

Trade Interdependence in Flux: Network-Based Evidence of ASEAN's Post-Pandemic Regional Reorientation

Nobuo YAZAWA

Abstract

The COVID-19 pandemic posed a severe test to global trade networks, raising critical questions about the resilience and adaptability of regional economic blocs such as ASEAN. This study investigates whether ASEAN countries reinforced intra-regional trade ties or reoriented toward extra-regional partners during the post-pandemic recovery (2020–2022). Employing a network-based framework, we introduce a novel **Outer/Inner trade orientation ratio** that compares each country's average bilateral trade interdependence with key Asia-Pacific partners (China, the U.S., Japan, South Korea, India) versus intra-ASEAN partners. Unlike prior studies that rely on aggregate trade volumes or centrality indices, our analysis emphasizes interdependence at the **link level**, capturing both **reciprocity** and **dependence** in trade relationships.

Results reveal a marked divergence in trade orientation among ASEAN members: Singapore and Vietnam became increasingly outward-looking, the Philippines remained inward-focused, and other members exhibited transitional or balanced patterns. A historical comparison with the 2015 Chinese currency devaluation shows that COVID-19 induced a sharper and more asymmetric restructuring of ASEAN trade linkages. These findings offer a high-resolution understanding of regional trade resilience and suggest that shocks such as COVID-19 do not generate uniform responses but rather reinforce structural heterogeneity. The Outer/Inner trade orientation ratio provides policymakers with a diagnostic tool to assess trade exposure, diversification, and resilience in crafting post-pandemic trade strategies.

1. Introduction

This paper examines how trade interdependence among six major ASEAN countries—Singapore, Vietnam, Indonesia, Malaysia, Thailand, and the Philippines—responded to two major external shocks: the COVID-19 pandemic and China's 2015 currency devaluation. By comparing a global health crisis with a regionally concentrated financial disturbance, the study sheds light on the resilience, flexibility, and asymmetries within ASEAN's trade architecture.

As one of the world's most dynamic economic blocs, ASEAN includes countries with varying levels of trade openness and integration into global value chains. Together, they play a central role in Asia-Pacific supply networks, particularly in sectors like electronics and consumer goods. Systemic disruptions such as COVID-19 offer a revealing test of ASEAN's internal cohesion and external vulnerabilities.

The pandemic, beginning in early 2020, caused unprecedented disruptions in global trade. For ASEAN, this tested both intra-regional links and ties with external partners such as China, Japan, South Korea, the United States, and India. Some countries reinforced regional ties, while others deepened external engagement. Yet most existing research focuses on aggregate trade volumes or sectoral trends, leaving the structural dynamics of bilateral interdependence largely unexamined. To address this gap, we employ a network-based framework that emphasizes bilateral trade interdependence—defined by reciprocity and dependence—at the link level. We introduce a novel indicator, the *Outer/Inner trade orientation ratio*, which compares a country’s average trade interdependence with five major Asia-Pacific partners (Outer) against that with its ASEAN neighbors (Inner). A ratio above 1.0 indicates outward orientation, while below 1.0 suggests stronger intra-regional ties.

We use China’s 2015 yuan devaluation as a historical reference point. Although the immediate impacts were modest, the years following saw gradual shifts in trade interdependence. Comparing this event with the COVID-19 shock allows us to determine whether ASEAN’s recent adjustments reflect exceptional turbulence or ongoing structural change.

Contrasting a localized financial shock with a global pandemic highlights different mechanisms of disruption. The former involved monetary policy shifts, while the latter triggered public health responses, border closures, and fiscal interventions across nations. This comparison helps identify features of ASEAN’s trade structure—such as asymmetry or resilience—that influence how different members adapt to crises.

This study contributes to broader discussions on globalization, regionalism, and trade resilience. As digital trade, nearshoring, and supply-chain shifts gain momentum, ASEAN’s evolving trade patterns take on greater strategic significance. The Outer/Inner ratio offers a diagnostic tool to help policymakers assess exposure and craft more resilient trade strategies.

We pursue three central research questions:

1. How did ASEAN countries’ trade interdependence evolve during the COVID-19 recovery (2020–2022)?
2. How do these post-COVID shifts compare with the dynamics following the 2015 devaluation?
3. What do these patterns reveal about ASEAN’s trade resilience and structural adaptability?

To answer these, we analyze bilateral trade data from 2000 to 2022 using our interdependence metric and Outer/Inner orientation ratio. Findings show clear divergence in post-pandemic trade strategies: Singapore and Vietnam became more outward-oriented, while the Philippines maintained an inward focus. The contrast with the 2015 event underscores the more intense and asymmetric effects of the pandemic—particularly an increased dependence on China.

The rest of the paper is structured as follows: Section 2 reviews relevant literature; Section 3 details the methodology; Section 4 presents empirical findings; Section 5 outlines limitations; and Section 6 concludes with policy implications and directions for future research.

2. Literature Review

ASEAN economies have long displayed deep trade interdependence, shaped by production sharing and complex supply-chain linkages with both intra-regional and Asia-Pacific partners. Before the COVID-19 pandemic, intra-ASEAN trade made up roughly 20–25% of the bloc’s total trade (UOB, 2023), indicating growing but incomplete regional integration. Traditional assessments of ASEAN integration often focus on macroeconomic indicators or institutional frameworks (Capannelli et al., 2009).

The COVID-19 pandemic caused a sharp contraction in ASEAN merchandise trade—around 12% in 2020 (ASEAN, 2020; Shingal, 2022)—but trade ties with China and the U.S. rebounded quickly (ERIA, 2021; Petri & Plummer, 2020). This asymmetric recovery raised concerns about ASEAN’s overdependence on a few external partners. Recent studies (Hayakawa & Mukunoki, 2021; Vidya, 2022) emphasized China’s resilient role in global value chains, accelerating ASEAN’s tilt toward its northern neighbor.

Network analysis has become an increasingly popular method for analyzing trade interdependence (Newman, 2010). Early studies (Serrano & Boguñá, 2003; Fagiolo et al., 2010) established that world trade networks display scale-free, hierarchical features. Garlaschelli and Loffredo (2004), and later Squartini et al. (2013), examined trade reciprocity in directed and weighted networks. More recent work highlights mesoscale structures and clustering (Chen & De Lombaerde, 2023), and Opsahl et al. (2010) extended centrality metrics for weighted networks.

However, few studies explore link-level trade interdependence or analyze bilateral responses to shocks. Most focus on macro indicators, centrality, or aggregate volumes, missing nuanced patterns of mutual dependence. Our research addresses this gap using two new metrics: a composite interdependence index (capturing reciprocity \times dependence) and the Outer/Inner trade orientation ratio (measuring average interdependence with extra- vs. intra-regional partners).

Table 1 contrasts key prior studies with this paper’s approach. For instance, Garlaschelli et al. (2004) measured binary trade reciprocity, while Maluck and Donner (2015) used MRIO tables and Hamming distance to identify structural shifts during crises. Our link-level method captures asymmetries and reorientation more precisely. Yazawa and Nam (2024) used a similar

interdependence index for Asia-Pacific countries, showing how crises caused long-term shifts—particularly the displacement of Japan by China as a key trade hub. We extend their framework to ASEAN and offer comparative analysis across two shocks.

Table 1. Comparative Analysis of Key Prior Studies and This Research

Article	Their Method	Their Key Findings	Our Method	Our Key Findings
Garlaschel li et al. (2004)	Defined reciprocity using binary directed trade networks (adjacency matrix correlation).	Trade reciprocity increased significantly (from 0.68 in 1948 to 0.90 in 2000).	Link-level interdependence combining weighted reciprocity and dependence.	Revealed post-COVID divergence in trade ties.
Maluck & Donner (2015)	Employed multi-region input-output (MRIO) tables with Hamming distance across 186 economies.	Detected structural trade shifts during global crises; observed reciprocity saturation.	Introduced the Outer/Inner trade orientation ratio comparing interdependence with external vs. intra-ASEAN partners.	Identified divergence in trade orientation post-COVID.
Yazawa & Nam (2024)	Developed an interdependence index (reciprocity × dependence) for five Asia-Pacific countries.	Found that crises prompted long-term structural trade shifts; China displaced Japan as sub-hub post-2007.	Applied enhanced interdependence index across ASEAN and Asia-Pacific using updated data.	Confirmed COVID-19 accelerated asymmetric network shifts; reaffirmed China's centrality in ASEAN trade realignment.
Prabheesh & Vidya (2025), Todo et al. (2023)	Used firm-level and node-level network analysis of ASEAN supply chains.	Identified Singapore and Malaysia as resilient core nodes; firm-level diversity enhanced resilience.	Conducted bilateral link-level network analysis using interdependence metrics.	Revealed country-specific reorientations within ASEAN; captured patterns obscured in country-level centrality.
Schoenema n et al. (2024)	Bipartite shock propagation modeling across partners and sectors.	Demonstrated sector-specific susceptibility to shocks; trade resilience varied by link.	Emphasized directional trade intensity shifts using Outer/Inner ratio.	Uncovered ASEAN link-level heterogeneity in shock response, aligning with sector-specific dependencies.
Kiyota (2022)	Analyzed post-COVID trade data using world trade network metrics.	Found underlying trade network structure remained stable despite flow disruptions.	Interpreted network stability alongside orientation shifts.	Suggested that macro-stability coexisted with micro-level bilateral divergence in ASEAN.

Recent firm- and node-level studies also offer insight. Prabheesh and Vidya (2025) and Todo et al. (2023) found that countries like Singapore and Malaysia acted as resilient nodes during COVID-19, with diverse trade links supporting recovery. Bipartite models by Schoeneman et al. (2024) revealed how trade volatility and shock propagation differ across sectors and partners. Kiyota (2022), using global trade network metrics, found that structural properties remained stable despite disruptions—suggesting micro-level divergence beneath macro-level continuity. While these contributions are valuable, most focus on one type of shock, aggregate indicators, or structural topology. Cross-shock comparisons remain rare, and few use bilateral-level data to examine how individual ASEAN countries reoriented in response to crisis. Earlier work (Yamakage, 1977) emphasized ASEAN’s structural interdependence but lacked the empirical tools to capture evolving bilateral trade dynamics.

Our study contributes by:

Focusing on bilateral interdependence rather than country-level centrality;

Introducing the Outer/Inner ratio to capture directional shifts in trade orientation;

Providing a dual-shock comparison (COVID-19 vs. the 2015 yuan devaluation);

Revealing heterogeneous responses among ASEAN countries during recovery.

In doing so, we offer a higher-resolution view of trade resilience and challenge assumptions of convergence in regional responses. Our findings highlight the diversity of ASEAN’s structural positions and strategic adaptations during global and regional disruptions.

3. Methodology

3.1 Theoretical Framework

This study draws on theories from international political economy, network science, and economic resilience to explain the divergence in trade interdependence among ASEAN countries during the post-COVID recovery. The framework focuses on bilateral trade dynamics and combines four key perspectives.

3.1.1 Trade Interdependence and Orientation

Interdependence refers to the mutual reliance between countries in trade, with implications for both cooperation and vulnerability (Hirschman, 1945; Keohane & Nye, 1977). We define bilateral interdependence as the product of two components:

Reciprocity, which captures the balance of trade flows between partners;

Dependence, which captures the concentration of a country’s trade in a specific partner.

This link-level approach moves beyond aggregate trade volume and highlights structural asymmetries. To evaluate trade directionality, we introduce the Outer/Inner trade orientation ratio, comparing a country's average interdependence with five Asia-Pacific partners (China, the U.S., Japan, South Korea, India) to that with six ASEAN neighbors. A ratio above 1 indicates outward orientation; below 1 indicates intra-regional embeddedness.

3.1.2 Regionalism, Globalization, and Trade Strategy

ASEAN countries have historically balanced regional integration with global trade expansion—a dynamic shaped by external shocks. The theory of open regionalism (Baldwin, 1997) suggests that regional blocs can simultaneously deepen internal ties and engage global partners. The “second unbundling” (Baldwin, 2013) highlights that countries deeply embedded in global value chains (GVCs) are more exposed to external disruptions and may pivot outward to restore demand after a shock. Others may turn inward, relying on more stable regional ties. Thus, trade orientation is partly shaped by a country's structural position and its degree of GVC integration.

3.1.3 Shock-Response in Trade Networks

From a network theory perspective (Barabási, 2002), trade systems are complex, featuring uneven connectivity and vulnerability to cascading disruptions. Shocks like the COVID-19 pandemic serve as stress tests, revealing the fragility or adaptability of bilateral and regional trade structures. Countries with diversified and reciprocal ties can adjust more flexibly, while those with concentrated or asymmetric ties may face greater constraints.

3.1.4 Resilience Through Diversification vs. Embeddedness

The literature on regional resilience (Martin & Sunley, 2015) outlines two paths:

Diversification resilience, where countries spread risk by cultivating a broad set of trade partners;

Embeddedness resilience, where countries rely on dense regional ties for stability during global shocks.

The Outer/Inner trade orientation ratio operationalizes these ideas. A rising ratio signals diversification, while a falling or stable ratio suggests regional embeddedness. These shifts are not random but reflect strategic adaptation to the changing global environment.

3.1.5 Synthesis

In sum, this framework:

Defines bilateral interdependence using reciprocity and dependence;

Views trade orientation as a strategic response to shocks and structural positioning;

Applies network sensitivity to explain divergent national paths;

Uses the Outer/Inner ratio as a dynamic indicator of trade reorientation.

This approach provides the conceptual foundation for our empirical analysis of ASEAN’s trade response to external shocks.

3.2 Definition of Interdependence

Trade relationships among multiple countries are best understood through a network perspective. Our approach seeks to identify the network-based metrics that most accurately represent **interdependence** among ASEAN and Asia-Pacific economies. Recent studies of weighted networks (including international trade networks and even the World Wide Web) have explored concepts of **reciprocity** and **dependence** in connectivity (De Lombaerde et al., 2018; Squartini et al., 2013; Ruzzenenti et al., 2010; Garlaschelli & Loffredo, 2004). Based on insights from this literature, we focus on interdependence as a composite concept encompassing both **reciprocity** (the balance of mutual trade flows) and **dependence** (the exclusivity or concentration of bilateral ties). Our definitions of these components partly differ from those in Squartini et al. (2013), as described below.

3.2.1 Reciprocity

Suppose there are n actors: A_1, A_2, \dots, A_n . When there is a link from A_1 to A_2 and a link from A_2 to A_1 , and both links have the same flow quantity, we say the relationship between A_1 and A_2 is perfectly reciprocal (Figure 1(a)). On the other hand, if the link from A_1 to A_2 has a large flow quantity while the link from A_2 to A_1 has a small flow quantity, we say the relationship between A_1 and A_2 has low reciprocity (Figure 1(b)).

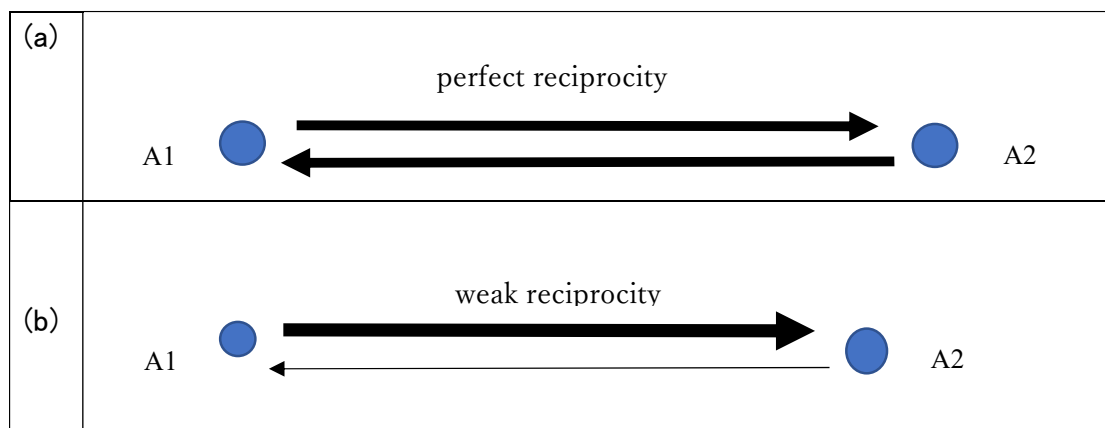


Figure.1 Illustration of two types of reciprocity between two actors in a trade network:(a) Perfect reciprocity, where trade flows are equal between actors;(b) Weak reciprocity, characterized by a significant difference in trade flows (Source: Adapted from Yazawa, 2023.)

We will quantify the strength of the link and let it have positive real number a . Let the flow quantity of the link from A_1 to A_2 be $F(1,2)$, and from A_2 to A_1 be $F(2,1)$. Then we quantify the

degree of reciprocity between A1 and A2 as $R(1,2)$ in the following way.

In this subsection, we regard directed links as output flows from actors. In equation (1), $X(1,2, t_0)$ represents the proportion of output flow from A1 to A2 in the total output flow from A1 at the time t_0 .

$$X(1,2, t_0) = \frac{F(1,2,t_0)}{\sum_{i=2}^n F(1,i,t_0)} \quad (1)$$

$T(t_1)$ is defined in equation (2)

$$T(t_1) \equiv \sum_{i=1}^n \sum_{k \neq i} F(i, k, t_1) \quad (2)$$

In general, $X(i, j, t_1)$ is formulated as below (equation (3)).

$$X(i, j, t_1) \equiv \frac{F(i,j,t_1)}{\sum_{k \neq i} F(i,k,t_1)} \quad (3)$$

In equation (3), $X(i, j, t_1)$ represents the proportion of output flow from A_i to A_j in the total output flow from A_i at the time $t = t_1$. Next, we define the reciprocity index (R) between A1 and A2 in the following way.

$$R(1,2, t_1) = \min (X(1,2, t_1), X(2,1, t_1)) / \max (X(1,2, t_1), X(2,1, t_1))$$

Therefore, in general, $R(i, j)$ is formulated as below (equation (4)).

$$R(i, j, t_1) \equiv \min (X(i, j, t_1), X(j, i, t_1)) / \max (X(i, j, t_1), X(j, i, t_1)) \quad (4)$$

Note that $0 \leq R(i, j, t_1) = R(j, i, t_1) \leq 1$

We define the reciprocity index of a network of n nodes in equation (5).

$$R_{\text{net}(t_1)} \equiv \frac{1}{2} \sum_i \sum_{j, j \neq i} |R(i, j, t_1)| \quad (5)$$

3.2.2 Dependence

When a link from A1 to A2 and a link from A2 to A1 exist, and A1 has only one link directed to others which is to A2, and A2 also has only one link directed to others which is to A1, the dependence between A1 and A2 is maximal. On the other hand, when the link from A1 to A2 is non-existent as well as from A2 to A1, the dependence between A1 and A2 is minimal.

Based on the manner of quantification of reciprocity, which we formulated in 3.1, we quantify the degree of dependence as follows.

From equation (3), we define dependence measure (D) between A_i and A_j as equation (6).

$$D(i, j, t_1) \equiv \min (X(i, j, t_1), X(j, i, t_1)) \quad (6)$$

Note that $0 \leq D(i, j, t_1) \leq 1$ and $D(i, j, t_1) = D(j, i, t_1)$. The larger $D(i, j, t_1)$ is, the stronger the bond between A_i and A_j is. However, $D(i, j, t_1)$ cannot indicate the degree of reciprocity.

We define the dependence index of a network of n elements in equation (7).

$$D_{\text{net}}(t_1) \equiv \frac{1}{2} \sum_i \sum_{j, j \neq i} D(i, j, t_1) \quad (7)$$

3.2.3 Interdependence

In this article, we regard interdependence index as composed of reciprocity measure and dependence measure. Therefore, we define interdependence index between A_i and A_j as equation (8)

$$I(i, j, t_1) \equiv D(i, j, t_1)R(i, j, t_1) \quad (8)$$

Note that $0 \leq I(i, j, t_1) \leq 1$ and $I(i, j, t_1) = I(j, i, t_1)$

We define an interdependence index of a node in a network of n nodes in equation (9).

$$I(i, t_1) = \sum_{j \neq i}^n I(i, j, t_1) \quad (9)$$

We define the interdependence index of a network of n nodes in equation (10).

$$I_{\text{net}}(t_1) \equiv \frac{1}{2} \sum_i \sum_{j \neq i} I(i, j, t_1) \quad (10)$$

In this paper, we apply the three indices, which we defined in chapter 3, to a case of international trade of the US, China, India, Japan, and South Korea, using data from WITS database. We calculate dependence, reciprocity, and interdependence indices of the ten links from 2000 to 2022. Thus, $t_0 = 2000, t_1 = 2001, \dots, t_{22} = 2022$.

3.3. Data and Country Selection

This study uses annual bilateral merchandise trade data from the World Integrated Trade Solution (WITS) database, spanning 2000–2022. The data capture total trade flows between 11 key Asia-Pacific economies: the United States, China, India, Japan, South Korea, and six major ASEAN members—Singapore, Vietnam, Indonesia, Malaysia, Thailand, and the Philippines. These countries were selected for their significant roles in regional trade and to ensure consistent, high-quality data coverage.

Our sample reflects the core ASEAN trade network and its ties with dominant external partners. We excluded smaller ASEAN economies (e.g., Brunei, Cambodia, Laos, Myanmar) due to inconsistent data and their limited influence on regional trade patterns.

While the WITS database provides comprehensive official statistics, it may underrepresent informal or unrecorded trade, which could affect some ASEAN economies. Data quality also varies across countries and years, potentially influencing the precision of our interdependence calculations. As a result, our findings should be interpreted with some caution, particularly regarding the completeness of trade relationships and their sectoral composition.

Despite these limitations, the dataset offers a reliable foundation for assessing structural shifts in trade interdependence across two major shocks: the 2015 Chinese devaluation and the COVID-19 pandemic.

4. Analysis and Results

4.1 Outer/Inner Trade Interdependence Ratios (2020–2022)

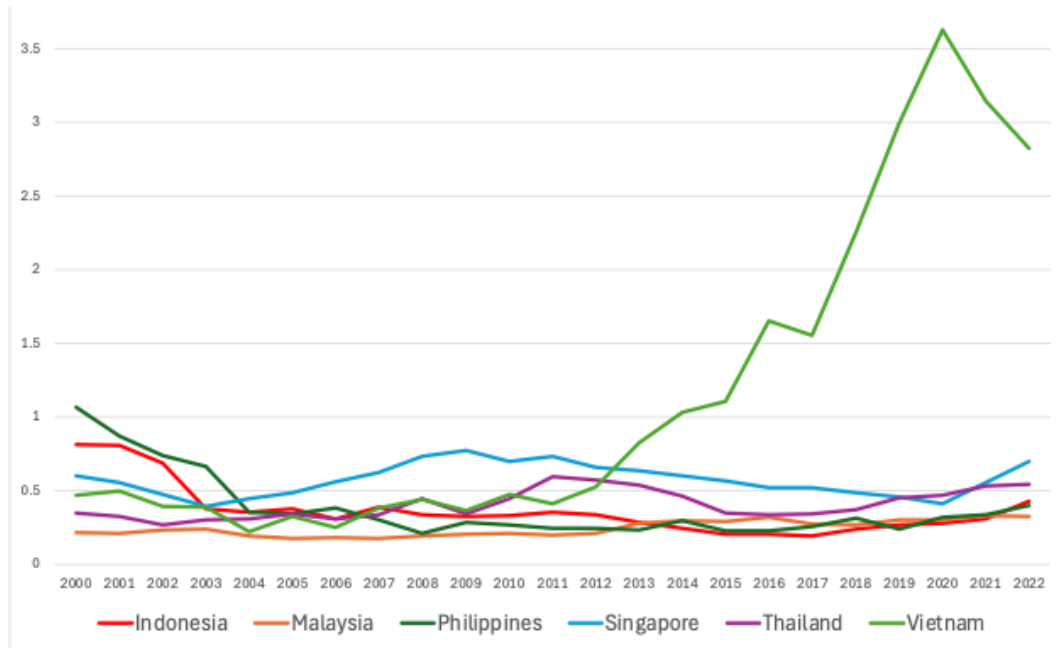


Figure.2 Outer/Inner Trade Interdependence Ratios for ASEAN Countries from 2000 to 2022

This figure presents the annual Outer/Inner trade orientation ratio for six ASEAN countries, comparing each country's average trade interdependence with Asia-Pacific (Outer) versus intra-ASEAN (Inner) partners. The trajectories reveal national differences in external engagement and internal cohesion over time.

Table.2 Outer/Inner Trade Interdependence Ratios for ASEAN Countries from 2000 to 2022

Year	Indones ia	Malaysi a	Philippi nes	Singapo re	Thailan d	Vietna m
2000	0.811	0.216	1.064	0.600	0.347	0.468
2001	0.805	0.208	0.870	0.551	0.324	0.499
2002	0.689	0.233	0.739	0.476	0.267	0.393
2003	0.375	0.241	0.662	0.392	0.301	0.389
2004	0.354	0.191	0.355	0.443	0.305	0.224
2005	0.376	0.176	0.340	0.487	0.341	0.326
2006	0.307	0.180	0.383	0.559	0.304	0.248
2007	0.385	0.178	0.299	0.624	0.338	0.381
2008	0.336	0.191	0.211	0.732	0.446	0.438

2009	0.326	0.205	0.284	0.773	0.341	0.362
2010	0.332	0.208	0.266	0.699	0.446	0.472
2011	0.350	0.200	0.245	0.733	0.593	0.413
2012	0.335	0.207	0.246	0.656	0.572	0.527
2013	0.283	0.278	0.231	0.636	0.535	0.822
2014	0.241	0.293	0.296	0.598	0.464	1.033
2015	0.202	0.288	0.228	0.564	0.346	1.105
2016	0.205	0.318	0.226	0.518	0.334	1.654
2017	0.190	0.271	0.253	0.517	0.339	1.557
2018	0.236	0.266	0.313	0.483	0.370	2.258
2019	0.265	0.300	0.238	0.457	0.453	2.998
2020	0.276	0.299	0.319	0.413	0.471	3.627
2021	0.309	0.329	0.333	0.555	0.529	3.149
2022	0.429	0.324	0.399	0.697	0.542	2.826

A central question of this study is whether ASEAN economies became more externally oriented or more regionally focused in the wake of the COVID-19 shock. To investigate this, we calculate the **Outer/Inner trade interdependence ratio** for each country and track its evolution. **Figure 2** shows the Outer/Inner trade orientation ratio for six ASEAN countries — Singapore, Vietnam, Thailand, Indonesia, Malaysia, and the Philippines — from 2000 through 2022. (A ratio above 1.0 indicates stronger trade interdependence with the five major Asia-Pacific partners than with ASEAN neighbors, whereas a ratio below 1.0 implies a more inward-oriented trade pattern.) The trajectories of these ratios over time reveal clear cross-country differences, especially during the post-2020 recovery.

Overall Trends (2000–2022)

Sharp externalization: Vietnam shows a structural shift from 2014 onward, consistently above 1, peaking at 3.627 in 2020. Its average rose from 0.366 (2000–07) to 2.103 (2013–22).

High and stable: Singapore maintains consistently high ratios (min 0.392, max 0.773), with only minor fluctuations: 0.517 (2000–07) → 0.544 (2013–22).

Gradual rise: Thailand moves up from 0.316 (2000–07) to 0.438 (2013–22).

Low but slightly increasing: Malaysia remains at the low end but shows a mild upward shift (0.203 → 0.297).

Decline then recovery: Indonesia and the Philippines show long-term declines during the 2000s but partial rebounds after 2017.

Country Highlights

Indonesia

2000: 0.811 (peak) → 2017: 0.190 (bottom) → 2022: 0.429.

Average: 0.513 (2000–07) → 0.264 (2013–22).

→ Long-term shift toward intra-regional focus, but recent rebound suggests renewed outward orientation.

Malaysia

Range: 0.176 (2005) – 0.329 (2021).

Average: 0.203 (2000–07) → 0.297 (2013–22).

→ Still the lowest among peers, but gradually leaning more toward external trade dependence.

Philippines

Peak: 1.064 (2000) (>1, strong external dependence).

Bottom: 0.226 (2016).

Average: 0.589 (2000–07) → 0.284 (2013–22).

→ Shift from external to internal orientation, though slight rebound by 2022 (0.399).

Singapore

Range: 0.392 (2003) – 0.773 (2009).

2020 dip (0.413) followed by a recovery to 0.697 (2022).

Average: 0.517 (2000–07) → 0.544 (2013–22).

→ Always high; consistently the most externally oriented economy in ASEAN.

Thailand

Range: 0.267 (2002) – 0.593 (2011).

Average: 0.316 (2000–07) → 0.438 (2013–22).

→ Mid-range values but a clear upward shift, showing stronger external linkages.

Vietnam

2013: 0.822 → >1 from 2014 onward.

Peak: 3.627 (2020), still high in 2022 (2.826).

Average: 0.366 (2000–07) → 2.103 (2013–22).

→ Strong evidence of deep integration into global value chains and a structural dependence on external markets.

2022 Snapshot (High → Low)

Vietnam 2.826 >> Singapore 0.697 > Thailand 0.542 > Indonesia 0.429 > Philippines 0.399 > Malaysia 0.324

Implications

Externally driven: Vietnam, Singapore

Balancers / gradual externalization: Thailand, Malaysia

Intra-regional leaning (but rebounding): Indonesia, Philippines

These findings demonstrate that the post-pandemic period saw a **reordering of trade interdependencies** within ASEAN, rather than a one-size-fits-all shift. The Outer/Inner trade orientation ratio proves useful in quantifying this reorientation, as it encapsulates both changes in trade volume and the balance of trade relationships for each country. We observe that Singapore and Vietnam emerged from the pandemic with a decidedly **outward-looking** trade stance, whereas the Philippines retained an **inward-looking** stance. Other economies fell in between, showing more nuanced adjustments. This diversity in outcomes underscores the importance of country-specific factors in shaping trade strategies following a global shock.

4.2 Long-Term Trends and Shock Comparisons (2000–2022)

Beyond the immediate post-COVID period, it is instructive to examine longer-term trends in ASEAN’s trade interdependence and to compare the impact of the COVID-19 shock with that of the 2015 Chinese devaluation shock. **Figure 3** plots the average interdependence per bilateral link for four groupings of relationships in our dataset: (a) among the five Asia-Pacific major economies (U.S., China, Japan, South Korea, India), (b) among the six ASEAN countries, (c) between ASEAN and the Asia-Pacific economies, and (d) all eleven countries combined. This visualization provides context on how the overall network evolved from 2000 to 2022, including periods of stability and disruption. Correspondingly, **Figure 4** zooms in on the trend of intra-ASEAN interdependence over time, while **Figure 5** focuses on the ASEAN–Asia-Pacific interdependence trend.

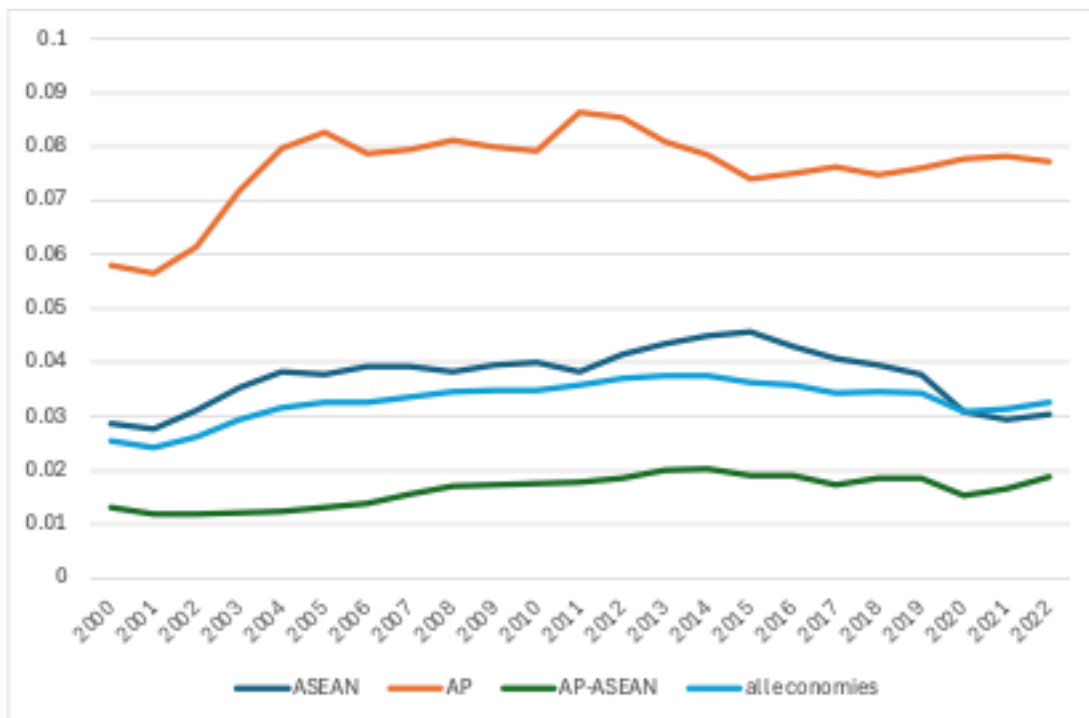


Figure.3 Trend of interdependence per link in Asia-Pacific region, in ASEAN region, between ASEAN and Asia-Pacific, and all areas

This figure shows the average interdependence values per bilateral link within the Asia-Pacific region, within the ASEAN region, between ASEAN and Asia-Pacific countries, and all areas over the period 2000–2022. It highlights how trade interdependence across these four groupings evolved, particularly during and after the COVID-19 pandemic.

Table 3. Intra-ASEAN Interdependence per Link (2000–2022)

This table presents the annual values of bilateral trade interdependence for each ASEAN country, reflecting shifts in internal trade linkages across time.

Year	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam
2000	0.010	0.065	0.008	0.063	0.023	0.003
2001	0.011	0.059	0.008	0.059	0.026	0.004
2002	0.013	0.063	0.009	0.062	0.033	0.007
2003	0.031	0.060	0.009	0.074	0.031	0.008
2004	0.032	0.062	0.014	0.073	0.035	0.014
2005	0.034	0.061	0.010	0.074	0.038	0.010
2006	0.036	0.061	0.010	0.074	0.042	0.013
2007	0.037	0.061	0.012	0.075	0.037	0.013
2008	0.038	0.056	0.014	0.073	0.034	0.015
2009	0.035	0.060	0.011	0.073	0.040	0.018
2010	0.031	0.065	0.015	0.075	0.039	0.014
2011	0.031	0.061	0.015	0.069	0.034	0.019
2012	0.037	0.066	0.015	0.073	0.040	0.018
2013	0.040	0.071	0.014	0.076	0.040	0.018
2014	0.046	0.068	0.016	0.080	0.042	0.017
2015	0.046	0.066	0.019	0.071	0.050	0.021
2016	0.041	0.061	0.021	0.066	0.051	0.018
2017	0.040	0.059	0.019	0.063	0.046	0.017
2018	0.034	0.058	0.020	0.063	0.047	0.015
2019	0.037	0.053	0.019	0.065	0.041	0.011
2020	0.032	0.043	0.013	0.053	0.036	0.008
2021	0.025	0.046	0.015	0.046	0.035	0.008
2022	0.023	0.051	0.014	0.049	0.036	0.009

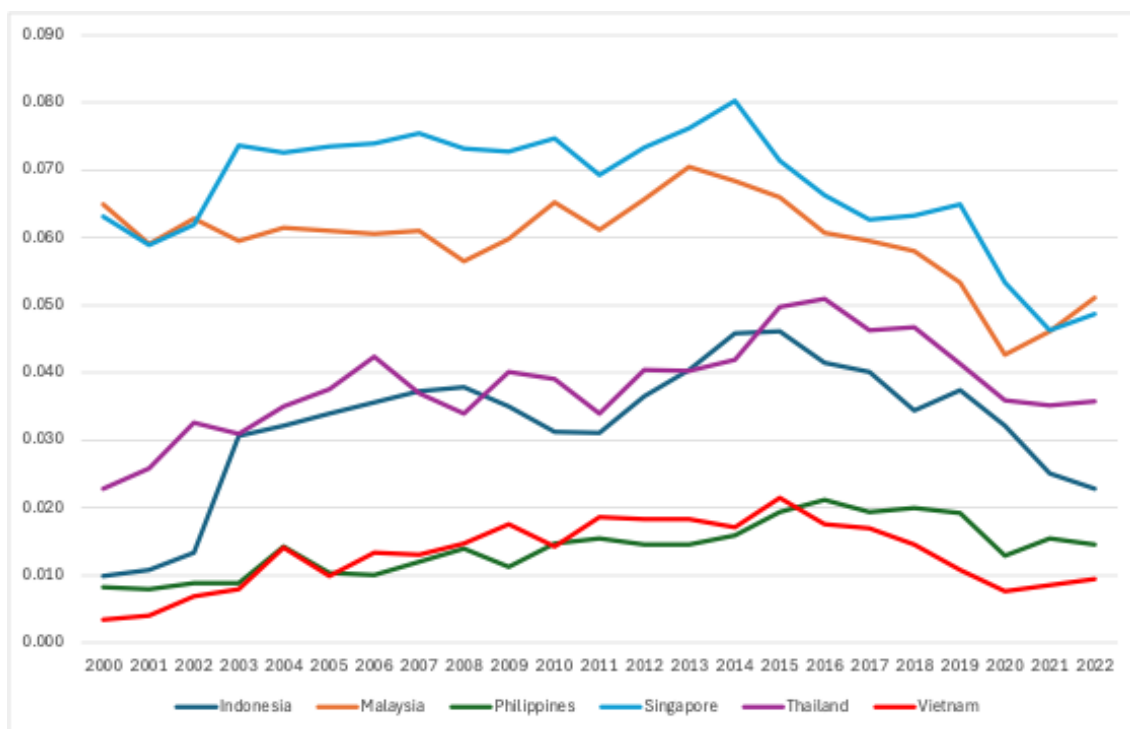


Figure.3 Trend of interdependence per link in ASEAN nations

This figure illustrates how intra-ASEAN bilateral trade interdependence changed over time. The trend reflects regional cohesion and internal connectivity, with particular focus on post-pandemic adjustments.

Table 4. ASEAN–Asia-Pacific Interdependence per Link (2000–2022)

This table provides detailed yearly figures for bilateral interdependence between ASEAN members and their key Asia-Pacific trade partners.

Year	Indonesia	Malaysia	Philippine s	Singapore	Thailand	Vietnam
2000	0.008	0.014	0.009	0.038	0.008	0.002
2001	0.009	0.012	0.007	0.032	0.008	0.002
2002	0.009	0.015	0.006	0.029	0.009	0.003
2003	0.011	0.014	0.006	0.029	0.009	0.003
2004	0.011	0.012	0.005	0.032	0.011	0.003
2005	0.013	0.011	0.004	0.036	0.013	0.003
2006	0.011	0.011	0.004	0.041	0.013	0.003
2007	0.014	0.011	0.004	0.047	0.012	0.005
2008	0.013	0.011	0.003	0.054	0.015	0.006

2009	0.011	0.012	0.003	0.056	0.014	0.006
2010	0.010	0.014	0.004	0.052	0.017	0.007
2011	0.011	0.012	0.004	0.051	0.020	0.008
2012	0.012	0.014	0.004	0.048	0.023	0.010
2013	0.011	0.020	0.003	0.049	0.022	0.015
2014	0.011	0.020	0.005	0.048	0.019	0.018
2015	0.009	0.019	0.004	0.040	0.017	0.024
2016	0.008	0.019	0.005	0.034	0.017	0.029
2017	0.008	0.016	0.005	0.032	0.016	0.026
2018	0.008	0.015	0.006	0.031	0.017	0.033
2019	0.010	0.016	0.005	0.030	0.019	0.032
2020	0.009	0.013	0.004	0.022	0.017	0.027
2021	0.008	0.015	0.005	0.026	0.019	0.027
2022	0.010	0.017	0.006	0.034	0.019	0.027

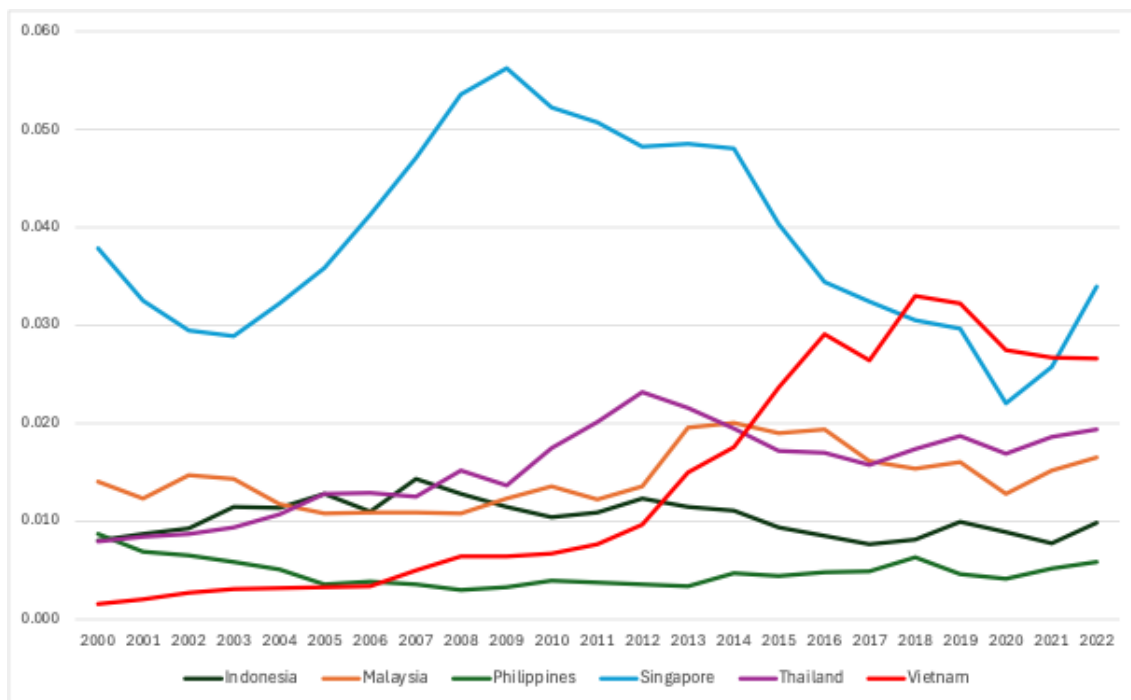


Figure.5 Trend of interdependence per link between ASEAN and Asia-Pacific nations

This figure tracks the average bilateral interdependence between ASEAN countries and major Asia-Pacific economies from 2000 to 2022. The analysis captures ASEAN's shifting orientation toward external partners, especially in the aftermath of the pandemic.

Table.5 Trend of interdependence per link between ASEAN and Asia-Pacific nations

Year	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam
2000	0.008	0.014	0.009	0.038	0.008	0.002
2001	0.009	0.012	0.007	0.032	0.008	0.002
2002	0.009	0.015	0.006	0.029	0.009	0.003
2003	0.011	0.014	0.006	0.029	0.009	0.003
2004	0.011	0.012	0.005	0.032	0.011	0.003
2005	0.013	0.011	0.004	0.036	0.013	0.003
2006	0.011	0.011	0.004	0.041	0.013	0.003
2007	0.014	0.011	0.004	0.047	0.012	0.005
2008	0.013	0.011	0.003	0.054	0.015	0.006
2009	0.011	0.012	0.003	0.056	0.014	0.006
2010	0.010	0.014	0.004	0.052	0.017	0.007
2011	0.011	0.012	0.004	0.051	0.020	0.008
2012	0.012	0.014	0.004	0.048	0.023	0.010
2013	0.011	0.020	0.003	0.049	0.022	0.015
2014	0.011	0.020	0.005	0.048	0.019	0.018
2015	0.009	0.019	0.004	0.040	0.017	0.024
2016	0.008	0.019	0.005	0.034	0.017	0.029
2017	0.008	0.016	0.005	0.032	0.016	0.026
2018	0.008	0.015	0.006	0.031	0.017	0.033
2019	0.010	0.016	0.005	0.030	0.019	0.032
2020	0.009	0.013	0.004	0.022	0.017	0.027
2021	0.008	0.015	0.005	0.026	0.019	0.027
2022	0.010	0.017	0.006	0.034	0.019	0.027

Several observations stand out from these trend figures. First, intra-ASEAN interdependence (Figure 3) was on a modest upward trajectory in the early 2000s, reflecting deepening regional integration, but it experienced a notable dip during the global financial crisis (2008–2009) and again during the initial COVID-19 shock in 2020. The 2020 drop in intra-ASEAN interdependence is especially pronounced, aligning with reports of intra-regional trade contracting as supply chains were disrupted. By late 2021 and into 2022, intra-ASEAN trade interdependence began to recover, indicating a partial restoration of regional trade ties as pandemic restrictions eased. In contrast, the

interdependence between ASEAN and its external Asia-Pacific partners (Figure 4) shows a relatively milder decline in 2020. This suggests that ASEAN’s trade with major outside partners was **more resilient** during the pandemic’s peak disruption than trade within ASEAN. One reason, supported by other studies, is the robust demand and quick rebound in China–ASEAN trade flows (ERIA, 2021), which propped up the ASEAN–external trade links even as internal ASEAN trade suffered. By 2022, the ASEAN–Asia-Pacific interdependence measure had largely rebounded, and in fact outpaced the intra-ASEAN measure, underscoring how pivotal external markets (especially China) were in the recovery phase.

To directly compare the effects of the two shocks of interest, Figure 6 isolates the trade interdependence between ASEAN and two sets of partners: China (alone), and the other four Asia-Pacific economies combined (Japan, South Korea, India, and the United States). This figure traces those two interdependence indicators annually from 2000 to 2022, highlighting key shock periods. During the 2015–2016 window surrounding China’s currency devaluation, ASEAN–China interdependence edged down, signaling a brief softening of that linkage. Over the same period, ASEAN’s ties with other Asia-Pacific partners stayed comparatively high and fairly stable, so the gap between “other AP” and China widened temporarily (exceeding a 2:1 ratio in 2017–2018).

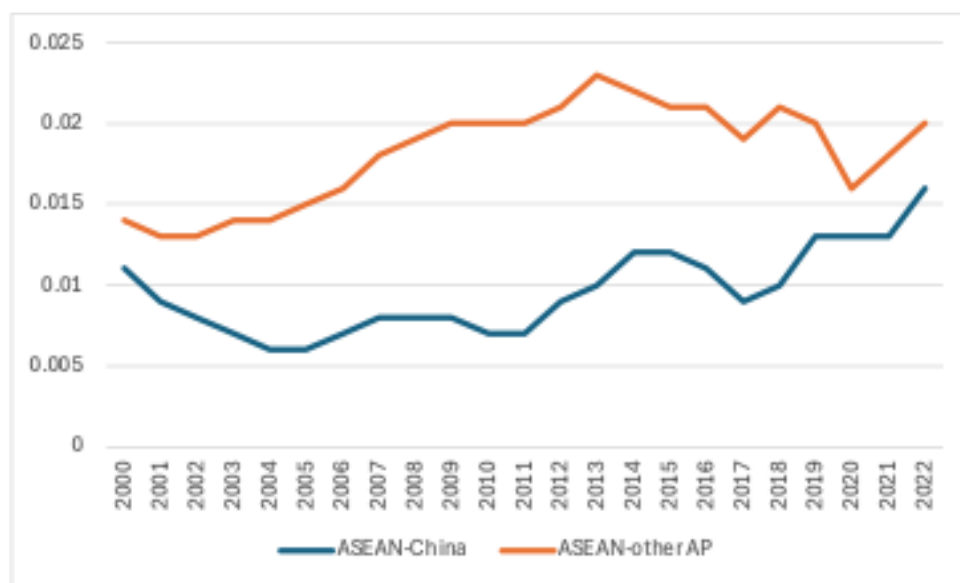


Figure.6 Trade Interdependence per Link Between ASEAN and Key Asia-Pacific Partners (2000–2022) :This figure shows the annual trade interdependence between ASEAN and two major partner groups—China and other Asia-Pacific economies (Japan, South Korea, India, and the United States)—from 2000 to 2022. The measure of interdependence reflects both trade volume and mutual balance. Key disruptions are highlighted: a slight dip during China’s currency devaluation (2015–2016), and a sharp divergence during the COVID-19 pandemic (2020–2022), where ASEAN’s interdependence with China increased while ties with other Asia-Pacific partners weakened

Table.6 Trade Interdependence per Link Between ASEAN and Key Partners (2000–2022): A
Comparison of China and Other Asia-Pacific Economies

Year	ASEAN- China	ASEAN- other AP
2000	0.011	0.014
2001	0.009	0.013
2002	0.008	0.013
2003	0.007	0.014
2004	0.006	0.014
2005	0.006	0.015
2006	0.007	0.016
2007	0.008	0.018
2008	0.008	0.019
2009	0.008	0.020
2010	0.007	0.020
2011	0.007	0.020
2012	0.009	0.021
2013	0.010	0.023
2014	0.012	0.022
2015	0.012	0.021
2016	0.011	0.021
2017	0.009	0.019
2018	0.010	0.021
2019	0.013	0.020
2020	0.013	0.016
2021	0.013	0.018
2022	0.016	0.020

In stark contrast, the 2020–2022 period shows a much more dramatic divergence. The ASEAN–China interdependence index surged to its highest level in two decades during these years, while the interdependence with other Asia-Pacific partners plummeted in 2020 and remained relatively low through 2021–2022. By 2022, the gap between the two had grown very wide: ASEAN’s trade interdependence with China was significantly higher than with the rest of its major external partners. This indicates that China became an even more dominant partner for ASEAN in the immediate post-

pandemic recovery, effectively acting as a stabilizing anchor for ASEAN trade. Meanwhile, reduced demand or slower recovery in the U.S., Japan, India, and South Korea meant that ASEAN's links with those economies weakened in relative terms. The net result is an asymmetric recovery in ASEAN's external trade relations, heavily tilted toward China.

These longitudinal trends and comparisons reinforce the idea that the COVID-19 shock had a fundamentally different impact on ASEAN's trade network than the 2015 shock. The 2015 Chinese devaluation prompted some reorientation, but it was limited and eventually reversed as conditions normalized. In contrast, COVID-19 generated a sharper break in network structure, amplifying ASEAN's dependence on a single external economy (China) while diminishing the relative weight of others, at least in the short run. Whether this change will persist or gradually revert is a question for future observation. Still, as of 2022, the imprint of the pandemic on ASEAN's trade network is clearly distinct from that of the earlier financial shock.

4.3 Robustness Checks

We conducted several robustness checks to ensure that our findings are not artifacts of specific methodological choices. First, to test the robustness of our results to the exact definition of the interdependence metric, we recomputed the analysis using an alternative measure of reciprocity. In this alternative, the interdependence index was redefined by replacing the dependence component with a pure trade volume weight. In other words, we used a weighted reciprocity measure that emphasizes the symmetry of trade flows but scales it by total trade volume between the pair (instead of the dependence index). This alternative formulation gives more weight to larger trade relationships but still penalizes imbalance. The core patterns observed in our primary analysis remained unchanged under this specification: Singapore and Vietnam still showed strong outward orientations (high Outer/Inner trade orientation ratios), the Philippines remained inward-leaning, and Indonesia, Malaysia, and Thailand exhibited relatively balanced or transitional profiles. These consistent results increase confidence that our conclusions are not sensitive to the precise way interdependence is measured.

Second, to validate our country classifications based on Outer/Inner trade orientation ratios, we performed a hierarchical clustering analysis using the standardized Outer/Inner trade orientation ratios for the six countries over 2020–2022. The resulting dendrogram (Figure 7) revealed three distinct clusters of countries: (1) Vietnam alone in one cluster, reflecting its consistently high Outer/Inner trade orientation ratios and strong outward orientation; (2) Singapore in a second cluster, indicating a moderately high outward orientation that still sets it apart from the more inward-focused group; and (3) a cluster comprising Thailand, Malaysia, the Philippines, and Indonesia, which all have relatively lower and closer-to-parity Outer/Inner trade orientation ratios. This data-driven grouping aligns well with our qualitative assessment: Vietnam is an outlier on the outward end, the

Philippines (and to some extent Thailand, Malaysia, Indonesia) are on the inward/balanced end, and Singapore lies somewhere in between but leaning outward. The clustering thus corroborates our interpretation of the Outer/Inner trade orientation ratio patterns and suggests that the differences we highlighted are both statistically and economically significant. Figure 7 visualizes these clusters, confirming a clear stratification of ASEAN countries by trade orientation in the post-pandemic period.

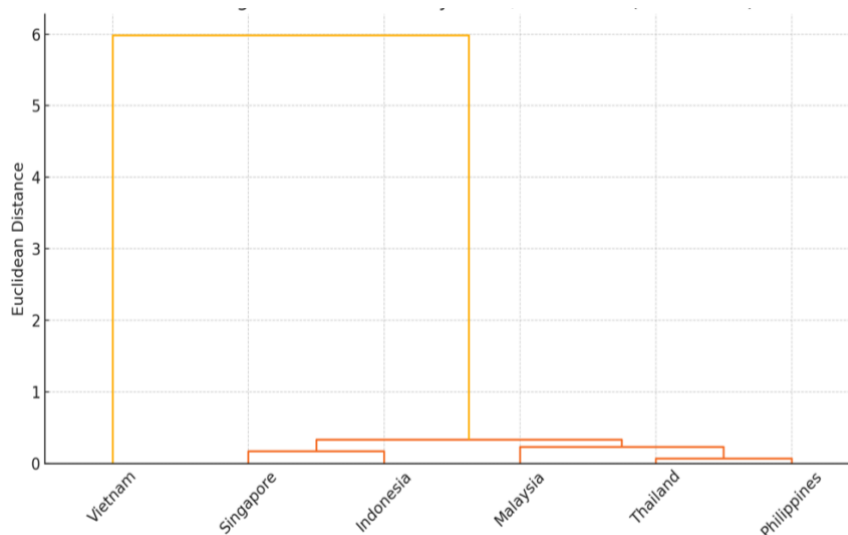


Figure. 7 Clustering ASEAN Countries by Outer/Inner trade orientation ratio (2020-2022)

The dendrogram confirms a clear stratification of ASEAN countries by trade orientation. Vietnam forms a distinct cluster, reflecting its exceptional outward orientation. Singapore is moderately outward-oriented but separate from the inward-leaning group. The Philippines, Thailand, Malaysia, and Indonesia are grouped closely together, indicating similar patterns of trade orientation with a relatively inward or balanced tendency.

5. Limitations

Data limitations: The analysis relies on official WITS trade data, which may not capture informal or unrecorded cross-border trade—particularly relevant for some ASEAN countries. Inconsistencies in data reporting across years may also affect the precision of calculated indices.

Country coverage: We focused on six major ASEAN economies, excluding Brunei, Cambodia, Laos, and Myanmar due to limited and inconsistent data. While this improves reliability, it narrows the generalizability of the findings.

Lack of sectoral detail: Our analysis uses aggregate merchandise trade and does not disaggregate by industry. As a result, sector-specific dynamics—such as divergence between electronics and agriculture—are not captured. This could obscure important within-country variations.

Simplification of metrics: The Outer/Inner trade orientation ratio is a valuable summary measure but simplifies complex trade strategies into a single value. It does not capture qualitative factors such as firm-level behavior or supply chain complexity.

Omitted contextual variables: Our analysis does not directly incorporate policy changes, trade agreements, or geopolitical shifts beyond the two major shocks. These background factors likely influence trade patterns but are not separately modeled.

Despite these constraints, the study offers a novel, network-based approach to assessing ASEAN's evolving trade structures and provides a foundation for future research that incorporates more countries, sectoral data, or institutional factors.

Moreover, the current study does not disaggregate trade flows by product category. Given the centrality of intermediate goods in global value chains, future research will aim to construct and analyze a distinct network layer based on intermediate goods alone. This would enable a deeper understanding of structural vulnerabilities and dependencies within ASEAN's production-oriented trade architecture.

6. Conclusion and Discussion

This study investigated how ASEAN trade interdependence evolved during the COVID-19 recovery (2020–2022), using a network-based framework that emphasizes bilateral interdependence. We introduced the Outer/Inner trade orientation ratio to assess each country's average trade interdependence with major Asia-Pacific partners versus intra-ASEAN neighbors, allowing a dynamic and comparative view of trade orientation.

Our findings show clear divergence in ASEAN's post-pandemic trade strategies. Singapore and Vietnam leaned further outward, while the Philippines maintained a strong inward focus. Malaysia, Thailand, and Indonesia exhibited more balanced or transitional orientations. These variations suggest that ASEAN's recovery was not defined by a shared shift but rather by differentiated realignments shaped by structural conditions and policy priorities.

Compared with China's 2015 currency devaluation, the COVID-19 shock had a more profound and asymmetric impact. The earlier financial disturbance prompted mild diversification—ASEAN briefly strengthened ties with Japan, Korea, and the U.S.—but the pandemic reversed this trend. From 2020 to 2022, ASEAN's interdependence with China surged, while ties with other Asia-

Pacific partners weakened. This deepened ASEAN's reliance on China and marked a notable structural shift in regional trade architecture.

From a policy standpoint, these patterns raise important considerations for ASEAN's economic resilience. Outward-oriented economies like Vietnam and Singapore benefit from integration into global value chains but face exposure to external shocks. Inward-oriented economies may enjoy stability through regional trade but risk limited diversification. For ASEAN as a bloc, this structural heterogeneity implies that one-size-fits-all trade policies may be ineffective. Instead, tailored strategies—strengthening regional frameworks for some, while enabling external engagement for others—are needed.

Policy Implications

The findings of this study carry important policy implications for ASEAN economies as they seek to navigate a more fragmented and uncertain global environment. The divergence in trade orientation patterns suggests that a unified, one-size-fits-all strategy for ASEAN economic integration may be ineffective. Policymakers should instead pursue tailored trade strategies that reflect the structural positions and resilience capacities of individual member states.

For outward-oriented economies such as Vietnam and Singapore, there is a need to complement global engagement with robust risk mitigation mechanisms—for example, by diversifying trade partners beyond a heavy reliance on China and strengthening participation in multilateral trade agreements like the CPTPP or RCEP.

In contrast, inward-leaning economies such as the Philippines may benefit from further enhancing intra-ASEAN supply chain integration and improving regional trade facilitation mechanisms, including faster customs procedures and deeper harmonization of standards.

At the regional level, ASEAN should institutionalize monitoring tools similar to the Outer/Inner Trade Orientation Ratio introduced in this study. Regular assessment of trade orientation shifts could help detect emerging vulnerabilities early and inform more agile and differentiated regional policy responses.

In a world of recurring systemic shocks, ASEAN's long-term resilience will depend on embracing structural heterogeneity while strengthening both internal cohesion and external diversification. This study offers concrete empirical tools to support such an adaptive, evidence-based policy framework. Methodologically, this study contributes to trade network research by moving beyond country-level indicators to link-level analysis. The Outer/Inner ratio and interdependence index reveal patterns often obscured by aggregate metrics. Our framework could be adapted to other regional blocs or global shocks—for instance, analyzing EU trade post-Brexit or Latin American trade during commodity cycles.

Future research should explore sector-specific trade flows to identify which industries drive reorientation. Expanding the country set to include all ten ASEAN members and incorporating policy variables such as trade agreements or industrial strategies would also enhance the analysis. Finally, firm-level network data could help reveal the micro-foundations of trade resilience, particularly in how production networks adapt during disruptions.

In conclusion, this paper offers a nuanced, high-resolution view of ASEAN's post-pandemic trade landscape. It shows that global shocks can reinforce rather than erase structural differences in trade orientation. By recognizing these differences, policymakers can better design trade strategies that balance integration, diversification, and resilience in an increasingly uncertain global economy.

Looking ahead, the interdependence framework developed in this study will be extended to construct a multi-layered trade network, with particular focus on intermediate goods. Comparing the structure and dynamics of the total trade network with that of the intermediate goods network will shed light on the backbone of regional production systems and the fragility or resilience of supply chains under stress. This layered approach promises to complement and deepen the insights gained from the aggregate analysis presented here.

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