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Examining the impact of air cargo growth on poor Vietnamese rural and urban households

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ABSTRACT

This study adopts a Structural Path Analysis to explore the ways in which air cargo can play a role in reducing poverty in Vietnam. This study departs from the prevalent and extensively researched macroeconomic analysis of air cargo, focusing instead on the microeconomic and distributional effects. The results show that air cargo growth stimulates the production of the sectors that employ semi-skilled and unskilled rural workers. The results indicate that the effect of air cargo expansion on poverty is more pronounced in rural households than in urban households. The conclusion drawn from this study is that policies focused on decreasing transaction costs and enhancing human capital have the potential to amplify the effects of air cargo on poverty. Moreover, expanding air cargo and simultaneously improving human capital in Vietnam would provide the catalyst for upgrading from value-added assembling functions to higher value-added roles in global value chains.

1. Introduction

Both theoretical and empirical evidence supports the correlation between improved air cargo connectivity and economic growth. Theoretical research suggests that air cargo reduces trade costs associated with distance and enables vertical specialisation in global trade [18]. Empirical studies demonstrate that air cargo plays a crucial role in enabling industries like horticulture and electronics, as well as countries, to compete through product differentiation and fast delivery. Groom and MacGregor [13] highlight the importance of efficient air freight logistics in the development of the horticulture sector in Kenya and land-locked African countries such as Ethiopia and Zambia. The International Civil Aviation Organisation [20] emphasises that air cargo transport is a key enabler of economic progress in developing nations. Numerous studies confirm the significant contribution of air cargo to economic development [17,22,35,3,6]. Cech [4], for instance, suggests that access to air cargo services has a positive catalytic effect on local economies, leading to job creation and regional productivity growth. Kasarda and Green [22] investigate the relationship between air cargo traffic, GDP, and GDP per capita, finding a statistically significant association. Similarly, Chang and Chang [5] demonstrate the crucial role of air cargo expansion in promoting economic growth in Taiwan, with strong evidence of bi-directional causality between the two.

While GDP and employment are the most cited indicators in studies on the economic impact of air cargo, it is crucial to consider the microeconomic and distributional impacts to explore potential linkages between local communities, sectors, and the air cargo industry. Daley [7] questions the effectiveness of air transport for sustainable development, emphasising the need to examine its distributional impacts and social costs more thoroughly. Therefore, it remains an open question, from both an equity and poverty alleviation standpoint, how an increase in air cargo services affects the incomes of different household groups and which sectors and households would be most affected by changes in air cargo trade. Limited research exists on the impact of air cargo growth on poverty and the channels through which air cargo multipliers transmit throughout the economy.

Considering these considerations, this paper aims to explore the potential of air cargo to contribute to broad-based development and poverty alleviation. Reducing poverty and income inequality through pro-poor growth aligns with the Sustainable Development Goals. Poverty is understood as an economic phenomenon in this study, following inconsistent definitions of poverty [45]. Pro-poor air cargo growth is defined as growth that disproportionately raises the income of the poor compared to the non-poor. Unlike previous research that

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predominantly adopts a macroeconomic perspective, this study focuses on the meso- and micro-level analysis of improved air connectivity. It adopts a novel approach to assessing the economic impacts of enhanced air connectivity, capturing the implications at the sectoral, household, and regional levels in terms of distribution channels. The study extends basic economic impact measures to incorporate institutional linkages, including income distribution. Using a structural path analysis approach, this study aims to comprehensively analyse the ripple effect of air cargo growth on poverty in Vietnam. The paper contributes methodologically by providing a detailed understanding of how air cargo growth affects poverty through structural path analysis. Examining the interconnectedness between the air cargo sector and the rest of the economy in Vietnam is particularly relevant, as economic development in Vietnam has been driven by exports, with air cargo playing a crucial role in the export industry. Although it has been argued that significant linkages exist between air cargo and the Sustainable Development Goals (ICAO, n.d.), empirical studies exploring these linkages and the relationship between air cargo growth and poverty in Vietnam are limited.

The structure of the paper is as follows: Section 2 highlights the importance of air transport to Vietnam and poverty in the country. Section 3 provides a review of the literature on the link between air cargo, trade, and economic development. Section 4 describes the data and methodology used in the study. Section 5 presents the simulation results, followed by a discussion of the key findings in Section 6. Finally, Section 7 concludes the paper.

2. The Vietnam setting

Vietnam has been recognised as one of the most open economies globally [43]. In 2018, its trade-to-GDP ratio stood at an impressive 190 %. Over the past decade, Vietnam's exports have outpaced the global average, growing at a remarkable rate of 14% [43]. The World Bank report emphasises that Vietnam's key trade partners, situated in East Asia, North America, and Europe, are primarily accessed through sea and air routes. Among these partners, China holds the largest market share for air cargo imports in Vietnam, accounting for 26 %, followed by the Republic of Korea with 20 % and the United States with 9 % [43]. The report also reveals that Vietnam's air freight sector, which represents approximately 25 % of the country's trade value, has experienced significant growth in the past decade. Prior to the Covid-19 pandemic, freight volumes had surged from 82.90 million ton-km in 1996–1022.84 million ton-km in 2019 (Fig. 1), showcasing a remarkable expansion. The COVID-19 pandemic had a profound impact on the air freight industry, leading to a substantial decrease in volume. Specifically, air freight volume dropped significantly from over 1000 million tonne-km in 2019 to less than 600 million tonne-km in 2020.

Vietnam's vegetable and fruit exports are a significant part of its agricultural commodities, ranking second after seafood. In 2020, the export revenue from these products reached $3.2 billion, with fruit accounting for nearly 80 % of the total. Vietnam exports various types of fresh fruit to the United States, China, Japan, Korea, Australia, Europe, and the Middle East [39]. However, limited air freight availability and high costs have posed challenges for Vietnamese fruit exports, leading them to seek alternative markets. Logistics plays a crucial role in the value chain of agricultural products, but Vietnam's logistics system faces limitations such as high port costs, surcharges, and longer processing times [37].

Despite the significant economic progress and rapid growth of air freight in Vietnam, there are still several challenges to address. One of the key challenges is the quality of the country's air transport infrastructure, particularly the limited availability of air cargo terminals and logistics centres across its 22 airports [43]. Furthermore, Vietnam's air service indices fall behind those of other Asian countries involved in global manufacturing value chains, such as the Philippines or Thailand. In terms of the efficiency of air transport services, Vietnam was ranked 103rd out of 140 countries, while its airport connectivity index stood at 22nd globally [40]. For comparison, Thailand and the Philippines ranked 48th and 96th, respectively, in terms of air transport service efficiency, and 9th (Thailand) and 26th (the Philippines) in airport connectivity. Vietnam also lags behind the Philippines and Thailand in the Air Trade Facilitation Index (ATFI), which measures a country's ability to facilitate air cargo through customs and border processes and regulations [40]. According to the International Air Transport Association [19], Vietnam ranks 73rd out of 124 countries in terms of ATFI, while the Philippines and Thailand hold positions at 54th and 27th, respectively.

Poverty has been a significant challenge in Vietnam for many years, but the country has made remarkable progress in reducing poverty rates. This positive trend can be attributed to various factors, including robust economic growth and targeted government initiatives aimed at poverty reduction. Vietnam has witnessed substantial economic growth, with air cargo playing a pivotal role in its export-oriented development, particularly in industries such as electronics, clothing, and furniture. By positioning itself as a cost-effective manufacturing base, the country has generated employment opportunities and higher wages. Over the past few decades, Vietnam's GDP per capita has risen from around $100 in the 1980 s to approximately $2566 in 2018 (current USD). The extreme poverty rate, measured by the poverty headcount ratio at $1.90 a day (2011 US prices, PPP adjusted for Vietnam prices), declined from 58 % in 1993 to 1.8 % in 2018 [31]. According to Quyen [31], the poverty rate, based on the national poverty line, stood at 6.7 % in 2018, equivalent to 6.4 million people.

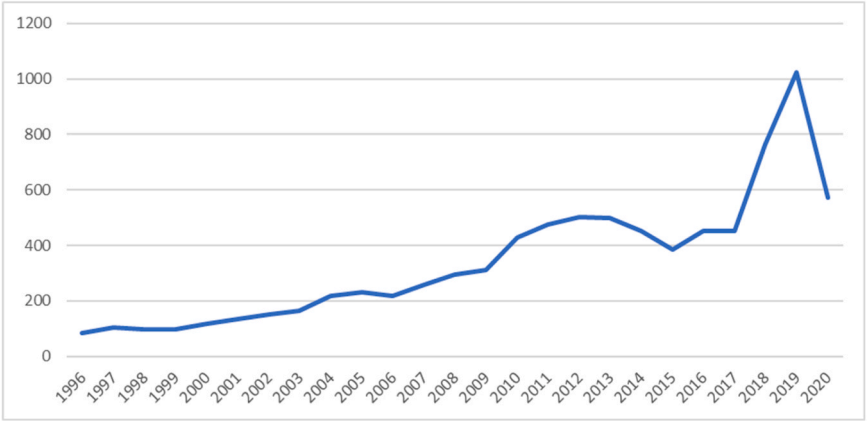

Fig. 1. Air transport, freight (million tonne-km) Vietnam.
Source: WDI.

The reduction in poverty can be attributed to government policies that specifically target poverty alleviation. These policies encompass social assistance programs and investments in infrastructure and education. Despite the substantial progress made, there are ongoing challenges related to reducing inequality and ensuring inclusive growth that benefits all segments of society, particularly rural poor households. Many of the poorest households in Vietnam reside in rural areas and rely on agriculture for their livelihoods. These households are typically small-scale farmers with limited skills, large family sizes, and inadequate access to essential infrastructure such as transportation, energy, water, and education facilities. Furthermore, a significant proportion of the rural poor belong to ethnic minority groups, who make up 15 % of the population but account for 70 % of the extreme poor, as measured by the national extreme poverty line [43]. Based on the poverty line established by the General Statistics Office and the World Bank, poverty incidence in 2016 ranged from approximately 1 % in the Southeast region to 24 % in the Central Highlands region and 28 % in the Northern Mountainous region [43]. Given these circumstances, understanding the impact of air cargo growth on poverty in rural areas becomes particularly crucial, as it provides valuable insights for targeting poverty reduction policies and programs in these regions.

3. Literature review

Existing literature predominantly examines the relationship between air cargo and economic growth [5,6], regional development [3], and participation in the global value chain [36], with limited attention given to exploring the connection between air cargo and poverty. Chi and Baek [6] and Chang and Chang [5] reveal a long-term relationship between air freight services and economic growth. Button and Yuan [3] explore the potential impact of air cargo services on local and regional economic development in the United States, highlighting the connection between changes in air cargo volume and per capita income. Green [12] compares the contribution of passenger and cargo traffic, noting that cargo traffic has limited predictive power for economic development due to increasing automation in warehouses near air cargo hubs, where low-wage warehouse and distribution jobs are prevalent.

Air cargo has received much attention in recent years due to its role as a trade facilitator and a key enabler of e-commerce. Research has shown that improved transport infrastructure and services can increase trade, economic growth and poverty alleviation. Improved transport infrastructure leads to increased access to markets for goods and services, which can drive economic growth and reduce poverty levels. In rural areas, improved transport can provide access to markets for agricultural products, increasing incomes and reducing poverty levels. Hewit and Gillson [14] argue that in theoretical terms trade facilitation helps the movement of goods by increasing the efficiency of the trading environment, which provides jobs and access to new technology, increases household and government revenues, reduces consumer prices, including on food which is essential for tackling poverty.

ICAO (n.d.) points out that air cargo plays a vital role in facilitating trade of high value and perishable goods, especially in linking remote and landlocked lower-income countries to global supply chains. The exports of perishables by air can play a crucial role in boosting economic growth and reducing poverty by providing access to new markets and increasing trade. Air freight connects remote markets and global supply chain speedily and reliably, boosts exports and increases competition and the capacity to host subsidiaries of foreign-based companies [22]. Air freight logistics is viewed as a core competence in the supply chain of many countries, regions, and individual companies engaged in global trade, particularly those in the periphery of global economic activity [22]. Moreover, air freight logistics can provide a competitive advantage through faster transport, a more precise supply chain and leveraging production advantages of distant regions [25]. Leinbach and Bowen [25] argue that air cargo is vital for the integration of peripheral regions like Southeast Asia into the global economy and can be a source of competitive advantage to companies located in those regions. Kazarda and Sullivan [23] suggest in addition to facilitating trade, air cargo also creates trade, which in turn contributes to the competitive advantage of nations.

Hoekman and Shepherd [15] examine trade facilitation from an equity perspective, focusing on the distribution of their benefits across and within developing nations. The authors found that firms of all sizes export more in response to improved trade facilitation. Sakyi et al. [34] explore the extent to which reductions in overall costs of the international movement of goods contributes to improving social welfare in Africa. Their findings suggest that effective trade facilitation reforms, targeted particularly at improving infrastructure, institutions, and market efficiency, would improve social welfare in Africa. Dennis and Shepherd [9] argue that improved trade facilitation can help promote export diversification in poorer countries. For a sample of 118 developing countries, the authors find that 10 % reductions in the costs of international transport and domestic exporting costs are associated with export diversification gains of 4 % and 3 % respectively.

In addition to contributing to economic growth and job creation, air cargo facilitates participation and advancement in global value chains [36]. The facilitation of integration into global value chains by air cargo has the potential to influence poverty levels. A study commissioned by IATA shows that a 1 % increase in air cargo connectivity is associated with a 6.3 % increase in total exports and imports. Moreover, a 1 %-point increase in the air cargo connectivity would lead to a 2.9 % rise in global value chains (GVC) participation [36]. Several interlinked factors determine countries' participation in GVCs including among others geography, factor endowments, market size and institutions, trade facilitation policies and measures, efficient transport and communications infrastructure [11]. Dollar et al. [11] argue that GVCs provide opportunities for developing and emerging economies to attract investments, increase and diversify exports, access new technologies and innovations, which in turn helps to support growth, create jobs and reduce poverty. In contrast, Rodrik [33] argues that new technologies and their deployment through GVCs are generating limited employment prospects in developing countries, implying that the most abundant resource that developing countries have, which is low skilled labour, is particularly disadvantaged by these new technologies.

It has been argued that the gains from removing the burdens of trade transaction costs are substantial for developing countries. Wilson et al. [41] show that investment in trade facilitation in the APEC regions, such as the increased provision of transport services and access to communications and finance is associated with an increase in GDP per capita. Ismail and Mahyideen [21] quantify the impacts of the quality of infrastructure on trade volume and various economic growth indicators in Asia and conclude that the relationship between the quality of transport and logistics infrastructure and trade is positive. Groom and MacGregor [13] indicate that GVCs provide a useful perspective from which to examine both the importance and the likely developmental impact of aviation intensive sectoral linkages, such as floriculture. The cost and availability of air freight cargo space for export crops is a key determinant of Kenya's competitiveness. Button [2] shows that floriculture is an important employer and earner of foreign exchange for African countries. He further argues that low transportation costs, among others, are a key driver for the development of GVCs. According to Hollweg et al. [16], efficient air connectivity induces greater linkages between domestic production and international markets through reduced trade costs and increased reliability of domestic firms in the delivery of orders.

4. Methodology and data

4.1. SAM multiplier analysis

Previous studies that have examined the socioeconomic effects of air transport activities have predominantly employed either an input-

output (IO) approach or a Social Accounting Matrix (SAM) multiplier approach ([28]; Dimitrou and Sartzetaki, [10] [29]). The SAM multiplier model is particularly useful for analysing the repercussions of increased air cargo expenditures across sectors and institutions. It provides insights into the socioeconomic structure of a country, including the interconnections between the production of goods and services and the distribution of income among institutions and regions. The model operates under simplified assumptions regarding the relationship between air cargo and economic output. It assumes linearity between sectors and economic output, full resource employment, constant and exogenous prices, and no substitution effects.

By applying the methodology introduced by Pyatt and Round [30], we calculate the multiplier effects of air cargo expansion in Vietnam, as represented by Eq. 1. In matrix notation, we define the SAM multiplier as:

$$X = A \cdot X + Y \tag{1}$$

The vector X represents the total endogenous entities, while the vector Y represents the final demand, representing the total of exogenous entities. The matrix A, denoted as [aij], is composed of SAM coefficients.

X can be solved numerically for an exogenously specified Y as follows:

$$X = [I - A]^{-1} Y \tag{2}$$

The inverse matrix $[I - A]^{-1}$, where I represents the identity matrix, is computed as the matrix of SAM multipliers denoted by mij. Each element mij represents the total effect of a one-dollar shock to the endogenous variable indicated in column j on another endogenous variable indicated in the ith row. Applying the multipliers Eq. (2) can be written as.

$$\Delta X = [I - A]^{-1} \Delta Y \tag{3}$$

ΔY records the direct impact, and $[I - A]^{-1}$ approximates the ripple effects.

We conduct a simulation to examine the effects of a 1 billion Vietnamese Dong increase in air freight services. The specific amount chosen for the increase is arbitrary, but it does not impact the findings due to the linearity of the model. This linearity implies that the results obtained from smaller or larger shocks would be proportionally identical. Our analysis focuses on assessing the impact on sectors, labour categorised by skill level based on workers' education, geographical locations, and various household groups.

4.2. Structural path analysis

Although SAM multiplier analysis is a valuable tool for estimating the economic impact of changes in demand for goods or services, it lacks the ability to provide a comprehensive measure of how these changes translate into desired outcomes such as poverty reduction, income distribution, or growth maximisation. Additionally, the IO/SAM multiplier framework does not offer insights into how the multiplier effect operates within the economic system. To address this limitation and identify the various stages of ripple effects, a decomposition of the multiplier by product becomes necessary.

This is where structural path analysis (SPA) comes into play, as it decomposes the multiplier into an infinite number of paths or production chains. [8]) first proposed the concept of SPA. Wood and Lenzen [42] described it as a utilisation of the series to expand upon Leontief's inverse. SPA enables the identification of transmission mechanisms from one shock to another, ultimately reaching the final node, and identifies the production chains that contribute the most to a specific desired outcome.

SPA extends the IO/SAM multiplier analysis model by decomposing the Leontief inverse into direct, indirect, and total influences from the origin to the destination pole [24]. Consequently, the Leontief inverse can be expanded into a power series of A, revealing the various stages of ripple effects (see Eq. 4).

$$\boldsymbol{L} = (\mathbf{1} - \boldsymbol{A})^{-1} = \boldsymbol{I} + \boldsymbol{A} + \boldsymbol{A}^2 + \boldsymbol{A}^3 + \boldsymbol{A}^4 + \tag{4}$$

Lenzen [27] provides a comprehensive demonstration of the derivation of structural path analysis (SPA) and illustrates the decomposition of the components of Leontief multipliers as the Taylor expansion of the Leontief inverse, as shown in Eq. 4. By following the approach presented by Lenzen [27], the decomposed multipliers can be obtained by substituting Eq. 4 into Eq. 5, as well as into Eqs. 6 and 7.

$$\boldsymbol{x} = (\boldsymbol{I} - \boldsymbol{A})^{-1} \bullet \boldsymbol{f} \tag{5}$$

$$= \sum_{i,j=1}^{n} \left(\boldsymbol{\delta}_{ij} + \boldsymbol{A}_{ij} + \boldsymbol{A}_{ij}^2 + \boldsymbol{A}_{ij}^3 + \ldots \right) \bullet \boldsymbol{f}_j \tag{6}$$

$$= \sum_{i,j=1}^{n} \left(\boldsymbol{\delta}_{ij} + \boldsymbol{A}_{ij} + \sum_{k=1}^{n} \boldsymbol{A}_{ik}\boldsymbol{A}_{kj} + \sum\nolimits_{l=1}^{n} \sum\nolimits_{k=1}^{n} \boldsymbol{A}_{il}\boldsymbol{A}_{lk}\boldsymbol{A}_{kj} + \ldots \right) \bullet \boldsymbol{f}_j \tag{7}$$

In Eq. 7, the indices i, j, k, and l represent different compartments. The direct influence, denoted as the first-order influence, is quantitatively expressed by A_{ij}. On the other hand, the indirect influence, representing the second-order influence, is expressed as $\sum_{k=1}^{n} A_{ik}A_{kj}$. This signifies the influence that originates from sector i, passes through intermediate sector k, and eventually transmits to sector j. Similarly, paths with longer supply chains provide more detailed decomposition, as indicated by the term $\sum_{l=1}^{n}\sum_{k=1}^{n} A_{il}A_{lk}A_{kj}$. This term represents the third-order influence, involving the linkage of sectors i, l, k, and j. It should be noted that the computation can be extended indefinitely; however, since higher-order influences have a lower impact, it is necessary to set an upper limit on the order of influence in the estimation of structural path analysis (SPA). In this study, the maximum order of influence is set at the sixth level.

When considering a direct influence from pole i to pole j, the total influence from i to j encompasses the influence transmitted along the direct impact, including all indirect effects attributable to the path. The global influence, also known as the total multiplier impact, from pole i to pole j is simply given by the accounting multiplier obtained from the inverse matrix as discussed earlier.

SPA serves as a valuable tool for gaining insights into the primary channels through which economic shocks are distributed within a local economy. It allows for the identification of sectors that experience the greatest benefits from exogenous demand shocks. In the context of Vietnam, SPA helps identify the sectors that play a crucial role in supporting the growth of the air cargo industry and the backward input linkages connecting these sectors. By providing a more comprehensive view, SPA complements traditional economic multiplier analysis.

The additional information provided by SPA can aid policymakers in understanding the effectiveness of sectoral investments, enhancing positive effects, and mitigating negative impacts on specific sectors. SPA has been widely used in various applications, including rural economic analysis, technology choices, tourism impacts, and environmental assessments. In this study, we employ SPA to examine the Vietnam economy, specifically focusing on the air cargo industry as the origin in the simulation, and households as the destination accounts. We present the income distribution channels of air cargo expansion for the poorest Vietnamese households, specifically those belonging to the lowest expenditure deciles (Q1 and Q2), residing in both rural and urban areas.

4.3. Data

The study uses an updated and adjusted version of the 2012 Social Accounting Matrix (SAM) of Vietnam to analyse the impact and distribution channels of air cargo expansion. The 2012 SAM, developed by the

Central Institute for Economic Management (CIEM), is the most recent available matrix and is under the authority of the Ministry of Planning and Investment in Vietnam. To enhance the accuracy of the SAM, the activities, commodities, household, and factors accounts were updated using data from the 2019 Input-Output table for Vietnam and other relevant economic indicators from sources such as the Asian Development Bank and the General Office of Statistics. Data reconciliation was performed using the cross-entropy approach, a well-known method for data reconciliation [26].

The Vietnam SAM encompasses 164 activities and commodities, covering 11 different types of factors, including various capital types and labour categories. Capital is disaggregated into agricultural, non-agricultural, livestock, and fisheries capital, while labour is categorised by workers' education levels and rural/urban locations. Labour education levels consist of primary (grades 1–4), secondary (grades 5–11), and tertiary (grades 12 or higher). Households are disaggregated based on national per capita expenditure quintiles, urban or rural areas, and engagement in non-farm or farm activities. There are 20 household groups differentiated by location, activity type, and expenditure deciles (1–5, with 1 being the lowest decile and 5 the highest). Other accounts include transaction margins, government accounts (government, activity taxes, factor taxes, direct taxes, import tariffs, sales taxes), investment accounts (savings-investment and changes in stocks or inventories), and the rest of the world account.

According to the World Bank [44], the industry and construction sector contributed 34.5 % of Vietnam's GDP in 2019, while agriculture, forestry, and fishing accounted for 14% of the total GDP, predominantly driven by crop production. The services sector contributed 41.6 % to the national GDP during the same period. An important feature of Vietnam's SAM is the level of sector disaggregation, particularly within the transport accounts, enabling analysis of changes in specific subsectors of the transport industry. The transport sector is further disaggregated into eight accounts, including passenger air transport services and freight air transport services. Passenger air transport services contribute 0.38 % to GDP, while freight air transport services contribute 0.07 %. In terms of trade structure, the main exports are textiles & footwear (20.07%) and food processing (17.84 %). Agriculture and services account for 6.45 % and 7.75 % of all exports, respectively. The data reveals that while the manufacturing sector generates a significant portion of the country's export earnings, it also represents a substantial share of total imports. Specifically, agriculture imports account for 8.34 % of all imports, while the services sector constitutes 6.53 % of total imports.

5. Results

5.1. Results of SAM multiplier

5.1.1. Output and value-added multiplier of air cargo growth

Fig. 2 provides insights into the expected changes in revenue in various sectors with a unit (equivalent to one billion Vietnamese Dong) increase in air cargo. The values represent the estimated additional value that can be attributed to the rise in air cargo demand. Among the sectors included in the SAM, those engaged in petroleum products, wood products, and repair of machinery and equipment exhibit the most substantial changes.

Source: Authors.

Specifically, a unit increase in air cargo is projected to generate a revenue change of 0.58 billion Vietnamese Dong in the petroleum products sector. Similarly, the wood products sector is expected to experience a revenue change of 0.17 billion Vietnamese Dong. Furthermore, the repair of machinery and equipment sector is estimated to undergo a revenue change of 0.15 billion Vietnamese Dong. The additional revenues in all sectors resulting from the increase in air cargo demand generates an output multiplier of 2.8 billion Vietnamese Dong.

Fig. 3 provides information on the initial factor shares in cargo air transport production costs and the impact of a unit increase in air cargo

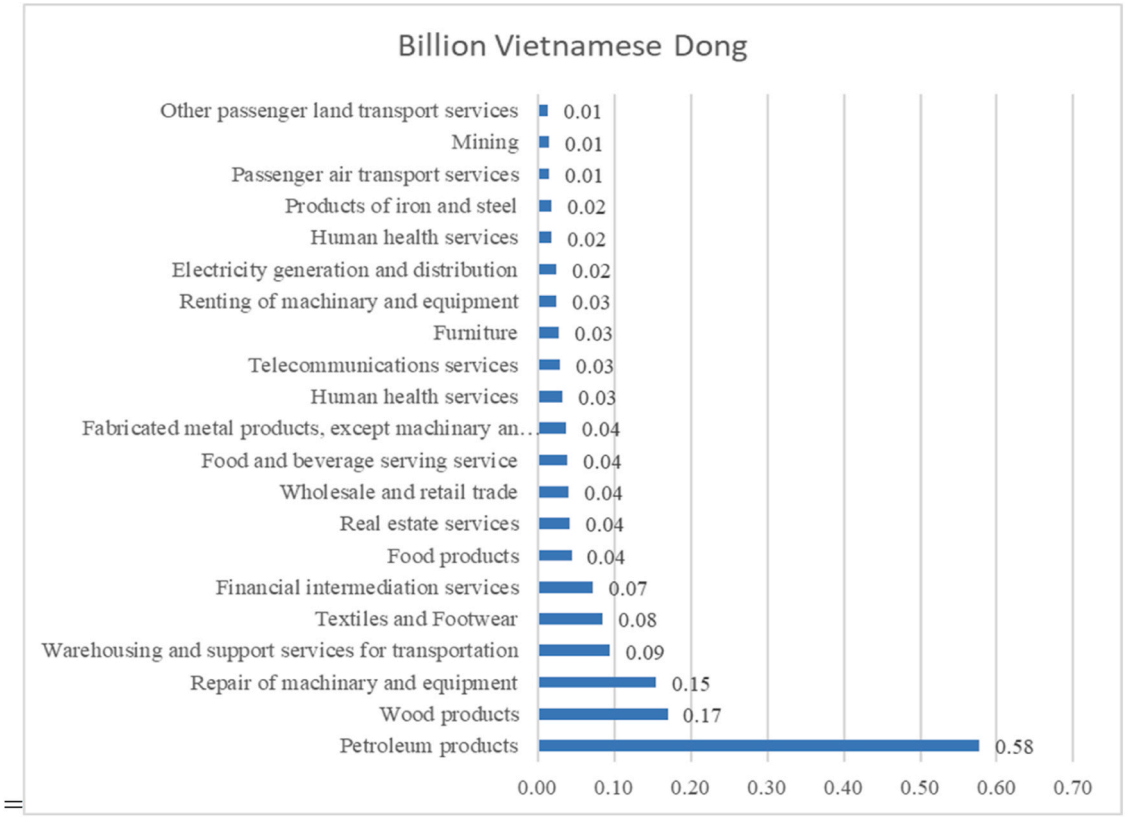

Fig. 2. Estimated revenue changes in various sectors with a unit increase in air cargo demand (in billion Vietnamese Dong).

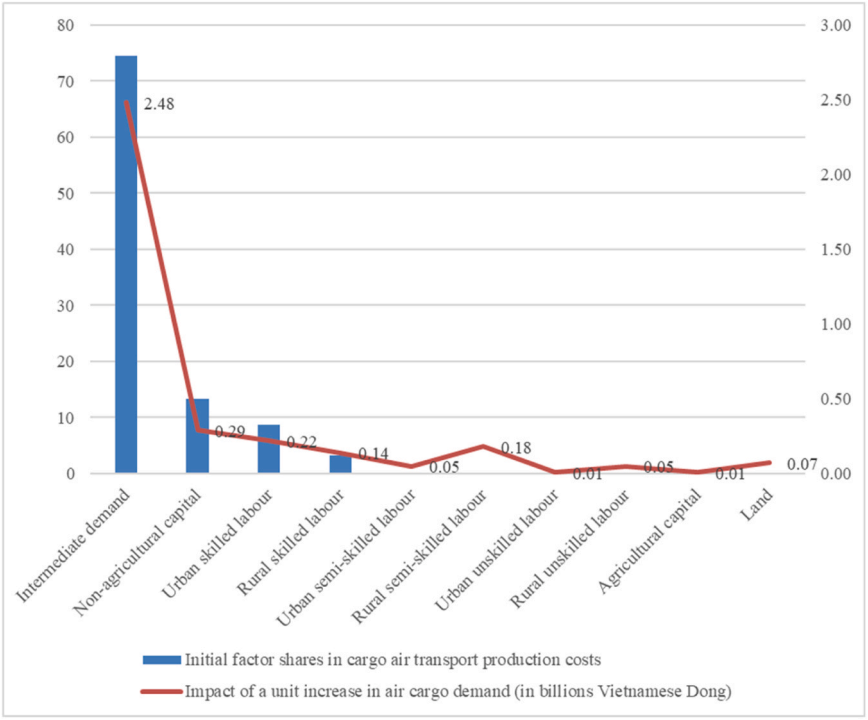

Fig. 3. Value-added multipliers.
Source: Authors.

demand in billions of Vietnamese Dong. In terms of the initial share of total production costs in the air cargo industry, intermediate demand accounts for the largest portion at 74.54 %. Non-agricultural capital represents 13.34 % of the costs, while urban skilled labour contributes 8.63 %. The share of production costs attributed to rural skilled labour is 3.28 %, while urban semi-skilled labour and rural semi-skilled labour account for 0.16 % and 0.04 % respectively.

When air cargo demand increases by one unit, the intermediate demand in the industry experiences a substantial impact of 2.48 billion Vietnamese Dong. These results confirm the significant role of air cargo in facilitating the trade of intermediate goods. Non-agricultural capital investments in sectors related to air cargo observe an impact of 0.29 billion Vietnamese Dong. In urban areas, the skilled labour force encounters an impact of 0.22 billion Vietnamese Dong, whereas in rural areas, the impact on skilled labour amounts to 0.14 billion Vietnamese Dong, reflecting the air cargo industry's high skill and capital intensity. The impact on semi-skilled labour is relatively smaller, with urban semi-skilled labour and rural semi-skilled labour experiencing impacts of 0.05 billion Vietnamese Dong and 0.18 billion Vietnamese Dong, respectively. Urban unskilled labour sees a minimal impact of 0.01 billion Vietnamese Dong, while rural unskilled labour experiences an impact of 0.05 billion Vietnamese Dong. Capital investments related to the agricultural sector, known as agricultural capital, witness an impact of 0.01 billion Vietnamese Dong. Lastly, land resources used in the air cargo industry encounter an impact of 0.07 billion Vietnamese Dong.

Employment serves as the most direct channel through which air cargo contributes to economic development. Analysing the impact on different factors or skill types is crucial for understanding the effects of increased air cargo connectivity on income distribution. Fig. 3 illustrates a strong connection between air cargo and jobs for both rural and urban skilled labour. Decomposing the SAM reveals that air cargo in Vietnam heavily relies on non-agricultural capital (52.39 %), skilled urban labour (33.90 %), skilled rural labour (12.90 %), semi-skilled urban labour (0.63 %), and semi-skilled rural labour (0.15 %) to generate value-added. According to the Vietnam SAM, capital returns (mostly non-farm enterprise profits) contribute to 20 % of total household income. Wages and salaries, particularly from labour with secondary and tertiary education, constitute the largest share of total income (averaging 70 %). Income from land and livestock returns, remittances, and government transfers also play significant roles, accounting for approximately 10 % of household income. Moreover, the results of the SAM multiplier show that growth of air cargo disproportionately benefits certain regions in Vietnam. Rural aggregate jobs experience faster growth compared to urban jobs, increasing by 370 million Vietnamese Dong and 280 million Vietnamese Dong, respectively.

5.1.2. *Income multiplier of air cargo growth*

Figs. 4 and 5 highlight the income multiplies associated with a unit increase in air cargo expenditures for different types of rural and urban households. The income multiplier represents the change in income that results from a change in air cargo expenditures. Urban farm households in the lowest expenditure deciles (Q1 and Q2) exhibit an income multiplier of 0.00. This implies that an increase in air cargo expenditures does not result in a significant change in income for these households. On the other hand, urban farm households in Q3 and Q4 experience a small positive change in income, with an income multiplier of 0.01 when air cargo expenditures increase. Urban farm households in Q5 witness a slightly higher positive change in income, with an income multiplier of 0.02 (0.02 billion Vietnamese Dong).

For urban nonfarm households in Q1 and Q2, similar to urban farm households in the same deciles, their income multiplier is 0.00. However, for urban nonfarm households in Q3, an increase in air cargo expenditures is expected to lead to an income multiplier of 0.01. Urban nonfarm households in Q4, unlike the previous categories, are projected to experience a larger positive change in income, with an income multiplier of 0.04. Finally, urban nonfarm households in Q5, belonging to the highest expenditure decile, demonstrate the most significant positive change in income compared to other categories, with an income multiplier of 0.24.

Rural farm households in the lowest decile (Q1) have an income multiplier of 0.04. Moving to Q2, rural farm households experience a slightly higher income multiplier of 0.06. The income multiplier further

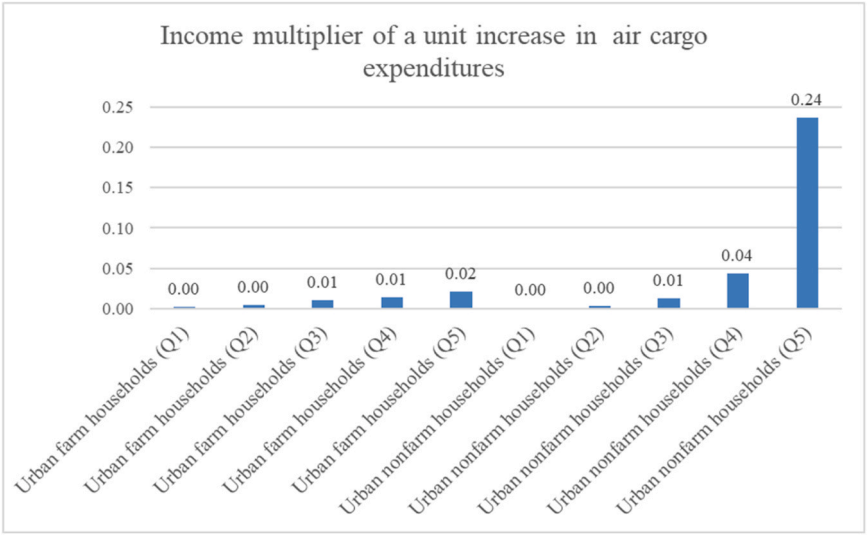

Fig. 4. Urban farm and nonfarm income multiplier from a unit increase in air cargo demand.
Source: Authors.

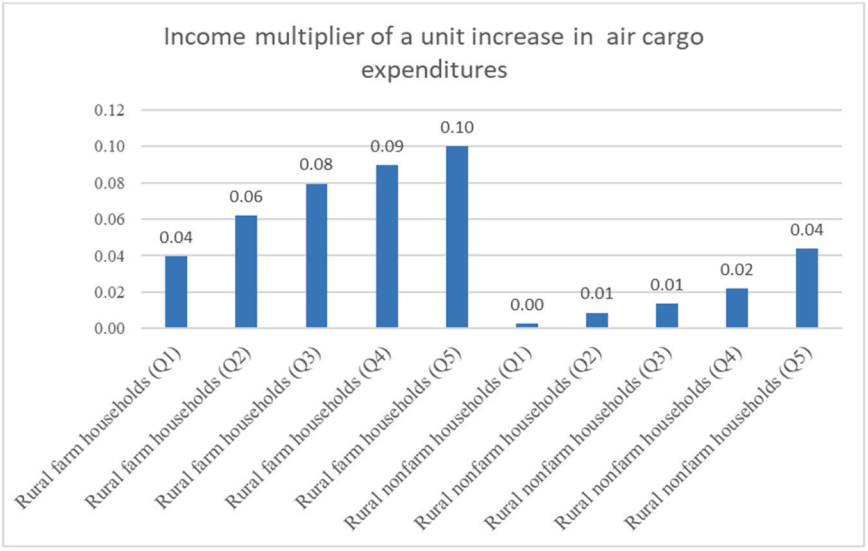

Fig. 5. Rural nonfarm and farm income multiplier from a unit increase in air cargo demand.
Source: Authors.

increases to 0.08 for rural farm households in Q3 and reaches 0.09 for those in Q4. Among rural farm households, Q5 exhibits the highest income multiplier of 0.10.

For rural nonfarm households, Q1 has an income multiplier of 0.00, indicating that an increase in air cargo expenditures does not lead to a significant change in income for these households. In Q2, the income multiplier is expected to increase by a factor of 0.01. Q3 of rural nonfarm households also has an income multiplier of 0.01. Moving to Q4, the income multiplier is expected to increase by a factor of 0.02. Among rural nonfarm households, Q5 demonstrates the highest income multiplier of 0.04.

Among all household types, those in the highest expenditure deciles (decile 5) derive the most significant advantages in both rural and urban areas. The results indicate that rural farm households generally have higher income multipliers compared to rural nonfarm households, indicating that increases in air cargo expenditures have a more significant impact on the income of rural farm households. This emphasises the role of air freight in enhancing the income and productivity of rural farm households and highlights the strong connection between agriculture and air freight, driven by the agricultural sector's substantial export intensity. It is important to note that rural farm households represent the largest group in Vietnam, measured by expenditure deciles [38,1].

5.2. *Results of structural path analysis*

SPA allows for a detailed analysis of the pathways through which the multiplier effects travel, specifically examining how these effects impact different household groups. This breakdown enables a comprehensive understanding of the channels through which the impacts are transmitted to various segments of the population.

5.2.1. *Urban farm households*

Fig. 6 provides a visual representation of the transmission pathways of demand shocks in the air cargo sector to urban farm households at the lowest decile. Additionally, Fig. 6 presents the quantitative outcomes derived from the structural path analysis (SPA), illustrating the different

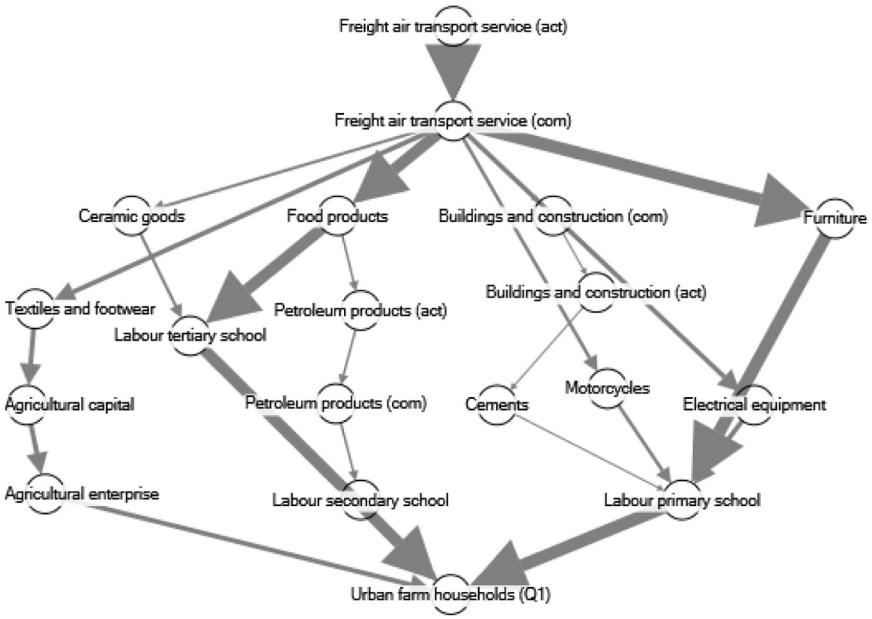

Fig. 6. Path linkages from air cargo to urban farm households (at the lowest decile of expenditures: Q1).
Source: own illustration of the output of SPA using NodeXL.

routes through which the income distribution effects of air cargo expansion are dispersed across sectoral linkages. The varying thickness of the lines in the figure indicates the strength and significance of the connections between the air cargo sector and households, particularly those belonging to the lowest expenditure deciles (Q1).[1]

The primary pathways depicted in Fig. 6 indicate that air cargo activities exert a direct influence on the production and transportation of air cargo commodities, specifically food products and furniture. This influence subsequently affects urban labour in tertiary and primary school education, ultimately impacting urban farm households. The pathway linking air cargo activities to air cargo commodities, food products, urban labour tertiary school, and urban farm households has a path multiplier of 1.3 (refer to appendix A1), indicating that the influence or impact along this path will be amplified by 1.3 times. The path with the highest path multiplier (2.1) connects air cargo activities, food products, petroleum and chemical production, urban labour secondary school, and urban farm households.

According to the results of the structural path analysis (SPA), approximately 33 % of the total multiplier effect is transmitted through the furniture sector, 16 % through the food products sector, 10% through textiles and footwear, and 10 % through electrical equipment. These four sectors collectively account for 71 % of the overall indirect impact of air cargo on the income of urban farm households via sectoral linkages. While other sectors, such as machinery motorcycles, construction, cement, petroleum, and ceramic goods, contribute to the transmission of air cargo's influence, their impact is comparatively less significant. In terms of factors, most of the impact on urban farm households in the lowest expenditure decile (Q1) is transmitted through skilled labour (tertiary education level) and unskilled labour (primary education level.

5.2.2. *Urban nonfarm households*

When considering urban nonfarm households (as shown in Fig. 7), the sectors that act as major conduits for the impact of air cargo through sectoral linkages are food products (contributing 17% to the total income multiplier), electrical equipment (17 %), textiles and footwear (2 %), and furniture (9 %). These sectors transmit their effects through both skilled and unskilled labour. Together, these five sectors account for 73 % of the total income multipliers generated by the impact of air cargo on urban nonfarm households through sectoral linkages. Additionally, other sectors that play a role in transmitting the effects of air cargo to households include petroleum products and pharmaceutical products. A significant portion of the multiplier is transmitted through skilled and unskilled labour. As observed in urban farm households, the path characterised by the highest path multiplier (2.1) establishes a linkage between air cargo activities, food products, petroleum and chemical production, urban labour secondary school, and urban farm households (refer to appendix A2). This indicates that the influence or impact along this path is significantly amplified.

5.2.3. *Rural farm households*

Fig. 8 illustrates the various pathways through which the effects of an air cargo demand shock unfold and impact rural farm households as it traverses the economy. The most substantial impact is channelled through furniture, accounting for 7.7 % of the total impact, and is transmitted via skilled labour. The second-largest pathway involves food products, contributing 6.8 % to the total impact, and is transmitted through semi-skilled labour. These two sectors combined make up 2.3 % of the total impact of air cargo's distributional effects on rural farm households through sectoral linkages. Other significant sectors through which the income multiplier effects of air cargo are transmitted to poor rural farm households include textile and footwear, wood products, and motorcycles.

5.2.4. *Rural nonfarm households*

Fig. 9 demonstrates the significant channels through which air cargo shocks are transmitted to rural nonfarm households. The sectors that play a crucial role in this transmission include food products (19 % of total multiplier), electrical equipment (12 %), and textiles and footwear (10 %), all involving skilled and non-agricultural labour. These sectors collectively account for 42 % of the path linkages from air cargo to rural farm households. The pathway connecting air cargo activities, air cargo commodities, food products, non-agricultural capital, non-agricultural enterprise, and rural nonfarm households has the highest overall influence. On the other hand, the pathway connecting air cargo activities, air

[1] Figs. 6 to 9 were generated using Nodexl and are based on the results presented in Appendices A1, A2, A3, and A4. The results obtained from the SPA analysis were generated using SIMSIP software.

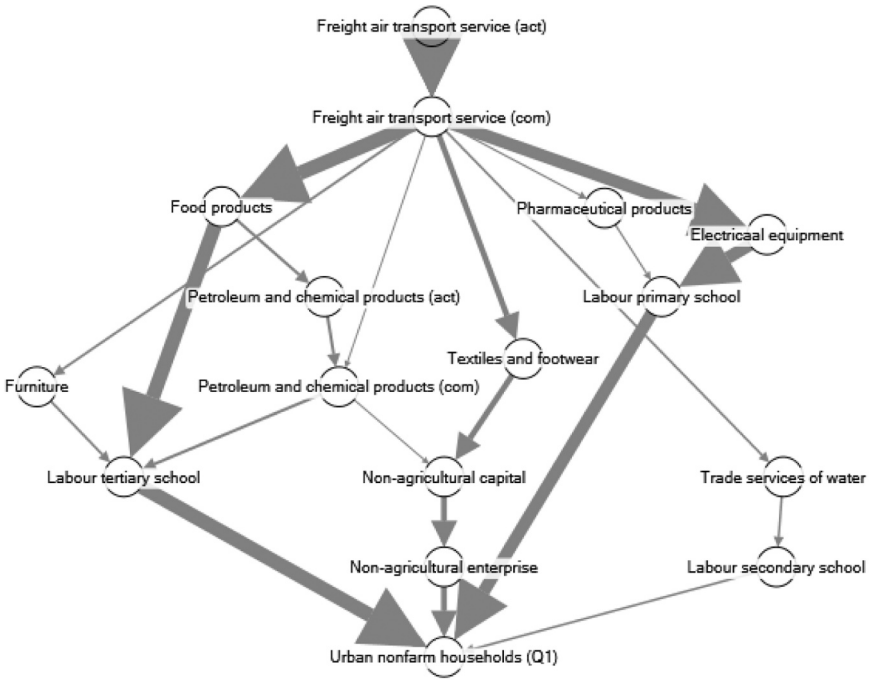

Fig. 7. Path linkages from air cargo to urban nonfarm households (at the lowest decile of expenditures: Q1).
Source: own illustration of the output of SPA (see Appendix) using NodeXL.

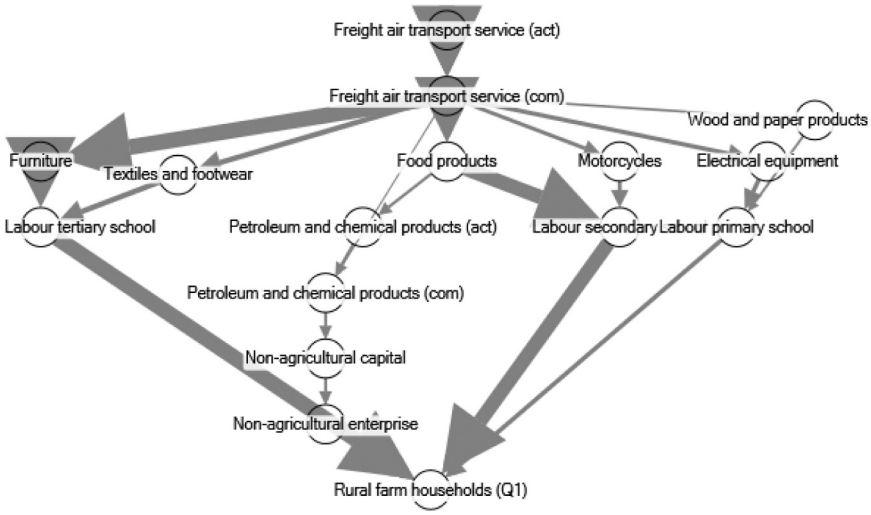

Fig. 8. Path linkages from air cargo to rural farm households (at the lowest decile of expenditures: Q1).
Source: own illustration of the output of SPA (see Appendix) using NodeXL.

cargo commodities, food products, petroleum and chemical production, petroleum and chemical products, rural labour primary school, and rural nonfarm households has the highest path multiplier (refer to appendix A3).

The above analysis reveals that a significant portion of the multiplier is attributed to the pathway linked to furniture, food products, textiles and footwear, motorcycles, skilled labour, and non-agricultural capital. These sectors and production factors serve as the primary channels through which the income effects of air cargo expansion are transmitted to poor households.

6. Discussions and policy implications

The simulation findings highlight the positive potential of the Vietnamese air cargo sector in addressing rural poverty by contributing to economic growth, employment, and income distribution. One notable outcome from the multiplier analysis is that the income growth of rural households is projected to outpace that of urban households. This finding suggests that air cargo has the capacity to narrow the regional income disparities within Vietnam. Additionally, rural farm households are expected to be the primary beneficiaries of air cargo expansion, experiencing the highest increase in earnings. Furthermore, the demand for skilled labour in both rural and urban areas is projected to grow at a faster rate compared to other types of labour.

The results of the SPA analysis reveal that the growth of the air cargo sector has a stimulating effect on sectors that employ low-skilled workers, particularly those with primary school education in rural areas. Fig. 10 depicts the distribution of various factors in key sectors that are influenced by air cargo. The sectors analysed in the figure are food products, textile and footwear, motorcycles, and furniture. For

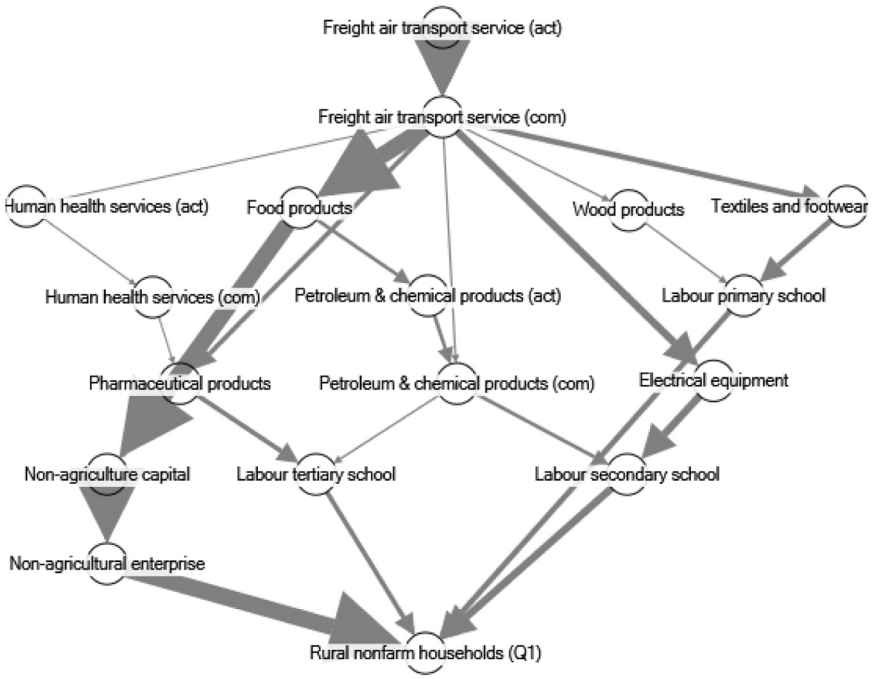

Fig. 9. Path linkages from air cargo to rural nonfarm households (at the lowest decile of expenditures: Q1).
Source: own illustration of the output of SPA (see Appendix) using NodeXL.

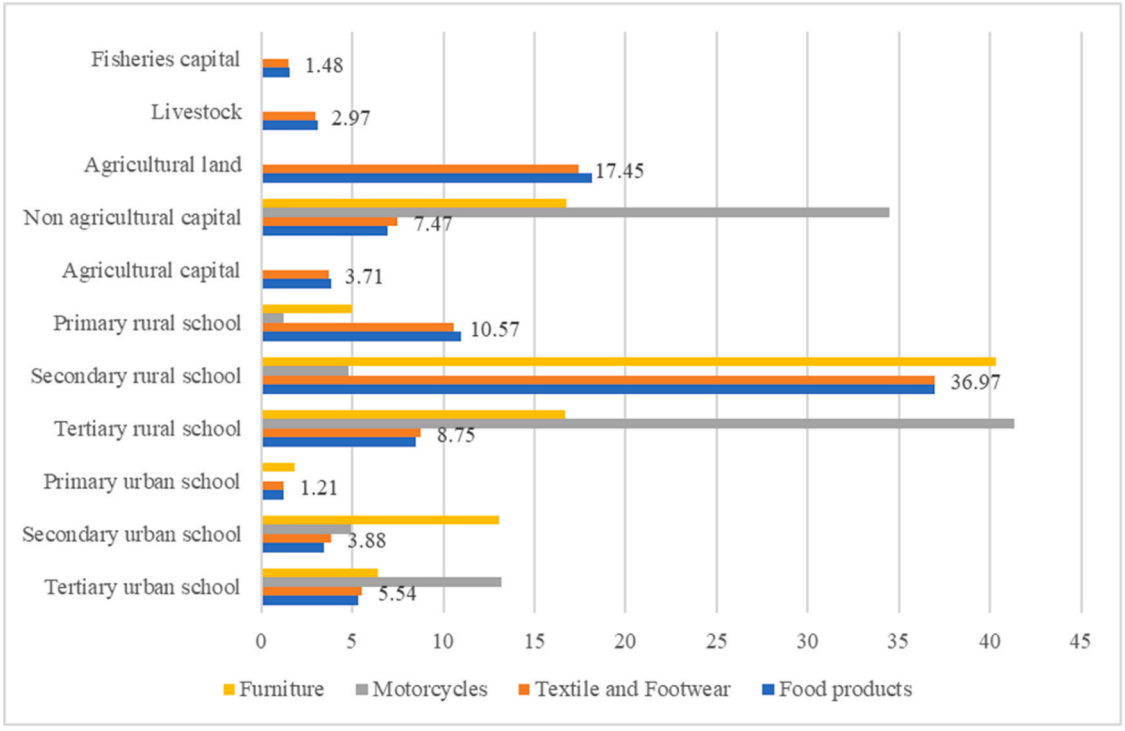

Fig. 10. Value-added of selected Vietnamese sectors.
Source: 2012 [38,1].

example, secondary rural school contributes to approximately 36 % of the overall factor costs in the food products and textile and footwear sectors, and 40 % in the furniture sector. Additionally, agricultural land plays a significant role, accounting for 18.17 % of the total value added in the food products sector and 17.45 % in the textile and footwear sector. On the other hand, primary rural school represents 10% in the textile and food sector and 5 % in the furniture sector. The benefits of air cargo growth for poor households are likely to arise from the integration of smallholder farm and non-farm households, as well as urban poor households, into the global supply chains of agriculture, textiles, and footwear. However, it is worth noting that all four primary sectors that contribute to income benefits rely on semi-skilled labour (secondary school education). This finding implies that in order to enhance the positive impact of air cargo as a tool for poverty reduction in both rural

and urban areas, the government should prioritise support for farm and non-farm businesses by improving access to skills and training opportunities. Additionally, other mechanisms such as technical assistance, subsidies, market linkages programs, and loan guarantees should be considered.

An important policy implication of this study is that the Vietnamese government should prioritise investment in air cargo infrastructure in rural areas. This investment would enhance access to various goods, including agricultural products, livestock products, processed foods, and handicrafts, while also improving the competitiveness of the air cargo industry. Rasker et al. [32] argue that the availability of transportation infrastructure, including access to airports, plays a crucial role in determining the types of industries that can flourish in remote areas. Despite rapid urbanisation, 62 % of Vietnam's population still resides in rural areas, where access to air cargo infrastructure is limited compared to urban areas. Investing in air cargo infrastructure in rural areas would unlock economic opportunities, discourage rural-to-urban migration, contribute to sustainable rural development, and help reduce poverty and inequality between urban and rural areas.

In addition to infrastructure investment, the government should consider regulatory reforms aimed at reducing barriers to air trade and creating incentives for private investment in rural air cargo infrastructure. As mentioned earlier, Vietnam lags behind the Philippines and Thailand in terms of the Air Trade Facilitation Index (ATFI), which measures a country's facilitation of air cargo through customs and border processes and regulations. Simplifying licensing requirements and streamlining customs procedures would lower trade costs and enhance the benefits of air cargo. Lower trade costs and improved air connectivity enable businesses to respond quickly to demand fluctuations, strengthen existing trade links, and create new connections. Air transport plays a vital role in facilitating global value chains (GVCs), and Vietnam's capacity to host subsidiaries linked through value chains is a factor in its participation in GVCs.

Dollar et al. [11] argue that limited access to domestically efficient services can hinder agriculture and manufacturing sectors from fully leveraging global integration and participating in higher value-added activities within GVCs. Therefore, improving domestic supply chain connectivity is as crucial as reducing trade costs in maximising trade benefits. Vietnam's ability to connect to world markets through global and regional value chains is a key driver of its international competitiveness [11]. While Vietnam has made progress in air connectivity, there is still room to close the infrastructure and connectivity gap compared to its peers and leverage air connectivity for international exchange of goods, services, capital, and people.

Enhanced air connectivity would lead to increased integration of sectors such as furniture, food products, motorcycles, textiles, and footwear into global exports. Air cargo efficiency is particularly important for products with complex linkages, such as textiles and apparel, perishable goods, and motor vehicles [36]. Air cargo's impact on multiple sectors and its connection to households through trade stimulation have the potential to generate employment opportunities and reduce poverty rates under favourable conditions. Moreover, improved air connectivity acts as a catalyst for greater participation in global value chains, driving economic development and welfare enhancement through sectoral and institutional linkages. Button [2] argues that the most dynamic trading regions are those that have become integrated into the network of global value chains. Given Vietnam's geographical distance from major economies, air cargo services are particularly significant, as the country serves as an important lightweight, high-value electronics export platform [25].

7. Conclusion

The primary objective of this study was to explore the potential of air cargo as a tool for rural development and poverty alleviation. Air cargo offers emerging economies opportunities to access new markets and expand their industrial base, fostering economic diversification. It also enables firms and countries to leverage the trend of international production organised into vertically specialised stages across different nations. Vietnam serves as an example of a country that has capitalised on recent global production trends. However, despite improvements in connectivity, Vietnam's air connectivity index remains below the ASEAN average, indicating limited integration with the global air transport network. While previous studies have examined the impact of improved air cargo on GDP and trade, the income distributional and poverty effects of enhanced air cargo connectivity have received less attention. This study aims to bridge that gap by examining the linkages between Vietnam's air cargo industry and the local economy. It employs a Social Accounting Matrix (SAM) multiplier and a Sectoral Production Analysis (SPA) to measure production linkages and assess the impact of air cargo sector performance on other sectors in the country. The SPA analysis reveals the transmission pathways from air cargo to households and identifies sectors most responsive to air cargo demand shocks.

The SAM analysis shows rapid growth in the demand for skilled labour, both in urban and rural areas, as well as non-agricultural capital. Furthermore, the study finds that the incomes of urban non-farm households and rural farm households experience a higher increase compared to other household groups. Importantly, the incomes of rural farm households grow faster on average than those of non-farm rural households and urban households, highlighting a strong linkage between air cargo and agriculture. The SPA analysis confirms these findings, indicating that textiles and footwear, food products, and furniture play significant roles as channels for transmitting air cargo income multiplier effects to households, particularly in semi-skilled and unskilled activities. Overall, the results of the SAM and SPA analyses suggest that air cargo has the potential to reduce rural poverty and regional inequality in Vietnam.

This study's contribution can be summarised in three aspects: firstly, it provides a detailed understanding of the distributional effects of air cargo, shedding light on its potential role in achieving sustainable development goals such as poverty reduction and addressing income inequality within countries. Secondly, it offers practical insights for policymakers on maximising air cargo's potential as a tool for rural poverty alleviation. Thirdly, it contributes to the broader literature on the relationship between trade, economic development, and poverty reduction in developing countries. The lessons learned from this study may also be relevant to other emerging countries, such as Ethiopia, Kenya, Colombia, and other landlocked African nations engaged in the production of perishable products primarily for export. Emerging economies worldwide are increasingly recognising the importance of air connectivity for value chain development and participation in global value chains (GVCs). As production costs rise in China, apparel producers are seeking alternatives in low-wage countries to outsource their production. Countries like Ethiopia, Rwanda, and South Africa have benefited from this shift partly due to their relatively high air connectivity scores.

Closing the infrastructure and skill gaps, as observed in Vietnam's case, is a common challenge for most developing countries. It is worth noting that, like any technique, SAM multipliers have limitations. One drawback is the assumption of unlimited excess capacity in all sectors and unemployed factors of production, which may overstate the total impacts if capacity constraints exist. The excess capacity assumption can be relaxed by considering supply constraints. SAM analysis also lacks consideration of substitution effects, behavioural changes, and non-linear relationships between economic variables. Additionally, it does not account for price, wage, and exchange rate changes, making it unsuitable for long-term analysis of demand shocks. Nevertheless, despite these limitations, SAM multipliers and SPA remain important tools for policy analysis as they provide valuable insights into the overall economy's response to demand shocks.

Future research could consider employing computable general equilibrium (CGE) models to expand the analysis. This approach would

enable the exploration of additional factors that were not covered in this study, including the welfare implications and negative externalities arising from air cargo. By using a CGE model, future studies can delve deeper into the price and distributional consequences that arise from the growth of air cargo.

Declaration of Competing Interest

The authors wish to declare that they have no conflict of interest with regards to the research conducted and the manuscript submitted for publication in *Transport Economics and Management*. The authors confirm that this work is original and has not been published elsewhere, nor is it under consideration for publication in any other journal. Furthermore, the authors attest that all individuals who have contributed significantly to this work have been acknowledged appropriately and have consented to the submission of this manuscript for publication.

Data availability

Data will be made available on request.

Appendix A1

Fixed Destination Structural Path Analysis						
Origin	**Destination**	**Elementary Paths**	**Direct Influence**	**Path Multiplier**	**Total Influence**	**Total/ Global (in %)**
Air Cargo Activities	**Urban farm households**	Air Cargo activities → Air Cargo commodities → Furniture → Urban labour primary school → Urban farm households	0.0	1.1	0.0	4.7
		Air Cargo activities → Air Cargo commodities → Food products → Urban labour tertiary school → Urban farm households	0.0	1.3	0.0	4.4
		Air Cargo activities →Air Cargo commodities → Textiles and footwear → non-agricultural capital → non-agricultural enterprise → Urban farm households	0.0	1.2	0.0	2.1
		Air Cargo activities → Air Cargo commodities → Electricity generation and distribution → Urban labour primary school → Urban farm households	0.0	1.1	0.0	2.1
		Air Cargo activities →Air Cargo commodities → Motorcycles → Urban labour primary school → Urban farm households	0.0	1.6	0.0	1.7
		Air Cargo activities → Air Cargo commodities → Ceramic goods → Urban labour tertiary school → Urban farm households	0.0	1.1	0.0	1.5
		Air Cargo activities → Air Cargo commodities → Food products →Petroleum and chemical production → Petroleum and chemical products → Urban labour secondary school → Urban farm households	0.0	2.1	0.0	1.3
		Air Cargo activities → Air Cargo commodities → Buildings and construction works commodities → Buildings and construction works activities → Cements –> Urban labour tertiary school → Urban farm households	0.0	1.1	0.0	1.1

Appendix A2

Fixed Destination Structural Path Analysis						
Origin	**Destination**	**Elementary Paths**	**Direct Influence**	**Path Multiplier**	**Total Influence**	**Total/ Global (in %)**
Air Cargo Activities	**Urban nonfarm households**	Air Cargo activities → Air Cargo commodities → Food products → Urban labour tertiary school → Urban nonfarm households	0.0	1.3	0.0	5.2
		Air Cargo activities → Air Cargo commodities → Electrical equipment → Agricultural capital → Agricultural enterprise → Urban nonfarm households	0.0	1.1	0.0	4.6
		Air Cargo activities → Air Cargo commodities → Textiles and footwear → Urban labour secondary school → Urban nonfarm households	0.0	1.2	0.0	2.4
		Air Cargo activities → Air Cargo commodities → Food products → Petroleum and chemical production → Petroleum and chemical products → Urban labour tertiary school → Urban nonfarm households	0.0	2.1	0.0	1.5
		Air Cargo activities → Air Cargo commodities → Furniture → Urban labour primary school → Urban nonfarm households	0.0	1.1	0.0	1.3
		Air Cargo activities → Air Cargo commodities → Trade services of water → non-agricultural capital → non-agricultural enterprise → Urban nonfarm households	0.0	1.1	0.0	1.3
		Air Cargo activities → Air Cargo commodities → Pharmaceutical products → Urban labour primary school -→ Urban nonfarm households	0.0	1.3	0.0	1.1
		Air Cargo activities → Air Cargo commodities → Petroleum and chemical production → Petroleum and chemical products → non-agricultural capital → non-agricultural enterprise → Urban nonfarm households	0.0	1.3	0.0	1.0

Appendix A3

Fixed Destination Structural Path Analysis						
Origin	**Destination**	**Elementary Paths**	**Direct Influence**	**Path Multiplier**	**Total Influence**	**Total/ Global (In %)**
Air Cargo Activities	**Rural farm households**	Air Cargo activities → Air Cargo commodities → Furniture → Rural labour primary school → Rural farm households	0.0	1.2	0.0	5.7
		Air Cargo activities → Air Cargo commodities → Food products → Rural labour secondary school → Rural farm households	0.0	1.4	0.0	5.3
		Air Cargo activities → Air Cargo commodities → Textiles and footwear→ Rural labour tertiary school → Rural farm households	0.0	1.2	0.0	2.3
		Air Cargo activities → Air Cargo commodities → Electrical equipment → Rural labour primary school → Rural farm households	0.0	1.2	0.0	2.0
		Air Cargo activities → Air Cargo commodities → Motorcycles –> Non-agricultural capital → non-agricultural enterprise→ Rural farm households	0.0	1.6	0.0	1.8
		Air Cargo activities → Air Cargo commodities → Food products → Petroleum and chemical production → Petroleum and chemical products → agricultural capital → agricultural enterprise → Rural farm households	0.0	2.1	0.0	1.5
		Air Cargo activities → Air Cargo commodities → Wood and paper products → Rural labour primary school → Rural farm households	0.0	1.2	0.0	1.3
		Air Cargo activities → Air Cargo commodities → Petroleum and chemical products → Rural labour tertiary school → Rural farm households	0.0	1.3	0.0	1.0

Appendix A4

Fixed Destination Structural Path Analysis						
Origin	**Destination**	**Elementary Paths**	**Direct Influence**	**Path Multiplier**	**Total Influence**	**Total/ Global (In %)**
Air Cargo Activities	**Rural nonfarm households**	Air Cargo activities → Air Cargo commodities → Food products –> non-agricultural capital → non-agricultural enterprise → Rural nonfarm households	0.0	1.3	0.0	5.8
		Air Cargo activities → Air Cargo commodities → Electricity generation and distribution → Rural labour primary school → Rural nonfarm households	0.0	1.1	0.0	2.9
		Air Cargo activities → Air Cargo commodities → Textiles and footwear –> Rural labour secondary school → Rural nonfarm households	0.0	1.2	0.0	2.3
		Air Cargo activities → Air Cargo commodities → Pharmaceutical products → Rural labour tertiary school → Rural nonfarm households	0.0	1.3	0.0	2.0
		Air Cargo activities → Air Cargo commodities –> Food products → Petroleum and chemical production → Petroleum and chemical products → Rural labour primary school → Rural nonfarm households	0.0	2.1	0.0	1.7
		Air Cargo activities → Air Cargo commodities → Petroleum and chemical products → Rural labour tertiary school → Rural nonfarm households	0.0	1.3	0.0	1.1
		Air Cargo activities → Air Cargo commodities → Wood products → Rural labour secondary school → Rural nonfarm households	0.0	1.1	0.0	1.1
		Air Cargo activities → Air Cargo commodities → Human health services commodities–> Human health services activities → non-agricultural capital → non-agricultural enterprise → Rural nonfarm households	0.0	1.3	0.0	1.0

Appendix A5. . Vietnam Social Accounting Matrix

VNSAM-2012.xlsx (live.com).

https://view.officeapps.live.com/op/view.aspx?src=https%3 A%2 F%2Fwww.wider.unu.edu%2Fsites%2Fdefault%2Ffiles%2FDat%2FVNSAM-2012.xlsx&wdOrigin=BROWSELINK.

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