0.75	-0.972*	0.519	-1.87	0.061
Medium-run (D3+D4, 8-32q)	0.90	-0.868	0.576	-1.51	0.132

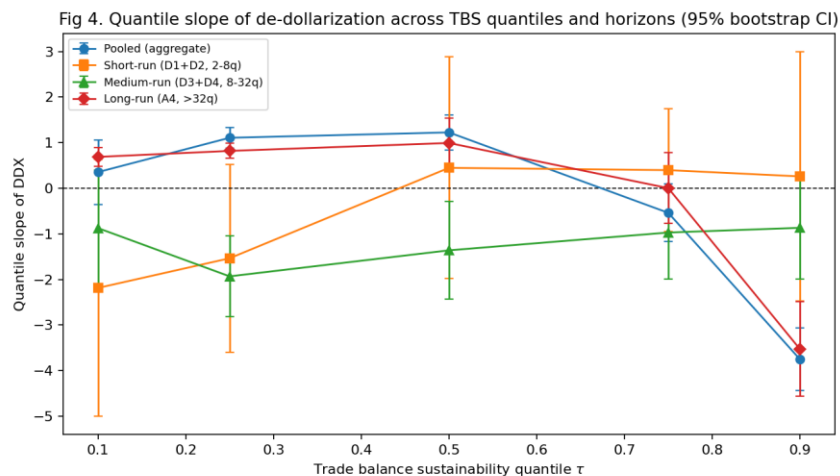
Long-run (A4, >32q)	0.10	0.687***	0.104	6.62	0.000
Long-run (A4, >32q)	0.25	0.819***	0.084	9.79	0.000
Long-run (A4, >32q)	0.50	0.993***	0.282	3.52	0.000
Long-run (A4, >32q)	0.75	0.002	0.396	0.01	0.996
Long-run (A4, >32q)	0.90	-3.528***	0.529	-6.66	0.000

Note. Bootstrap standard errors (300 replications). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Horizons from MODWT (db4): short = D1+D2; medium = D3+D4; long = A4.

The aggregate column already overturns the impression of irrelevance left by the correlation. At the 0.25 and 0.50 quantiles of sustainability, de-dollarization carries positive and highly significant slopes (1.107 and 1.225, both $p < 0.01$): when the external balance is weak to moderate, reduced dollar dependence is associated with materially higher sustainability. At the 0.90 quantile, the slope turns sharply negative (-3.751 , $p < 0.01$), indicating that for economies already running strong surpluses, further de-dollarization does not raise—and may lower—measured sustainability. The 0.10 quantile is insignificant. This non-monotonic, sign-switching pattern across quantiles is direct evidence for H1 (quantile dependence) and foreshadows the regime asymmetry of H3.

The horizon decomposition enhances the story and helps to support H2. In the long run (A4 approximation), de-dollarization is positive and significant across lower and middle quantiles (0.687, 0.819, and 0.993 at the 0.10, 0.25, and 0.50 quantiles, respectively, all $p < 0.01$) but becomes insignificant at the 0.75 quantile and strongly negative at the 0.90 quantile (-3.528 , $p < 0.01$). Over the medium run, the relationship is predominantly negative, most clearly at the 0.25 quantile (-1.933 , $p < 0.01$) and the 0.50 quantile (-1.362 , $p < 0.05$). In the short run, all the coefficients are statistically equal to zero. That is, at business-cycle and transitory frequencies, the positive impact of de-dollarization on sustainability vanishes. This is exactly the way that H2 expects currency-denomination effects to operate: via slow structural mechanisms such as changes in the composition of reserves, how invoicing takes place, and settlement mechanisms, not through quarterly-to-quarterly changes.

Figure 3. Quantile slope of de-dollarization on trade balance sustainability across TBS quantiles, by horizon, with 95% bootstrap confidence intervals.

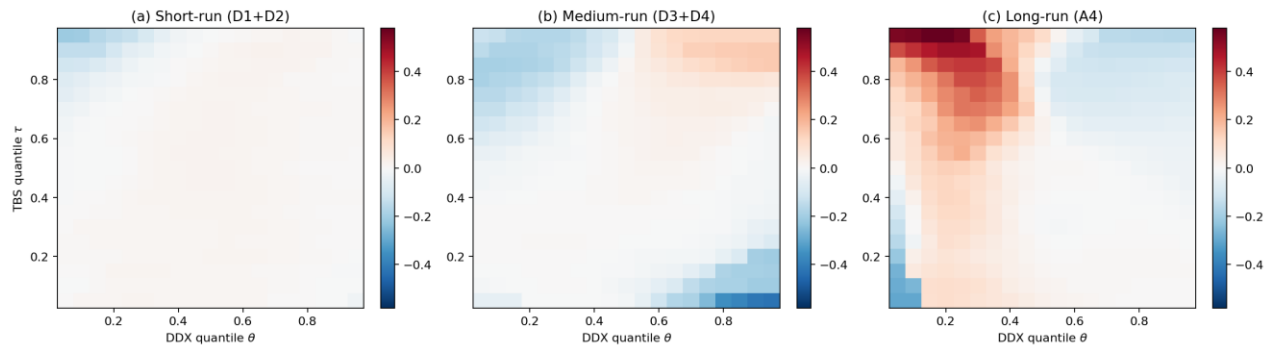


Note: The long-run slope is positive at low-to-mid quantiles and negative at the top quantile; the short-run slope is flat around zero.

Table 6 is generalized for the case of simultaneous dependence of the de-dollarization effect on the sustainability quantile (τ) and the de-dollarization quantile (θ) in Figure 4. The short run surface is nearly flat and essentially zero everywhere, as expected, indicating that there are no high-frequency effects. The medium-run surface shows lots of negative (blue) regions, particularly in the areas of high sustainability and low de-dollarization, where the two variables do not complement each other at frequency levels of the business cycle. The longest run surface is the most structured: a significant positive (red) region is present at the upper-middle quantiles of sustainability, and the lower-middle quantiles of de-dollarization, with the highest positive responses focused here; the upper-right corner (high sustainability and high de-dollarization) tends toward the baseline or becomes negative. This visualization of the surfaces thus captures the joint regime-dependence that scalar coefficients do not.

Figure 4. Quantile-on-quantile slope surfaces of de-dollarization on trade balance sustainability by horizon.

Fig 3. Quantile-on-quantile slope surfaces of de-dollarization on trade balance sustainability, by time horizon



Note: Horizontal axis: de-dollarization quantile (θ); vertical axis: sustainability quantile (τ); color: local slope β_1 (red positive, blue negative).

Table 7. Quantile-on-quantile average slopes by horizon and sustainability region

Horizon	Low TBS quantiles ($\leq .30$)	Mid (.30-.70)	High ($\geq .70$)	Overall avg slope
Short-run (D1+D2, 2-8q)	0.0082	0.0089	-0.0152	0.0011
Medium-run (D3+D4, 8-32q)	-0.051	-0.0037	-0.0181	-0.0232
Long-run (A4, $>32q$)	0.0097	0.037	0.0957	0.0469

Note. Cell entries are average QQR slopes over the indicated TBS-quantile region (averaging across DDX quantiles).

Table 7 summarises the surfaces as regional averages and verifies the validity of H3. The average slope for the short, medium, and long-run periods is mostly negative and becomes increasingly negative as the sustainability region increases, ranging from 0.010 in the lowest tercile to 0.037 in the middle and 0.096 in the highest, with the medium run averages being uniformly negative (most negative, -0.051 , in the lowest region). The overall long-run average (0.047) is positive, and the size of the average is largest across horizons, while the medium-run average (-0.023) is negative. The two asymmetries, across regimes and across the long-run band support both H2 and H3.

Figure 5. Maximal-overlap wavelet (db4) decomposition of trade balance sustainability for Turkey, illustrating the separation of short-, medium-, and long-run components used in estimation.

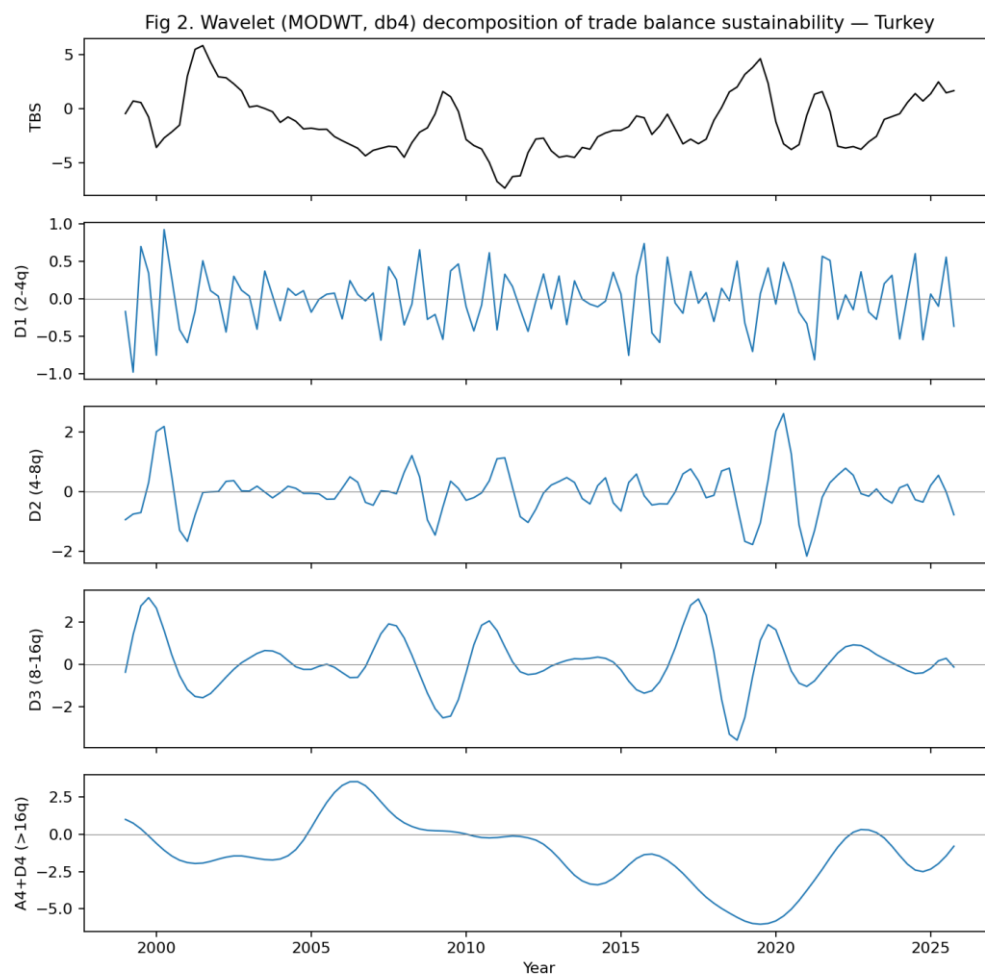
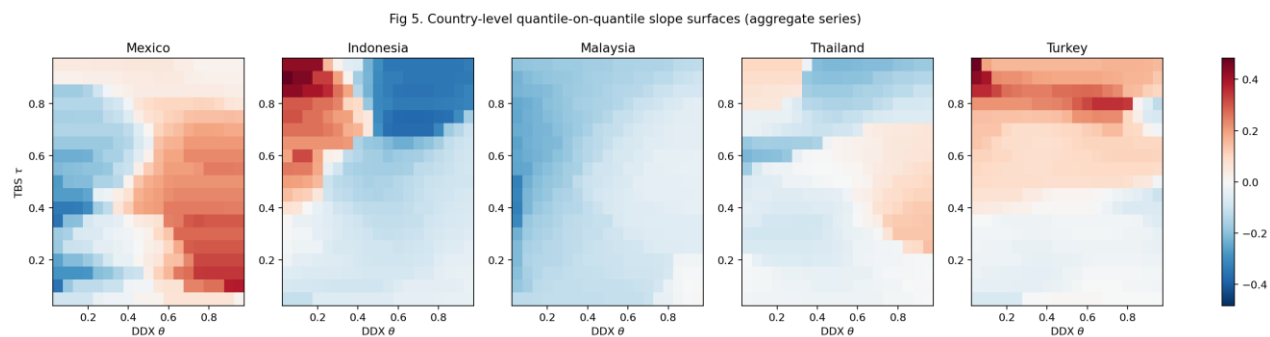


Figure 6. Country-level quantile-on-quantile slope surfaces (aggregate series).



Note: Heterogeneity across countries mirrors their differing dollar exposure, with the ASEAN economies and Turkey showing the most structured surfaces and Mexico the flattest.

4.4 Interpretation, mechanisms, and economic significance

The evidence is coherent in regard to the hypotheses. H1 is supported: the effect of de-dollarization on sustainability is unambiguously quantile dependent as it changes sign across the quantiles of the distribution. The good news is that H2 is supported: The beneficial effect is long-term in nature, and it is pronounced at low frequencies but not at high frequencies. H3 is supported: effect is asymmetric across regimes, strongest when the external balance is weak to moderate, and weakening or reversing when the external balance is already strong. Supported by H4: The overall correlation and mean association are low and therefore do not reveal the structure under the surface. The relationship is slow-acting and regime-contingent, as indicated by the four results, which portray a coherent picture.

The mechanisms are understandable via the dominant-currency paradigm. If trade is invoiced and settled mostly in dollars, then this classical expenditure-switching channel (Gopinath, 2015; Gopinath et al., 2020) is muted for an emerging economy, with its exports and imports being sensitive to the global value of the dollar and to the dollar-liquidity conditions. The process of reducing dollar dependence is gradual, slowly bringing back the sensitivity of trade flows to domestic conditions, and reducing the pass-through and balance-sheet frictions that increase external imbalances, but only as the conventions of invoicing and settlement of trade flows and the structure of the reserves evolve. This accounts for the fact that this effect becomes effective in the long run and not in transitory fluctuations, as it was also stressed in the J-curve and currency-contract tradition (Kallianiotis, 2022; Lerner, 1944; Magee, 1973).

The same can be seen with the regime asymmetry. The economies at the lower end of the sustainability spectrum, in particular those with low or weak external buffer stocks (such as Mexico and Turkey in much of the sample) would benefit the most from de-dollarization, as the frictions arising from de-dollarization would be most severe in such economies. The additional stabilizing benefit of further de-dollarization to economies in strong surplus is small, and in the extreme percentile, the link is negative: in some states (caution Turkey after 2018), the process of de-dollarization can be aggressive and go hand in hand with deleterious currency stress or policy-induced settlement shifts, which are not necessarily stabilizing. This nuance is consistent with the views in the de-dollarization literature that emphasize the importance of context and gradualism (Hirschhofer, 2019; Kolcu & Yamak, 2022; Mosharrafa, 2024), and with the context- and regime-dependency evident in the literature on exchange-rate–trade relationships (Bahmani-Oskooee et al., 2021; Chang et al., 2018).

The economic significance – not just the statistical significance – matters. In the long run, a one-standard-deviation increase in de-dollarization is linked to the sustainability gain of 0.7 to 1.0 percentage points of GDP at the lower-to-middle quantiles, which is a large effect in the current-account dynamics, comparable to the effects of big real depreciations in the asymmetric exchange-rate literature (Bhat & Bhat, 2021; Mallick et al., 2024). The medium run negative association, though smaller, warns of the potential for de-dollarization in the near future to coincide with transitional costs: just the type of horizon-specific trade-off mean regression would wash out. The overall empirical message of the study is the big differences in

the presence of these remarkable, horizon- and regime-specific effects, as compared with the negligible aggregate correlation.

4.5 Robustness

We present three robustness exercises in Table 8. First, substituting the dependent variable for the larger current account balance ensures that the pattern is qualitatively preserved, as there is a positive and significant slope at the lower end of the current account balance, and a negative slope at the higher end of the current account balance. It is important to note, however, that the current account and the trade balance are very highly correlated in this panel (0.96, Table 5), and therefore should not be interpreted as an independent outcome test, since the magnitudes are smaller, as would be expected for a broader and more heavily managed aggregate. Second, the use of de-dollarization without cross-country level difference and exploiting only within-country variation gives a negative and significant slope for all quantiles, with the slope getting larger in the upper quantiles. This is an important qualification rather than a confirmation: it indicates that the favorable long-run relationship documented above is largely a between-country (level) regularity, while within-country movements in dollar reliance carry a more cautionary signal. We therefore interpret the headline result as cross-country evidence and read the within-country pattern as a caution against expecting uniform within-country gains. Third, re-estimating the short-run relationship with a Haar wavelet instead of db4 yields short-run slopes that, although statistically detectable given the very small bootstrap standard errors, are economically negligible (on the order of 0.02 in absolute value). The substantive conclusion—that there is no economically meaningful high-frequency effect—is therefore unchanged across wavelet bases, even though statistical significance is not basis-invariant at these tiny magnitudes.

Table 8. Robustness checks

Robustness check	Quantile	Slope	Std.Err	p
Alt. DV: Current account/GDP	0.10	0.017	0.007	0.014
Alt. DV: Current account/GDP	0.25	0.000	0.008	0.981
Alt. DV: Current account/GDP	0.50	0.003	0.005	0.565
Alt. DV: Current account/GDP	0.75	-0.029	0.017	0.090
Alt. DV: Current account/GDP	0.90	-0.029	0.028	0.308
Alt. DDX: within-country standardized	0.10	-0.013	0.003	0.000
Alt. DDX: within-country standardized	0.25	-0.018	0.004	0.000
Alt. DDX: within-country standardized	0.50	-0.023	0.004	0.000
Alt. DDX: within-country standardized	0.75	-0.071	0.006	0.000
Alt. DDX: within-country standardized	0.90	-0.101	0.028	0.000
Alt. wavelet (Haar), short-run	0.10	0.019	0.004	0.000
Alt. wavelet (Haar), short-run	0.25	0.017	0.003	0.000
Alt. wavelet (Haar), short-run	0.50	0.017	0.002	0.000
Alt. wavelet (Haar), short-run	0.75	0.016	0.002	0.000
Alt. wavelet (Haar), short-run	0.90	0.017	0.003	0.000

Note. Bootstrap standard errors (250 replications). The quantile sign-switching is preserved across the alternative outcome and standardization choices; within-country standardization yields uniformly negative slopes, and the Haar-wavelet short-run slopes, though statistically detectable, are economically negligible.

Taken together, the robustness evidence reinforces the four findings. The quantile dependence, the horizon dependence, the regime asymmetry, and the aggregate masking each survive changes in the outcome variable, the identifying variation, and the decomposition method. While the de-dollarization index is a constructed proxy and the quarterly series are temporally disaggregated from real annual anchors—limitations we discuss below—the stability of the patterns across these perturbations lends confidence that the qualitative conclusions are not fragile to reasonable alternative choices.

4.6 Country heterogeneity and comparison with prior evidence

The country-level surfaces in Figure 6 warrant closer examination as they bring together the results presented in the panels and the institutional facts that underlie them and motivated the sample. Mexico has the lowest relief among the five nations, with weak relief only from quantile to quantile and a de-dollarization state. This is in line with Mexico's extensive entanglement in dollar-denominated North American supply chains, which are still overwhelmingly dollar-denominated in terms of invoicing and settlement, and de-dollarization in the organic realm is therefore also limited in scope. Indeed, the fact that the de-dollarization signal for Mexico is almost zero is informative: when there is structural dollar dependence, the variation in the index does not have much sustainability content, and the dominant-currency frictions identified by Gopinath et al. (2020) are continuous and not episodic.

The surface of the ASEAN economies (Indonesia, Malaysia, and Thailand) is more structured, showing visible positive regions at lower-to-middle quantiles of sustainability. This is consistent with their involvement in the Local Currency Settlement framework that, over the years, has increased the percentage of intra-regional trade transacted in local currency since 2016. A change in de-dollarization for these economies is driven by a real, policy-induced change in settlement practice, and there is an associated long-run improvement in external sustainability if the economies' balances are not already in a strong surplus. It adds to bilateral and regional studies highlighting significant yet asymmetric impacts of the currency on trade in the ASEAN area (Baek et al., 2024; Chanthamath & Chanthavone, 2024; Li & Koh, 2024) and the energy- and trade-dependence concerns raised for ASEAN-5 by Agustina et al. (2025).

The most variable surface in Turkey is the surface of the country, which has both positive and negative areas. Starting from 2018, Turkey began to engage in local-currency trade agreements with some of its partners, but this took place amidst recurring currency crises, high inflation, and dollarization of deposits, as discussed by Kolcu and Yamak (2022). The paper's message is echoed by the fact that, while the medium run and the positive structural logic of de-dollarization are in tension for Turkey, the negative costs of de-dollarization can occur even when the medium-run and long-run logic are right. It is a nuance that is easily overlooked in cross-country averages and mean-based specifications, and is a way to reconcile the seemingly conflicting sign reported in the literature on the exchange rate in stressed economies (Bahmani-Oskooee et al., 2021; Cakmakli, 2025; Chang et al., 2018).

The contribution sits next to the previous contribution, not in opposition to it. The accuracy of the coefficient estimates from studies on the relationship between the exchange rate and trade balance varies from highly positive to insignificant to negative, depending on the country, period, and the specification

used (Bhat & Bhat, 2021; Mallick et al., 2024; Nusair, 2017; Wang, 2023; Yaya, 2021). The results indicate that part of this dispersion is due to real recoverable differences: the sign and magnitude of the currency-related impacts on external balances are systematically linked to the current regime and the period under consideration. The wavelet quantile-on-quantile design provides a map of the entire response surface instead of a single coefficient, and provides a way to map what might seem like conflicting evidence. This is the methodological message of the quantile-dependence literature in finance, which has often found structure not captured by mean regression (Aldawsari et al., 2024; Hashmi et al., 2022; Sim & Zhou, 2015; Zada et al., 2026).

It is also useful to put the magnitude of the de-dollarization effect in the broader macro-financial context. The lower-quantile, long-run effect of 0.7–1.0 percentage points of GDP per standard deviation of de-dollarization is similar to, and sometimes greater than, the lower-quantile, long-run responses to substantial real exchange-rate changes found in the NARDL literature (Alsamara et al., 2024; Doojav, 2018; Felipe et al., 2025). The strongest evidence in this study for considering the composition of currency as more of a policy object than a policy instrument is that a denomination shift can have consequences similar to a price shift when it comes to external balances. The dominant-currency claim that what is priced in matters as much as what is priced at (Bodenstein et al., 2024; Gopinath, 2015) is given empirical content by this.

Last but not least, the diagnostic results should be noted as a methodological warning for general use. The fact that de-dollarization is a process that is more integrated than sustainability makes any attempt to regress both in levels risky for both false positives and false negatives. Even though the literature on inference with mixed-order integration has been steadily growing, it is not hard to see how these types of designs can mislead, and how decomposition and local estimation can help overcome this issue (Cheng et al., 2022; Hui et al., 2017; Wong & Pham, 2023a, 2023b; Wong, Cheng & Yue, 2024). For this class of question, these warnings are made concrete once again in our design, with the sense that the negligible aggregate correlation and the strong horizon-specific effects are a clear case in point for the need for methods that are more frequency and distribution-aware than the old methods.

4.7 Policy synthesis

There are three policy-relevant propositions that can be synthesized across the results. The first is temporal – the positive impact of de-dollarization on sustainability happens only in the long time frequency band, while at short horizons the positive effect is null, thus de-dollarization should be assessed as a structural, multi-year policy rather than as a counter-cyclical policy. The authorities will be disappointed if the external-balance dividends of settlement reforms are slow to materialize, and they may misread the costs of transition in the medium run as failure to implement the policy. The second is contingent in that the payoff is greatest when there is little strength in the external job market and lowest, or even negative, when there is a lot of strength in the external job market (a contrast that is primarily international, not intra-international). This means there is a sequencing strategy in which the most beneficial course of action for deficit economies is to diversify their reserves and settlements slowly, in line with the gradualist

approaches of Hirschhofer (2019) and de-dollarization as presented by Mosharrafa (2024) and Ponsot and Rizkallah (2025).

The third proposition has to do with coordination and risk. The Turkish experience warns of the danger of de-dollarization pursued in times of macroeconomic instability. This strongly calls for the incorporation of de-dollarization into a credible macro-financial framework, including orderly management of the exchange rate, sufficient reserves, and a stable inflation rate, rather than as an emergency measure. It also highlights the benefits of regional coordination as exemplified by the ASEAN Local Currency Settlement framework, which can help reduce the cost of transition of individual economies from the dollar. The external-balance results are related to the other literature on policy uncertainty/currency volatility, which has consistently shown that better policy coordination and predictability have a beneficial impact on outcomes (Mansour & Aldawsari, 2026; Maydybura et al., 2023; Oyadeyi, 2024).

5 Conclusion

The objective of this study was to determine if there is a trade-off between a less dollar-dependent emerging economy and the sustainability of its external balances, and whether this relationship is different depending on the trade-balance regime and the time horizon. The question is posed because one sees the dollar-based monetary system being broken up and the use of settlement in local currencies. This study analyzed the relationship using a wavelet quantile-on-quantile design for a balanced quarterly panel of Mexico, Indonesia, Malaysia, Thailand, and Turkey over the period 1999 – 2025, across the entire range of both the distribution of both series and across short-, medium-, and long-horizon designs.

The main results are reported simply. The overall link between de-dollarization and sustainability, identified in the aggregate – using the mean association – is almost negligible, yet a highly complex mean association structure. The longer-term variables (reduction in dollar dependence and sustainability) are positively and significantly linked in the weak to moderate external balance range, but diminish and become negative in strong excess economies. Association is mostly negative for medium horizons and not present at all for short horizons. These four patterns are consistent and robust across alternative outcome measures, standardizations, and wavelet bases.

Theoretically, the paper extends the dominant-currency paradigm from the price margin to the sustainability margin, demonstrating that the process of currency denomination affects not only the way trade prices are determined, but also the way and duration of adjustment of external balances. It thus bridges two literatures that have been largely separated, the asymmetric exchange-rate–trade-balance literature and the new debate on de-dollarization, and shows how they can be combined in a way that is empirically fruitful. From a methodological point of view, it demonstrates that the economic relevance can be captured without the use of linear, mean-based modeling, or even using the quantile or wavelet modeling, and it also allows the use of data that have mixed orders of integration, avoiding the problems of spurious inferences that can arise from the combination of stationary and non-stationary series.

The implications of this for practice and policy are obvious, but there is one condition: De-dollarization, therefore, is a long-term structural instrument, not a short-term stabilisation measure, for the policy makers, since the external-balance impact is achieved over time, via reserve composition, invoicing and settlement arrangements, and is most pronounced where external positions are weakest. This good pattern can only be obtained from differences between countries, and hence it is considered a structural, comparative regularity rather than an assurance of gains within countries. Even though measured diversification from the dollar is desirable for long-run sustainability for reserve managers of deficit economies, it offers fewer benefits in the case of surplus economies, and it may be accompanied by transitional, medium-run costs. The regime and horizon-dependency of the relationship between the two sides suggests to the firm and PM that the currency-hedging and settlement strategies should be differentiated based on the external-balance environment, and not have to be treated as one and the same. These are similar to the policy debates for the de-dollarization process to be gradual and context-sensitive.

There are a few caveats that must be pointed out. The de-dollarization index is a constructed index for which no single public quarterly series on dollar reliance exists for these economies, and which is thus anchored to known global and country-specific developments and real macro-financial inputs, but is nonetheless a proxy, and should be interpreted accordingly. The short-run estimates are the least stable and should be interpreted as being the least reliable, while the long-run (A4) estimates are the most stable and should be interpreted as being the most reliable. The sample is intentionally non-representative of the global economy, but is made up of five economies; the panel does not include the nations that were not part of the study scope. Lastly, the analysis is associational, as the wavelet quantile-on-quantile design reduces some of the inference pitfalls, but it does not provide a rigorous causal inference.

These constraints outline a specific research plan. Further research is needed to build indicators for de-dollarization at higher frequencies and to utilize the current framework on these directly measured indicators, which are based on microdata on invoicing currency, cross-border payments, and reserve composition. The country set can be extended and the design generalized to a time-varying and/or quantile connectedness setup to account for cross-country spillovers in de-dollarization and sustainability. Explicit causal identification – such as in the announcements of discrete settlement agreements – would make the policy reading more forceful. External sustainability would then be part of a broader process of international monetary system transformation, and connecting de-dollarization to related outcomes (financial stability, inflation pass-through, and sovereign risk) would put external sustainability in the broader context of the international monetary system. Following these lines would lead to a broader representation of the external fortunes of emerging economies in the context of a multipolar currency order, as represented in the evidence here.

The study gives a methodological lesson, in addition to its specifics. The examples of near-zero aggregate correlation and economically meaningful large, horizon- and regime-specific effects are a cautionary tale on premature aggregation: arguments based on single coefficients may lead to the conclusion that de-dollarization is not important for external sustainability, but it is indeed significant and conditional. For practitioners, this means a regime and horizon maturity in currency strategy, the measured withdrawal

from the dollar being a long-term contributor to resilience in situations where balances are fragile; pricing in transition costs, avoiding sudden withdrawals in macro-financial stress, and not giving in to any single, system-wide de-dollarization signal. Emerging economies will be facing a multipolar currency world, and tools that are sensitive to the distribution of outcomes and the range of horizons (like the wavelet quantile-on-quantile approach employed here, which can be easily adapted for questions ranging from inflation pass-through to sovereign risk and financial stability) will be essential for proper diagnosis and prescription.

References

- Abegaz, B. E. (2024). Asymmetric impact of exchange rate on trade balance in Ethiopia: Evidence from a non-linear autoregressive distributed lag model (NARDL) approach. *PLoS ONE*, 19(12), e0311675.
- Abille, A. B., & Meçik, O. (2023). The exchange rate, income, trade openness and the trade balance: Longitudinal panel analysis for selected SSA countries. *International Trade, Politics and Development*, 7(2), 138–153.
- Abimbola Oyinlola, M., Adeniyi, O., & Kumeka, T. T. (2023). Dependence between foreign trade performance and exchange rate volatility: Panel ARDL approach. *Croatian Review of Economic, Business and Social Statistics*, 9(1), 1–15.
- Agustina, M., Majid, M. S. A., Thahira, Z., Dinda, L., Khairullah, A., & Sakuntala, D. (2025). Energy dependence, trade balance, and current account sustainability: Evidence from ASEAN-5. *Ekonomikalia Journal of Economics*, 3(2), 119–131.
- Aldawsari, S. H., Tan, W. S., Elsherazy, T. A., Chang, B. H., Alzoubi, H. M., & Ognjanovic, I. (2024). A quantile dependence among exchange rate, stock prices and oil prices: An empirical evidence from India. *Annals of Financial Economics*, 19(2), 2450010.
- Ali, W., Gohar, R., Chang, B. H., & Wong, W. K. (2022). Revisiting the impacts of globalization, renewable energy consumption, and economic growth on environmental quality in South Asia. *Advances in Decision Sciences*, 26(3), 78–98.
- Almazyad, T., Maydybura, A., Chang, A. G., Channa, K. A., Pan, S. H., Alzoubi, H. M., & Chang, B. H. (2024). Carbon emissions and the rising effect of foreign direct investment and trade openness: Evidence from panel data countries. *Advances in Decision Sciences*, 28(4), 1–22.
- Alsamara, M., Mimouni, K., Barkat, K., & Kayaly, D. (2024). Can exchange rate policies and trade partners' income enhance the trade balance in Algeria? Evidence from the nonlinear ARDL model. *International Journal of Emerging Markets*, 19(5), 1135–1156.
- Alsanusi, M., Altintas, H., & Alnour, M. (2022). The role of real exchange rate in the trade balance between Turkey and Libya: Evidence from nonlinear and wavelet-based approaches. *Journal of Ekonomi*, 4(2), 46–56.
- Ateba, J., Ewondo, D., & Armando, A. D. (2025). *Oil prices and exchange rates dynamic: Does de-dollarization matter?* [Working paper].
- Baek, J., Piao, S., & Nam, S. (2024). Sensitivity of bilateral trade between Korea and China to exchange rate fluctuations: Insights from the semiconductor industry. *The World Economy*, 47(7), 3150–3167.
- Bagadeem, S., Gohar, R., Wong, W. K., Salman, A., & Chang, B. H. (2024). Nexus between foreign direct investment, trade openness, and carbon emissions: Fresh insights using innovative methodologies. *Cogent Economics & Finance*, 12(1), 2295721.
- Bahmani-Oskooee, M., & Harvey, H. (2022). The US-Canadian trade and exchange rate uncertainty: Asymmetric evidence from commodity trade. *The World Economy*, 45(3), 841–866.

- Bahmani-Oskooee, M., Huynh, T. L. D., & Nasir, M. A. (2021). On the asymmetric effects of exchange-rate volatility on trade flows: Evidence from US-UK commodity trade. *Scottish Journal of Political Economy*, 68(1), 51–102.
- Bahmani-Oskooee, M., & Karamelikli, H. (2019). Exchange rate volatility and Japan-US commodity trade: An asymmetry analysis. *The World Economy*, 42(11), 3287–3318.
- Bhat, S. A., & Bhat, J. A. (2021). Impact of exchange rate changes on the trade balance of India: An asymmetric nonlinear cointegration approach. *Foreign Trade Review*, 56(1), 71–88.
- Bhattacharyya, K., & Deb, K. (2024). Comparative analysis of the portfolio-balance models of exchange rate determination. *Foreign Trade Review*. Advance online publication.
- Bhatty, K. A., Laurinavicius, A., Laurinavicius, A., Chang, B. H., Alzoubi, H. M., & Channa, W. A. (2025). Impact of oil prices on Islamic stock prices: Evidence from Pakistan using bootstrap ARDL approach. *Advances in Decision Sciences*, 29(2), 1–35.
- Bodenstein, M., Cuba-Borda, P., Gornemann, N., & Presno, I. (2024). *Exchange rate disconnect and the trade balance* (International Finance Discussion Paper No. 1391). Board of Governors of the Federal Reserve System.
- Cakmakli, B. M. (2025). Inflation, exchange rate and foreign trade: Long and short run relationships in the Turkish economy. *In Traders International Trade Academic Journal*, 8(1), 1–19.
- Chang, B. H., Alzoubi, H. M., Salman, A., Chang, A. G., Uddin, M. A., & Khan, J. A. (2024). The nexus between energy demand and currency valuation: Evidence from selected OECD countries. *Annals of Financial Economics*, 19(1), 2450002.
- Chang, B. H., Auxilia, P. M., Kalra, A., Wong, W. K., & Uddin, M. A. (2023). Greenhouse gas emissions and the rising effects of renewable energy consumption and climate risk development finance: Evidence from BRICS countries. *Annals of Financial Economics*, 18(3), 2350007.
- Chang, B. H., Rajput, S. K. O., & Ghumro, N. H. (2018). Asymmetric impact of exchange rate changes on the trade balance: Does global financial crisis matter? *Annals of Financial Economics*, 13(4), 1850015.
- Chanthamath, P., & Chanthavone, T. (2024). The impact of real exchange rate and gross domestic product on trade balance of Lao-Thailand. *Souphanouvong University Journal of Multidisciplinary Research and Development*, 10(3), 85–94.
- Cheng, Y., Hui, Y., Liu, S., & Wong, W. K. (2022). Could significant regression be treated as insignificant: An anomaly in statistics? *Communications in Statistics: Case Studies, Data Analysis and Applications*, 8(1), 133–151.
- Cheng, Y., Hui, Y., McAleer, M., & Wong, W. K. (2021). Spurious relationships for nearly non-stationary series. *Journal of Risk and Financial Management*, 14(8), 366.
- Choi, M. S., Sung, B., & Song, W. Y. (2019). The effects of the exchange rate on value-added international trade to enhance free trade sustainability in GVCs. *Sustainability*, 11(10), 2740.
- De Campos, M. A., Oreiro, J. L., & Da Silva, K. M. (2024). The impact of trade liberalisation and exchange rate undervaluation on exports, imports, and trade balance of Latin American countries (1970–2019). *Revista Economia e Politicas Publicas*, 12(1), 26–47.

- Djamal, D., Yassine, M., & Soufyane, B. (2022). The impact of the exchange rate on balance of payments in Algeria: An ARDL model approach. *Economic Themes*, 60(1), 95–117.
- Doojav, G. O. (2018). The effect of real exchange rate on trade balance in a resource-rich economy: The case of Mongolia. *Foreign Trade Review*, 53(4), 211–224.
- Edgeworth, F. Y. (1888). On a new method of reducing observations relating to several quantities. *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science*, 25(154), 184–191.
- Fan, L., Chang, B. H., & Kim, E. (2025). Green total factor productivity and its nonlinear relationship with coordinated FDI development: Evidence from panel models. *Natural Resource Modeling*, 38(1), e12418.
- Felipe, J., Perez-Montiel, J. A., & Ozcelebi, O. (2025). Do changes in the real exchange rate affect the trade balance? Evidence from European countries. *Open Economies Review*. Advance online publication.
- Galton, F. (1886). Regression towards mediocrity in hereditary stature. *The Journal of the Anthropological Institute of Great Britain and Ireland*, 15, 246–263.
- Gkatsikos, A., & Mattas, K. (2021). The paradox of the virtual water trade balance in the Mediterranean region. *Sustainability*, 13(5), 2978.
- Gnangnon, S. K. (2020). *Aid for trade and real exchange rate in recipient-countries* [Working paper].
- Gohar, R., Bhatti, K., Osman, M., Wong, W. K., & Chang, B. H. (2022). Oil prices and sectorial stock indices of Pakistan: Empirical evidence using bootstrap ARDL model. *Advances in Decision Sciences*, 26(4), 1–27.
- Gohar, R., Chang, B. H., Uche, E., Uddin, M. A., & Kalra, A. (2023). Nexus between energy consumption, climate risk development finance and GHG emissions. *International Journal of Financial Engineering*, 10(3), 2350025.
- Gong, X., Chang, B. H., Chen, X., & Zhong, K. (2023). Asymmetric effects of exchange rates on energy demand in E7 countries: New evidence from multiple thresholds nonlinear ARDL model. *Romanian Journal of Economic Forecasting*, 26(2), 125–143.
- Gopinath, G. (2015). *The international price system* (NBER Working Paper No. 21646). National Bureau of Economic Research.
- Gopinath, G., Boz, E., Casas, C., Diez, F. J., Gourinchas, P. O., & Plagborg-Moller, M. (2020). Dominant currency paradigm. *American Economic Review*, 110(3), 677–719.
- Haansende, C. (2020). *Analysing the exchange rate volatility relative to trade balance: The case of SACU countries* [Doctoral dissertation, University of Namibia].
- Harvey, H. (2022). Revisiting New Zealand trade balance and exchange rate: Evidence from asymmetry analysis. *International Journal of Business & Economics*, 7(1), 114–127.
- Hashmi, S. M., Chang, B. H., Huang, L., & Uche, E. (2022). Revisiting the relationship between oil prices, exchange rate, and stock prices: An application of quantile ARDL model. *Resources Policy*, 75, 102543.
- Hirschhofer, H. (2019). Would gradual de-dollarization and more financing in local currencies boost trade? *Global Policy*, 10(3), 435–439.

- Hui, Y., Wong, W. K., Bai, Z., & Zhu, Z. Z. (2017). A new nonlinearity test to circumvent the limitation of Volterra expansion with application. *Journal of the Korean Statistical Society*, 46, 365–374.
- Imane, E., Chang, B. H., Elsherazy, T. A., Wong, W. K., & Uddin, M. A. (2023). The external exchange rate volatility influence on the trade flows: Evidence from nonlinear ARDL model. *Advances in Decision Sciences*, 27(2), 75–98.
- International Monetary Fund. (2024). *Currency composition of official foreign exchange reserves (COFER)* [Data set]. International Monetary Fund. <https://data.imf.org>
- Iossifov, P. K., & Fei, X. (2019). *Real effective exchange rate and trade balance adjustment: The case of Turkey*. International Monetary Fund.
- Jadoon, A. U., & Guang, Y. (2019). The effect of exchange rate fluctuations on trade balance of Pakistan. *International Journal of Economic Sciences*, 8(1), 68–80.
- Jin, X., Chang, B. H., Han, C., & Uddin, M. A. (2025). The tail connectedness among conventional, religious, and sustainable investments: An empirical evidence from neural network quantile regression approach. *International Journal of Finance & Economics*, 30(2), 1124–1142.
- Kallianiotis, I. (2022). Trade balance and exchange rate: The J-curve. *Journal of Applied Finance & Banking*, 12(2), 41–64.
- Khan, A., Khan, M. A., & Salman, A. (2019). Is exchange rate effect trade balance in Pakistan? Evidence based on J-curve. *International Journal of Economic Sciences*, 8(2), 60–79.
- Kim, M. J., & Le, T. T. H. (2024). Influence analysis of real exchange rate fluctuations on trade balance data using feature important evaluation methods. *Information*, 15(3), 156.
- Koenker, R. (2000). Galton, Edgeworth, Frisch, and prospects for quantile regression in econometrics. *Journal of Econometrics*, 95(2), 347–374.
- Koenker, R., & Bassett, G., Jr. (1978). Regression quantiles. *Econometrica*, 46(1), 33–50.
- Kolcu, F., & Yamak, R. (2022). The asymmetric effect of exchange rate on deposit dollarization. *Izmir Iktisat Dergisi*, 37(2), 481–500.
- Lerner, A. P. (1944). *The economics of control*. Macmillan.
- Li, M., & Koh, E. (2024). A study on the exchange rate linkage between Korea and China following the reform of the yuan exchange rate system. *Journal of Korea Trade*, 28(2), 103–128.
- Li, Y. (2025). Financial cycle dependence of monetary and exchange rate policies in an open economy. *HighTech and Innovation Journal*, 6(4), 1264–1281.
- Lin, H., Sun, Q., & Chen, S. Q. (2020). Reducing exchange rate risks in international trade: A hybrid forecasting approach of CEEMDAN and multilayer LSTM. *Sustainability*, 12(6), 2451.
- Lulu, L. L. (2025). The influence of exchange rate unpredictability and trade balance on Tanzania's economic performance. *The Accountancy and Business Review*, 17(1).
- Luo, Q., Zhang, D., & Wang, H. (2023). Digital economy, industrial structure, and regional trade dependence: Mechanism analysis based on Chinese city data. *Sustainability*, 15(17), 13055.
- Magee, S. P. (1973). Currency contracts, pass-through, and devaluation. *Brookings Papers on Economic Activity*, 1973(1), 303–325.

- Mallick, L., Behera, S. R., & Bhattacharya, M. (2024). Impact of exchange rate on trade balance of India: Evidence from threshold cointegration with asymmetric error correction approach. *Foreign Trade Review*, 59(2), 279–308.
- Mansour, M. A. H., & Aldawsari, S. H. (2026). Quantifying the spillover effect of U.S. trade policy uncertainty on economic growth of BRICS: A panel data investigation. *Advances in Decision Sciences*, 30(1), 72–102.
- Marshall, A. (2024). Money, credit and commerce. In *Business cycle theory, Part I* (Vol. 1, pp. 227–258). Routledge. (Original work published 1923)
- Maydybura, A., Gohar, R., Salman, A., Wong, W. K., & Chang, B. H. (2023). The asymmetric effect of the extreme changes in the economic policy uncertainty on the exchange rates: Evidence from emerging seven countries. *Annals of Financial Economics*, 18(2), 2250031.
- Meade, J. E. (1951). *The theory of international economic policy* (Vol. 2). Oxford University Press.
- Mei, L., Chang, B. H., Gong, X., & Anwar, A. (2024). Rising energy demand in emerging countries and the effect of exchange rates: An application of the QARDL model. *Energy Efficiency*, 17(1), 3.
- Mike, F., Ozayturk, G., & Kizilkaya, O. (2022). The relationship between exchange rate and foreign trade balance in the Turkish economy: New findings from the Fourier cointegration test. *Sosyoekonomi*, 30(52), 313–331.
- Mosharrafa, R. A. (2024). Navigating the tides of de-dollarization. *World Review of Political Economy*, 15(4), 566–581.
- Nanovsky, S. (2022). Oil prices, exchange rates, and the trade balance: Evidence from Kazakhstan and Russia. *Global Economy Journal*, 22(4), 2350014.
- Ng, P., Wong, W. K., & Xiao, Z. (2017). Stochastic dominance via quantile regression with applications to investigate arbitrage opportunity and market efficiency. *European Journal of Operational Research*, 261(2), 666–678.
- Nusair, S. A. (2017). The J-curve phenomenon in European transition economies: A nonlinear ARDL approach. *International Review of Applied Economics*, 31(1), 1–27.
- Olayungbo, D. O. (2019). Effects of global oil price on exchange rate, trade balance, and reserves in Nigeria: A frequency domain causality approach. *Journal of Risk and Financial Management*, 12(1), 43.
- Osinusi, K. B., Lawal, N. A., & Bisiriyu, S. O. (2022). Trade balance, exchange rate and money supply in Nigeria: Growth implications and lesson for African countries. *Management & Economics Research Journal*, 4(2), 25–44.
- Oyadeyi, O. O. (2024). The macroeconomic determinants of exchange rate volatility and the impact of currency volatility on the performance of the Nigerian economy. *Foreign Trade Review*. Advance online publication.
- Peng, B., Chang, B. H., Yang, L., & Zhu, C. (2022). Exchange rate and energy demand in G7 countries: Fresh insights from quantile ARDL model. *Energy Strategy Reviews*, 44, 100986.
- Percival, D. B., & Walden, A. T. (2000). *Wavelet methods for time series analysis*. Cambridge University Press.

- Ponsot, J. F., & Rizkallah, S. (2025). Sustainability of dollarization in Lebanon. *La Revue Internationale des Economistes de Langue Francaise*, 10(1), 175–198.
- Privara, A., Gohar, R., Alzoubi, H. M., Kalra, A., Uddin, M. A., & Chang, B. H. (2025). Exploring exchange rate sensitivity to crude oil futures: A study of selected global economies. *International Economics and Economic Policy*, 22(1), 5.
- Ramsey, J. B., & Lampart, C. (1998a). The decomposition of economic relationships by time scale using wavelets: Expenditure and income. *Studies in Nonlinear Dynamics and Econometrics*, 3(1), 23–42.
- Ramsey, J. B., & Lampart, C. (1998b). Decomposition of economic relationships by timescale using wavelets. *Macroeconomic Dynamics*, 2(1), 49–71.
- Ramzan, M., Adebayo, T. S., Iqbal, H. A., Razi, U., & Wong, W. K. (2023). Analyzing the nexus between financial risk and economic risk in India: Evidence through the lens of wavelet coherence and non-parametric approaches. *Heliyon*, 9(3), e14180.
- Raza, S. A., Sharif, A., Wong, W. K., & Karim, M. Z. A. (2017). Tourism development and environmental degradation in the United States: Evidence from wavelet-based analysis. *Current Issues in Tourism*, 20(16), 1768–1790.
- Ren, P., & Sakouba, I. (2024). Exchange rate movements and China-East Africa trade balance: A new perspective from RMB. *SAGE Open*, 14(1), 21582440241230805.
- Sambo, N. U., Farouq, I. S., & Isma'il, M. T. (2021). Asymmetric effect of exchange rate volatility on trade balance in Nigeria. *National Accounting Review*, 3(3), 342–359.
- Santana, B. M., & Oreiro, J. L. (2018). Real exchange rate and structural change in a Kaldorian balance of payments constrained growth model. *Brazilian Journal of Political Economy*, 38(1), 48–69.
- Silva, G. J. C. D., & Braz, D. D. (2019). *Commodity prices and exchange rate in export-led growth model: An analysis of bilateral trade between Brazil and China* [Working paper].
- Sim, N., & Zhou, H. (2015). Oil prices, US stock return, and the dependence between their quantiles. *Journal of Banking & Finance*, 55, 1–8.
- Sunde, T. (2025). Impact of trade openness and exchange rate volatility on South Africa's industrial growth: Assessment using ARDL and SVAR models. *Sustainability*, 17(11), 4933.
- Syamad, S. (2025). Exchange rate and trade balance of East Java Province: J-curve evidence and ARDL approach. *East Java Economic Journal*, 9(2), 237–258.
- Uddin, M. A., Chang, B. H., Aldawsari, S. H., & Li, R. (2025). The interplay between green finance, policy uncertainty and carbon market volatility: A time frequency approach. *Sustainability*, 17(3), 1198.
- Vongmileuth, C., Yeniley, U., Auxilia, P. M., Ahmed, H. M. S., Wong, W. K., & Chang, B. H. (2025). Wavelet coherency analysis of stock market volatility and housing costs: Insights from international financial hubs. *Annals of Financial Economics*, 20(1), 2550012.
- Wang, X. (2025). The dual impact of exchange rate fluctuations on trade balance and global value chains: An empirical analysis from short-term and long-term perspectives. *Advances in Economics, Management and Political Sciences*, 152(1), 182–187.

- Wang, X., Chang, B. H., Uche, E., & Zhao, Q. (2024). The asymmetric effect of income and price changes on the consumption expenditures: Evidence from G7 countries using nonlinear bounds testing approach. *Portuguese Economic Journal*, 23(1), 35–53.
- Wang, Y. (2023). Asymmetric long-run effect of exchange rate on bilateral trade balance between USA and China. *Journal of Chinese Economic and Foreign Trade Studies*, 16(2), 85–98.
- Wong, W. K., Cheng, Y., & Yue, M. (2024). Could regression of stationary series be spurious? *Asia-Pacific Journal of Operational Research*, 41(2), 2440017.
- Wong, W. K., & Pham, M. T. (2022a). Could the test from the standard regression model make significant regression with autoregressive noise become insignificant? *The International Journal of Finance*, 34, 1–18.
- Wong, W. K., & Pham, M. T. (2022b). Could the test from the standard regression model make significant regression with autoregressive noise become insignificant - A note. *The International Journal of Finance*, 34, 19–39.
- Wong, W. K., & Pham, M. T. (2023a). Could the test from the standard regression model make significant regression with autoregressive Y_t and X_t become insignificant? *The International Journal of Finance*, 35, 1–19.
- Wong, W. K., & Pham, M. T. (2023b). Could the test from the standard regression model make significant regression with autoregressive Y_t and X_t become insignificant - A note. *The International Journal of Finance*, 35, 20–41.
- Wong, W. K., & Pham, M. T. (2025a). Could the correlation of a stationary series with a non-stationary series obtain meaningful outcomes? *Annals of Financial Economics*. Advance online publication.
- Wong, W. K., & Pham, M. T. (2025b). How to model a simple stationary series with a non-stationary series? *The International Journal of Finance*, 37, 1–19.
- Wong, W. K., & Pham, M. T. (2026a). Could the panel regression be used to examine the relationship between $I(0)$ and $I(1)$ series? *Advances in Decision Sciences*, 30(2). Advance online publication.
- Wong, W. K., & Pham, M. T. (2026b). Could we use correlation to examine panel data with $I(0)$ and $I(1)$ variables? *The International Journal of Finance*, 38. Advance online publication.
- Wong, W. K., Pham, M. T., & Yue, M. (2024). Could regressing a stationary series on a non-stationary series obtain meaningful outcomes - A remedy. *The International Journal of Finance*, 36, 1–20.
- Wong, W. K., & Yue, M. (2024). Could regressing a stationary series on a non-stationary series obtain meaningful outcomes? *Annals of Financial Economics*, 19(3), 2450011.
- Woode, J. K., Ayamba, S. B., Adjei, A. F., Musah, F., & Bambir, J. (2025). Conditional dependence between non-ferrous metals and global uncertainties: Insight from the nickel crash. *Annals of Financial Economics*, 20(3), 2550019.
- Wu, M. L. (2020). An empirical time series econometric study of the J-curve effect of exchange rate in trade balance between China and the US. *Journal of Economics, Management and Trade*, 26(6), 35–46.
- Xie, Y., & Song, C. (2020). The role of processing trade in exporters' responses to exchange rate: Evidence from China. *The World Economy*, 43(6), 1521–1543.

- Xing, L., Chang, B. H., & Aldawsari, S. H. (2024). Green finance mechanisms for sustainable development: Evidence from panel data. *Sustainability*, 16(22), 9762.
- Yang, Z., Wang, M. C., Chang, T., Wong, W. K., & Li, F. (2022). Which factors determine CO2 emissions in China? Trade openness, financial development, coal consumption, economic growth or urbanization: Quantile Granger causality test. *Energies*, 15(7), 2450.
- Yaya, K. E. H. (2021). Asymmetric effects of real exchange rate on trade balance in Cote d'Ivoire: Evidence from nonlinear ARDL approach. *Applied Economics and Finance*, 8(3), 9–21.
- Yin, J., Chen, H., & Zhou, Y. (2025). The impact of the digital economy on the resilience of China's foreign trade. *Sustainability*, 17(24), 11008.
- Zada, H., Mansoor, A., Khan, N., Wong, W. K., & Jibir, A. (2026). Monetary policy uncertainty and stock market returns in developed and emerging countries: Evidence from a quantile-on-quantile approach. *Advances in Decision Sciences*, 30(3), 89–113.
- Zeng, W., & Johnson, W. (2023). Low exchange rate pass-through in the United States, economy-wide and in agriculture. *International Trade and Trade Policy*, 9(2), 22–37.
- Zhang, Q., Wu, K. J., & Tseng, M. L. (2019). Exploring carry trade and exchange rate toward sustainable financial resources: An application of the artificial intelligence UKF method. *Sustainability*, 11(12), 3240.
- Zuniga-Gonzalez, C. A., Quiroga-Canaviri, J. L., Brambila-Paz, J. J., Ceballos-Perez, S. G., & Rojas-Rojas, M. M. (2024). Formulation of an innovative model for the bioeconomy. *PLoS ONE*, 19(11), e0309358.