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ECONOMIC SECTORS IMPACT HOUSEHOLD INCOME IN VIETNAM: A STRUCTURAL PATH ANALYSIS[1]

Abstract. Despite the remarkable achievements in poverty reduction, income inequality in Vietnam still tends to increase, consequently having negative impacts on the sustainable growth of the country. The goals of this research are to identify and measure the impact of propagation channels of economic sectors on the income of the household groups, which is of great importance to poverty reduction efforts in Vietnam. The study aims to unravel the critical supply chain paths that drive changes in household income. To this end, the structural path analysis methodology is used based on the 2016 Vietnam Social Accounting Matrix model, which has not been extensively studied in Vietnam. Compared with previous studies, this research was conducted at the national level instead of the regional level and detailed the factors involved in income distribution such as economic sectors, labour, and household groups. The analysis finds 513 higher-order paths of 25 sectors that lead to an income increase for the household groups. When economic sectors expand under policy changes, household income improvements are mainly affected by labour skill, capital, and the magnitude of inter-industry linkages. It is noteworthy that high-skilled labour has a significant impact on the income of urban households, while the income of rural households is considerably affected by the capital. The analysis also demonstrates 32 selected paths having the greatest influence on household income. The importance of forestry, wood and wood products, fisheries, coal, crude oil and natural gas, footwear, distribution of electricity, gas, water, and utilities, and retail and wholesale for poverty alleviation is underlined for their distributional impact. Based on the research findings, relevant policy implications are also recommended.

Keywords: household income, structural path analysis (SPA), social accounting matrix (SAM), economic sector, labour, capital, inter-industry linkages, urban areas, rural areas, income inequality.

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ИССЛЕДОВАТЕЛЬСКАЯ СТАТЬЯ

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Неравенство доходов в различных секторах экономики Вьетнама: анализ структурных связей

Аннотация. Несмотря на выдающиеся достижения в области сокращения бедности, неравенство доходов во Вьетнаме по-прежнему имеет тенденцию к увеличению, оказывая негативное влияние на устойчивое развитие страны. Цель исследования — выявление и измерение влияния секторов экономики на доходы различных групп населения; полученные данные могут быть использованы для снижения уровня бедности во Вьетнаме. Связь между секторами экономики и распределением доходов населения Вьетнама была выявлена при помощи методологии анализа структурных связей, основанной на матрице социальных счетов за 2016 г., которая до сих пор не получила широкого применения среди вьетнамских ученых. По сравнению с предыдущими работами, данное исследование проведено на уровне страны, а не региона. Также были подробно описаны факторы, влияющие на распределение доходов, такие как секторы экономики, трудовые ресурсы и группы населения. Анализ выявил, что распределение большей части доходов 25 секторов экономики происходит по 513 потокам. При расширении секторов экономики вследствие политических изменений повышение доходов населения в основном зависит от таких показателей, как квалификация работников, капитал и масштаб межотраслевых связей. Примечательно, что на доходы городских домохозяйств существенное влияние оказывает показатель «высококвалифицированный труд», в то время как капитал является наиболее важным фактором, влияющим на доходы сельских домохозяйств. Согласно проведенному анализу, 32 потока наиболее значимо влияют на доходы населения. Важную роль в борьбе с бедностью играют следующие секторы экономики: лесное хозяйство, древесина и изделия из древесины, рыболовство, добыча угля, сырой нефти и природного газа, производство обуви, поставки электроэнергии, газа, воды и коммунальных услуг, а также розничная и оптовая торговля. Полученные данные послужили основой для рекомендаций в области сокращения неравенства доходов.

Ключевые слова: доходы населения, анализ структурных связей, матрица социальных счетов, сектор экономики, труд, капитал, межотраслевые связи, городские районы, сельские районы, неравенство доходов

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1. Introduction

Household income is informative when comparing living standards between cities, regions, or countries. In Vietnam, not only policymakers but also the whole communities are concerned about the issues related to the income of citizens. Over the years, Vietnam has achieved remarkable successes in poverty reduction by implementing inequality control policies. The poverty index in Vietnam decreased from 19 % to 7 % of the population between 1993 and 2002 (Müller et al., 2006). The Vietnam General Statistics Office (GSO)[1] stated that the proportion of poor households in the country decreased from 37.4 % to 5.8 % between 1998 and 2016. Despite those achievements, the poverty rate in Vietnam remains high and inequality tends to increase. Moreover, the implementation of Free Trade Agreements in the context of globalisation has caused Vietnam to face many challenges. Natural disasters and epidemics, especially the development of the Covid-19, are seriously affecting the economy and lives of citizens. Therefore, the economic growth strategies need to be thoroughly calculated to ensure beneficial welfare, diminish income inequality, and create a driving force for sustainable growth.

[1] General Statistics Office. (GSO). The poverty rate classified by urban and rural areas and by region. Retrieved from: https://www.gso.gov.vn/px-web 2/?pxid=V1140&theme=Y%20t%E1%BA%BF%2C%20v%C4%83n%20h%C3%B3a%20v%C3%A0%20C4%91%E1%BB%9Di%20s%E1%BB%91ng (Date of access: 22.05.2021).

Among the determinants of economic growth, sectoral structure plays a decisive role in poverty alleviation. The fact is that there always exists the unevenness of household income among different industries, and the growth of different industries has heterogeneous effects on reducing poverty. Ivanic and Martin (2018) stated that in poor economies, an increase in agricultural productivity has a larger poverty-reduction impact than a similar-sized increase in industry or services. Urgessa (2015), in the context of Ethiopia, argued that households living on non-farm income are wealthier than households completely depending on farming. Several studies in Vietnam also noted the unequal influences of economic sectors on income as well as poverty alleviation. Pham and Riedel (2019), obtaining data from Statistical Yearbook of Vietnam in 2010–2016, found that the proportion extension of industrial and agricultural sectors positively affects poverty reduction, while the growth of service sectors even increases the poverty rate. Luan et al. (2016) showed that bank credit in Vietnam is effective to non-farm income only while bringing no benefit for households living on farm income. This conclusion is consistent with Linh et al. (2019) that credit causes the farmers to be excluded from formal financial markets and to face challenges in improving their income.

The above studies mostly used traditional micro- and macroeconomic approaches, such as pooled ordinary least square, propensity score matching method, descriptive statistics, only leading to aggregate results without clarifying the mechanisms of impacts spreading in income distribution. To give insight into such mechanisms and the different linkages among accounts in an economy, the structural path analysis (SPA) is a useful approach. SPA is a variant of multiplier decomposition which provides a complete movement network from the beginning to the end of an exogenous shock. Compared to the two traditional multiplier decompositions proposed by Stone (1978) and Pyatt and Round (1979), this method better illustrates in detail the direction of the spread of effects along with their magnitude.

Defourny and Thorbecke (1984) were one of the first to apply SPA to a Social Accounting Matrix (SAM) database to explore the influence of production activities on household groups. This study adopted the 1968 SAM of South Korea, composed of three accounts: production activities, the factorial income distribution, and the income distribution among institutions (particularly among household groups). The authors found different interesting effects that economic sectors could have on household income. For example, the medium-sized farming households benefited more from production increase than other size farms. In every agricultural sector, the smaller-sized farms received a higher proportion of global influence directly transmitted from production expansion in other agricultural sectors. The integration of SPA and SAM in this research forms a potentially useful tool to explore specifically how the policies might affect the whole economic system.

A similar methodology was implemented by Khan and Thorbecke (1989) based on the 1975 SAM of Indonesia to evaluate the macroeconomic impacts of the step-by-step replacement of conventional technologies by modern ones. The research reaffirmed the usefulness of SPA in addressing policy issues in the economy, in particular, illustrating how income yielded by a specific choice of technology is transmitted to specific factors and households. Also based on the SAM approach, Puttanapong and Sessomboon (2017) used SPA to assess the contribution of agricultural and food processing sectors to Thai economy. The study revealed that among the examined sectors, grain processing produces the largest impacts on farming household income, mainly through indirect paths.

One of the very few studies using SPA to examine how economic sectors may influence household income in Vietnam was conducted by Arndt et al. (2012). This study employed the SAM framework of Vietnam in 2003, questioning if the economic accounts have significant roles in poverty reduction. For that purpose, Arndt et al. (2012) focused on the income of poor households (or rural income) rather than all household groups in the economy. SPA was used to specify the impact channels that deliver income to rural households from urban consumer demand and the two key sectors: agriculture and construction. The results showed that both of these sectors provided highly important impact channels to rural household income through the land, capital, and low-skilled labour. A demand stimulus from urban households also significantly benefited rural income through the channels of food and agricultural sectors. That was one of the reasons why major cities located close to agricultural production zones could make a crucial contribution to raise the income of these farming areas. The study, therefore, concluded that in the case of Vietnam, structural characteristics of the economy can partly determine growth–poverty relationships.

In this paper, we aim to solve the following research questions: (1) How do production factors and inter-industry linkages affect the income dis-

tribution from economic sectors to the household groups? (2) Which economic sectors play important roles in improving income inequality, helping to reduce poverty in Vietnam?

Based on those research questions, the purpose of this study is to introduce the applicability of SPA to determine the linkages between the economic sectors and household income, which has not been extensively studied in Vietnam. In particular, this relationship is demonstrated in the SAM model to emphasise the effect of production activities on household income through different impact propagation channels. This SPA approach not only provides a more accurate understanding regarding which sectors have the greatest impact on household income but also clarifies the role of production factors and the inter-industry linkages beneficial to it through direct and indirect influences. Although there is a large number of empirical studies on the linkages between sectors and household income, there still exist some limitations regarding sector extents and research location which is mostly at the regional level, and level of detail in sectors and households by income. The novelty of this research is adopting an SPA approach based on SAM framework to quantify such linkages at the national level with the involvement of all the sectors in the economy. The findings of this study enrich research literature on the relationship between the economic sectors and household income, clarifying the role of the sectors in developing countries (such as Vietnam) so as to build the right economic growth strategies that improve citizens' well-being and poverty alleviation under resource constraints.

The rest of the article is organised into three sections. Section 2 describes the data and research method. Section 3 discusses the empirical results. Section 4 concludes the study and gives recommendations arising from the analysis.

2. Research Methodology and Data

2.1. Structural Path Analysis

Hartono and Resosudarmo (2008) argued that SAM is an important tool for analysing the impact of economic policies on income distribution. In particular, SAM is preferable thanks to its simplicity, straightforwardness, especially when it is used in conjunction with some other analyses, such as SPA. The main purpose of the SAM multiplier is to examine the overall effects of an exogenous injection on each account. However, this framework only shows the final result and is unable to present the component effects propagating through the accounts within the economic system. Therefore, it is necessary to decompose the SAM multiplier framework to clarify its nature. According to Taylor expansion (Lenzen, 2003; Lenzen, 2007; Oshita, 2012; Wood & Lenzen, 2009), formula of the SAM multiplier matrix can be written as follows:

$$M_a = (I - A)^{-1} = I + A + A^2 + A^3 + A^4 + \ldots \quad (1)$$

Or:

$$\begin{aligned} X &= \left(I - A\right)^{-1} F = \\ &= \left(I + A + A^2 + A^3 + A^4 + \ldots\right) F = \\ &= \sum_{i,j=1}^{n} (I + A_{ij} + A_{ij}^2 + A_{ij}^3 + A_{ij}^4 + \ldots) F_j = \\ &= \sum_{j=1}^{n} F_j + \sum_{i,j=1}^{n} A_{ij} F_j + \sum_{i,k=1}^{n} A_{ik} \sum_{j=1}^{n} A_{kj} F_j + \\ &\quad + \sum_{i,l=1}^{n} A_{il} \sum_{k=1}^{n} A_{ik} \sum_{j=1}^{n} A_{kj} F_j + \ldots \end{aligned} \quad (2)$$

where X is the matrix of endogenous variable (production activity, the factor of production, institutional groups: households); F is the matrix of exogenous variable (the remaining accounts in SAM); I is the identity matrix.

A is the coefficient matrix or the inter-industry requirements matrix (Leontief, 1941; Miller & Blair, 2019); United Nations[1]), calculated by the proportion between intermediate inputs, or income factor, or household income by sector and the total output of that account. The matrix $M_a = (I - A)^{-1}$ is called the SAM-multiplier matrix or Leontief inverse, presenting the total (direct and indirect) effects of each account generated by the effect of one unit of exogenous shock on the economy.

$A^t_{ij} F_j$ can be decomposed into elements that express supply chains representing the income requirements generated from the t^{th} production layer. Each account requires intermediate input induced by the final demand F_j from the preceded account. X is the sum of the income flows regenerated from the propagation of demand F_j between any two input and output poles (accounts) in the economy. The larger the production layer, the more poles (accounts) the effect spreads through. According to Peters and Hertwich (2006), with n endogenous accounts, the number of poles of each production layer increases exponentially to n^{t+1}.

At the zeroth production layer ($t = 0$), n poles directly generate the amount of income F_j.

[1] United Nations. Statistical Division, & Social Affairs. Statistics Division. (1999). Handbook of input-output table compilation and analysis (No. 74). UN.

At the first production layer ($t = 1$), n^2 poles generate the amount of income $A_{ij}F_j$. This expression shows that the impact is spreading from j to i.

At the second production layer ($t = 2$), n^3 poles generate the amount of income $A_{ik}A_{kj}F_j$. This expression shows that the impact is spreading from j to k to i.

This process keeps proceeding in the same way to the t^{th} production layer. There is always a certain number of paths between any two poles in the economy. The calculation of the amount of generated income across all paths can identify the most important transmission paths in all of the production layers. That is what SPA does to add an extra degree of transparency in clarifying the linkages among the actors in the economy in general and between the economic sectors and groups of households in particular. According to Defourny and Thorbecke (1984), SPA measures three influences, including direct, total, and global influence.

Direct Influence

The direct influence between any two poles describes only the income of the poles in the elementary path.

$$I^D_{(i\to j)} = a_{jn}\dots a_{mi}. \quad (3)$$

Total Influence

An exogenous effect propagated through the poles located on any given path can be amplified by the effects of adjacent feedback circuits. All of these effects originate from a certain pole and end at the same pole. The total influence is defined as the sum of the direct and indirect effects generated during the propagation of the influence over the poles located on that path and measured using the following formula:

$$I^T_{(i\to j)} = I^D_{(i\to j)}M_p, \quad (4)$$

where M_p is called the path multiplier. This value is always greater than 1. It equals to 1 only when the path has no adjacent circuit and then $I^T_{(i\to j)} = I^D_{(i\to j)}$.

Global Influence

Global influence measures the total influence of all the paths between the poles j and i and can be decomposed as follows:

$$I^G_{(i\to j)} = \sum_{p=1}^{p} I^T_{(i\to j)p} = \sum_{p=1}^{p} I^D_{(i\to j)p}M_p. \quad (5)$$

Global influence is also the magnitude of the SAM-multiplier framework. That is why the SAM-multiplier matrix is also called the matrix of global influence.

2.2. Data Sources

The database used in this study is Vietnam SAM (VSAM) 2016, which is built by the authors based on CIEM's method (method promoted by Central Institute for Economic Management). Each account is measured in Vietnamese currency (VND).

Micro SAM is built based on detailing the accounts in macro VSAM 2016 as follows:

— Production activities and Goods and services are detailed into 25 sectors: C1 (Agriculture), C2 (Forestry), C3 (Wood and wood products), C4 (Fisheries), C5 (Coal, crude oil, and natural gas), C6 (Ores and minerals), C7 (Food and beverages), C8 (Textiles and garments), C9 (Footwear), C10 (Paper and paper products), C11 (Petroleum and chemical products), C12 (Non-metallic mineral products), C13 (Metals and metal products), C14 (Computers, electronic products, and components), C15 (Machines, equipment, tools, spare parts, and components), C16 (Other goods), C17 (Distribution of electricity, gas, water, and utilities), C18 (Construction), C19 (Retail and wholesale), C20 (Hotel and catering services), C21 (Transportation), C22 (Financial services and business), C23 (Public Administration), C24 (Education and Health), C25 (Other Services).

— Households are detailed into 10 groups (Table 1) classified by area and income quintile (urban: income increases from H1 to H5; rural: income increases from H6 to H10). Each group accounts for 20 % of households in each area. Household income is the total income from factors of production (capital and labour), government aid, and remittances from abroad according to 2016 VHLSS (Vietnam Household Living Standard Survey) data.

— Factors of production consist of capital (C) and 06 types of labour (Table 2) classified by region (urban: from L1 to L3; rural: from L4 to L6) and education level.

Table 1

Classification of household groups

Type of household group	Area	Household group
H1	Urban	Group 1
H2		Group 2
H3		Group 3
H4		Group 4
H5		Group 5
H6	Rural	Group 1
H7		Group 2
H8		Group 3
H9		Group 4
H10		Group 5

Table 2

Classification of labour

Type of Labour	Area	Labour skill
L1	Urban	Upper secondary education and higher
L2		Lower secondary education
L3		Pre-primary and primary education
L4	Rural	Upper secondary education and higher
L5		Lower secondary education
L6		Pre-primary and primary education

— Government and foreign transfers are detailed into household groups in proportion to the transfer rate determined in the 2016 VHLSS data.

3. The Empirical Results

3.1. The Reality of Income Inequality in Vietnam and the Role of Production Factors in Income Generation

According to the GSO, Vietnam's Gini index did not change much in the period 2002–2018, ranging from 0.42 to 0.43 (Fig. 1). Although this index shows that Vietnam is currently above the safe threshold, it is noteworthy that the Gini index of rural areas tends to increase and has recently been higher than that of urban areas.

In addition, while the disparity in per capita income between the richest and the poorest households in urban areas is decreasing, the disparity in rural areas and the whole country is on the rise (Fig. 2). This poses a risk of income inequality that may occur as the country develops.

The causes of income differences primarily arise from assets and labour. According to the results calculated from VSAM 2016, 88.9 % of the household income is derived from capital and labour. Table 3 shows that these factors contribute differently to the income of different household groups. For example, in urban areas, high-skilled labour (L1) is the greatest contributor to most of the income groups (H2 to H5), while low-skilled labour (L3) contributes the most to the lowest income households (H1). Meanwhile, in rural areas, high-skilled labour (L4) contributes significantly to the two highest income groups only (H9 and H10), while low-skilled labour (L6) plays a prominent role in income generating for the other three groups (H6 to H8).

The contribution of capital (C) to the income of different household groups is also uneven. The highest proportion in urban areas is observed in the highest-income households (H5), while it is the lowest-income group (H6) that receives the largest contribution from the capital in rural areas. Notably, the capital contribution propor-

Table 3

Percentage of the contribution of capital and labour to household income

		L1	L2	L3	C
Urban areas	**H1**	23.1	26.6	37.9	12.4
	H2	39.4	22.5	26.6	11.5
	H3	48.3	19.7	17.5	14.5
	H4	59.8	11.1	7.9	21.3
	H5	62.6	5.4	3.3	28.7
		L4	**L5**	**L6**	**C**
Rural areas	**H6**	7.4	21.7	39.5	31.4
	H7	12.7	23.3	36.5	27.5
	H8	21.5	24.0	27.2	27.3
	H9	33.0	21.8	22.0	23.1
	H10	41.8	17.4	14.3	26.5

Source: The authors' calculation from VSAM 2016 data.

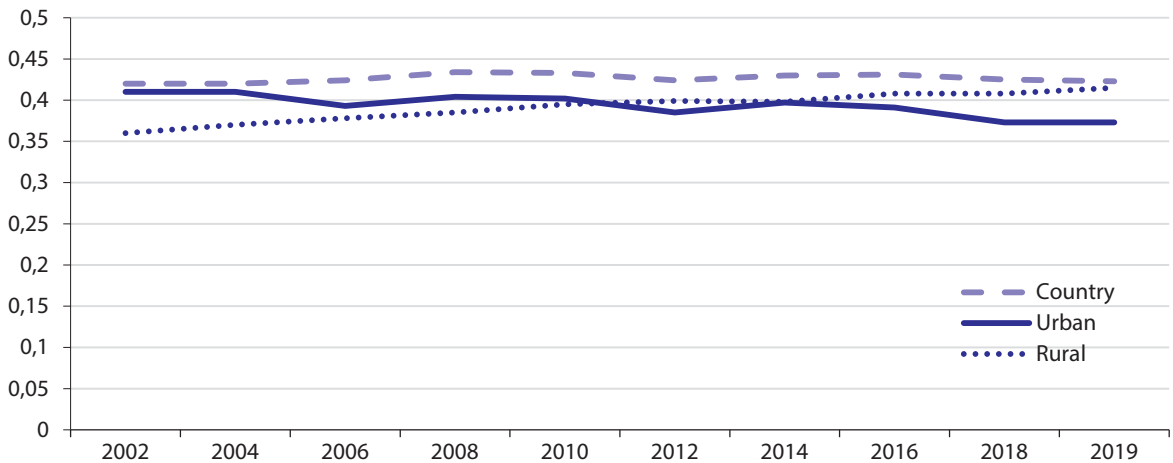

Fig. 1. *Gini coefficient of the whole country, urban areas, and rural areas. Source: GSO (General Statistics Office (GSO). Income distribution inequality coefficient (Gini coefficient). Retrieved from: https://www.gso.gov.vn/px-web 2/?pxid=V1135&theme=Y%20t%E1 %BA%BF%2C%20v%C4 %83n%20h%C3 %B3a%20v%C3 %A0 %20 %C4 %9 %E1 %BB%9Di%20s%E1 %BB%91ng (Date of access: 22.05.2021))*

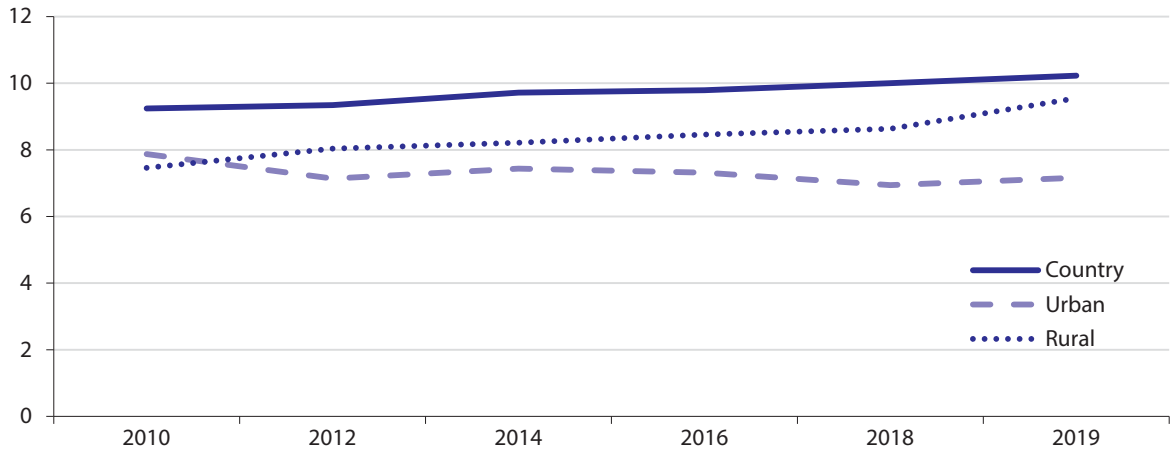

Fig. 2. *The difference in monthly income per capita between the richest quintile and the poorest quintile. Source: The authors' calculation from GSO data (General Statistics Office (GSO). Per capita income per month at current prices by 5 income groups, by urban and rural areas, by gender of household head, and by region. Retrieved from: https://www.gso.gov.vn/px-web-2/?pxid=V1130&theme=Y%20t%E1 %BA%BF%2C%20v%C4 %83n%20h%C3 %B3a%20v%C3 %A0 %20 %C4 %91 %E1 %BB%9Di%20s%E1 %BB%91ng (Date of access: 22.05.2021))*

tion to income in rural areas is remarkably higher than in urban areas, except for the highest income groups (H5 and H10). It is evident that the capital factor plays a significant role in income generation in rural areas, especially for low-income households.

3.2. SAM-Based Multiplier Analysis

The result in Table 4 shows the variation in household income induced by a unit change in the economic output from a policy adjustment, such as demand stimulation in consumption. Of the sectors, Forestry (C2), Public Administration (C23), Retail and wholesale (C19), and Wood and wood products (C3) are predicted to generate the largest income for the household groups once such a change occurs. They are followed by Distribution of electricity, gas, water, and utilities (C17), Education and Health (C24), Fisheries (C4), Agriculture (C1), Financial services and business (C22), Construction (C18), and Food and beverages (C7) generating the medium amount, while the remaining sectors are likely to provide relatively low household income.

The influences of the economic sectors on household income in each region are dissimilar. Public Administration (C23), Retail and wholesale (C19), Distribution of electricity, gas, water, and utilities (C17), Financial services and business (C22), Forestry (C2), Hotel and catering services (C20) are likely to generate the most considerable income for the households in urban areas. Meanwhile, in rural areas, household income is likely to be improved under the impact of Forestry (C2), Public Administration (C23), Wood and wood products (C3), Agriculture (C1), Retail, and wholesale (C19), and Fisheries (C4).

Household income arisen from the economic sectors increases successively from H1 to H5 in both urban and rural areas when the sectors expand due to policy changes. It is worth noting that all of the agricultural sectors (Agriculture (C1), Forestry (C2), and Fisheries (C4)) generate higher income for rural household groups than for the urban ones. Coal, crude oil and natural gas (C5), Ores and minerals (C6), Paper and paper products (C10), and Other goods (C16) produce a greater amount of income for the highest income households in urban areas (H5) compared to rural areas (H10). Similarly, Coal, crude oil, and natural gas (C5) produces larger income for the urban middle income groups than for those in the farmland. All the highest income households in urban areas earn more from services sectors (from C17 to C25) than those in rural areas. Also, Distribution of electricity, gas, water, and utilities (C17), Retail and wholesale (C19), Transportation (C21), and Financial services and business (C22) generate higher income for the middle-income group in urban areas (H3) than for the counterpart in rural areas (H8).

When considering separately the impacts of economic sectors on each household group in each region, it is interesting to note that the income of the poor quintiles in both urban (H1 and H2) and rural areas (H6 and H7) are affected significantly by agricultural sectors (Forestry (C2) and Fisheries (C4) in urban areas, Agriculture (C1), Forestry (C2) and Fisheries (C4) in rural area). Retail and wholesale (C19) sector also generates a prominent amount of income for the poorest group in urban areas (H1). However, its impact on the lowest income quintile in rural areas (H6) is relatively modest.

Table 4

SAM-based multiplier analysis of sector and household group accounts

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	Total household income	Total urban household income	Total rural household income
C1	0.01	0.03	0.05	0.07	0.11	0.04	0.08	0.10	0.12	0.13	0.74	0.26	0.48
C2	0.02	0.05	0.07	0.09	0.15	0.06	0.13	0.16	0.20	0.21	1.14	0.37	0.77
C3	0.02	0.04	0.06	0.08	0.12	0.04	0.08	0.11	0.14	0.14	0.83	0.32	0.51
C4	0.02	0.04	0.06	0.07	0.11	0.04	0.07	0.09	0.12	0.12	0.75	0.30	0.44
C5	0.01	0.03	0.06	0.10	0.17	0.02	0.05	0.06	0.08	0.09	0.66	0.36	0.30
C6	0.01	0.02	0.04	0.06	0.09	0.02	0.03	0.04	0.06	0.07	0.44	0.22	0.23
C7	0.01	0.03	0.05	0.07	0.12	0.03	0.07	0.09	0.11	0.12	0.70	0.29	0.42
C8	0.01	0.02	0.04	0.05	0.09	0.02	0.04	0.06	0.08	0.09	0.49	0.21	0.28
C9	0.01	0.03	0.05	0.07	0.11	0.03	0.06	0.08	0.11	0.12	0.68	0.27	0.41
C10	0.01	0.03	0.05	0.07	0.12	0.02	0.04	0.06	0.08	0.09	0.58	0.29	0.30
C11	0.01	0.02	0.03	0.05	0.09	0.01	0.03	0.04	0.06	0.07	0.40	0.20	0.21
C12	0.01	0.03	0.06	0.08	0.14	0.03	0.05	0.07	0.10	0.12	0.69	0.32	0.37
C13	0.01	0.02	0.03	0.04	0.07	0.01	0.03	0.04	0.05	0.06	0.37	0.17	0.20
C14	0.01	0.01	0.02	0.03	0.05	0.01	0.02	0.03	0.04	0.05	0.27	0.12	0.15
C15	0.00	0.01	0.01	0.02	0.04	0.01	0.01	0.02	0.03	0.03	0.18	0.08	0.10
C16	0.01	0.02	0.02	0.04	0.06	0.01	0.02	0.03	0.04	0.05	0.30	0.14	0.16
C17	0.01	0.04	0.06	0.10	0.19	0.03	0.06	0.08	0.10	0.13	0.79	0.40	0.39
C18	0.01	0.04	0.06	0.08	0.13	0.03	0.06	0.08	0.11	0.12	0.72	0.31	0.41
C19	0.02	0.05	0.09	0.12	0.21	0.03	0.07	0.09	0.12	0.15	0.95	0.49	0.46
C20	0.01	0.03	0.05	0.08	0.14	0.02	0.04	0.06	0.08	0.09	0.60	0.31	0.30
C21	0.01	0.03	0.06	0.08	0.14	0.02	0.04	0.06	0.08	0.10	0.61	0.32	0.29
C22	0.01	0.04	0.07	0.10	0.17	0.02	0.05	0.07	0.09	0.11	0.72	0.39	0.33
C23	0.02	0.05	0.08	0.13	0.23	0.03	0.06	0.10	0.14	0.18	1.02	0.51	0.52
C24	0.01	0.04	0.06	0.10	0.17	0.02	0.05	0.08	0.12	0.15	0.78	0.37	0.42
C25	0.02	0.04	0.07	0.09	0.14	0.03	0.06	0.08	0.10	0.12	0.74	0.36	0.38

Source: The authors' calculation from VSAM 2016 data.

Figure 3 shows the disparity of income multiplier between the poorest and the richest quintiles generated by the economic sectors. This disparity in rural areas is lower than in urban ones. Thus, when there is an increase in production, the income gap in rural areas can be shortened more than that in urban areas. The lowest income multiplier difference in rural areas (3.3) is induced by Forestry (C2) and Fisheries (C4), while Fisheries (C4) and Wood and wood products (C3) cause the lowest differences in urban areas, which are 6.4 and 6.7, respectively.

3.3. Structural Path Analysis

In fact, there is a multitude of paths passing through the starting pole (economic sector) to the

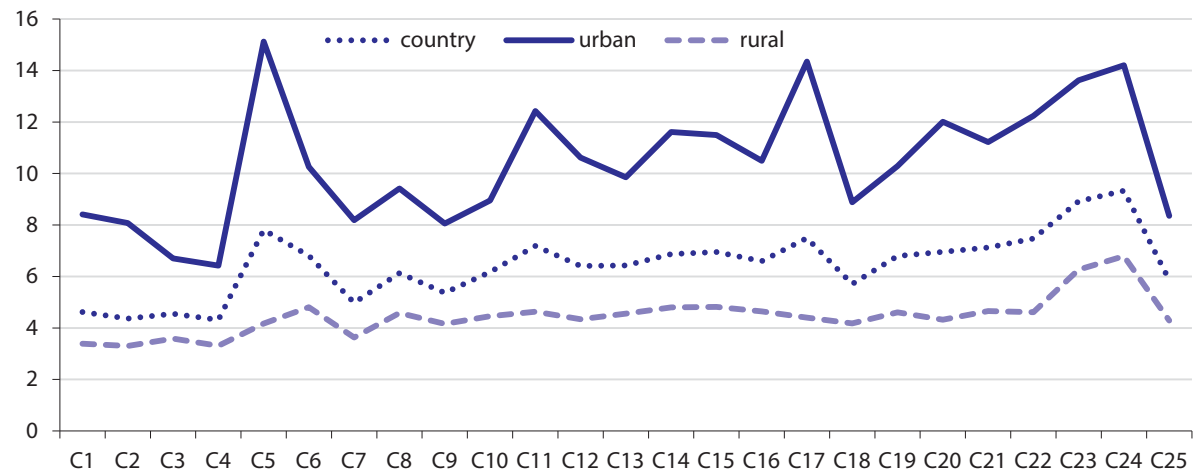

Fig. 3. *Income multiplier difference between the richest quintile and the poorest quintile of the whole country, urban areas, and rural areas. Source: The authors' calculation from the data of Table 4*

end pole (household group). The more poles the path passes, the smaller total effect is obtained. This study focuses on the paths with the total effect accounting for at least 8 % of the global effect, sufficiently reflecting important linkages between economic sectors and household income.

The analytical results show that 39 % of global effects is spread from the economic sectors to the household groups through 513 major paths. Of these effects, 38 % is directly transmitted by factors of production. The rest 1 % is spread indirectly through another economic sector, which creates inter-industry linkages. The presence of a pole on the selected paths reveals its key role in impact propagation compared to the other poles. Therefore, the inter-industry linkages imply that the direct effects are sometimes more significant than the indirect ones in impact transmission.

Based on the results of the SAM multiplier analysis, this study selects and focuses on analysing the paths of the key sectors in agriculture, industry, and services which have the greatest impact on the income of each type of the household group.

Agricultural Sectors (C1, C2, and C4)

The results in Figure 4 show that L3 and L6 mainly appear on the selected paths of agricultural sectors. This implies the important role of the low-skilled labours in income generating for the household groups in these sectors, especially in rural areas. The appearance of the labour poles in most of the sectors in these areas shows that labour is the principal factor generating income for the household groups. This finding reveals a relatively high degree of labour intensity of these sectors.

The capital factor and a small percentage of labour with high-skilled levels play a material role in improving household income in urban areas. The capital of Fisheries (C4) has a greater influence on income of the rich group (H4 and H5). In Forestry (C2), the income of household groups depends on high-skilled labour (L1). The appearance of the L1 pole on the paths with the total effect increasing from 18 % to 26 % from H3 to H5 (C2.L1.H3 — % *It/Ig* = 18 %, C2.L1.H4 — % *It/Ig* = 24 %, C2.L1.H5 — % *It/Ig* = 26 %) reveals that the influence of high-skilled labour on income is proportional to the household income level. As a rule, higher-skilled labour groups are likely to generate a higher amount of income.

Table 5 demonstrates that the most influential paths in the agricultural sectors in both areas belong to Forestry (C2), which are C2.L1.H5 and C2.L6.H9 with the corresponding captured total effects of 0.038 and 0.068. For low-income households in rural areas (H6 and H7), the paths with the most significant impact on income also originate from this sector, namely C2.L6.H6 and C2.L6.H7, with the captured total effects of 0.032 and 0.061, respectively. However, for the low-income household groups in urban areas (H1 and H2), the paths of Fisheries (C4), including C4.L3.H1 and C4.L3.H2, are the ones having the most significant impact on household income with the captured total effects of 0.007 and 0.013, respectively. In addition, selected paths such as C4.L6.H6 and C4.L6.H7 are also noticeable as they are likely to generate the lowest income gap, which helps reduce income inequality.

Industrial Sectors (C3, C5, and C9)

Household income in urban areas is substantially generated by the high-skilled labour (L1) of Coal, crude oil, and natural gas (C5). Notably, the influence of the high-skilled labour (L1) is directly proportional to the income level of the household groups. Meanwhile, in rural areas, the capital factor (C) has a huge impact on household income in this sector, which is considered a capital intensive industry.

The industries such as Wood and wood products (C3), Footwear (C9) affect household income through labour from low to high skill levels, corresponding to the income level of the household groups. These sectors are labour-intensive, which means their capital factor (C) has a negligible impact on household income. Linkages C3-C2 illustrate the strong inter-industry relationships of these sectors in indirect impact transmission from Wood and wood products (C3) to household income (Fig. 5).

The results of the SPA analysis in Table 5 also present the paths having significant effects on the household income of Wood and wood products (C3) with the captured total effect of 0.011 (C3.L3.H3, C3.L1.H5, C3.C2.L1.H5) in urban areas and 0.019 (C3.L5.H9) in rural areas. It is worth noting that SPA helps to unravel the most influential paths in this sector, such as C5.L1.H5 and C5.C.H10 with the captured total effects of 0.079 and 0.026, respectively. However, this sector does not show the crucial impact on household income according to the results of the SAM-based multiplier analysis. For low-income households (H1, H2, H6, and H7), the paths such as C3.L3.H1, C5.L1.H2, C5.C.H6, and C9.L6.H7 have a significant influence on their income with the captured total effects of 0.005, 0.013, 0.007, and 0.013, respectively.

Table 5

Global influence, captured direct and total influence, and path multiplier by the selected largest impacts in the agriculture, industry, and service sectors

Paths	Global influence	Captured direct influence (*Id*)	Path multiplier	Captured total influence (*It*)	% *It*/*Ig*
C4.L3.H1	0.018	0.005	1.339	0.007	40.016
C3.L3.H1	0.018	0.003	2.155	0.005	30.002
C19.L3.H1	0.020	0.004	1.142	0.005	22.838
C4.L3.H2	0.040	0.010	1.356	0.013	32.451
C3.L3.H2	0.042	0.005	2.184	0.010	23.751
C5.L1.H2	0.033	0.009	1.383	0.013	38.648
C23.L1.H2	0.049	0.016	1.179	0.019	38.232
C4.L3.H3	0.058	0.010	1.379	0.014	24.199
C5.L1.H3	0.058	0.018	1.390	0.025	43.357
C23.L1.H3	0.084	0.031	1.185	0.037	43.833
C2.L1.H4	0.092	0.013	1.691	0.022	23.811
C5.L1.H4	0.095	0.032	1.390	0.045	47.597
C23.L1.H4	0.132	0.056	1.186	0.066	50.014
C2.L1.H5	0.147	0.023	1.708	0.038	26.103
C5.L1.H5	0.167	0.057	1.403	0.079	47.528
C19.L1.H5	0.206	0.066	1.268	0.084	40.672
C2.L6.H6	0.064	0.020	1.567	0.032	49.766
C4.L6.H6	0.037	0.009	1.395	0.013	34.112
C5.C.H6	0.022	0.005	1.366	0.007	30.533
C17.C.H6	0.029	0.011	1.242	0.014	49.360
C2.L6.H7	0.130	0.039	1.586	0.061	47.112
C4.L6.H7	0.074	0.017	1.411	0.024	32.727
C9.L6.H7	0.062	0.010	1.266	0.013	21.096
C17.C.H7	0.057	0.020	1.259	0.026	45.590
C2.L6.H8	0.161	0.039	1.604	0.062	38.460
C5.C.H8	0.061	0.012	1.395	0.017	27.346
C17.C.H8	0.078	0.027	1.269	0.035	44.525
C2.L6.H9	0.204	0.042	1.631	0.068	33.468
C3.L5.H9	0.135	0.008	2.299	0.019	14.084
C23.L4.H9	0.144	0.051	1.147	0.059	40.924
C2.L6.H10	0.211	0.031	1.650	0.052	24.592
C5.C.H10	0.093	0.018	1.419	0.026	27.538
C19.L4.H10	0.147	0.030	1.227	0.037	25.397

Source: The authors' calculation from VSAM 2016 data.

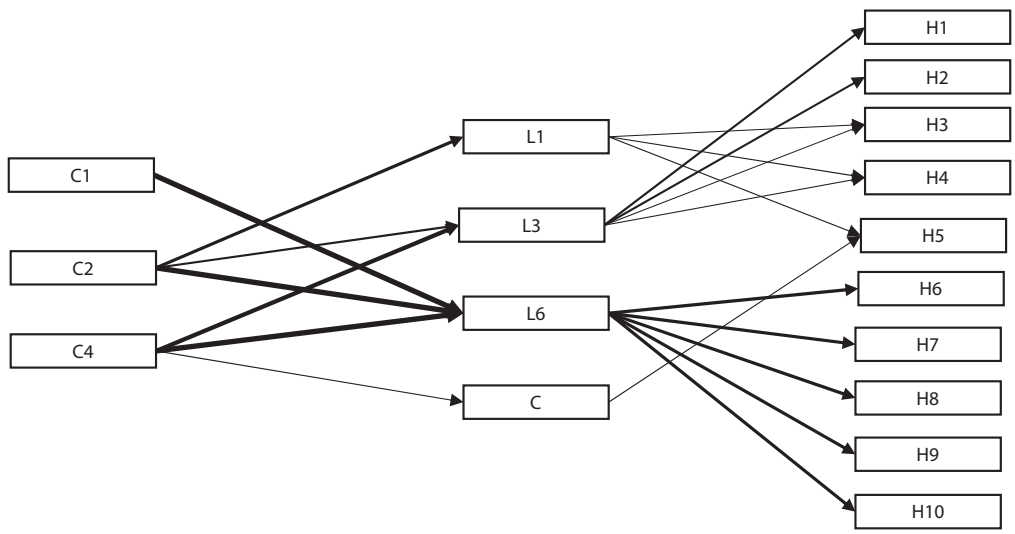

Fig. 4. *The paths selected from SPA analysis in agricultural sectors (The width of the lines represents the repetition of the linkages between two accounts in the selected paths). Source: The authors' calculation from VSAM 2016 data*

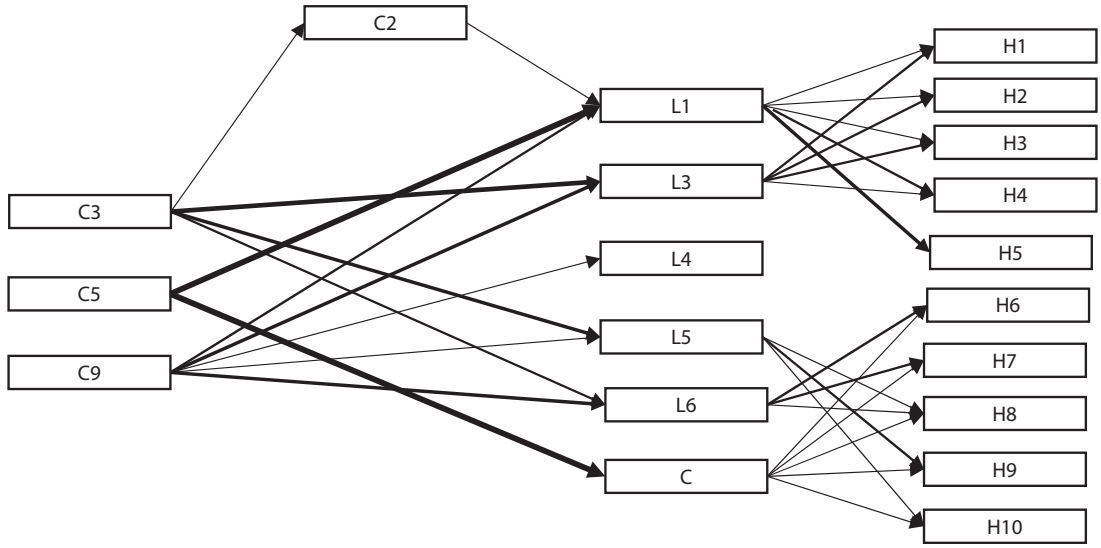

Fig. 5. *The paths selected from SPA analysis in industrial sectors. Source: The authors' calculation from VSAM 2016 data*

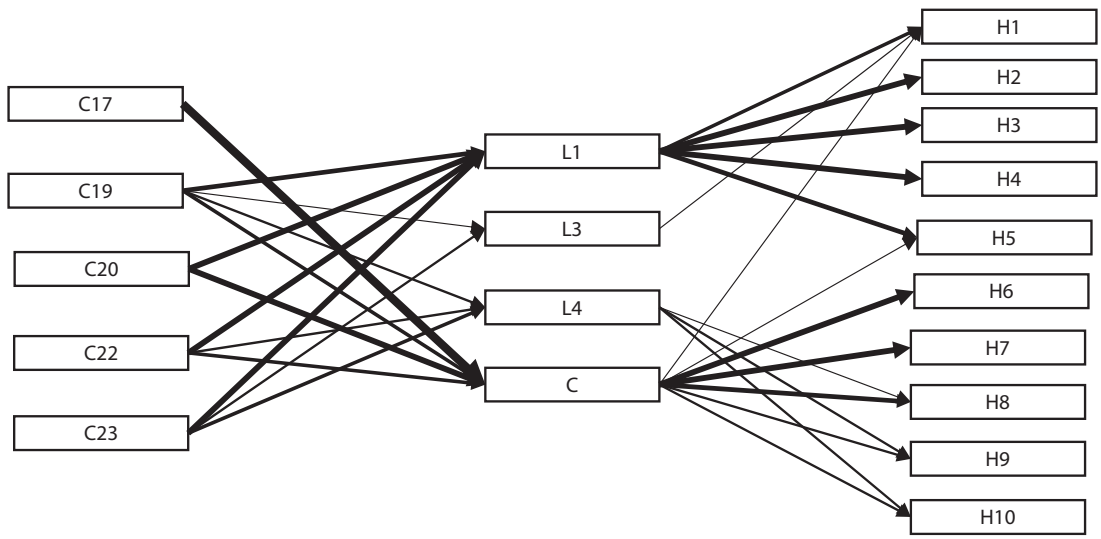

Fig. 6. *The paths selected from SPA analysis in service sectors. Source: The authors' calculation from VSAM 2016 data*

Service Sectors (C17, C19, C20, C22, and C23)

The analysis results from Figure 6 clarify that the high-skilled labour and the capital of the service sectors have an immense influence on household income. The low-skilled labour in some industries such as Retail and wholesale (C19) and Public Administration (C23) has a significant influence on the poor household income in urban areas (H1). While the urban household income is affected by the high-skilled labour, the capital factor has a considerable influence on the rural household income, especially the household groups that have middle- and low-income levels (H6, H7, and H8).

Distribution of electricity, gas, water, and utilities (C17) is considered capital-intensive, especially in rural areas. The captured total effect of the selected paths of this sector having the capital factor (C) is quite enormous, ranging from 39 % to 49 % (C17.C.H6 — % *It/Ig* = 49 %; C17.C.H7 — % *It/Ig* = 46 %; C17.C.H8 — % *It/Ig* = 45 %; C17.C.H9 — % *It/Ig* = 39 %; C17.C.H10 — % *It/Ig* = = 42 %).

Table 5 shows that the paths with the most considerable total impact on household income in the service sector belong to Public administration (C23), such as C23.L1.H5 and C23.L4.H10, with the captured total effect of 0.116 and 0.086, respectively. The paths having the greatest impact on household income in C19 are C19.L1.H5 and C19. L4.H10, with the captured total effects of 0.084 and 0.037, respectively. For low-income household groups (H1, H2, H6, and H7), the paths having significant impact on household income include C19. L3.H1, C23.L1.H2, C17.C.H6, C17.C.H7, with the total effects of 0.005, 0.019, 0.014, 0.026, respectively. Although the paths of Distribution of electricity, gas, water, and utilities (C17) are selected

when applying SPA, this sector shows a negligible effect on the household income according to the SAM multiplier analysis.

4. Conclusion

Today, a sustainable economic development strategy in terms of income distribution is one of the urgent requirements in Vietnam because the country must maintain a growth rate to escape poverty. However, Vietnam's capacity for sustainable development may be limited due to the risks regarding income inequality, leading to disparities in education levels and living standards. These risks cause many consequences related to economic development results as well as problems of social welfare and evils.

The main cause of income disparity is the unequal impact of the economic sectors on household income through the factors of production such as capital and labour. The results of the SPA analysis underline that labour skills are directly proportional to household income. In particular, the level of labour skill in the industrial and service sectors is higher than in the agricultural ones. Therefore, labour income from these two sectors is larger than that of agriculture. The presence of L poles on the selected paths also implies the potential to attract employees of some economic sectors. The labour intensity of the sectors such as Agriculture (C1), Forestry (C2), Wood and wood products (C3), Fisheries (C4), Footwear (C9) in rural areas is much higher than in urban ones. In order to shorten the income distances among the household groups in both areas, it is essential to improve labour skills, especially in the countryside, by innovating investment mechanisms and training human resources with advanced technology and professional skills. It is noticeable that Forestry (C2) and Wood and wood products (C3) are likely to provide large income for household groups. Hence, economic policies should focus on attracting and shifting the workforce from Agriculture (C1), Fisheries (C4), and Footwear (C9) as well as stimulating consumption and investment in these two areas to create more job opportunities and raise income for the household groups. Once the poor household income is significantly improved, the income gap between the poor and the rich households will be narrowed, thereby reducing the risk of inequality.

Although the rate of capital income of the household groups is much lower than labour income, the capital factor is also crucial in generating household income. It is clear that most of the paths selected from the high-income household groups witness the appearance of the capital factor. In particular, the role of the capital factor in rural areas is more significant than that in urban areas, as proved through the greater capital income. To ensure capital for production activities, capital support policies and credit policies should be formulated to facilitate loan access for households. In addition, strengthening the cooperation with foreign investors is absolutely important to attract financing for the production stages, increase added value of products, and reinforce national competitiveness. Such policies are particularly meaningful to the capital-intensive sectors such as Coal, crude oil, and natural gas (C5) and Distribution of electricity, gas, water, and utilities (C17).

The paths selected in Tables 5 also emphasise the vital role in income generating of some economic sectors not belonging to the critical industry groups from the results of the SAM multiplier analysis, such as Fisheries (C4), Coal, crude oil, and natural gas (C5), Distribution of electricity, gas, water, and utilities (C17), Footwear (C9). Therefore, when planning economic strategies, the policymakers should pay attention to these sectors as well as support the labour and capital factors to ensure that household income reaches the best level, especially for low-income groups in limited resource conditions.

One other advantage of the SPA method is the clarification of indirect effects through inter-industry link on the selected paths such as C3.C2. L1.H5. This finding emphasises that the product of one economic sector used as input for another is sometimes more influential in the income distribution process than the product produced by that sector itself. Therefore, any policy promoting the development of one sector is likely to spur the development of many other related sectors. These inter-industry relationships sometimes create significant income for the household groups. This is the basis for building welfare policies associated with the development of the economic sectors. In particular, special attention should be paid to developing sectors to provide input materials for other sectors in accordance with the economic development strategy in proper periods.

In summary, the study provides empirical evidence on the effects of production factors in income distribution from economic sectors to household groups. Based on selected paths, research results discovered the economic sectors having a significant influence on the income of household groups, such as Forestry (C2), Wood and wood products (C3), Fisheries (C4), Coal, crude oil, and natural gas (C5), Footwear (C9), Distribution of electricity,

gas, water, and utilities (C17), Retail and wholesale (C19), Public Administration (C23). These sectors are also capable of improving income for poor household groups in both urban and rural areas, helping to narrow the income gap of household groups as well as contribute to poverty alleviation in Vietnam. In comparison with the studies of Defourny and Thorbecke (1984) and Arndt et al. (2012), our study is more detailed in terms of economic sectors, labour groups, and households. Besides, with a large research scale at the national level with 25 economic sectors, we discover the trends of income distribution concerning the capital factor and the labour factor, clarify capital-intensive and labour-intensive characteristics of the economic sectors, uncover the paths that have the greatest influence on the household income as well as the paths with the greatest impacts on low-income households, and the paths narrowing the income gap between the household groups for poverty alleviation. Based on these findings, the lawmakers may develop necessary policies to create employment and support income improvement for poor households which are unable to sustain economic shocks in an economy with resource limitation. Besides, the research affirms that economic growth and development achievements can spread to poor household groups. That conclusion can be the basis to guarantee social equity, shorten the gap between the rich and the poor, improve welfare, and create positive impacts on socio-economic development.

References

Arndt, C., Garcia, A., Tarp, F. & Thurlow, J. (2012). Poverty reduction and economic structure: Comparative path analysis for Mozambique and Vietnam. *Review of Income and Wealth, 58(4),* 742-763. DOI: https://doi.org/10.1111/j.1475-4991.2011.00474.x.

Defourny, J. & Thorbecke, E. (1984). Structural path analysis and multiplier decomposition within a social accounting matrix framework. *The Economic Journal, 94(373),* 111-136. DOI: https://doi.org/10.2307/2232220.

Hartono, D. & Resosudarmo, B. P. (2008). The economy-wide impact of controlling energy consumption in Indonesia: An analysis using a Social Accounting Matrix framework. *Energy Policy, 36(4),* 1404-1419. DOI: https://doi.org/10.1016/j.enpol.2007.12.011.

Ivanic, M. & Martin, W. (2018). Sectoral productivity growth and poverty reduction: National and global impacts. *World Development, 109,* 429-439. DOI; https://doi.org/10.1016/j.worlddev.2017.07.004.

Khan, H. A. & Thorbecke, E. (1989). Macroeconomic effects of technology choice: Multiplier and structural path analysis within a SAM framework. *Journal of Policy Modeling, 11(1),* 131-156. DOI: https://doi.org/10.1016/0161-8938(89)90028-8.

Lenzen, M. (2003). Environmentally important paths, linkages and key sectors in the Australian economy. *Structural Change and Economic Dynamics, 14(1),* 1-34. DOI: https://doi.org/10.1016/S0954-349X(02)00025-5.

Lenzen, M. (2007). Structural path analysis of ecosystem networks. *Ecological Modelling, 200(3-4),* 334-342. DOI: https://doi.org/10.1016/j.ecolmodel.2006.07.041

Leontief, W. W. (1941). *The Structure of the American Economy, 1919–1929*. Cambridge: Harvard University Press.

Linh, T. N., Long, H. T., Chi, L. V., Tam, L. T. & Lebailly, P. (2019). Access to rural credit markets in developing countries, the case of Vietnam: A literature review. *Sustainability, 11(5),* 1468. DOI: https://doi.org/10.3390/su11051468.

Luan, D. X., Bauer, S. & Kuhl, R. (2016). Income Impacts of credit on accessed households in rural Vietnam: Do various credit sources perform differently? *AGRIS on-line Papers in Economics and Informatics, 8(1),* 57-67.

Miller, R. E. & Blair, P. D. (2009). *Input-output analysis: Foundations and extensions*. Cambridge University Press.

Müller, D., Epprecht, M. & Sunderlin, W. D. (2006). Where are the poor and where are the trees?: targeting of poverty reduction and forest conservation in Vietnam. CIFOR Working Paper, 34(V). Bogor, Indonesia, Center for International Forestry Research (CIFOR), 20. DOI: https://doi.org/10.17528/cifor/002026.

Oshita, Y. (2012). Identifying critical supply chain paths that drive changes in CO2 emissions. *Energy Economics, 34(4),* 1041-1050. DOI: https://doi.org/10.1016/j.eneco.2011.08.013.

Peters, G. P. & Hertwich, E. (2006). A comment on the "functions, commodities and environmental impacts in an ecological-economic model". *Ecological Economics 59,* 1–6. DOI: https://doi.org/10.1016/j.ecolecon.2005.08.008.

Pham, T. H. & Riedel, J. (2019). Impacts of the sectoral composition of growth on poverty reduction in Vietnam. *Journal of Economics and Development, 21(2),* 213–222. DOI: https://doi.org/10.1108/JED-10-2019-0046.

Puttanapong, N. & Sessomboon, P. (2017). *Revealing the Paths Connecting Thai Agriculture, Food Industry and Household from Structural Path Analysis*. Bangkok, Thailand. DOI: https://doi.org/10.22004/ag.econ.284850.

Pyatt, G. & Round, J. I. (1979). Accounting and fixed price multipliers in a social accounting matrix framework. *The Economic Journal, 89(356),* 850-873. DOI: https://doi.org/10.2307/2231503.

Stone, J. R. N. (1978). The disaggregation of the household sector in the national accounts. In: *Paper presented at World Bank Conference on Social Accounting Methods in Development Planning* (pp. 16-21). Cambridge, United Kingdom.

Urgessa, T. (2015). The determinants of agricultural productivity and rural household income in Ethiopia. *Ethiopian Journal of Economics, 24(2),* 63-91.

Wood, R. & Lenzen, M. (2009). Structural path decomposition. *Energy Economics, 31(3),* 335-341. DOI: https://doi.org/10.1016/j.eneco.2008.11.003

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