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ARTICLE

Evidence-Based Analysis for ASEAN Agroeconomic Development: Implications for the US Tariff Policy

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ABSTRACT

In response to rising US protectionist trade policies, this study is important to provide evidence-based analysis for the long-standing efforts of ASEAN in agroeconomic development. Agriculture continues to play a central role in ASEAN, not only as a source of food security but also as a key driver of employment and rural development. This study contributes to the literature on input-output analysis by linking structural multiplier effects with the implications of external trade policy, thereby offering a perspective on the vulnerabilities of ASAN agriculture to US protectionism. Using a multiregional input-output table, the study computes output and value-added multipliers by decomposing them into direct, indirect, and induced effects, and estimates bilateral linkages to trace cross-country production impacts and key enabling sectors in 2023. The findings show that most ASEAN countries experience strong indirect effects, which indicate dense intersectoral linkages and reliance on domestic supply networks. Highly induced effects in countries such as Indonesia and the Philippines further highlight the important role of agriculture in generating income and reducing poverty. The US tariff policy on Indonesia's increased agricultural commodity imports and the removal of local content requirements for its long-protected agricultural industry may disrupt the domestic supply network. This disruption could affect both local and regional markets, with particular consequences for micro, small, and medium enterprises (MSMEs).

Keywords: Agriculture; Asean; Local Content; Tariffs; Input-Output

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1. Introduction

In the era marked by intensifying geopolitical tensions, economic volatility, and climate unpredictability, food and agricultural sovereignty has re-emerged as a foundation pillar of national resilience. This is particularly prominent for the ASEAN region, where agriculture remains an important driver of socioeconomic development, a source of livelihood for the majority of rural populations. On top of that, the agriculture sector may also play a strategic buffer against global supply shocks, which was the case during the pandemic of 2020 [1].

The recent imposition of US tariffs, particularly as part of broader protectionist shifts, has brought concern to ASEAN member states. For example, US and Indonesia have negotiated a new trade agreement, which stipulates that Indonesia will remove 99% of its tariffs on American exports and commit to purchasing $4.5 billion of agricultural commodities, which include soybeans, soybean meal, wheat, and cotton. The clause also includes the elimination of local content requirements, which indicates that US companies can operate in Indonesia without sourcing from local suppliers [2].

The existing literatures highlight the critical role of ASEAN as a destination for US agricultural exports, while reflecting the increasing competitiveness pressures that challenge the sustainability of this trade relationship. For example, Sabala and Gale [3] show that US agricultural exports to ASEAN are dominated by soybean products, wheat, and cotton. Similarly, Smith and Khanal [4] demonstrate that ASEAN has persistent deficits in these commodities. There is a substantial untapped demand that could be met by US exports, with agricultural exports already representing 20% of US agricultural and food product value.

Though the United States plays a crucial role in supplying agricultural commodities to ASEAN countries, the United States has started facing competitors, such as Brazil, Australia, New Zealand, the European Union, and China. While China's exports largely complement rather than compete with US products, Brazil has come off as a competitive player in soybean, cotton, poultry, and beef markets [5]. This outlines some possible threats to the US whereby it faces price pressure, geopolitical ties, and geographical proximity [3]. In addition, ASEAN favours intra-regional trade over imports from external suppliers though the intra-regional trade is not as significant as imports [6].

The United States has faced a few facets of competition, which include preferential trade agreements established by ASEAN and its importing countries, low costs, geopolitical ties, and geographical proximity [3].For example, in the meat sector, the absence of a US-ASEAN free trade agreement and the expansion of trade agreements under RCEP tilt ASEAN import growth toward Australia and New Zealand, placing US exporters at a relative disadvantage [7]. The literature therefore indicates that without stronger trade policy commitments such as mandatory import clauses in ASEAN agreements, the US risks losing further market share to competitors who benefit from preferential access and tariff reductions.

This has exerted some pressure on establishing global trade policy and domestic agroeconomic strategies within ASEAN member states. While ASEAN countries have progressively liberalized trade through frameworks such as the ASEAN Free Trade Area (AFTA), ASEAN Trade in Goods Agreement (ATIGA), and the Regional Comprehensive Economic Partnership (RCEP), the agricultural sector has lagged behind other industries in terms of liberalization, owing to persistent barriers such as inconsistent rules of origin, sensitive product exclusions, and non-tariff measures.

The agriculture sector plays a significant role in ASEAN as it plays an important role in generating a substantial share of GDP in Cambodia, Myanmar, Laos, Vietnam, and Indonesia. Additionally, agriculture contributes notably to exports in countries, namely, Myanmar, Indonesia, Thailand, Vietnam, and Malaysia. For many ASEAN economies, especially those in the lower-middle-income bracket, agriculture not only supports livelihoods but also underpins downstream industries such as food processing, logistics, and agritech. For example, Malaysia's New Economic Policy [8] from 1971 to 1990 has prioritized agricultural development as the central focus for poverty eradication. This initiative successfully reduced the national poverty incidence from approximately 49.3% in 1970 to about 16.5% by 1990. The GDP per capita has increased from USD379.6 in 1970 to USD2468.7 in 1990 [5].

The sector's importance is emphasized in the ASEAN Economic Community (AEC) Blueprint, which promotes sustainable agriculture, rural development, and regional trade integration [9]. Despite structural shifts reducing agriculture's share in GDP, the sector continues to be vital for inclusive growth, particularly in rural areas. Moreover, rice, a dietary staple and cultural commodity, remains central to food security planning across the region. Countries like Indonesia, Vietnam, the Philippines, and Thailand have emphasized rice self-sufficiency, backed by state subsidies and infrastructure investments [10]. These policies not only secure food availability but also stimulate sectoral development and technological adoption.

Agricultural development has also been widely utilized as a tool for poverty alleviation and rural upliftment. In Indonesia and Cambodia, agriculture continues to be a primary economic driver in rural areas. Studies such as Mukhlis et al. [11] confirm a significant link between agricultural growth and poverty reduction in ASEAN, showing how food availability, price stabilization, and income generation among the rural poor can be enhanced through agricultural development. However, a key limitation of such analyses lies in treating ASEAN as a homogeneous region, overlooking significant heterogeneities in institutional capacity, infrastructure, and policy responses across countries [12].

The COVID-19 pandemic further exposed the vulnerabilities of ASEAN's agri-food systems [1]. Border closures, disruptions in transportation, and export restrictions exacerbated existing weaknesses, revealing a lack of coordinated regional response mechanisms and highlighting the absence of resilient supply chains. This experience has reinforced the importance of trade facilitation, investment in logistics and cold-chain infrastructure, and regulatory harmonization as prerequisites for unlocking the full potential of the agricultural sector within the region.

Structurally, agriculture in ASEAN is deeply integrated within complex intersectoral production networks. Its backward linkages encompass inputs such as fertilizers, machinery, and agro-technology, while forward linkages extend into food processing, retail, and logistics. Strengthening these connections, particularly through increased utilization of domestic inputs, can enhance local value addition and reduce dependence on external suppliers [13]. The services sector, including transportation, storage, and finance, also plays a crucial role in improving market access and reducing volatility. Recent innovations in cold-chain logistics have notably expanded reach and efficiency, as evidenced by developments in Myanmar and Brazil [14].

In addition, agriculture contributes to productivity growth through knowledge spillovers. Studies from Indonesia's manufacturing sector demonstrate that upstream and downstream integration fosters technological advancement and competitiveness, particularly when firms possess the capacity to absorb new knowledge [15]. Regional input-output models further reveal disparities in value chain integration. Regions characterized by interconnected and diversified production networks exhibit greater economic resilience, whereas those reliant on a narrow range of resources remain highly susceptible to external shocks [16, 17]. This underscores the importance of examining agriculture not in isolation, but within its wider production and trade networks.

Input-output (I-O) analysis remains an essential tool for capturing the intricate interdependencies between agriculture and the broader economy. Heady and Schnittker [18] were early pioneers in this field, demonstrating how agricultural outputs support not only final consumption but also serve as critical inputs for industrial processes. Through the use of technical coefficients and interdependence matrices, their foundational work enabled the quantification of agriculture's systemic significance. The strength of the methodology is particularly relevant for the present study, as US tariff policies on agricultural commodities not only affect direct trade flows but also trigger cascading impacts across supply chains, employment, and value-added generation.

Contemporary research has extended these I-O methodologies to assess sectoral linkages and employment effects, particularly in the Asia-Pacific's least developed countries. Norbu et al. [13], for example, utilized ADB-MRIO and ILO data to show that, while agriculture often exhibits weak backward linkages due to limited use of modern inputs, it remains a major source of employment,

reflecting substantial employment multipliers. Marlianti et al.[19], focusing on Indonesia's West Nusa Tenggara region, highlighted the dual linkages of various agricultural subsectors and identified agriculture as a key strategic sector using the Rasmussen linkage model.

Given the strategic importance of agriculture to ASEAN economies and the growing uncertainty in global trade dynamics, this study focuses on the Association of Southeast Asian Nations (ASEAN), which comprises ten member states, namely, Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam. Owing to data limitations, Myanmar is excluded from the analysis. The study investigates the impact of US tariff policies on the agroeconomic development of these countries and is guided by three specific objectives. First, it aims to quantify the economic significance of the agriculture sector within individual ASEAN member states by assessing the output and value-added contributions using input-output multipliers. Second, the key interlinked sectors that support agricultural development are identified through the decomposition of domestic multipliers. Third, the paper evaluates the role of intra-ASEAN agricultural trade in propagating economic impacts across borders, with special attention to bilateral multiplier linkages and the identification of regional impulse-generating countries. The paper is organized as follows: Section 2 presents the materials and methods on the framework of input-output. Section 3 reports the empirical findings. Section 4 offers a comprehensive discussion on the implications of the findings and recommendations of policies. Section 5 concludes the study.

2. Materials and Methods

2.1. Source of Data

The data used is based on a multi-regional input-output table from the Asian Development Bank[20]. The table consists of all member states of ASEAN, Brunei, Cambodia, Indonesia, Laos, Malaysia, the Philippines, Singapore, Thailand, and Vietnam, except for Myanmar. There are 35 sectors, including our interest sector, the agriculture sector. The period of the data is 2023, which is the most recent data. The ADB dataset is used instead of the input-output table from government officials published data. The ADB dataset has a standardized number of sectors and a classification of the sectors. This makes it comparable between the member states of ASEAN.

2.2. Methodology

This research adopts input-output analysis as its core methodological tool. The fundamental purpose of input-output analysis is to analyze the interdependence of industries within an economy[21]. The interlinked structure of economic sectors implies that interventions in a single sector can have cascading impacts across the broader economy. This analytical framework supports the exploration of how the agriculture sector operates and interacts within ASEAN economies. Several studies have utilized an input-output table to analyze issues in the agriculture sector, as demonstrated[22–24].

The input-output calculation is based on the calculation of the Leontief inverse matrix and the Ghosh inverse matrix. The calculation of technical coefficients and allocative coefficients is done before calculating the Leontief and Ghosh inverse matrix.

The calculation of technical coefficients is:

$$a_{ij} = z_{ij}/x_j \tag{1}$$

z_{ij} represents the intermediate input of sector i bought by sector j, and z_j is the value of production of sector j.

The calculation of the Leontief Inverse matrix is:

$$L = (I - A)^{-1} \tag{2}$$

I represents the identity matrix, A represents the Leontief Inverse matrix, and L represents the matrix of a_{ij}.

The calculation of allocative coefficients is:

$$b_{ij} = z_{ij}/x_i \tag{3}$$

z_{ij} represents the output of sector i bought by sector j, and z_j is the value of total input of sector i.

The calculation of the Ghosh Inverse matrix is:

$$G = (I - B)^{-1} \tag{4}$$

I represents the identity matrix, B represents the Leontief Inverse matrix, and G represents the matrix of b_{ij}.

The first objective quantifies the economic significance of the respective ASEAN agriculture sector. This calculation of the Agriculture sector's multiplier is done by using the Leontief Inverse matrix. The calculation of both Type One and Type Two multipliers is required, as Type One provides the values of direct and indirect effects, while Type Two provides the values of induced effects [21, 25].

The domestic sectoral output multiplier of the agriculture sector is extracted from the Leontief inverse matrix.

Type Two Leontief multipliers are calculated, with the inclusion of the value-added row and household consumption column. For example, there are 2 sectors within the economy, whereby sector 1 represents the agriculture sector, sector 2 the manufacturing sector, and sector 3 the household sector. We have the Leontief inverse matrix:

$$L=\begin{bmatrix} l_{1,1} & l_{1,2} & l_{1,3} \\ l_{2,1} & l_{2,2} & l_{2,3} \\ l_{3,1} & l_{3,2} & l_{3,3} \end{bmatrix} \tag{5}$$

l_{ij} represents the element of the multipliers of all sectors within the Leontief inverse matrix.

$l_{1,1}$ is the sectoral multiplier specific to the agriculture sector. It is interpreted as when \$1 million increase in agriculture sector, there is \$$l_{1,1}$ of additional output generated in the agriculture sector.

Value-added multipliers can be calculated as:

$$V = v_{n+1,i}(I - A)^{-1} \tag{6}$$

$v_{n+1,i}$ represents the value-added of each sector arranged diagonally in a matrix, and V is the product of the matrix multiplication of the value-added matrix and the Leontief Inverse matrix.

Each of the values of the multiplier is broken down into direct, indirect, and induced effects [21]. Direct effect reflects the direct requirement of the sector, in this case, agriculture. The calculation of the direct effect is the calculation of technical coefficients.

The indirect effect shows the interindustry transactions caused by the initial and direct effects of the agriculture sector. Indirect effect is calculated by deducting the direct effect from the total effect. Indirect effect reflects the additional impacts that occur in the supply chain within the domestic economy [26]. The calculation of the indirect effect takes the total Type One multiplier effect away from the direct effect.

Lastly, the induced effect captures the impact arising from household re-spending as a result of changes in income. It is calculated by subtracting the total effects of the Type I multiplier from those of the Type II multiplier. When an exogenous shock occurs in the agricultural sector, it alters the output levels across various sectors of the economy. This, in turn, affects labor demand and household incomes. A positive shock leads to increased income generation, which subsequently drives higher household consumption, further stimulating economic activity across sectors.

Lastly, the total effects represent the sum of the multiplier effects from direct, indirect, and induced effects.

The relationship between the multiplier effects is:

$$\begin{aligned} Total\ Multiplier\ Effect = Direct\ Effects \\ +Indirect\ Effects + Induced\ Effects \end{aligned} \tag{7}$$

To answer the second objective, which is to identify the key interlinked sectors that contribute to agricultural development within ASEAN countries, sectoral decomposition multipliers are calculated. We decompose the calculation of the Leontief Inverse matrix by looking into the inter-industry multiplier effect.

$$L=\begin{bmatrix} l_{1,1} & l_{1,2} & l_{1,3} \\ l_{2,1} & l_{2,2} & l_{2,3} \\ l_{3,1} & l_{3,2} & l_{3,3} \end{bmatrix} \tag{8}$$

Based on equation (5), sectoral decomposition multipliers for sector 1 are $l_{2,1}$. It is interpreted as, when there is a \$1 million increase in final demand of sector 1, sector 2 will increase production by \$ $l_{2,1}$ million.

The final objective, which involves assessing the role of intra-ASEAN agricultural trade, is addressed through the computation of the bilateral output multiplier for the agricultural sector.

A bilateral input-output table captures the economic transactions between two countries, denoted as r and s, across various sectors [27, 28]. Let Z represent the matrix of intermediate input flows among sectors. Elements such as z_{ij}^{rr} represent intra-regional flows and

z_{ij}^{sr} represent interregional flows. The overall structure of the bilateral input-output system can be expressed as:

$$Z=\begin{bmatrix} Z^{rr} & Z^{rs} \\ Z^{sr} & Z^{ss} \end{bmatrix} \tag{9}$$

Within each submatrix Z^{xy}, there is a square matrix of dimension $n \times n$, where n is the number of sectors in each country.

To compute bilateral IO multipliers, one must first derive the technical coefficients. For intra-regional flows:

$$a_{ij}^{ss}=\frac{z_{ij}^{ss}}{x_j^s} \tag{10}$$

For interregional flows:

$$a_{ij}^{rs}=\frac{z_{ij}^{rs}}{x_j^s} \tag{11}$$

$$a_{ij}^{sr}=\frac{z_{ij}^{sr}}{x_j^r} \tag{12}$$

The combined technical coefficient matrix A:

$$A=\begin{bmatrix} A^{rr} & A^{rs} \\ A^{sr} & A^{ss} \end{bmatrix} \tag{13}$$

Correspondingly, the total output vector x and final demand vector f for the two countries are:

$$x=\begin{bmatrix} x^r \\ x^s \end{bmatrix} \tag{14}$$

$$f=\begin{bmatrix} f^r \\ f^s \end{bmatrix} \tag{15}$$

The identity matrix of the bilateral input-output:

$$I=\begin{bmatrix} I & 0 \\ 0 & I \end{bmatrix} \tag{16}$$

The Leontief inverse, which yields the output multipliers, is calculated as:

$$L=\left\{\begin{bmatrix} I & 0 \\ 0 & I \end{bmatrix}-\begin{bmatrix} A^{rr} & A^{rs} \\ A^{sr} & A^{ss} \end{bmatrix}\right\}^{-1} \tag{17}$$

To capture induced effects, the model can be extended by including household consumption as an additional column and value-added as an additional row. Notably, the household row entries in A^{sr} and A^{rs} are set to zero, assuming no direct cross-border household flows. The resulting extended Leontief inverse captures the total output effects, including both direct, indirect, and induced effects for the bilateral systems.

All results in the study are derived from the ADB [20] MRIO database. This database is widely used and harmonised across countries, providing consistent sectoral and regional coverage. While the reliance on a single database could raise robustness concerns, the reliability of ADB MRIO is supported by its validation process and alignment with other international input-output datasets.

2.3. Limitations of Methodology

While input-output analysis captures the changes of supply and demand across different industries, it relies on several simplifying assumptions to facilitate the interpretation of bilateral multipliers. Firstly, the model assumes a constant price. When there is a change in the final demand of any sector, the impact of the change is reflected solely on quantity. Secondly, it assumes the absence of constraint capacity in production. This implies that changes of supply or demand are presumed to eventually lead to equilibrium, with inputs assumed to be available in whatever quantities are required. Thirdly, the model assumes fixed technical coefficients, indicating that each industry uses inputs in a fixed proportion, with no allowance for technological change. Fourthly, the analysis is limited by sectoral aggregation into 35 sectors, which does not capture more granular transactions between commodities. Nevertheless, the employed dataset provides one of the most practical sources for achieving comparable sectoral classification across the selected countries.

In mathematical economics, input-output analysis is derived from deterministic accounting identities rather than statistical inference. Thus, robustness checks in the econometric sense are not directly applicable [21, 29]. The results are reproducible once the database and technical coefficients are defined. However, differences across databases may introduce some variation. This study does not conduct cross-database comparisons, which remains a potential avenue for future work.

3. Results

3.1. Decomposition of Output and Value-Added Multipliers for the Agriculture Sector in ASEAN Member States

In **Table 1**, among all ASEAN countries, the Philippines and Indonesia record the highest total output multipliers in the agriculture sector. Both countries have a total output multiplier of 1.9 and above. This is interpreted as when there is $1 million increase in final demand of the agriculture sector, the agriculture sector itself will generate $1.9 million more output.

In terms of value-added multipliers, Indonesia and Laos lead the region. Indonesia has a value-added multiplier of 1.5765, while Laos has 1.1107. This indicates that the agriculture sector in these countries contributes significantly to domestic income generation. Indonesia exhibits a balanced distribution of multiplier effects spreading across direct, indirect, and induced effects [30]. This reflects strong backward linkages and consumption feedback mechanisms.

Two countries that exhibit the lowest multipliers across both output and value-added indicators are Brunei and Singapore. Singapore's total output multiplier is 1.1889, and its total value-added multiplier is 0.2712. This may be explained by the fact that both Brunei and Singapore are small in land size, which limits the sector's capacity to generate more output and value-added within the country [31].

Cambodia and Vietnam show promising multiplier effects. This suggests that the growing importance of agriculture as a driver of broader economic activity. Their agriculture sector has a relatively larger proportion of induced effects which reflects that their agriculture sector is an income generating sector, which reflects in higher consumption, which further drives production in other sectors.

Malaysia and Thailand reflect moderate propagation effects. Their agriculture multipliers are close to the lowest. This indicates a more diversified economic structure, whereby the agriculture sector is less central in driving the economic growth.

3.2. Sectoral Decomposition of Output and Value-Added Multipliers of ASEAN Countries

Tables 2–10 reflect that in every ASEAN member states, agriculture is consistently the top contributor to both output and value-added multipliers. Output multipliers are consistently higher than value-added multipliers, as output includes all intermediate inputs. Countries such as Indonesia, Malaysia, and Philippines show higher total output and value-added multipliers, reflecting stronger inter-industry connections.

Based on **Table 2**, Brunei's agriculture exhibits that agriculture sector significantly boosts the finance, petroleum, and real estate sectors. It has a strong self-multiplier, which creates an opportunity for internal supply chain strengthening.

Table 1. Decomposition of Output and Value-Added Multipliers for the Agriculture Sector in ASEAN Member States.

ASEAN Countries	Multipliers	Direct Effects	Indirect Effects	Induced Effects	Total Effects	Rank*
Brunei	Output	0.0074	1.0002	0.0897	1.0972	9
	Value-Added	0.457	0.0035	0.041	0.5014	
Cambodia	Output	0.0498	1.004	0.3264	1.3802	4
	Value-Added	0.7361	0.0396	0.2402	1.0159	
Indonesia	Output	0.0278	1.0187	0.8787	1.9252	2
	Value-Added	0.8189	0.0381	0.7195	1.5765	
Laos	Output	0.0241	1.0054	0.2551	1.2846	6
	Value-Added	0.8646	0.0255	0.2205	1.1107	
Malaysia	Output	0.0136	1.0162	0.2599	1.2896	5
	Value-Added	0.735	0.0218	0.191	0.9479	
Philippines	Output	0.2713	1.1438	0.5352	1.9503	1
	Value-Added	0.5009	0.2079	0.2681	0.9769	

Table 1. *Cont.*

ASEAN Countries	Multipliers	Direct Effects	Indirect Effects	Induced Effects	Total Effects	Rank*
Singapore	Output	0.1571	1.0301	0.0017	1.1889	7
	Value-Added	0.2281	0.0427	0.0004	0.2712	
Thailand	Output	0.0335	1.009	0.1259	1.1684	8
	Value-Added	0.6578	0.028	0.0828	0.7685	
Vietnam	Output	0.1352	1.1398	0.2988	1.5738	3
	Value-Added	0.5008	0.1377	0.1496	0.7881	

Note: * Ranking of the countries depend on total output multipliers.

Table 2. Sectoral Decomposition of Output and Value-Added Multipliers in Brunei.

Rank	Output Multipliers		Value-Added Multipliers	
	Sectors	Output Multipliers	Sectors	Value-Added Multipliers
1	Agriculture	1.0972	Agriculture	0.5014
2	Financial intermediation	0.4482	Financial intermediation	0.3115
3	Petroleum and Fuel	0.3735	Petroleum and Fuel	0.1718
4	Real estate activities	0.1807	Real estate activities	0.166
5	Post and telecommunications	0.1363	Education	0.0769
	Others	0.8412	Others	0.4313
	Total	3.0771	Total	1.6589

Table 3 shows the breakdown of Cambodia's agricultural sectoral multipliers. Agriculture leads the highest output multiplier, exhibiting 1.3802. Construction and wholesale trade follow as important enablers. The value-added multipliers represent a similar impact as output multipliers, except that the food and beverage manufacturing sector is not found to be significant in contributing to value-added activities.

Table 3. Sectoral Decomposition of Output and Value-Added Multipliers in Cambodia.

Rank	Output Multipliers		Value-Added Multipliers	
	Sectors	Output Multipliers	Sectors	Value-Added Multipliers
1	Agriculture	1.3802	Agriculture	1.0159
2	Construction	0.3153	Construction	0.1665
3	Wholesale trade	0.18	Mining and quarrying	0.1027
4	Inland transport	0.1756	Wholesale trade	0.0974
5	Food and beverage manufacturing	0.1672	Inland transport	0.0909
	Others	0.849	Others	0.3599
	Total	3.0673	Total	1.8333

Table 4 shows Indonesia's agriculture spillover effects on other sectors. The output multipliers show that the Food and beverage and wholesale trade sectors are key enablers to the supply chain of the agriculture sector. The food and beverage sector has an output multiplier effect of 1.5487, which is interpreted as when there is $1 million increase in the final demand of the agriculture sector, food and beverage sector will increase production by $1million.

Table 4. Sectoral Decomposition of Output and Value-Added Multipliers in Indonesia.

Rank	Output Multipliers		Value-Added Multipliers	
	Sectors	Output Multipliers	Sectors	Value-Added Multipliers
1	Agriculture	1.9252	Agriculture	1.5765
2	Food and beverage manufacturing	1.5485	Food and beverage manufacturing	0.5027
3	Wholesale trade	0.3962	Wholesale trade	0.2679
4	Post and telecommunications	0.3625	Post and telecommunications	0.2396

Table 4. *Cont.*

Rank	Output Multipliers		Value-Added Multipliers	
	Sectors	**Output Multipliers**	**Sectors**	**Value-Added Multipliers**
5	Hotels and restaurants	0.3428	Financial intermediation	0.2299
	Others	3.9277	Others	1.9547
	Total	8.5029	Total	4.7713

Table 5 shows that Laos Agriculture has higher than 1 output and value-added multipliers, however, the sectors within its supply chain have relatively lower multiplier effects, in both output and value-added. This reflects the disconnected supply chain of the agriculture sector within the domestic economy.

Table 5. Sectoral Decomposition of Output and Value-Added Multipliers in Laos.

Rank	Output Multipliers		Value-Added Multipliers	
	Sectors	**Output Multipliers**	**Sectors**	**Value-Added Multipliers**
1	Agriculture	1.2846	Agriculture	1.1107
2	Food and beverage manufacturing	0.2382	Real estate activities	0.2027
3	Construction	0.2379	Retail trade	0.0738
4	Real estate activities	0.2249	Financial intermediation	0.0732
5	Financial intermediation	0.1385	Food and beverage manufacturing	0.0684
	Others	0.7202	Others	0.4228
	Total	2.8443	Total	1.9516

Table 6 shows Malaysia's agriculture sectoral decomposition multipliers. The financial and telecommunications sectors are found to be significant in the domestic production chain of the Agriculture sector in Malaysia. This reflects the importance of the services sector in supporting the agriculture sector in Malaysia.

Table 6. Sectoral Decomposition of Output and Value-Added Multipliers in Malaysia.

Rank	Output Multipliers		Value-Added Multipliers	
	Sectors	**Output Multipliers**	**Sectors**	**Value-Added Multipliers**
1	Agriculture	1.2896	Agriculture	0.9479
2	Food and beverage manufacturing	0.5177	Financial intermediation	0.1512
3	Petroleum and Fuel	0.2918	Retail trade	0.1445
4	Post and telecommunications	0.2732	Post and telecommunications	0.1371
5	Financial intermediation	0.2302	Real estate activities	0.1338
	Others	2.2621	Others	0.9049
	Total	4.8646	Total	2.4194

Table 7 shows Philippines' agriculture sector sectoral decomposition multipliers. The food and beverage manufacturing sector has more than 1 output multiplier, showing a vibrant agro-industrial base. The Philippines relies heavily on agriculture and agro-processing for both output and income, with retail and education sectors also involved in value-added distribution.

Based on **Table 8,** Singapore has a high agriculture output multiplier, though this may reflect niche agritech or re-exporting activities. The production network is supported by the services sector. The value-added multiplier of the agriculture sector is relatively lower than other ASEAN member states. Despite being urbanized, Singapore's agriculture shows systemic importance, possibly through vertical farming and input provision, though the income effects are subdued.

Table 9 shows Thailand's agricultural sectoral decomposition of multiplier effects. Its agriculture sector is supported by tourism-related sectors such as hotels and restaurants, or wholesale trade. This reflects the dominance of the tourism sector in impacting the agriculture sector.

Table 7. Sectoral Decomposition of Output and Value-Added Multipliers in the Philippines.

Rank	Output Multipliers		Value-Added Multipliers	
	Sectors	**Output Multipliers**	**Sectors**	**Value-Added Multipliers**
1	Agriculture	1.9503	Agriculture	0.9769
2	Food and beverage manufacturing	1.031	Retail trade	0.4868
3	Retail trade	0.7084	Food and beverage manufacturing	0.3438
4	Financial intermediation	0.5078	Financial intermediation	0.2784
5	Utilities	0.1834	Education	0.1554
	Others	1.9062	Others	0.9936
	Total	6.2871	Total	3.2349

Table 8. Sectoral Decomposition of Output and Value-Added Multipliers in Singapore.

Rank	Output Multipliers		Value-Added Multipliers	
	Sectors	**Output Multipliers**	**Sectors**	**Value-Added Multipliers**
1	Agriculture	1.1889	Agriculture	0.2712
2	Financial intermediation	0.3868	Financial intermediation	0.1867
3	Wholesale trade	0.3651	Real estate activities	0.1673
4	Electricity, gas, and water supply	0.2796	Wholesale trade	0.1582
5	Renting of M&Eq and other business activities	0.2781	Utilities	0.0953
	Others	1.3504	Others	0.4887
	Total	3.8489	Total	1.3674

Table 9. Sectoral Decomposition of Output and Value-Added Multipliers in Thailand.

Rank	Output Multipliers		Value-Added Multipliers	
	Sectors	**Output Multipliers**	**Sectors**	**Value-Added Multipliers**
1	Agriculture	1.1684	Agriculture	0.7685
2	Hotels and restaurants	0.4299	Retail trade	0.1791
3	Retail trade	0.3024	Hotels and restaurants	0.1713
4	Wholesale trade	0.2796	Wholesale trade	0.1702
5	Financial intermediation	0.2299	Financial intermediation	0.1612
	Others	1.3533	Others	0.4449
	Total	3.7635	Total	1.8952

Table 10 shows Vietnam Agriculture's Sectoral Decomposition of multiplier effects. Vietnam's agriculture sector is supported by its domestic food and beverage and hospitality sectors. The agriculture sector has a 0.7881 value-added multiplier, with contributions from services and real estate sectors.

Table 10. Sectoral Decomposition of Output and Value-Added Multipliers in Vietnam.

Rank	Output Multipliers		Value-Added Multipliers	
	Sectors	**Output Multipliers**	**Sectors**	**Value-Added Multipliers**
1	Agriculture	1.5738	Agriculture	0.7881
2	Food and beverage manufacturing	0.4388	Real estate activities	0.0782
3	Hotels and restaurants	0.1331	Food and beverage manufacturing	0.0756
4	Renting of M&Eq and other business activities	0.1326	Financial intermediation	0.0738
5	Post and telecommunications	0.1302	Renting of M&Eq and other business activities	0.0718
	Others	1.1705	Others	0.5773
	Total	3.579	Total	1.6648

3.3. Intra-ASEAN Agriculture Bilateral Output and Value-Added Multipliers

Table 11 displays bilateral output multipliers within the ASEAN region, indicating how agriculture exports from a home country stimulate total output of a host country, while **Table 12** shows the bilateral value-added multipliers within the ASEAN region. The higher the value of the multiplier, the stronger the economic interdependencies between the countries' agriculture sectors. This signifies that the agriculture sector of that home country is an impulse generator within the region.

The main impulse generators are Indonesia, Malaysia, and Singapore. Their bilateral output multipliers are higher than the regional average and have contributed to many countries. Indonesia has strong linkages with Singapore, 0.3161, and Malaysia, 0.2561. This indicates deep regional value-added networks and possibly intermediate goods supply from Indonesia. Indonesia also exhibits notable integration with Thailand, 0.085, and Vietnam, 0.1233. Singapore has substantial value-added from Brunei, 0.2416, Malaysia, 0.1273, and Indonesia, 0.0795, highlighting its role as a hub for agri-logistics, processing, and re-exporting. The key recipient countries are Cambodia and Laos. They have been acting as value-added recipients rather than generators, benefiting significantly from demand in countries such as Thailand and Vietnam.

Table 11. Intra-ASEAN Agriculture Bilateral Output Multipliers.

	Country	Host Country/Export Destination								
		Brunei	**Cambodia**	**Indonesia**	**Laos**	**Malaysia**	**Philippines**	**Singapore**	**Thailand**	**Vietnam**
	Brunei		0	0.0064	0	0.0108	0.0081	0.008	0.0072	0.0036
	Cambodia	0.0031		0.0006	0	0.0019	0.002	0.011	0.0074	0.0628
	Indonesia	**0.141**	**0.2472**		0.0077	**0.4874**	**0.5935**	**0.2621**	**0.1608**	**0.238**
	Laos	0.0009	0.025	0.0013		0.0002	0.0001	0.0005	0.0219	0.0137
Home	Malaysia	**0.5454**	0.0646	0.0851	0.0275		0.1059	**0.2499**	0.0934	0.1034
	Philippines	0.0622	0.0046	0.0334	0.001	0.043		0.0413	0.0605	0.0246
	Singapore	**0.5845**	0.1145	**0.2158**	0.0748	**0.3345**	**0.1656**		**0.129**	0.1097
	Thailand	0.0486	**0.4622**	0.121	**1.2302**	**0.1734**	**0.1425**	0.0535		0.0997
	Vietnam	0.0272	**0.251**	0.0548	**0.223**	0.0904	0.092	0.0991	0.0733	

Note: The average ASEAN bilateral output multiplier is approximately 0.123. Values in bold indicate sectors with multipliers exceeding the regional average, while non-bold indicate sectors with multipliers below the average.

Table 12. Intra-ASEAN Agriculture Bilateral Value-Added Multipliers.

	Country	Host Country/Export Destination								
		Brunei	**Cambodia**	**Indonesia**	**Laos**	**Malaysia**	**Philippines**	**Singapore**	**Thailand**	**Vietnam**
	Brunei		0	0.0037	0	0.0062	0.0044	0.0046	0.0043	0.002
	Cambodia	0.0016		0.0003	0	0.001	0.0009	0.0061	0.0037	0.0372
	Indonesia	**0.0756**	**0.129**		0.004	**0.2561**	**0.3161**	**0.1404**	**0.085**	**0.1233**
	Laos	0.0006	0.0155	0.0007		0.0001	0.0001	0.0003	0.0137	0.0088
Home	Malaysia	**0.2545**	0.0263	0.0357	0.0127		0.0424	**0.1061**	0.0397	0.0415
	Philippines	0.0338	0.0023	0.0168	0.0005	0.0214		0.0213	0.0304	0.0125
	Singapore	**0.2416**	0.0429	**0.0795**	0.0314	**0.1273**	**0.0615**		0.0495	0.0377
	Thailand	0.0219	**0.1506**	0.0481	**0.4475**	**0.0683**	**0.0546**	0.0219		0.0339
	Vietnam	0.0132	**0.1011**	0.0203	**0.0871**	0.034	0.0344	0.0425	0.0258	

Note: The average ASEAN bilateral value-added multiplier is approximately 0.053. Values in bold indicate sectors with multipliers exceeding the regional average, while non-bold indicate sectors with multipliers below the average.

4. Discussion

ASEAN has been a major destination market for US agriculture[4]. Three ASEAN countries are among the top 15 destinations for US agricultural exports: the Philippines, Vietnam, and Indonesia[29].

Based on **Table 13,** the US exported the largest agricultural values, excluding livestock, to Indonesia ($1.58 billion), followed by Vietnam ($1.33 billion) and the Philippines ($844 million). These three countries account for more than 75% of US agricultural exports to ASEAN. The statistics from the USDA[32] are similar to our findings on the size of the multipliers among ASEAN member states. In **Table 1**, the Philippines, Indonesia,

and Vietnam ranked highest in the size of output multipliers. This reflects strong vulnerability to tariffs. The combination of high multipliers and being large US export markets signifies that any US tariff measures on agriculture could ripple strongly.

Referring to **Table 13**, the US has positive net exports with seven ASEAN countries. On the other hand, only Brunei and Thailand have recorded net deficits for the US. The numbers show where US agricultural exports are most vulnerable to tariff measures, especially in Indonesia and Vietnam. The table also highlights Thailand as a special case, where the US is a net importer, so tariffs might affect domestic consumers differently than in other ASEAN countries.

Table 13. Agricultural Trade of the US in 2023, excluding livestock [32].

Rank	Countries	Exports Values ($ Thousands)	Imports Value ($ Thousands)	Net Exports ($ Thousands)
1	Indonesia	1,582,332	287,897	1,294,435
2	Vietnam	1,330,546	384,540	946,006
3	Philippines	843,827	23,084	820,743
4	Malaysia	266,205	1,331	264,874
5	Singapore	32,056	1,293	30,763
6	Cambodia	5,874	3,160	2,714
7	Laos	2,065	322	1,743
8	Brunei	0	108	−108
9	Thailand	485,567	722,719	−237,152

These trade patterns connect directly with the multiplier analysis under Objective 1, which examines the broader economic impacts of agriculture across ASEAN countries through direct, indirect, and induced effects of agricultural output multipliers. While the export statistics identify where US agricultural trade is most concentrated and vulnerable, the multiplier results complement this picture by revealing how agriculture is embedded in domestic and regional value chains.

Figure 1 shows that most ASEAN member states rely heavily on indirect effects, especially Brunei, Thailand, and Malaysia, with 91%, 86%, and 79% respectively. This numerical trend suggests strong connections between industries and robust domestic production networks. The strength of indirect effects highlights the important role of agricultural supply chains and local sourcing in supporting national economies [33, 34]. Based on this evidence, one possible policy implication is that improving local input availability and processing capacity could strengthen these domestic production networks [35].

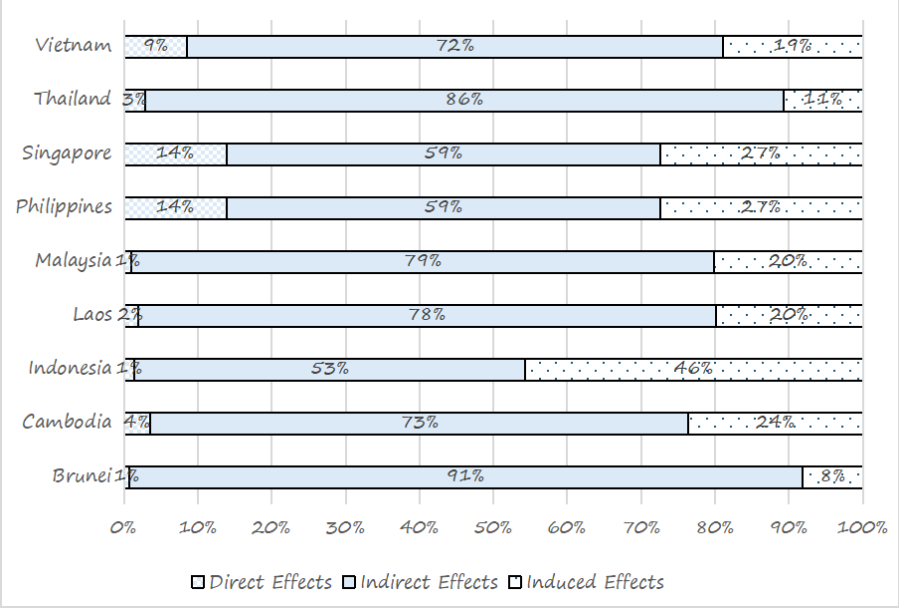

Figure 1. Agriculture Output Multipliers of ASEAN Countries.

In contrast, Indonesia, Singapore, and the Philippines show higher induced effects, making up more than 25% of total agricultural output impacts. This trend suggests that agriculture is a key driver of household incomes and consumption-based multiplier effects, reinforcing its role in reducing poverty and promoting rural development[36]. These findings match existing literature that points to agriculture as a vital mechanism for inclusive growth in ASEAN[1]. As a result, public investment in farm productivity, rural education, and health services can enhance these benefits, building socio-economic resilience through agricultural development.

Moving to Objective 2, the analysis identifies the leading sectors that support agriculture in each ASEAN country. The empirical results show strong connections between agriculture and food and beverage manufacturing in Indonesia, Laos, the Philippines, and Vietnam, as this sector ranked the 2nd highest multiplier within the supply chain of Agriculture. This highlights the economic significance of agro-processing[36]. This reflects the potential to expand the downstream infrastructures. One policy strategy would be to promote agro-processing parks, incentivize agribusinesses, and invest in logistics infrastructure.

Additionally, financial services and communications are vital sectors that support the agricultural value chain[37]. The significant role of financial services shows the need for accessible credit, insurance, risk management tools, and financial literacy programs, which are all important for modern, climate-smart farming. At the same time, the importance of telecommunication infrastructure demonstrates the growing need for digital access in agriculture. This includes mobile services, internet access, and e-commerce platforms for farmers. Policymakers should prioritize investing in rural financial institutions and ICT infrastructure to improve farmers' access to markets, information, and digital transactions.

Under Objective 3, the bilateral output and value-added multipliers shed light on the cross-border connections of agricultural production within ASEAN. Indonesia, Malaysia, and Singapore are the main drivers in the region, showing multiplier values above the ASEAN average of 0.123 for output, and 0.053 for value-added. Their role reflects their position as regional centers for agricultural production, processing, and trade. This finding can be interpreted as an opportunity for these economies to consolidate leadership through targeted investments in logistics, research network, and harmonized standards.

On the other hand, Cambodia and Laos show relatively low bilateral multiplier values, which are close to zero. This indicates limited upstream integration and weak agro-industrial capacity. Interpreting this result, such economies could benefit from programs that build capacity, promote technology transfer, and attract investments aimed at creating agri-processing zones and boosting productivity. Development cooperation and knowledge sharing within ASEAN could accelerate structural changes in these economies.

Drawing on the numerical findings across the three objectives, several broader implications emerge. Some of these are directly supported by multiplier evidence, such as financial services and ICT sectors, while others are interpretative extensions, such as safeguarding agricultural sovereignty through local content requirements.

Secondly, the governments shall strengthen agricultural supporting sectors. The growth of agriculture is tied to its supporting environment. Improving the financial sector through credit access, insurance, and rural banking services, along with expanding digital infrastructure, is crucial. Such measures will help smallholders and agribusinesses grow and integrate more effectively into local and regional supply chains.

Thirdly, regional agricultural integration is helpful to the agriculture sector within the region. At the ASEAN level, coordinated efforts to improve agricultural trade logistics, harmonize cross-border standards, and integrate regional supply chains are essential. This approach will support trade in agricultural products, enhance food security, and foster shared prosperity through agriculture-driven growth.

All in all, ASEAN's agricultural sector features strong links both domestically and regionally. A strategic mix of policies that combines local capacity building, infrastructure upgrades, and regional cooperation will be crucial for unlocking agriculture's full economic and social potential in the region.

Trade volatility has increasingly complicated the

policy environment for ASEAN economies. A recent example is the imposition of reciprocal tariffs by the United States in 2025, which reflects the broader trend of rising global protectionism [2]. These measures primarily targeted countries with which the U.S. has persistent trade deficits. Although some temporary concessions have been granted, such as the US-Indonesia trade agreement, which Indonesia eliminated most tariffs on US goods and relaxed local content and food safety regulations. The reality is that such arrangements often highlight the unequal bargaining positions between ASEAN and larger economies [2]. The evidence suggests that while stronger economies like Indonesia can negotiate partial relief, lower-multiplier countries such as Cambodia and Laos remain far more vulnerable. Their limited integration into regional value chains, as indicated by near-zero multiplier spillovers, leaves them with weaker leverage in trade negotiations and fewer buffers against external shocks. This underscores the need for ASEAN-level initiatives that strengthen the agro-industrial capacity of these economies, thereby improving both resilience and bargaining power in the global trading system.

Beyond regional disparities, global trends further underscore the necessity of food self-reliance. Rising demographic pressures and shifting consumption patterns are challenging the ability of global markets to ensure long-term food security [38]. While some ASEAN states are net food exporters, others face chronic reliance on imports due to low agricultural productivity and limited land use efficiency [39]. This exposes structural vulnerabilities within food systems, making it imperative for ASEAN countries to invest in domestic capabilities and reduce dependence on volatile global supply chains.

Despite the existence of multilateral trade frameworks within ASEAN, agricultural liberalization remains highly constrained. Non-tariff measures, especially those related to sanitary and phytosanitary standards as well as technical regulations, frequently impose costs equivalent to tariffs exceeding 40–60% [40]. As a result, intra-ASEAN agricultural trade is limited, largely consisting of low-value or unprocessed commodities. Empirical models indicate that intra-regional agri-food trade currently achieves only about 22% of its potential, with persistent inefficiencies stemming from inadequate infrastructure, inconsistent regulatory standards, and fragmented logistics networks [40].

5. Conclusion

This study provided evidence-based analysis on ASEAN's long-standing efforts in developing the agricultural sector through the lens of input-output multipliers, sectoral interdependencies, and intra-regional economic linkages. The prevalence of indirect effects in the multiplier structure among most ASEAN countries underscores the strong integration of the agriculture sector within domestic value chains. This reflects a degree of resilience rooted in local supply networks and the positive benefits of utilizing the local content to support the agriculture sector, or the other way round. This becomes crucial when facing external disruptions such as US trade protectionism. Similarly, a relatively high proportion of induced effects shows supporting evidence to the fact that the agriculture sector is an enabler in generating substantial household incomes, reinforcing the importance of the sector for the inclusive and equitable distribution of income within the countries.

The findings reveal that financial intermediation and post and telecommunications play a pivotal role in enabling the agriculture sector to absorb and respond to shocks. Access to capital, infrastructure, and technologies is essential to support the development of the agriculture sector in a sustainable way.

At the regional level, countries such as Indonesia, Malaysia, and Singapore are identified as key impulse generators, playing leading roles in maintaining the momentum of agriculture production networks across ASEAN. Meanwhile, Cambodia and Laos require targeted policy interventions to strengthen their agro-industrial base, foster technology adoption and transfer to deepen their integration into the regional value chain.

While this study has shed light on the structural dynamics of ASEAN's agroeconomic sector under the influence of US tariff policies, future research could benefit from conducting in-depth country-specific case studies. Such analyses would provide a deeper understanding of domestic policy frameworks and highlight the

role of critical infrastructure in shaping agricultural resilience. Additionally, further research could explore the prospects of regional agricultural collaboration to strengthen economic integration and foster collective agroeconomic development across ASEAN.

Author Contributions

Conceptualization, analysis, and supervision C.C.Y,; Methodology, C.C.Y, and E.J.J.N.P.; Writing,E.J.J.N.P.; Review and editing, C.C.Y. and E.J.J.N.P.

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Data Availability

Data are available on reasonable request.

Conflict of Interest

The authors declare no conflict of interest.

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