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# Job Creation from E-commerce: Sectoral Linkages and Implications for ASEAN

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## Abstract

E-commerce, a pivotal component of the burgeoning digital economy in Southeast Asia, is transforming traditional businesses and creating employment opportunities across various industries. This paper employs input-output (IO) analysis to quantify the employment impact of e-commerce, with an initial focus on Singapore as a case study before extending the comparison to other ASEAN nations. Utilising data from the Singapore Department of Statistics (DOS), we estimate the upper bound of job creation attributable to e-commerce, with wholesale & retail trade and information & communication technology (ICT) emerging as the primary drivers. Comparative analysis across six ASEAN countries indicates varying employment prospects under specific economic contexts. These findings underscore the imperative for Southeast Asian countries to equip their workforce, particularly in primary and secondary sectors, with digital skills crucial for harnessing e-commerce-driven job opportunities and adapting to ongoing structural economic transitions.

**Keywords:** E-commerce, digital economy, employment, input-output, ASEAN

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# 1 Introduction

E-commerce, defined as the sale or purchase of goods or services conducted over computer networks by methods specifically designed for the purpose of receiving or placing orders (WTO et al., 2023), has revolutionised consumer experiences and business operations. It offers consumers a vast array of products with competitive pricing and unparalleled convenience, transcending geographical constraints. Concurrently, businesses, particularly small and medium-sized enterprises (SMEs), increasingly adopt technological solutions like business intelligence and data analytics services to enhance operational efficiency.

The proliferation of e-commerce has sparked significant labour market dynamics. While brick-and-mortar stores face competition from online sales channels, potentially leading to job losses, expanding digital transactions generates new employment opportunities. These span from traditional roles in logistics and manufacturing to novel positions in software engineering, live-streaming, and financial technology (FinTech). Given this complex interplay of job creation and displacement, the net effect of e-commerce on a country's labour market remains ambiguous.

Southeast Asia has emerged as one of the world's most promising e-commerce markets, driven by increased internet penetration, a growing middle class, and mobile-first consumer behaviours. According to the "e-Conomy SEA 2024" report by Google, Temasek and Bain, e-commerce in the Association of Southeast Asian Nations (ASEAN) has shown healthy growth momentum in both gross merchandise value (GMV) and profitability (Google et al., 2024b). Notably, the Philippines, Malaysia and Vietnam ranked among the top 10 fastest-growing retail e-commerce markets globally in 2023 (eMarketer, 2024). Recognising this potential, ASEAN nations are enhancing collaboration in e-commerce development, exemplified by the ongoing negotiations of the ASEAN Digital Economy Framework Agreement (DEFA), which encompasses digital trade and cross-border e-commerce into its nine core elements (Boston Consulting Group, 2023).

Despite regional growth, socioeconomic disparities shape each ASEAN country's competitive advantages and challenges in e-commerce growth. For instance, despite resource constraints, Singapore leverages its world-class infrastructure and tech-savvy population, achieving the highest e-commerce penetration in ASEAN (PPRO, 2022). Meanwhile, Indonesia leads in terms of domestic market size but struggles with widening digital participation gaps beyond its capital city (Google et al., 2023, 2024a). This diversity presents ASEAN as a unique setting for examining e-commerce's labour market implications across different developmental stages.

E-commerce functions as an ecosystem comprising multiple interconnected industries rather than a standalone sector, making it difficult to classify under the conventional national accounting frameworks. Imagine a case where outputs from the textile manufacturing factories become the inputs of online retail sales. Workers across various industries contribute to every stage of the e-commerce value chain, both directly and indirectly. In this context, e-commerce-induced employment could be far more extensive and profound than initially perceived, highlighting the importance of accurately estimating labour input changes.

Obtaining such information is crucial for policy planning, particularly in designing skills development programs, to prepare the workforce for the digital age (UNCTAD, 2024).

Given statistical limitations in measuring digitalised economic activities, this paper employs Input-Output (IO) analysis (Leontief, 1936), to examine how the inter-industry interactions within the e-commerce ecosystem likely influence the labour market dynamics across six ASEAN countries leading the regional e-commerce growth, namely Singapore, Thailand, the Philippines, Malaysia, Indonesia and Vietnam (hereafter referred to as ASEAN-6). The analysis begins with a case study of Singapore before expanding to a comparative discussion of the ASEAN-6. Considering the absence of internationally comparable estimates of e-commerce employment, our cross-country analysis particularly focuses on the wholesale & retail sector, which Singapore's data identifies as the primary contributor to e-commerce revenue. With this approach, we aim to offer a broader perspective on potential e-commerce's impact under diverse economic contexts.

This research attempts to address two primary research questions: (1) How do the employment effects of e-commerce growth differ across industries in Singapore? (2) How do the potential employment effects vary across the ASEAN-6 countries?

Our case study of Singapore estimates that e-commerce generated over 1 million jobs across all industries in 2022. Of these, 28% were classified as “indirect” jobs—positions created through the cross-industry supply of intermediate inputs from other industries to e-commerce services. Specifically, indirect jobs include additional units of labour required by the manufacturing sector to support e-commerce-revenue-generating activities in the services sector. Among all the e-commerce services industries, wholesale & retail trade and information & communication technology (ICT) industries are the primary drivers of labour inputs demand, with the spill-over employment benefits extending to various labour-intensive service industries through inter-sectoral linkages.

However, the above numerical results inevitably overestimate the job creation effect of e-commerce in Singapore. This is partly due to the inability of the IO model to capture the full spectrum of labour market dynamics, such as retrenchment or career transitions. Additionally, given the prevalence of cross-border e-commerce purchases by Singaporean consumers (PPRO, 2022), a substantial portion of the estimated employment benefits may have accrued to overseas suppliers.

The comparative analysis across ASEAN-6 unpacks distinct patterns in labour market dynamics under heterogeneous socioeconomic landscapes. A notable contrast exists between Singapore and its ASEAN counterparts regarding the labour inputs requirements of the wholesale & retail trade sector. Singapore's efficient production processes and service-oriented economy enable it to effectively adapt to the demand shocks from e-commerce, while other markets in the region, which depend more heavily on labour from primary and secondary sectors, are likely to face greater challenges in managing this transition.

Our research contributes to the intellectual discourse by utilising available data to explore potential labour market implications across industries whose production processes have been

transformed by e-commerce to varying extents. Furthermore, by discussing the structural differences among the ASEAN-6, we emphasise the importance of tailoring human capital development strategies to each country's labour market and industrial circumstances so as to maximise the benefits of e-commerce while mitigating disruptions experienced by traditional employment creators.

The remainder of this paper is structured as follows: Section 2 provides a literature review, examining existing research on the employment effects of e-commerce and sectoral linkages. Section 3 details the IO analysis methodology and the data sources used. Section 4 presents the estimation results based on Singapore's e-commerce statistics. Section 5 discusses the implications for other ASEAN-6 countries, followed by our conclusions.

## 2 Literature Review

Technological progress exerts both substitution and compensation effects on the labour market. Automation and digitalisation displace jobs in traditional industries while simultaneously creating new roles elsewhere (Atasoy, 2013; Balsmeier & Woerter, 2019; Biagi & Falk, 2017; Evangelista et al., 2014; Jayakar & Park, 2013; Koellinger, 2008). The adoption of ICT not only enhances productivity but also reshapes skill requirements. Consequently, a large number of low- to medium-skilled retail employees could find themselves at risk under the rise of e-commerce (Corkery, 2017). On the other hand, e-commerce drives job creation through various mechanisms: it necessitates more ICT professionals to manufacture, deploy, and maintain the technological infrastructure; e-commerce demands more labour to meet the heightened final demand through new sales channels; and it introduces novel positions as e-commerce business models evolve, as evidenced by the growing popularity of social commerce and gaming commerce (VML, 2023)

Empirical evidence on e-commerce's employment impact remains inconclusive, varying based on the defined contexts. Some focus on the "Retail Apocalypse" phenomenon—widespread closure of brick-and-mortar retail stores due to online shopping dominance—linking e-commerce growth to job displacement in the traditional retail industry (Peterson, 2018; Thompson, 2017). Chun et al. (2020) found that increased online spending in Korea reduced county-level offline retail employment, but some laid-off workers in metropolitan areas successfully pivoted to other service businesses. Similarly, Chava et al. (2024) observed that the staggered rollout of fulfilment centres in the U.S. reduced employment at proximate stores. The e-commerce expansion accelerated during the COVID-19 pandemic, with mandatory store closures and shifting consumer behaviours exacerbating the prospects of brick-and-mortar retail (Chatterjee et al., 2021; Dorfman, 2022; Solis, 2021). Focusing on Indonesia in the pandemic period, Ridhwan et al. (2023) showed that e-commerce brought more informal work opportunities, and formal employment was negatively affected<sup>1</sup>.

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<sup>1</sup> Statistics Indonesia (BPS) defines formal sector workers as employers assisted by permanent/paid workers and employees, while informal sector workers consist of own-account workers, employers assisted by temporary/unpaid workers, casual employees, and family/unpaid workers.

Conversely, Mandel (2017a, 2017b) argued that e-commerce is a net job creator for the U.S., as fulfilment centres have a substantial capacity to absorb employment. In China, e-commerce has shown profound socio-economic benefits. Alibaba, one of China's largest e-commerce platforms, has engaged almost 11 million SMEs, generating over 30 million jobs from 2009 to 2019 (Zhang & Chen, 2019). Using a Difference-in-Difference (DID) method, Qin et al. (2023) found that China's national rural e-commerce comprehensive (NREC) policy boosted non-agricultural employment, suggesting that e-commerce can help improve the employability of the rural population.

Quantifying total employment engaged in a country's e-commerce activities poses significant statistical challenges. Conventional national accounting relies on supply-and-use tables (SUTs) and input-output tables (IOTs) to estimate industry-level employment, but these frameworks do not capture cross-cutting sectors (UN DESA, 2018). As digitalisation permeates economies, there is growing policy interest in developing "Digital SUTs", though international compilation progress remains nascent, especially for developing countries with large informal sectors (International Monetary Fund, 2018; Lumba & Santos, 2020; OECD, 2023; UNCTAD, 2024).

In ASEAN, national initiatives have been underway to enhance the representation of digital economic activities in macroeconomic statistics. The Philippines reported that e-commerce contributed to 1.17% of GDP and created 8.45 million jobs in 2023 (Philippine Statistics Authority, 2024). Malaysia estimated e-commerce's share in GDP at 13.3% in 2022 but provided no employment figures (Department of Statistics Malaysia, 2023). Singapore has published industry-level e-commerce revenues but is still developing more comprehensive estimates related to the digital economy (Ng, 2024).

To overcome these data limitations, some researchers have turned to IO analysis, "a method of systematically quantifying the mutual interrelationships among the various sectors of a complex economic system" (Leontief, 1986, p. 19). For example, Toh (2020) used this technique to estimate e-commerce sales revenues at S\$35.5 billion, with a total of 68,577 jobs generated in Singapore in 2015. However, as shown in Section 4, official statistics recorded that the actual e-commerce revenue in 2016 reached S\$173.3 billion—a staggering 500% increase from the previous year, which casts doubt on Toh's findings and suggests a potential underestimation of the e-commerce's scale and economic impact.

Building on Toh's IO methodology, we leverage the most recent e-commerce revenue data from Singapore to estimate the associated job creation. We focus on how job opportunities are created across different industries, acknowledging that industry-level heterogeneity can significantly influence labour market dynamics. E-commerce alters industries' roles within the production structure; for example, there is a decline in traditional wholesale and retail trade activities alongside businesses' increasing reliance on intermediary services such as logistics (De Vera, 2006; Delfmann et al., 2002). Furthermore, literature indicates that certain industries/sectors exhibit more pronounced employment effects than others (Kim & Kim, 2015; Kuan, 2017; Park & Chan, 1989; Pilat & Wölfl, 2005). U.S. digital economy statistics corroborate these variations, showing that professional and business services contribute to

34% of employment in the nation's digital economy, followed by wholesale trade and information, each accounting for 22% (BEA, 2023).

Lastly, considering that employment multiplier effects differ across countries with distinct development levels and industrial structures (Bartelme & Gorodnichenko, 2015; Fadinger et al., 2022; Sposi, 2019), our study extends IO analysis to ASEAN-6, aiming to shed light on how e-commerce potentially influences labour markets across diverse economic contexts within the region.

### 3 Methodology

In a modern interconnected economy, demand changes in one industry affect labour inputs both within itself and in all other industries with which it interacts. These ripple effects along the supply chains are summarised by the Leontief model (Asian Development Bank, 2020).

The cornerstone of the Leontief model is the IOT, which is a comprehensive framework consolidating observed product flow among various industries over a specific period, typically a calendar year. IOT is extensively used to measure the unintended consequences of certain economic activities, especially those amplified through inter-industry connections (Asian Development Bank, 2022).

The basic structure of an IOT for a two-industry economy is illustrated in Table 1, which consists of the following three matrices:

1. Intermediate transaction matrix (shaded yellow): flows of intermediate goods and services used in production processes. The outputs from the row industry  $i$  purchased by the column industry  $j$  are recorded by entry  $z_{ij}$
2. Final demand matrix (shaded green): final products consumed by non-producing industries, including households  $c_i$ , investment  $i_i$ , government  $g_i$ , and exports  $e_i$ ;
3. Primary inputs matrix (shaded blue): income of the production factor during the production process, including labour  $l_j$ , and other primary inputs  $n_j$ , imported intermediate inputs  $m_j$ , etc.).

The row-wise summation across 1 and 2 matrices yields the total production output per industry, written as  $x_i = \sum_{j=1}^n z_{ij} + f_i$ , where  $n$  is the total number of industries in the economy and  $f_i$  is the total final demand ( $f_i = c_i + i_i + g_i + e_i$ ) for the industry  $i$ . In a general equilibrium state, where the total output equals the total input, this horizontal summation also equals the vertical summation across 1 and 3 matrices.

In the Leontief model, a fundamental assumption is that the inter-industry flows from  $i$  to  $j$  depend entirely on the total output of the industry  $j$  within the same time period. For example, the more car outputs ( $j$ ) produced, the more steel inputs ( $i$ ) is needed by car producers. The sectoral linkage between industries  $i$  and  $j$  is operationalised by a technical coefficient  $a_{ij} = \frac{z_{ij}}{x_j}$ , the ratio of steel inputs used by automakers to the total car outputs.

Table 1 Basic IOT for a two-industry economy

		Buying industries		Final demand				Total output ( $x$ )
		Industry 1	Industry 2					
Selling industries	Industry 1	$z_{11}$	$z_{12}$	$c_1$	$i_1$	$g_1$	$e_1$	$x_1$
	Industry 2	$z_{21}$	$z_{22}$	$c_2$	$i_2$	$g_2$	$e_2$	$x_2$
Primary inputs	Value-added	$l_1$	$l_2$					L
		$n_1$	$n_2$					N
	Imports	$m_1$	$m_2$					M
Total inputs ( $x'$ )		$x_1$	$x_2$	$C$	$I$	$G$	$E$	$X$

Source: Adopted from Miller, R. E., & Blair, P. D. (2009). *Input-output analysis: Foundations and extensions*. Cambridge university press.

Suppose an industry uses inputs in fixed proportions to yield one unit of output, meaning that each  $a_{ij}$  is a fixed amount. The production functions of this two-industry economy can then be denoted as a system of linear equations, as shown in Equation (1), where  $A$  is the technical coefficients matrix (Miller & Blair, 2009):

$$X = \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} + \begin{pmatrix} f_1 \\ f_2 \end{pmatrix} = AX + F \quad (1)$$

Equation (1) can be rearranged to Equation (2), where  $I$  is the identity matrix:

$$X = (I - A)^{-1}F \quad (2)$$

Leontief Inverse Matrix  $L = (I - A)^{-1}$  captures the relationship between total output  $X$  and final demand  $F$ . Each entry of this  $L$  matrix  $l_{ij} = \frac{\partial x_i}{\partial f_j}$  denotes the total output change in the industry  $i$  spurred by a one-dollar change in the final demand in the industry  $j$ . For a typical economy where increased demand in one industry invariably requires higher outputs from the industry and its input suppliers,  $l_{ij}$  remains non-negative.

Next, to measure the impact on the labour market, the demand-to-output multiplier  $l_{ij}$  must be translated into demand-to-employment. The conversion necessitates employment coefficients, which captures employment  $e_i$  per unit of output in the industry  $i$ . Numerically, the vector of employment coefficients in a two-sector economy is denoted as  $e_c' = (e_{c1} \ e_{c2}) = (e_1/x_1 \ e_2/x_2)$ . Thus, combining Leontief matrix and employment coefficients, we can obtain an employment multiplier matrix  $E$  with the following structure:

$$E = \begin{pmatrix} e_{c1}l_{11} & e_{c1}l_{12} \\ e_{c2}l_{21} & e_{c2}l_{22} \end{pmatrix} \quad (3)$$

Each  $e_{ci}l_{ij}$  element captures the impact of every extra dollar increase in the final demand of the column industry ( $j$ ) on the row industry ( $i$ ). Diagonal entries represent “direct” job



creation effects within the industry itself, and the off-diagonal entries stand for “indirect” job creation effects received by other input-supplying industries located at row  $i$ .

The structure of employment multipliers determines the non-negativity of employment impact, meaning that positive final demand shocks will only raise labour input requirements across all industries. The magnitude of job creation fundamentally hinges on two factors: the labour-intensity level of the input-supplying industry  $i$ , reflected by  $e_{ci}$ , and the strength of sectoral linkages between  $i$  and  $j$ , measured by  $l_{ij}$ . Although this method does not account for the potential negative changes in the labour market, such as potential retrenchment due to automated operation processes, our IO estimation practically serves the research purpose of capturing the dynamics in the labour market amplified by sectoral linkages.

The final stage of our estimation process involves quantifying how e-commerce alters the final demand level of each industry. Following UNCTAD’s (2023) guidelines, we utilise national statistics on the monetary value of e-commerce transactions. And since industries are likely to be exposed to e-commerce shocks to varying degrees, we require the e-commerce data disaggregated by industry. Among all ASEAN countries, only Singapore publishes e-commerce data in the desired structure, thus becoming the choice of our case study. We then compute job creation from e-commerce by multiplying employment multipliers with the estimated final demand shock stemming from the e-commerce activities.

In summary, estimating the job creation effects of Singapore’s e-commerce consists of three procedures: (1) obtaining Leontief Inverse Matrix  $L$ ; (2) deriving employment multipliers  $E$  from  $L$  and employment coefficients  $e_c'$ ; (3) utilising weighted<sup>2</sup> industry-level e-commerce value as proxies for final demand shocks in each year to simulate the employment changes caused by e-commerce.

To conduct the analysis, we source three datasets from the Singapore Department of Statistics (DOS): the IO table (2019 version) and employment by industry (2019)<sup>3</sup> for the macroeconomic data, and the Annual Industry Survey conducted, which provides e-commerce revenue data<sup>4</sup> for six industries of the services sector from 2016 to 2022. It is worth noting that this data does not cover financial & insurance services and public administration activities. Fortunately, IO analysis captures the inter-sectoral production linkages, therefore allowing us to estimate e-commerce’s impact on employment in finance, even in other non-services industries in the economy. While all DOS datasets follow Singapore Standard Industrial Classification (SSIC), they present industries at different granularity levels. For consistency, this study consolidated them into the following ten industries.

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<sup>2</sup> For each industry, the weight corresponds to the proportion of its total output allocated to serve the final demand, as reflected in the IO table (2019 version). For example, suppose the total output of wholesale & retail trade is 100 billion S\$, and 80 billion S\$ were used by final demand, then we assign a weight of 0.8 to the wholesale & retail trade.

<sup>3</sup> Although the latest industry-level employment data is in 2023, we use the 2019 version to align with the 2019 IO table, which is the most updated IO table in Singapore at the time of data collection.

<sup>4</sup> The revenue earned from the sale of goods and services whereby the company received orders or agreed on the price and terms of sale via online means.

Table 2 List of industries in the case study of Singapore

Group	No.	Industry
E-commerce service industries	1	Wholesale & Retail Trade
	2	Transport & Storage
	3	Accommodation & Food
	4	ICT
	5	Business & Administrative Services
	6	Recreational & Community Services
Other industries without e-commerce revenues	7	Manufacturing
	8	Construction
	9	Finance
	10	Others

Note: “Business & Administrative Services” represents real estate, professional and administrative services. “Others” includes (1) agriculture and nursery products; (2) livestock; (3) fishing and aquaculture; (4) electricity; (5) gas; (6) water and sewerage; (7) waste collection, treatment and disposal services

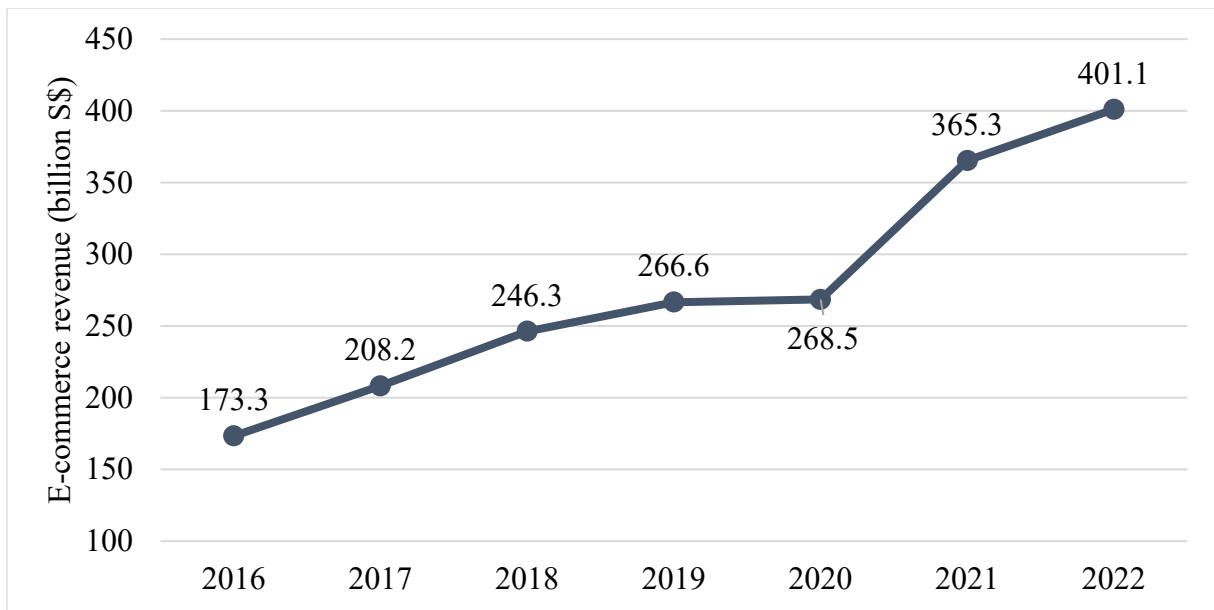
*Source: Authors’ creation*

As mentioned earlier, Singapore is the only ASEAN country published statistics on industry-level e-commerce sales values. But we can still infer the potential employment impact of e-commerce in different countries by focusing on an industry most related to e-commerce, namely wholesale & retail trade, and computing each country’s employment multipliers for this industry. To facilitate the cross-country comparisons among ASEAN-6 countries, we use Multi-Regional Input-Output Tables (MRIOTs) and employment data of 35 industries (classified under ISIC Rev.3) from the Asia Development Bank (ADB) for the year 2021.

#### **4 Estimation results from the case study of Singapore**

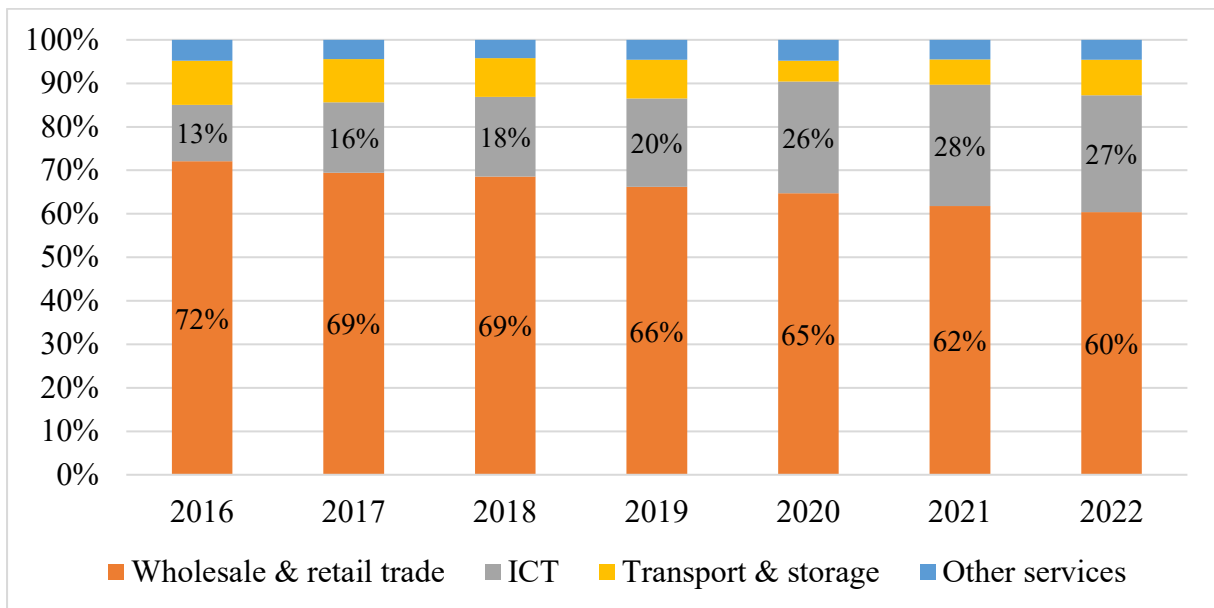
E-commerce in Singapore has demonstrated a stable growth trajectory in recent years. Total e-commerce revenues reached S\$401.1 billion in 2022, more than doubling from S\$173.3 billion in 2016 (See Figure 1). Despite temporary disruptions caused by COVID-19, consumers’ preferences have transitioned towards electronic transactions and digitalisation accelerated among businesses, resulting in a significant post-pandemic rebound. The primary contributors to the expansion were wholesale & retail trade and ICT (See Figure 2). Notably, ICT, encompassing web portals (e.g., social media sites and online marketplaces), software publishing, etc., exhibited the fastest growth in e-commerce revenue, increasing its share from 13% of total revenues in 2016 to 27% within a six-year span.

Figure 1 E-commerce revenue of total services industries (billion S\$)



Source: Authors' creation using DOS data

Figure 2 Share of e-commerce revenue (%)



Note: "Other services" include (1) accommodation & food services, (2) business & administrative services and (3) recreation & community services.

Source: Authors' creation using DOS data

Our IO estimation results in Table 3 reveal that over 1 million jobs were created across all industries in 2022. Of these, 762,000 were employed in industries which directly generated e-commerce revenues, accounting for 72% of total employment from e-commerce.

Interestingly, the remaining 296,000 were generated in the input-supplying industries, which indirectly supported the heightened e-commerce demand. In other words, job creation from e-

commerce extends beyond revenue-generating industries, benefiting others indirectly involved through input-output linkages.

The incremental but consistent rise in the proportion of indirect employment effects, from 26.8% to 28% between 2016 and 2022, reflects growing inter-industry integration within the value chain, where intermediate-input suppliers play an increasingly important role in supporting e-commerce operations. This phenomenon is primarily attributed to e-commerce expansion rather than structural shifts in the underlying production structure or labour market, as the macroeconomic data used for estimation remain anchored to the 2019 levels. Thus, by indirectly stimulating production in input-supplying industries, e-commerce fosters an interconnected ecosystem where multiple industries share employment benefits.

Table 3 Estimated total employment creation (thousands) in Singapore

<b>Year</b>	<b>Total effect</b>	<b>Direct effect</b>	<b>Indirect effect</b>	<b>Indirect %</b>
2016	485	355	130	26.8%
2017	572	416	156	27.3%
2018	670	486	184	27.5%
2019	719	521	198	27.5%
2020	726	524	202	27.8%
2021	969	697	272	28.1%
2022	1,058	762	296	28%

*Source: Authors' calculations using DOS data*

Examining individual e-commerce service industries, as detailed in Table 4, reveals that wholesale & retail trade and ICT were the two primary contributors to e-commerce-related employment in 2022—an anticipated result, as the two industries collectively account for nearly 90% of the revenue generation. Notably, the ICT industry exhibited the highest indirect share among all industries, with 35% of the labour required for ICT's e-commerce activities employed outside the ICT industry itself. As digital technologies increasingly permeate society, the indirect effect of ICT is expected to grow stronger, bringing new business and job opportunities to the overall economy.

Table 4 Estimated employment creation (thousands) by service industries in 2022

<b>Service industries</b>	<b>Total effect</b>	<b>Direct effect</b>	<b>Indirect effect</b>	<b>Indirect %</b>
Wholesale & retail trade	676	480	196	29%
ICT	196	127	69	35%
Recreational & community services	62	59	3	5.1%
Transport & storage	53	38	15	28%
Accommodation & food	47	42	5	10.5%
Business & administrative services	26	18	8	33.1%

*Source: Authors' calculations using DOS data*

Figure 3 dissects the distribution of indirect employment effects, illustrating the interrelation between e-commerce revenue-generating industries and their input-supplying counterparts. The heatmap shows ten industries (rows) and seven e-commerce-active sectors (columns), with cell values and colour intensity indicating the labour inputs required from row-wise industries for e-commerce activities in column-wise industries in 2022.

Figure 3 highlights a sizeable employment linkage between wholesale & retail trade and transport & storage, highlighting the critical role of efficient logistics in the e-commerce supply chain. Wholesale & retail trade also heavily relies on business & administrative services and recreational & community services (rows 5 and 6 in Figure 3). Despite their minor direct contribution to e-commerce revenues (See Figure 2), these two industries absorbed a total of 136,362 jobs, amounting to 46% of the indirect job creation from e-commerce<sup>5</sup>. This reflects their implicit connections with the core e-commerce industries, providing a wide spectrum of essential services, ranging from labour-intensive routines like customer services to high-productivity ones like business consulting.

Interestingly, even industries without e-commerce revenues benefited from the spillover job creation effects, gaining over 63 thousand new jobs. Notably, 74% of those were concentrated in manufacturing and finance, primarily through their linkages with wholesale & retail trade. This reflects e-commerce's transformative potential to reshape the employment landscape beyond its immediate sphere.

The promising employment outlook in non-service industries highlights the continued importance of foundational production activities for Singapore, a service-dominated economy embracing digitalisation. As e-commerce gains momentum, Singapore is poised to experience rising demand for manufacturing capacities to cater to an expanding customer base. Meanwhile, finance, an enabler industry of secure and seamless e-commerce transactions, will likely experience further employment growth, especially in advanced domains such as digital payment solutions and FinTech.

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<sup>5</sup> Summing up all cell numbers on rows 5 and 6, we can obtain 136,362, which is the total number of jobs arise in the two row-wise industries. 46% is dividing 136,362 by the total indirect job creation in Singapore in 2022, which was estimated at 296,000 (see Table 3).

Figure 3 Indirect job creation effect of Singapore (2022)

	1	2	3	4	5	6
1 Wholesale & retail trade	NA	1478	539	7884	285	211
2 Transport & storage	44725	NA	155	3121	250	98
3 Accommodation & food	15571	2282	NA	8408	422	312
4 ICT	8467	468	130	NA	360	246
5 Business & administrative services	62365	4206	1742	22641	NA	1294
6 Recreational & community services	25058	2063	862	11356	4775	NA
7 Manufacturing	13623	2571	559	8000	431	336
8 Construction	6521	725	389	2408	1106	337
9 Finance	16670	738	236	3341	637	181
10 Others	2623	250	292	1236	174	134

Source: Authors' calculations using DOS data

## 5 Implications for ASEAN-6

Compared to other ASEAN countries, Singapore stands out as a unique case with a series of distinctive factors, forging a conducive environment where the employment benefits are propagated through its compact production network. While Singapore's experience unfolds as a successful story, significant variations exist in the economic structure and labour markets across Southeast Asia, suggesting that the influence of e-commerce on employment may differ from country to country. Due to the constraint on industry-level e-commerce revenue data, we cannot estimate the explicit number of e-commerce job creation for all ASEAN-6 countries. Alternatively, we perform IO analysis to compare each country's employment multipliers of wholesale & retail trade, which can be interpreted as the thousands of jobs per billion USD of demand increase in the industry.

Results listed in Table 5 show that Singapore has the least total multiplier but the highest indirect share compared to other ASEAN countries, implying that Singapore's wholesale & retail trade industry has a high level of efficiency and economic integration, thanks to its technological capabilities and compact-size economy. Therefore, as e-commerce expands and more business opportunities arise in the wholesale & retail trade industries, it is expected to spread the employment benefits to other parts of the economy.

In contrast, other ASEAN countries exhibit much higher total multipliers, likely due to the labour-intensive nature of their wholesale & retail trade industries. We can infer from this characteristic that direct employment engaging in wholesale & retail trade activities will be

substantial, albeit often at the expense of productivity and efficiency. Furthermore, these countries show a lower indirect effect share, indicating a lower degree of inter-industry linkages between wholesale & retail trade and other industries.

Table 5 Estimated employment multiplier (thousands of jobs per billion USD final demand) of wholesale & retail trade (2021)

Country	Total multiplier	Direct effect	Indirect effect	Indirect %
Singapore	2.5	1.9	0.6	25%
Malaysia	35.9	30.9	5	14%
Thailand	49.6	42.7	6.9	14%
Philippines	119.8	111.6	8.2	7%
Indonesia	132.5	119.2	13.3	10%
Vietnam	167.7	149.9	17.8	11%

*Source: Authors' calculations using ADB data*

To analyse the ASEAN-6's differences in sectoral integration, we break down the indirect portion of each country's employment multiplier. In Figure 4, the cell in each column indicates the number of new jobs in non-wholesale & retail trade industries—located at the rows—in response to every extra one billion USD demand increase in the wholesale & retail trade industry of the column-wise country.

For Singapore, 92% of the indirect employment effects from the demand increase in the wholesale & retail trade industry was absorbed by the service industries<sup>6</sup>. Approximately half of these new job opportunities accrued to transport & storage and finance. In the Philippines and Vietnam, the transport & storage industry also gained the most from the indirect job creation of wholesale & retail trade, whereas their finance industry played a less prominent role than that of Singapore. But generally speaking, a distinction between the other five ASEAN countries and Singapore is the high sensitivity of employment in the non-service sector, comprised of primary, manufacturing, utilities and construction industries, to the demand changes in wholesale & retail trade. This finding aligns with the observation that Southeast Asia tends to lag in the liberalisation of modern tradeable services, such as ICT, business operations and financial services (International Monetary Fund, 2024).

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<sup>6</sup> Include the bottom six industries, namely, transport & storage, post & telecommunications, finance, hotel & restaurants, business services, and administrative services. Note that Singapore's estimation results in Section 5 differ from those in Section 4 because they are based on different datasets and under different industrial classifications.

Figure 4 Indirect job creation per billion USD of demand increase in wholesale & retail trade (2021)

	SGP	MYS	THA	PHL	IDN	VNM
Primary (Agriculture + mining)	0	620	2181	1967	3448	2707
Manufacturing	29	1157	1571	680	2593	2625
Utilities	10	270	238	204	304	745
Construction	8	974	185	143	1217	2346
Transport & storage	183	287	572	2948	1695	3294
Post & telecommunications	62	186	370	256	456	437
Finance	121	623	969	398	1280	1834
Hotel & restaurants	54	125	359	31	1160	2128
Business services (Real estate, etc.)	32	52	265	166	179	1078
Administrative services (Community services, etc.)	107	655	203	1368	962	617

Note: The column names are the ISO Alpha-3 codes of the ASEAN-6 countries. SGP – Singapore, MYA – Malaysia, THA – Thailand, PHL – Philippines, IDN – Indonesia, VNM – Vietnam.

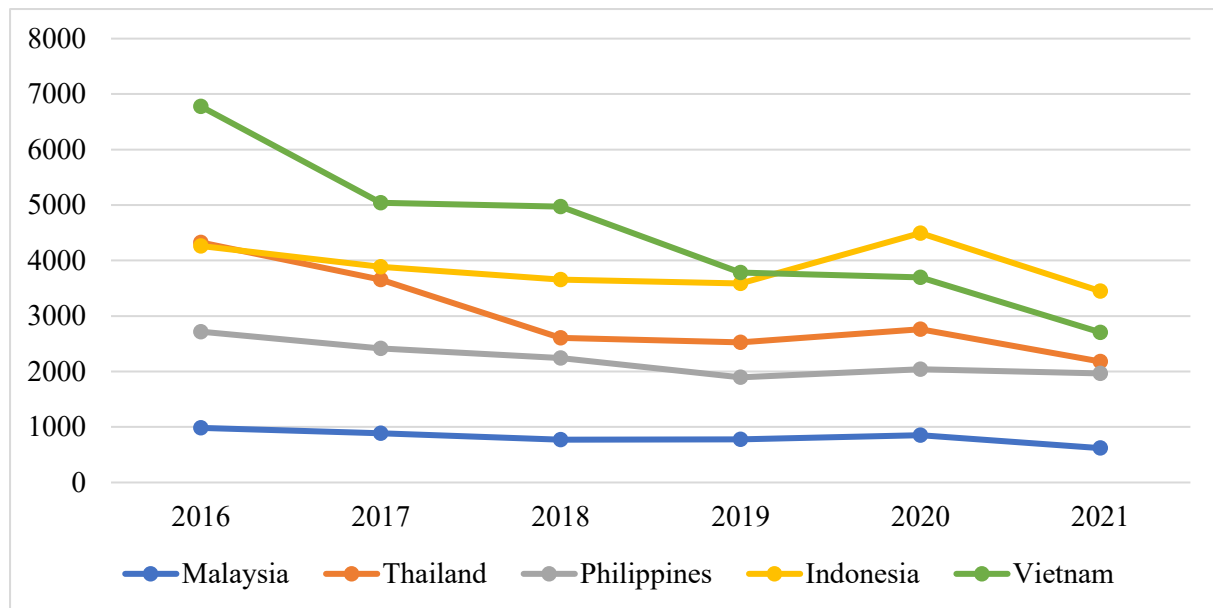
Source: Authors' calculations using ADB data

Structural shifts towards higher-value-added and industrialised economic activities are underway in the ASEAN region. Figure 5 summarises the evolution of employment in the primary sector in response to demand changes in wholesale & retail trade. Comparing the 2016 and 2021 levels, all five countries, particularly Vietnam, have experienced weakening linkages within this industry pair.

To help people stay resilient in the face of economic restructuring, ASEAN countries need to empower their workforce with skills that are compatible with the expanding services sector. In this way, those employed in the traditional sectors will have a better chance to capitalise on the newly generated jobs. The labour-saving nature of e-commerce and even the wider digital economy further underscores the urgency of human resource development. Policymakers in the region could facilitate a just transition by implementing strategies to lower entry barriers into the services sector, particularly tradeable services, which are vital for reducing transactional costs and developing infrastructure for e-commerce and digital trade (International Monetary Fund, 2024).



Figure 5 Indirect job creation in the primary sector per billion USD of demand increase in wholesale & retail trade (2016-2021)



Source: Authors' calculations using ADB data

## 6 Conclusions

This study employs the IO analysis to evaluate the effects of e-commerce on employment. Using Singapore as a case study, we estimate that e-commerce demand growth in the country generated 1 million jobs across all industries in 2022, though this figure only serves as an upper bound of the realisable e-commerce employment due to modelling constraints. The burgeoning ICT industry, with its strong sectoral linkages with the rest of the economy, has become particularly instrumental in amplifying indirect employment benefits. Other service industries like business & administrative services, despite modest contributions to e-commerce revenue, emerged as major recipients of spillover job opportunities from the core e-commerce segments.

While this paper emphasises the positive employment impacts of e-commerce growth, it is essential to acknowledge that the labour market dynamics are more complex than a mere number of job creation. Job displacement, career transitions and skills upgrades are not accounted for in IO modelling. Thus, the inherent limitations in the quantitative methodology necessitate a cautious interpretation of our estimation results.

When comparing across the ASEAN-6 countries on employment multipliers in the wholesale & retail trade industry—the largest contributor to e-commerce revenues according to Singapore's statistics—significant variations arise. Singapore's service-oriented economy and advanced technological infrastructure foster robust synergy among wholesale & retail trade, transport & storage and finance industries. This advantage leads to efficient logistics and seamless transactions with minimal labour inputs. In contrast, the wholesale & retail trade industry in other ASEAN-6 economies is more labour-intensive and reliant on production

from primary and secondary sectors. Furthermore, from the evolution of employment multipliers, we observe diminishing interconnectedness between wholesale & retail trade and the primary sector, which reflects the ongoing structural shifts among economies in the ASEAN region towards more diversified and industrialised economic activities.

Looking ahead, e-commerce in Southeast Asia is poised to grow at a double-digit rate, facilitating entrepreneurship and deepening inter-industry integration (Arora et al., 2022). To better capitalise on these transformative trends, countries should prepare their labour force for new employment prospects in the digital age. To achieve this, governments should implement reskilling and upskilling strategies tailored to the unique socioeconomic circumstances of individual countries.

For Singapore, a small-sized economy with well-established service industries, nurturing high-skilled workers in ICT, finance and professional services is imperative for bridging the talent gap resulting from rapid digitalisation. Whereas in economies elsewhere in the Southeast Asia region, the priority should be placed on enhancing digital literacy across the general workforce to boost digital participation.

Government subsidies for on-the-job training programmes aligned with industry demands could further incentivise professional education focusing on digital skills. Such practices are especially pertinent for workers in the traditional sectors because digital capabilities lower entry barriers to emerging positions, allowing the workers to stay competitive in the evolving e-commerce landscape. Furthermore, developing countries in Southeast Asia should also focus on infrastructure improvement, including logistics, internet and digital payment systems, as they are essential elements not only for e-commerce development but also for facilitating the broader transition towards higher-value-added economic activities in the digital era.

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