NBC Working Paper[1]

Supporting Pathways Post Covid-19 Economic Recovery in Cambodia: Characterizing Input-Output Linkages of Leading Sector

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Abstract

Since late 2019, the global COVID-19 pandemic has posed an unprecedented economic challenge. Cambodia is also affected by employment losses, business disruption, and economic decline. This paper aims to characterize the economic system's production structure from the perspective of its domestic sector and identify and characterize the backward and forward linkages pathways of a targeted sector using the input-output table of three-year periods, 2015, 2019, and 2020. Multiplier and linkage analyses are used in this study. We discover that the top five output multipliers before COVID-19 in 2015, except for textile and electricity in 2020, are food and beverage, tourism-related, electricity, textile, and public administration. All industries' output multipliers, however, decreased in 2020. Financial and insurance, education, real estate, agriculture, and mining are the top five generated value-added multipliers in 2015 but lower in 2020. Overall inter-industry linkage was relatively low. We also discover that non-garment, textile, transportation, and communication are crucial industries throughout the three periods. In 2019–2020, the construction sector emerged as a vital industry; in 2020, electricity, food, and beverage shifted to a critical sector. This study may suggest that there would be a need for promoting, encouraging, and investing in key economic sectors. Policy intervention should foster domestic linkages and bolster cross-industry links to diverse primary sectors that contribute to the local economy.

Keywords: *Multiplier, Linkages, Input-Output, Key Sectors*

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1. Introduction

The global pandemic crisis has severely impacted economies and communities worldwide for more than two-year since late 2019, primarily through profound effects on international trade, production, economic activities, supply chain, and employment. Numerous reputable organizations, including the Asian Development Bank, the United Nations System, and the International Monetary Fund, have calculated the enormous costs of the pandemic at national, regional, and global levels. The pandemic has caused an unparalleled employment dilemma, according to International Labour Organization (ILO) (2020). It is estimated that the manufacturing, real estate, wholesale and retail, and hotel and restaurant sectors will have the highest rates of youth unemployment globally. Currently, the world economy is going through another significant negative shock while dealing with the repercussions of the pandemic that lasted more than two years. In addition to causing a humanitarian disaster—thousands of people have died, and more have been displaced—Russia's invasion of Ukraine has had significant negative regional and global spillovers. Pre-existing strains from the epidemic, like bottlenecks in global supply chains and a considerable increase in the price of numerous commodities leading to high inflation and monetary tightening that caused the global economic recession, are being amplified by these spillovers.

Cambodia, an open economy country, unavoidably has negative affect from these spillovers either directly or indirectly. It is noteworthy that the supply and demand sides are both affected by the crisis. Due to its reliance on narrow-based industries in garment, tourism, agriculture, and construction, Cambodia is exceptionally vulnerable. It has a highly open economy, in which exports and imports account for roughly 62% and 63% of GDP, respectively. Foreign direct investment accounted for 11 percent of GDP. On the supply side, Cambodia heavily depends on China for the raw materials used in its garment industry and as a source of tourists. China is a significant export market for agricultural goods on the demand side. Construction is an important industry that receives capital mainly from China. Cambodia's higher value-added exports go primarily to the European and the United States market. In the COVID-19 period in 2020, Cambodia's GDP declined by 3.1%. The primary sources of revenue for Cambodia's economy—tourism, construction, and exports of manufactured goods—have all suffered as a result of the crisis. Cambodia’s economy gained momentum to gradually rebound to normal faster than expected in 2021, with an estimated growth of 3%, but it has not yet reached the pre-COVID-19 pandemic level at around 6.5%.

Sector-by-sector economic recovery stayed uneven, necessitating the creation of data on the underlying characteristics of sectors in production networks to adapt to and recover from the pandemic and general economic unpredictability. Therefore, this paper employs an input-output table (IOT) of the three points of years 2015, 2019, and 2020, which are the latest and available in the ADB database. This paper initially characterizes the economic system’s production structure from the perspective of its domestic sector. It is possible to provide valuable insight into which sectors are the most productive in output and value-added when the ultimate demand changes using multiplier analysis. Then, I also use the linkage analysis to identify and characterize the backward and forward linkages pathways of a targeted sector in a way that aids in the recovery from a shock to the production network of Cambodia and generates data for

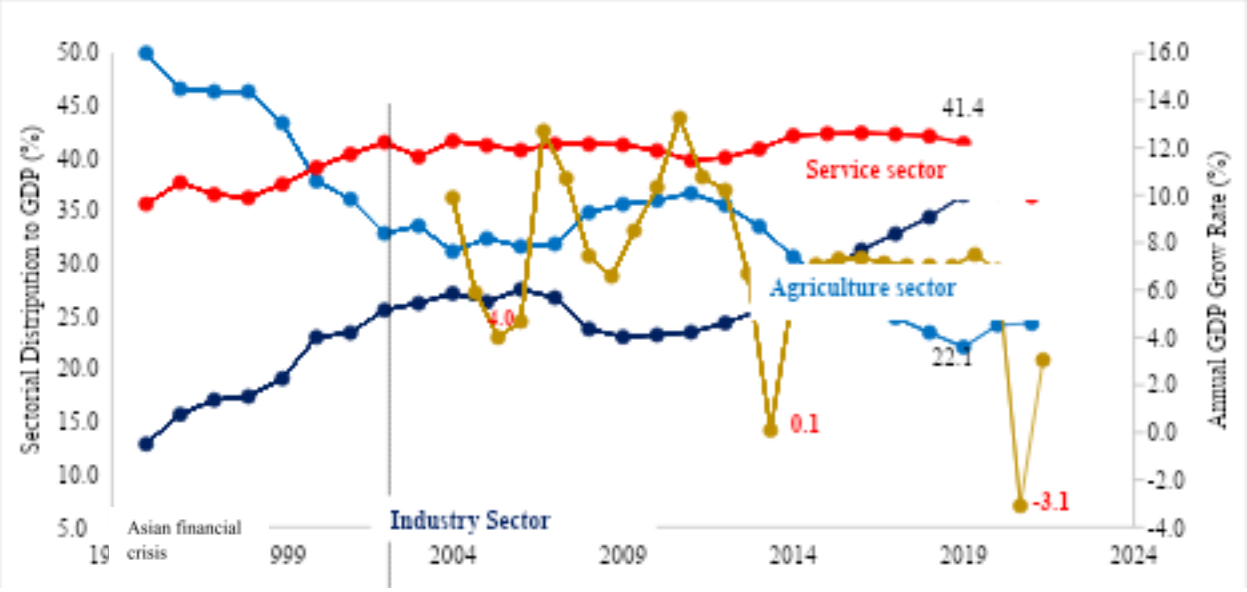
informed policymaking to address the harmful effects of the pandemic and global economic uncertainty.

This paper is designed into seven sections. Following the introduction, section 2 describes Cambodia's economic structure before and during COVID-19. Section 3 describes the relevant studies; Section 4 describes the research method; sector 5 describes the data source; sector six discusses the result, and the final section is the conclusion and policy recommendation.

2. Cambodia's economic structure before and during COVID-19

Cambodia is situated in the South-East Asian region, with a population of nearly 17 million people in 2021. The Cambodian economy has experienced significant expansion, with an average growth rate of 7.7% per annum from 1995 to 2019. During this time of development, Cambodia also experienced the Asia Financial Crisis in 1997 and the Global Financial Crisis in 2009. However, the economy quickly recovered to achieve a high economic growth rate of more than 7%, supported by macroeconomic stability, trade openness, foreign direct investment inflows, and structural transformation driven by export-oriented, labor-intensive manufacturing. Then Cambodia achieved lower-middle-income status in 2015, which led the government of Cambodia set a long-term goal to become an upper-middle-income country by 2030 and an upper-income country by 2050. Cambodia's fast-growing economy for nearly three decades ended in 2020 because of the global pandemic crisis causing Cambodia's GDP to contract by 3.1%. The problem has affected Cambodia's key economic drivers: tourism, construction, garment, and real estate. However, Cambodia's economy gained pace to gradually return to normal faster than anticipated in 2021, with an estimated increase of 3%, but it has not yet regained the pre-COVID-19 pandemic level.

Figure 1 Annual GDP Growth and Sector's Contribution to GDP, 1995-2021



Source: Elaborated by the author using data from key indicators for Asia and the Pacific-ADB (2022) and UNCTAD stat (2021)

Looking through Cambodia's economic structure, Cambodia has shifted from a traditional agricultural-based economy to a service-based and industrial-based economy since 2000 (Figure 1). The tourism sector has played an essential role in this transformation in the back of a fast-growing number of foreign tourist's inflow. Most sub-service sectors, hotel, restaurant, transportation and communication, finance, real estate, and other service sectors, have shown a sustained and stable GDP contribution before the pandemic. The GDP contribution of the agriculture sector fell substantially, by 29 percentage points, from 51% in 1995 to 22% in 2019. The service sector witnessed a 5.4 percentage point gain from 1995 to 2019 (from 36.4% to 41.4%), whereas the manufacturing industry saw a 23.5 percentage point increase (from 13.5% to 36.5%). Cambodia's economy became relatively more industrialized during the pandemic. In 2021, the industry's GDP contribution outpaced that of the service sector, and agriculture's GDP contribution increased as well.

3. Literature Review

This section's literature review will review the multiplier of industries before moving on to linkages to identify the study's gap for this paper's contribution.

Multipliers are essential to simulate the effects of an exogenous demand-side shock brought on by particular industries in the input-output table. In particular, multipliers determine the impact of a unit change in the final demand for a sector's product on an economy's gross output or overall value added (ADB, 2021). Asian Development Bank (2021) examines the output and value-added multipliers for the digital sector in 16 economies using two periods. According to the analysis, many nations showed decreased output multipliers across all digital industries in later periods. It suggested a greater reliance on the external economy (imported inputs) or, more broadly, the dilution of local connections in the digital industry. Each economy's value-added multiplier, meanwhile, became more consistent over time. Bekhet et al. (2016) examined Malaysia's manufacturing sector's energy consumption and performance during the global financial crisis using the output multiplier analysis. This study finds significant changes in the output multiplier of the manufacturing industry between 2005 and 2010. The energy-to-manufacturing sectors' output multiplier declined during the crisis because of a decline in export-oriented industries. Cassar and Rapa (2018) estimated input and output multipliers for the Maltese economy based on the symmetric IOT for 2010. This study finds that accommodation and food services activities are in the top 15 highest output and value-added multipliers. The public administration, education, and human health sectors also found consistently strong multiplier effects. Subanti et al. (2018) analyze the role of mining sectors on the Indonesian national economy using multiplier analysis. The study finds that Indonesian mining sectors ranked 6th, contributing 6.81% to national output and 12% to gross value added. This sector's output and value-added multiplier are around 1.24 and 0.71, respectively. Yoga et al. (2020) find that electricity and gas have the highest output multiplier, while agriculture, forestry, and fisheries have the lowest output multiplier. In addition, electricity and gas have the highest value-added in the economy. Mandras and Salotti (2020) calculate the output and value-added multipliers of the sectors to determine sectoral specialization and trade integration of the Western Balkans economies. They discover that Albania's demand-side monetary infusions have the potential to impact several construction-related industries positively.

In addition to the multiplier, the linkage analysis is used to understand the inter-industry links between economic sectors. It comes with a few crucial advantages. The linkage analysis is used to comprehend the inter-industry relationships between economic sectors in addition to the multiplier. It has a few significant benefits. It starts by giving a broad picture of the economy while noting domestic production changes. It also includes data on how the sector or industry is doing economically. Thirdly, it highlights the value of relationships across sectors. (Gabriel and Ribeiro, 2019; Pratt et al., 2018). There are two types of economic linkages, e.g., backward linkage (BL) and forward linkage (FL) (Cai et al., 2006). The BL shows the relationship between sectors' demand. For instance, if industry (X) grows its production, there will be an increase in demand for other industries whose outputs use the sector's raw materials. The FL also marks the supply association at the same time. The additional volume of production at sector (Y) that is available for use as inputs or intermediary goods for the output of another industry is referred to as an increase in producing products in the industry (Y).

Studies have used economic development during the previous 60 years to illustrate how interdependent and intersectoral industries are. Rasmussen (1956), Hirschman (1958), and Chenery and Watanabe (1958) were the first to introduce the connection approaches. Later, they were developed in-depth and were widely discussed (see Sonis et al., 1997; Temurshoev, 2010). Numerous studies focus on sectorial-level analysis in different nations while employing various econometric approaches to examine the economic impact and its connections. The nexus between tourism and economic growth is studied by Atan and Arslanturk (2012) using the IO model, which also entails a look at the economic ties between tourism and Turkey. According to the findings, Turkey's primary industry is not tourism, and all tourism-related sectors are backward-oriented. Using the IO table 2003-2008, Khanal et al. (2014) examine the inter-industry linkage between tourism and other sectors using a variety of linkage methodologies. The analysis demonstrates that from 2003 to 2008, the Lao PDR's tourism industry had a positive economic impact. The essential sectors are manufacturing, agriculture, wholesale and retail, food and beverage, and tourism. The rise of the tourist sector propels and enables the nation to experience one of the most significant economic growth rates in the Great Mekong Sub-Region. The use of the input-output table framework to explain the economic structure system and sectorial linkage in Cambodia, particularly during COVID-19, was still quite limited.

To the author's knowledge, this paper will fill the limited study with three recent IOT points from 2015, 2019, and 2020. Hence, this study uses three years of the IO tables and extends the literature for Cambodia's economy case to provide insight information on Cambodia's economic system and sectorial linkages of the leading sector using a multiplier and linkages analysis.

4. Research Method

4.1 Multiplier Analysis

The multiplier approach is used to describe the economic system's production structure, and it helps to examine how changes in the exogenous system affect the relevant macroeconomic variable. The multiplier determines which economic sectors would experience significant changes in output or value added if their ultimate demand changed by a certain amount. It is possible to determine which industries should be carefully explored or encouraged to promote more comprehensive economic growth. It is a widespread belief that exogenous changes frequently manifest as changes in ultimate demand, which implies a demand-driven input-output

model. The macroeconomic variables calculated by the system were output, income, employment, and value-added (Miller & Blair, 2009). Because there is a lack of data on income and employment in 2019-2020, this study will, however, only concentrate on output and value-added multiplier.

The input-output model calculates the output multiplier, representing the fundamental multipliers structure. The input-output model, as per Miller and Blair (2009), can be expressed as follows:

$$X = (I - A)^{-1}Y = BY$$

$X\ and\ Y$ denote outputs and total final demand; $A = \left[a_{ij}\right]$ is an input coefficient matrix; $B = (I - A)^{-1}$ is the Leontief inverse matrix.
The output multiplier for sector j of the economy is obtained by adding the column sum of the Leontief inverse. In mathematics, this is represented as:

$$A_j = \sum_{i=1}^{n} a_{ij}$$

The value-added multiplier is assessed to comprehend how ultimate demand changes impact the economy's overall value-added. The following is how the value-added multiplier equation is expressed:

$$vA_{(i,j)} = \sum_{i=1}^{N} v_{(i,j)} a_{(i,j)}$$

Where $v_{(i,j)}$ is a vector of value-added per unit of output in economy i sector j, the value-added multiplier of each sector is found by multiplying elements of the Leontief inverse with the value-added vector (Miller & Blair, 2009; Oosterhaven & Fan, 2006).

4.2 Linkage Analysis

The input-output paradigm allows for the estimation of the impact of one sector's production on the other sectors of the economy from two different perspectives: supply-driven and demand-driven perspectives. The demand-driven perspective is characterized by the backward linkages of economy-sector j, which measure its interconnectedness to other economies from which it purchases its inputs for production.

The backward linkage calculates a sector's importance as a buyer of inputs from other sectors (Miller & Blair, 2009). An industry with a greater backward value would significantly impact domestic output demand, claim Cai et al. (2006). Following Otchia (2013, p. 94), Rasmussen-Hirschman Backward Linkage can be equated as:

$$BL_j = \frac{\frac{1}{n}\sum_{i=1}^{n} b_{ij}}{\frac{1}{n^2}\sum_{i,j=1}^{n} b_{ij}} = \frac{\frac{1}{n}B_j}{\frac{1}{n^2}V} = \frac{B_j}{\frac{1}{n}V};$$

Where $V = \sum_{i=1}^{n}\sum_{j=1}^{n} b_{ij}$ is a summation of all cells in the inverse matrix, $B_{.j} = \sum_{i=}^{n} b_{ij}$ is the summation of the total j-th column of the Leontief Matrix.

Contrarily, the forward linkage of economy sector j, which represents the supply perspective, quantified its interconnectedness to other economies that buy its outputs to use as inputs in their respective production. The forward linkage gauges how vital a sector is to other industries as a source of inputs (Miller & Blair, 2009). A more significant impact on the economy is provided by forward linkage because of its higher value (Cai et al., 2006). The Rasmussen-Hirschman Forward Linkage can be expressed as follows:

$$FL_i = \frac{\frac{1}{n}\sum_{j=1}^{n} b_{ij}}{\frac{1}{n^2}\sum_{i.j=1}^{n} b_{ij}} = \frac{\frac{1}{n}B_{i.}}{\frac{1}{n^2}V} = \frac{B_{i.}}{\frac{1}{n}V}$$

Where $B_{i.} = \sum_{i=}^{n} b_{ij}$ is the summation of the total i-th row of the Leontief inverse matrix, in addition to the backward and forward linkage, I also applied critical sector analysis by identifying the key sectors in an economy using the results of backward and forward linkage. I list the following four categories of industries: Key sectors (both linkages measure larger than 1); backward-oriented sectors (only $BL_j > 1$); forward-oriented sectors (only $FL_i > 1$); and weak sectors (both linkages measure smaller than 1). Key sectors have the most significant effect within the system, i.e., those with the most significant capacity to boost production in both the upstream and downstream reaches of their respective supply chains. For instance, if economy-sector *i* has a stronger backward linkage than economy-sector *j*, increasing production in sector *i* could spur more economic activity in upstream sectors than in economy-sector *j*. Therefore, a policy that favors sector *i* may ultimately benefit the economy. The increase in output of economy-sector *j* is more advantageous or stimulating, however, if its forward linkage is greater than that of economy-sector *k*, as this results in an increase in production across all sectors that make up its downstream supply chain.

5. Data Source

The researcher and international organizations have created and launched Cambodian Input-Output Table (IOT). Dr. OUM Sothea founded the first IOT. In the Global Trade Analysis Project (GTAP) database, his two years of IOT (2004 and 2008) have been formally published. In 2004 it consisted of 35x35 sectors, and in 2008 it consisted of 22x22 industries. The second source is the ADB-created 6060 Supply and Use Table for 2011. (2012). The Organization for Economic Co-operation and Development has developed the third source of IOT (OECD). 35 x 35 areas are included, spanning the years 1995 to 2015. The OECD created the Cambodian IOT, which uses the industry-by-industry methodology. The fourth source of the IOT table has constructed by the Asian Development Bank (ADB). It has 35x35 sectors that span the years 2000–2020. Thus, this table contains functional, structural, and linkage analyses because it contains all industries of the economy.

As mentioned above, this study aims to describe the economic system's production structure and identify the leading sector in Cambodia. I chose IOT obtained from the ADB database (https://data.adb.org/dataset/cambodia-input-output-economic-indicators) because it

covers a more extended period than other sources, mainly including the COVID-19 period. Three years of IOT (2015, 2019, & 2020) have been used in this study. Each original 34-sector IOT is aggregated into 15-sector as shown in Table.1 in the appendix.

6. Result and Discussion

The results of the estimation have been covered in this section. Three sections comprise the discussion: Section 6.1 covers the economic structure of Cambodia; Section 6.2 examines output and value-added multipliers; Section 6.3 discusses backward and forward linkages; Section 6.4 discusses key sectors.

6.1 The summary statistics of Cambodian economic structure, 2015-2020

This section provides an overview of the economic structure in Cambodia based on Table 2's input-output tables for the years 2015, 2019, and 2020. The industries comprising 57% of all gross outputs in 2015 and 58% in 2020 in Cambodia were agriculture, textile, construction, wholesale, and retail. These industries also ranked first in terms of their contribution to GDP and value-added. Notably, the agriculture sector appeared to be the most significant contributor to gross outputs, GDP, and value-added, but it saw a slight decline in share compared to the manufacturing and service sectors. Specifically, textile, construction, wholesale and retail, transportation and communication, and real estate were the five economic sectors that dominated between 2015 and 2020 and contributed a sizeable portion of value-added. However, throughout 2019 and 2020, value-added shares in all sub-service sectors have increased. It is interesting to note that the majority of the sub-service sectors, all sub-industries except mining and agriculture, all showed a slight increase in their percentage of gross output.

In contrast to 2019, the economies of mining, finance, insurance, public administration, and education all experienced constant growth in 2020; while the sector related to tourism saw a sharp decline in its contribution to GDP, falling by more than half in size and by almost half when compared to 2015 and 2019. It was brought on by a substantial fall in international travelers in 2020. A positive increase in GDP contribution was seen in the sectors of agriculture, mining, non-garment, wholesale and retail, real estate, and banking and insurance, while other sectors experienced constant or declining growth in 2020 compared to 2019. Construction, however, saw a substantial increase compared to 2015, whereas all sectors' shares of gross value added were constant in 2020 compared to 2019.

Table 2 Cambodia's Industrial Structure, 2015-2020

Sector	Gross Output (%)			GDP (%)			VA (%)		
	2015	2019	2020	2015	2019	2020	2015	2019	2020
1. Agriculture	19.5	14.9	15.2	23.1	18.2	22.7	27.9	21.5	21.5
2. Mining	1.0	1.5	1.5	0.7	1.1	1.3	1.4	2.1	2.1
3. Textile	17.6	17.3	17.8	16.2	21.7	15.7	11.9	12.0	11.9
4. Food & beverage	5.6	5.6	5.7	5.8	5.6	5.3	2.6	2.7	2.7
5. Non-garment	4.2	4.4	4.5	2.0	2.9	4.0	3.3	3.5	3.5
6. Electricity	2.4	2.4	2.5	1.1	0.5	0.2	0.7	0.7	0.7
7. Construction	10.0	15.3	15.7	12.8	16.9	16.2	10.4	16.1	16.1

8. Transportation &communication	8.2	8.0	8.2	3.6	2.2	2.8	8.4	8.4	8.4
9. Wholesale & retail	9.4	9.0	9.2	8.3	2.4	6.0	10.1	9.8	9.8
10. Financial &Insurance	1.2	1.3	1.3	1.3	1.3	1.7	2.0	2.0	2.0
11. Real estate	6.1	7.4	7.6	5.3	7.3	8.9	6.3	7.6	7.7
12. Public Administration	1.7	1.5	1.5	2.5	2.1	2.0	1.5	1.4	1.4
13. Education	1.2	1.0	1.0	2.0	1.8	1.7	1.6	1.4	1.4
14. Human health	5.1	4.6	4.7	7.2	6.2	6.2	6.7	6.0	6.0
15. Tourism-related	6.9	6.0	3.5	7.9	9.8	5.1	5.3	4.7	4.7

Source: author's calculation based on ADB's IO table, 2015-2020

The export-import structure for Cambodia between 2015 and 2020 is displayed in Table 3. Agriculture, textile, wholesale and retail, and related tourism make up most of Cambodia's exports. These four industries made up 85.8% of all exports in 2015, but by 2020, that percentage had dropped to 83.3%. This pattern benefitted the non-garment, transportation, and communication sectors, which accounted for 8.9% of all industries in 2015 and 11% in 2020. Furthermore, the sector's export intensity, computed as the ratio of each sector's exports to its domestic output, is also shown in Table 3. In 2015, the textile industry was the one that exported 139% of its products to foreign markets. Following it were wholesale and retail (56.6%), tourism-related (68.8%), transportation and communication (70.5%), non-garment (72%), and other manufacturing (72%). The top three industries with the highest export intensity in 2019 were the textile, tourism-related, and non-garment industries, with respective export intensities of 99.7%, 99.6%, and 58%. These sectors outperformed the food and beverage (21.9%), transportation and communications (20.4%), and agricultural (18.3%) sectors. Agriculture had the second-highest export intensity in 2020, behind only the tourism-related (98.8%), non-garment (60.1%), food and beverage (28.3%), and transportation and communication industries (23.1%). The export intensity of the agricultural industry increased dramatically from 22.7% in 2015 to 85.3% in 2020. This upward trend shows that the global pandemic epidemic did not negatively affect Cambodia's agricultural sector.

Cambodia imports non-garment, wholesale and retail, construction, agriculture, transportation, and communication items. It accounted for 76% of total imports in 2015, rising to 78.4% in 2020. Due to COVID-19's disruption of the supply chain, most industries showed a declining trend in the proportion of imports to total imports in 2020 compared to the previous year. Contrarily, the proportion of textile and construction imports to overall imports has increased from 2015 to 2020. Table 3 displays each sector's import intensity, calculated as the ratio of imports to domestic production. The industry with the highest import intensity in 2015 was electricity, which imported 205% of its output. This number shows that the local supply in this industry is much lower than what is necessary to ensure self-sufficiency. Other sectors that experienced high import penetration over the same time frame were food and beverage (67%), textiles (66%), non-garment (62%), transportation and communication (33%), construction (32%), wholesale and retail (27%), and public administration (28%). Electricity, non-garment, and textile industries continued to have the highest import intensity in 2019, with 46.5%, 38%, and 35%, respectively, albeit at a lower rate than in 2015. It was followed by 25%, 24%, 23%, 21%, and 18% for wholesale and retail, public administration, food and beverage, construction, and transportation and communication. Electricity (67%), textiles (53.3%), construction (40%), transportation and communication (36%), and non-garment (34%) appeared to be the sectors

with the highest import intensity in 2020. This is a considerable increase from 2019. While other sectors' import intensity also showed a trend toward growth in 2020.

Table 3 Structure of Cambodia's Import-Export, 2015–2020

Sectors	Exports (%)			Imports (%)			Export Intensity			Import Intensity		
	2015	2019	2020	2015	2019	2020	2015	2019	2020	2015	2019	2020
1. Agriculture	11.6	8.3	31.0	10.2	8.5	8.4	22.7	18.3	85.3	10.5	12.5	18.0
2. Mining	0.1	0.1	0.2	0.7	0.9	1.1	6.5	2.4	4.3	14.2	13.7	23.2
3. Textile	50.0	52.8	42.2	27.5	27.9	28.9	139.3	99.7	99.7	66.0	35.3	53.3
4. Food & beverage	2.6	3.7	3.9	6.2	6.1	6.0	20.0	21.9	28.3	67.2	23.9	34.3
5. Non-garment	3.2	7.8	6.5	7.2	7.6	4.5	72.0	58.0	60.1	62.4	38.0	32.4
6. Electricity	0.0	0.0	0.0	5.0	5.1	5.1	0.6	0.0	0.0	205.7	46.5	67.2
7. Construction	0.3	0.0	0.0	11.8	16.0	19.4	1.1	0.1	0.1	32.3	22.9	40.3
8. Transportation &communication	5.7	5.0	4.5	9.8	9.1	9.0	70.5	20.4	23.1	32.9	24.9	35.7
9. Wholesale &retail	10.4	2.2	1.8	9.4	8.5	8.3	56.6	8.1	8.1	26.6	20.9	29.5
10. Financial &Insurance	0.2	0.0	0.0	0.2	0.2	0.1	7.8	0.2	0.3	3.0	3.0	3.5
11. Real estate	0.8	1.7	1.6	2.4	0.9	2.0	4.1	7.4	8.7	6.9	2.7	8.7
12. Public Administration	0.8	0.1	0.1	1.5	1.2	1.1	15.2	1.5	1.7	28.3	17.8	24.0
13. Education	0.1	0.1	0.0	0.6	0.4	0.4	2.5	1.8	1.7	10.4	9.4	12.1
14. Human health	0.2	0.1	0.0	3.7	3.2	3.1	1.4	0.4	0.3	15.7	15.3	22.0
15. Tourism-related	13.8	18.2	8.4	3.8	4.4	2.6	68.8	99.6	98.8	19.6	15.9	24.2

Source: author's calculation based on ADB's IO table, 2015-2020

6.2 Output and Value-Added Multipliers

This section summarizes the output and value-added multipliers for each industry resulting from the IOT for 2015, 2019, and 2020. The multiplier identifies which industries may provide significant changes in output or value added to the economy if their final demand changes by a certain amount. As a result, it is possible to determine which industries should be carefully explored or encouraged to promote more comprehensive economic growth.

Table 4 demonstrates that in 2015, the output multiplier for food and beverage was the highest at 1.86. It indicated that if the ultimate demand for food and beverage rose by US$1 million, the economy would generate a gross output of US$1.86 million. Following the food and beverage sector, the top four highest output multipliers are the electricity, textile, tourism-related, and public administration sectors, demonstrating the critical role these sectors play in raising gross output for the economy when an increase in final demand in these sectors. In contrast to 2019, all sectors' output multipliers in 2020 during COVID-19 are generally on the decline, except for non-garment.

In addition, Table 4 also displays the value-added multipliers for each sector in 2015, 2019, and 2020. Financial and insurance services were among the industries in 2015 with the highest value-added multipliers. This indicates that a final demand increase of $ 1 million for the finance and insurance sector would increase $0.95 million to the total value-added of an economy. The agriculture and education sectors claim the second and third highest value-added multipliers in the three points of the year after the financial and insurance industries. In 2020, the value-added multiplier trended downward across all industries.

Table 4 Results of output and value-added multipliers

Sectors	Output Multiplier			Value Added Multiplier		
	2015	2019	2020	2015	2019	2020
1. Agriculture	1.23	1.16	1.09	0.90	0.85	0.72
2. Mining	1.23	1.18	1.04	0.86	0.83	0.36
3. Textiles	1.67	1.38	1.13	0.64	0.57	0.30
4. Food & beverage	1.86	1.69	1.53	0.72	0.63	0.35
5. Non-garment	1.48	1.27	1.33	0.66	0.56	0.39
6. Electricity	1.76	1.48	1.19	0.57	0.43	0.16
7. Construction	1.41	1.30	1.07	0.76	0.71	0.27
8.Transportation&communication	1.42	1.28	1.12	0.77	0.70	0.43
9.Wholesale& retails	1.43	1.30	1.17	0.79	0.74	0.48
10.Financial&insurance	1.21	1.19	1.17	0.95	0.95	0.64
11. Real estate	1.53	1.48	1.39	0.87	0.90	0.48
12. Public Administration	1.60	1.47	1.34	0.78	0.74	0.50
13. Education	1.33	1.28	1.22	0.89	0.86	0.64
14. Human health	1.31	1.22	1.12	0.85	0.81	0.58
15. Tourism-related	1.81	1.69	1.27	0.82	0.73	0.55

Source: author's calculation based on ADB's IO table, 2015-2020

6.3 Backward and Forward Linkages Analysis

In addition to Section 6.2, this section illustrates the Hirschman-Rasmussen backward linkage (BL) and forward linkage (FL) indices for 2015 to 2020, as shown in Table 5. The BL is also known as the intensity of intermediate inputs, and it shows that a sector needs inputs from other industries to produce its goods. The BL of sector j quantifies the change in overall income concerning the average change in the economy brought on by a unitary injection in the sector j's final demand. If the BL is greater than one, it is implied that an increase in the final demand sector's activity will increase economic activity overall (Otchia, 2013). The FL depicts a sector of the economy that delivers intermediate inputs to other industries and the final domestic demand. The FL of sector j quantifies the change in the sector j's income compared to the overall economy due to a unitary injection in final demand across all sectors. After a unitary injection in all sectors, if the FL for sector j is more than one, the sector j's income will be higher than the average income changes in the economy (Otchia, 2013). Using the PyIO 2.1 program, the connections between each sector have been quantified.

The results demonstrate that seven of the fifteen sectors—tourism-related, food and beverage, textile, non-garment, electricity, construction, and transportation and communication—have significant backward linkages in the three-point periods. These industries highlight how reliant on other economic sectors for their inputs the industries are. Therefore, these sectors of the economy have a significant and positive impact on the whole country. Contrarily, the remaining sectors have shown low backward linkages. There is a little backward linkage in most service sectors, including wholesale and retail, financial and insurance, real estate, public administration, education, and human health. It argues that these sectors employ much lower intermediate inputs from other economic sectors.

Furthermore, the agriculture, textile, non-garment, transportation and communication, wholesale and retail, and tourism-related sectors show the top six highest forward linkages across periods. These industries suggest a crucial role in the supply of inputs to other economic sectors. In contrast, most service sectors have low forward linkage, exhibiting that they are not the dominant sector supplying inputs to other economic activities.

Regarding the linkage trend, backward linkages have grown over time in the textile, non-garment, transportation, and communication sectors. These industries see a rise in their need for intermediate inputs from other industries. In comparison, some industries have seen a relatively stable backward linkage. Agriculture, textiles, non-garment, transportation, and communication have all shown an escalating trend concerning the forward linking trend over time. This shows how crucial these industries are for providing intermediate inputs to other sectors of the national economy. Contrarily, the tourism-related industries have experienced a declining tendency, making their contribution as a source of intermediate inputs to other industries less significant.

Table 5 Result of backward and forward linkages, 2015-2020

Sectors	Backward Linkages			Forward Linkages		
	2015	2019	2020	2015	2019	2020
1. Agriculture	0.80	0.90	0.90	1.50	1.20	1.60
2. Mining	0.80	0.90	0.90	0.80	0.90	0.90
3. Textiles	1.10	1.30	1.50	1.98	2.10	2.20
4. Food & beverage	1.30	1.20	1.30	0.90	0.90	1.00
5. Non-garment	1.40	1.60	1.70	2.08	2.20	2.30
6. Electricity	1.05	1.07	1.06	0.90	0.90	1.00
7. Construction	1.20	1.16	1.18	0.70	0.65	0.80
8.Transportation&communication	1.10	1.30	1.20	1.52	1.60	1.80
9.Wholesale& retails	0.89	0.93	0.92	1.10	1.30	1.20
10.Financial&insurance	0.89	0.90	0.91	0.80	0.90	0.90
11. Real estate	0.73	0.74	0.74	0.60	0.56	0.70
12. Public Administration	0.89	0.89	0.90	0.70	0.80	0.80
13. Education	0.90	0.90	1.00	0.70	0.70	0.80
14. Human health	0.90	0.90	0.90	0.80	0.90	0.90
15. Tourism-related	1.20	1.20	1.10	0.88	0.89	0.77

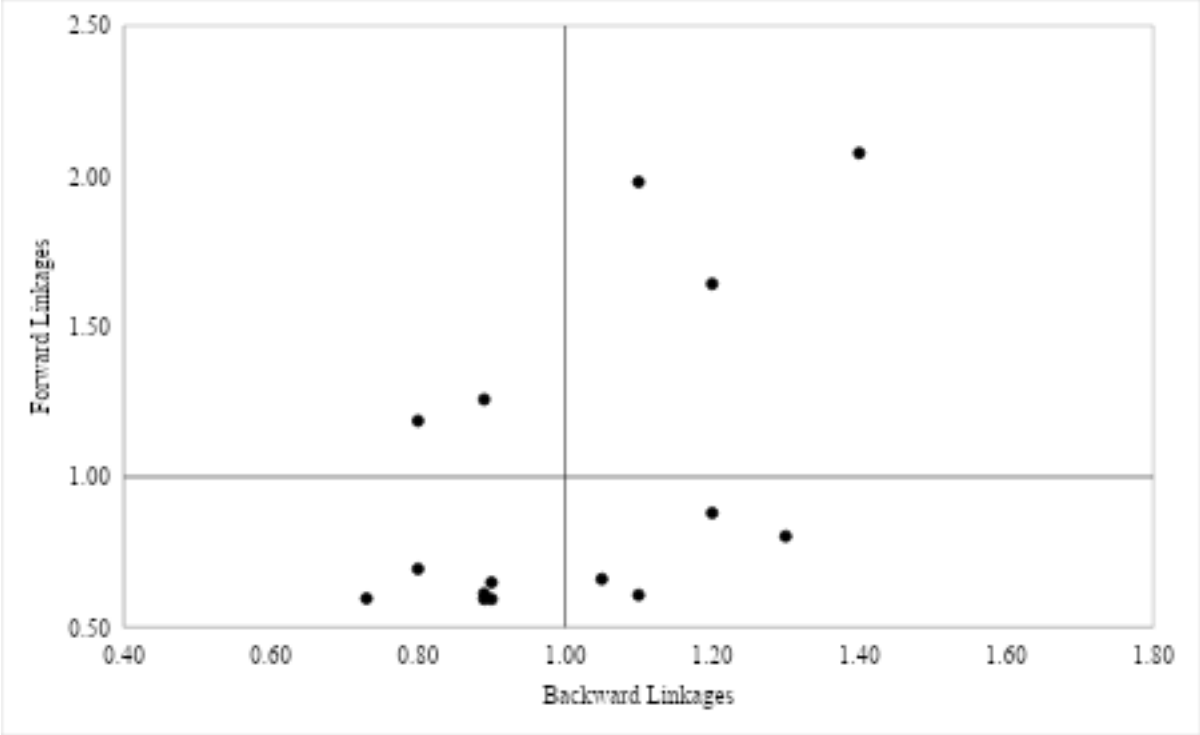
Source: Author's calculation based on ADB's IO Table, 2015-2020

6.4 Key Sectors

The key sector analysis has been used to group industries into four categories: key industries, forward-oriented industries, backward-oriented industries, and weak industries. This classification is based on normalized backward-and-forward linkage indices. The four quadrants in Figures 2 to 4 represent the categorization of the observed economic sectors. The upper right and left quadrants are key and forward-looking sectors, respectively, and the lower right and left quadrants are weak and backward-looking sectors.

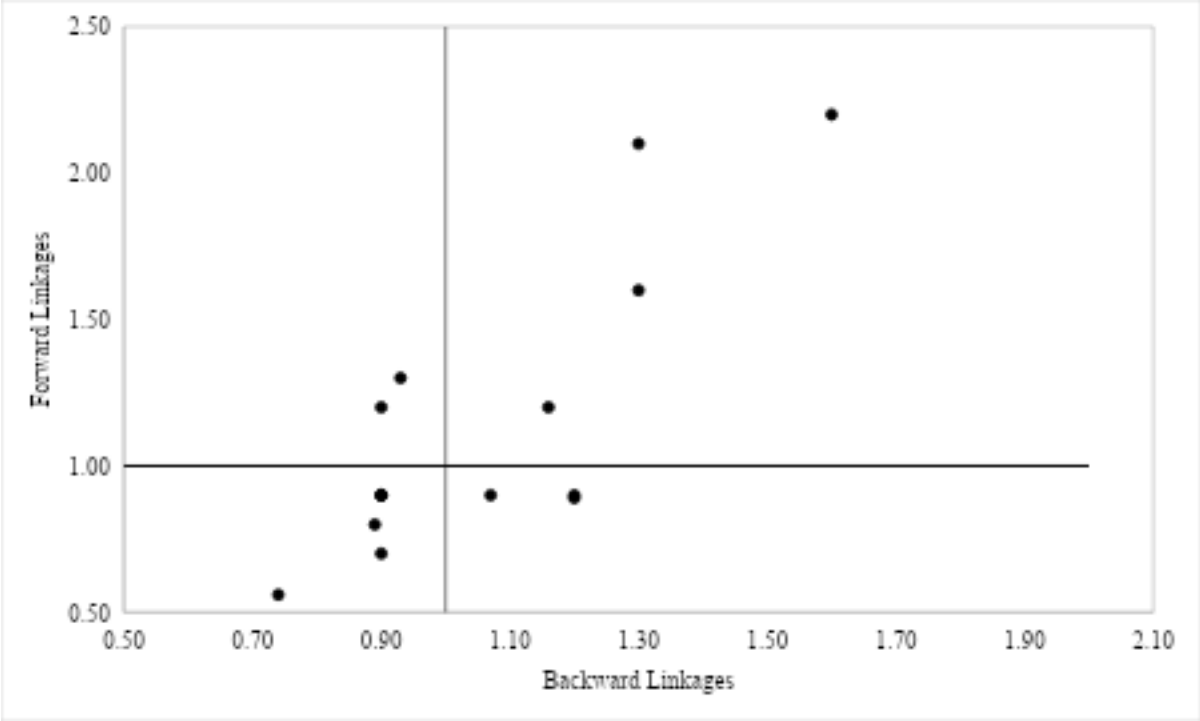
This analysis demonstrates that industries related to non-garment and textile, as well as transportation and communication, have BL and FL levels higher than one during three years. The construction industry emerged as a crucial sector in 2019 and 2020, and the electricity, food, and beverage industries also changed into key industries in 2020. This sector's dependence on other industries means that rising productivity or investment has a knock-on effect on those other sectors. Agriculture, wholesale and retail are forward-oriented sectors span three years, and the results imply that the products of these sectors are used as inputs in the manufacturing processes of other industries. Additionally, most service sectors were weak-oriented for the three years, while the tourism-related sector stood as the backward-oriented sector during the three periods, and education shifted to a backward-oriented industry in 2020.

Figure 2 Key Sector in 2015



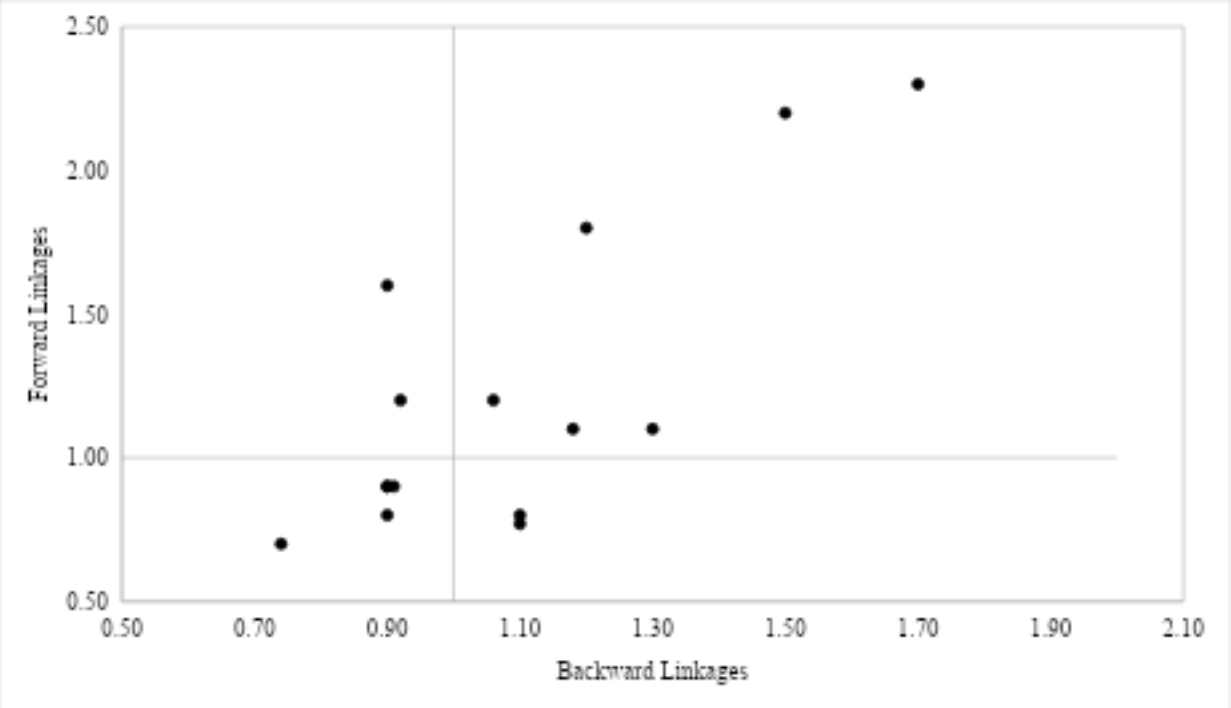
Source: Author's calculation based on ADB IO table, 2015

Figure 3 Key Sector in 2019



Source: Author's calculation based on ADB IO table, 2019

Figure 4 Key Sector in 2020



Source: Author's calculation based on ADB IO table, 2020

7. Conclusion

This study uses an input-output table of three years (2015, 2019, and 2020) to categorize Cambodia's economic production system and sectoral interlinks and identify a leading sector. Multiplier, backward and forward, and critical sector analysis are all used in this study.

The study discovered that the food and beverage industry had the highest output multiplier, indicating that if there were to be an increase in demand in this sector, it would generate additional gross output for the economy. Following this sector, the top four highest output multipliers are the public administration, textile, tourism-related, and electricity sectors, highlighting the crucial role these sectors play in increasing output in other sectors when the final demand in these sectors changes. Except for non-garment, all sectors' output multipliers in 2020 during COVID-19 are largely declining compared to 2019. The finance and insurance sectors were among the highest value-added multipliers in 2015. This suggests that a final rise in demand in the financial and insurance industries would have brought income for the national economy. The agricultural and educational sectors rank second and third in value-added multipliers during the studied period, respectively, behind the financial and insurance sectors. The value-added multiplier had a declining trend in all industries in 2020.

I also find that seven of the fifteen sectors—tourism-related, food and beverage, textile, non-garment, electricity, construction, transportation, and communication—have very significant backward linkages in the three-point periods. Contrarily, there is little backward linkage in the bulk of service sectors, including wholesale and retail, finance and insurance, real estate, public administration, education, and human health. It argues that these sectors employ much lower

intermediate inputs from other economic sectors. Furthermore, the agriculture, textile, non-garment, transportation and communication, wholesale and retail, and tourism-related sectors show the top six highest forward linkages across periods. On the other hand, most service sectors have minimal forward linkages, demonstrating that they are not the dominating sector for delivering inputs to other economic activities.

Intriguingly, this study shows that the non-garment, textile, transportation, and communication industries were the most important for three years. In 2019 and 2020, the construction industry became a significant sector. In 2020, the electricity, food, and beverage sectors also became significant. A rise in productivity or investment in this sector has a ripple effect on the other industries because of its dependence on them. These results highlight the significance of industrialization for Cambodia's economy. They are consistent with the country's Industrial Development Policy (2015–2025), which aims to modernize and transform Cambodia's industrial structure from specialized and labor-intensive industries into skill-driven ones by 2025.

Furthermore, from a policy perspective, these findings emphasize how important it is to link regional and international value chains to develop a thriving and competitive manufacturing sector. Cambodian public policymakers should increase competitiveness, increase the productivity of domestic companies, and work toward creating an industry that is knowledge-based and technology-driven. Investments in the field of transportation and communication should also be prioritized. Investment in this industry should strengthen distribution networks to domestic and international markets and boost market access through trade facilitation and ICT diffusions, such as using the internet and mobile phones. Agriculture, wholesale and retail are forward-oriented sectors that span three years. The service industries also tended to be weak-oriented throughout the three years, except for the education sector, which began to change to backward-oriented in 2020. The tourism-related industries remained backward-oriented for three periods.

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Appendix:

Table 1 List of aggregated sectors in the study

1. Agriculture 1. Agriculture, hunting, forestry, and fishing **2. Mining and quarrying** 2. Mining and quarry **3. Textile** 3. Textiles and textile products 4. Leather, leather products, and footwear **4. Food and Beverage** 5. Food, beverages, and tobacco **5. Non-garment** 6. Wood and products of wood and cork 7. Pulp, paper, paper product, printing, and publishing 8. Coke, refined petroleum, and nuclear fuel 9. Chemicals and chemical products 10. Rubber and plastics 11. Other non-metallic mineral products 12. Basic metals and fabricated metal 13. Machinery, nec 14. Electrical and optical equipment 15. Transport equipment 16. Manufacturing, nec; recycling **6. Electricity** 17. Electricity, gas, and water supply **7. Construction** 18. Construction	**8. Transportation and communication** 19. Inland transport 20. Water transport 21. Air Transport 22. Post and communication **9. Wholesale and Retail** 23. Sale, maintenance, and repair of motor vehicles and motorcycles; retail sale of fuel 24. Wholesale trade and commission trade, except for motor vehicles and motorcycles 25. Retail trade, except motor vehicles and motorcycles; repair of household goods **10. Finance and Insurance** 26. Financial intermediation **11. Real Estate** 27. Real estate activities 28. Renting of M&Eq and other business activities **12. Public Administration** 29. Public administration and defense; compulsory social security **13. Education** 30. Education **14. Human Health** 31. Health and social work 32. other community, social, and personal services **15. Tourism-related** 33. Hotels and restaurants 34. Other supporting and auxiliary transport activities; activities of travel agencies