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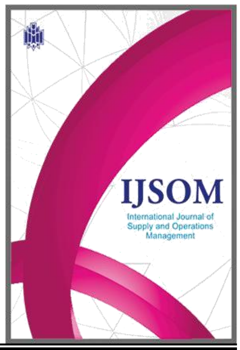

Transmission Paths of COVID-19 Impact on Energy Supply and Production Chain in Vietnam

Chung Van Nguyen [a,*]

[a] *Department of Economic and Tourism, Quang Binh University, Dong Hoi, Vietnam*

Abstract
The purpose of this study is to examine the impact of the COVID-19 epidemic on the energy supply chain and some key economic sectors of the Vietnamese economy in order to assist Vietnamese policymakers in solving the extremely difficult issues of whether or not the government should limit the energy supply when the economic demand falls. The researcher applies the Structure Path Analysis method to evaluate the impact of the energy supply chain on the main business sectors of the economy from 2015 to 2020; and the Constrained Fixed method Price Multiplier to determine the effect of COVID-19 on the energy supply chain before and after the epidemic. The results show that when the government is forced to limit the supply chain of coal, oil and electricity by 10-15%, it does not make much impact on the economy. However, if the government limits the supply chain by 20-25%, then it will have negative effect on the major industries of the economy, especially tourism, trade, construction, transportation and public services. The study also recommends how policymakers should limit the energy supply chain to a safe range for the economy of less than 15%.

Keywords: Energy supply; production chain; Constrained Fixed method Price Multiplier; COVID-19; Vietnam.

1. Introduction

According to the report of the Petroleum and Coal Department (Ministry of Industry and Trade), the exploitation of crude oil, natural gas and coal tends to decrease, especially in the recent period of Covid-19 epidemic. Specifically in 2016, the volume of domestic crude oil production reached 15.2 million tons and declined markedly to 9.43 million tons by the 2020. Similarly, gas exploitation has experienced a rapid decrease since 2016 from 12.18 million tons to 9.33 million tons. From 2007, the national energy security target has so far faced many challenges. The domestic supply source is not enough to meet the demand and requirements, not to mention the structure that is also imbalanced. Some energy security indicators are fluctuating in an adverse direction. For instance, the coal, oil and gas production reserves decrease day by day. The dependence on imports of coal, oil and natural gas becomes the norm as such. The costs of the imports naturally hold an increasing proportion in the total domestic income. The recent situation of COVID-19 in Vietnam gravely slows down the economic recovery process. The energy demand, however, decreases and the Vietnamese government is planning to cut down the energy supply chain. It is expected that the share of coal-fired thermal power will decrease from 34% in 2020 to 27% in 2030, same for other energy sectors. That being said, the reduction in different quantities will affect the momentum of economic growth differently. Therefore, it is crucial that the government realizes and determines the most appropriate line of the energy supply chain to be cut. There is a need for a mathematical calculation to properly curb the supply chain, saving energy for the economy to develop without affecting the major industries that are heavily dependent on energy. For that reason, this study will use the Constrained Fixed Price Multiplier method.

Corresponding author email address: jacknguyen200826@gmail.com
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In the scope of this study, the researcher focuses on the three main sectors, including agriculture, industries and services. The impact of COVID-19 through production reduction of these major industries will directly affect the national energy supply chain. It is important to capture and update the data as the energy supply chain continues to change under the influence of COVID-19 in order to consult the government about adjusting the energy supply chain in a timely manner, ensuring that energy security in production is not redundant or insufficient. Any small change in a production unit in agriculture will affect the supply chain of electrical energy through industries such as commercial and household with a corresponding increase and decrease of 0.2% and an amplifier level of 1.37 in 2015. When one unit of production is reduced due to the agricultural sector, the coal supply chain will decrease by 0.38% respectively through other industries such as commerce and machinery. In a similar manner, the petroleum industry will decrease by 0.41% by reducing one unit of production from agriculture. The impact of the agriculture sector on the supply chain is medium except for the petroleum industry, which is affected more heavily than the rest. There are 5 parts in this study: introduction, literature review, research method, research result and conclusion.

2. Literature review

The COVID-19 pandemic is a complicated situation. It has affected the whole supply chain in general and in particular the energy supply chain. It is crucial to have specific solutions to overcome the consequences caused by COVID-19 in the short term and in the long term (Sarkis, 2020). Consumers and businesses may be less optimistic about the economy, leading to lower consumption, investment, employment and production. Therefore, policymakers should continue pursuing expansionary policies in order to prevent a significant reduction in economic activity while at the same time taking safety measures to minimize the spread of the virus (Njindan, 2020). In the short run, the government has to cut energy supply chains to a moderate extent, accumulating momentum for the economy to develop again in the near future. Vasiev M. et al. (2020) used the input-output spatial data, migration indicators and pandemic spread statistics, running different scenarios for changes in production and consumption in 31 provinces and 42 sectors of the Chinese economy after the COVID-19 epidemic. The results show that coronavirus outbreaks greatly affect carbon dioxide emissions, hazardous waste levels and directly affect the energy chain supplying the Resource-Energy Efficiency economy. In all scenarios, a temporary drop is expected. Thus, early improvement of the environment and of the energy supply chain is a must after the COVID-19 pandemic. Sector-specific socio-economic development plans are needed for socio-economic growth as well as a strong business-friendly economy for businesses to be sustainable during the peak of the pandemic. The socioeconomic crisis reshaped investment in energy and significantly affected the energy sectors, which had most investment activities facing disruptions due to limited mobility. The COVID-19 pandemic has exposed businesses and societies to the unusual impact of production patterns to consumers' needs and their long-term effects on supply chains. Because of that, it is necessary to develop the localization, the agility and the digitization to control the supply chain (Santosh Nandi et. al, 2021). M.Mofijur et al. (2021) launches an investigation on the global preventive measures taken to reduce the transmission of COVID-19, providing a comprehensive analysis of the COVID-19 outbreak impact on the ecological, energy, social and economic sectors. More specifically, 2020 household income in India is severely affected due to the coronavirus (COVID-19) lockdown. Income levels have fallen dramatically with household income falling from about nine(?) percent to a whopping 45.7 percent in just two months (Keelery S., 2020). Research by Tran Xuan Bach et al (2020) on the Impact of COVID-19 on the economic welfare and quality of life of Vietnamese people during the period of national social isolation the results show that out of 341 of participants, 66.9% reported a household loss of income due to the impact of COVID-19. University degree holders working in fields other than health care, especially contract workers are more likely to experience a drop in earnings. Vietnam recorded GDP growth of 3.82% in the first quarter, the lowest level in a decade. Up to 18,600 companies suspended business in Q1, up 26% year-on-year. The Covid-19 pandemic has caused nearly 5 million Vietnamese workers to lose their jobs as of mid-April, bringing the first-quarter employment to a 10-year low (Nguyen T.2020). Dao Le Trang Anh explores effects of COVID-19 outbreak and subsequent lockdown on daily profits in Vietnam; Results show adverse impact of daily increase in COVID-19 cases on inventory returns in Vietnam. The study also revealed that the Vietnamese stock market before and during the nationwide shutdown performed in different ways. While the pre-COVID-19 lockdown had a significant negative impact on Vietnam's stock returns, the stock lockout period had a significant positive effect on the stock performance of the entire market and different business areas in Vietnam. The financial sector was the hardest hit on the Vietnamese stock market during the COVID-19 outbreak (Dao Le Trang Anh , Christopher Gan, 2020).

The study suggests that delays in energy projects are expected to have complications in the coming years. Although recent studies have discussed much about the effect of COVID-19 on the global supply chain, it has not been specifically mentioned on the energy supply chain, which is a very important factor in maintaining economic development as a sustainable recovery of each nation's economy. This study uses two main methods. The first method is the SPA method to consider the impact of the energy supply chain on the economy. The second method is the application of Constrained Fixed method Price Multiplier method to calculate the resilience of the economy when the Vietnamese state reduces the coal energy supply chain by 34% by 2020. However, in the context of the ongoing epidemic of covid-19 reducing production capacity for many economic sectors, the decline in the energy supply chain is expected to happen earlier than planned.

3. Research method

3.1. Structure of the Vietnamese SAM

The 1996 Social Accounting Matrix (SAM) used in this study was provided by (Nielsen, 2002). The data sources used to construct the SAMs include national accounts statistics, government budget data, the official 1996 input-output table, the 1997/98 Vietnam Living Standards Survey (VLSS) and COMTRADE trade data. The agricultural-food sectors are particularly well represented in the SAMs. Vietnam SAM contains 96 producing sectors with eight agricultural sectors, two agricultural service sectors and 13 food processing industries. In terms of institutional detail, the SAMs include five factors of production (three types of labor distinguished by skill level, one type of capital and one type of land), six household types (distinguished by rural/urban, agricultural/non-agricultural, wage/self-employed), and one account each for enterprises, government, investment/savings and the rest of the world.

Vietnam SAM for the year 2003 was provided by (Jensen et al., 2007). The 2003 Vietnam SAM contains 275 accounts including 112 production activity accounts, 112 retail commodity accounts, 3 transportation margin accounts, 3 trade margin accounts, 14 primary factor accounts, 1 enterprise sector account, 16 households group accounts, 7 government current budget accounts, 2 inventory accounts (private and public inventory accounts), 3 capital accounts (private, public and aggregate capital accounts), one rest of the world account and one totals account.

Vietnam SAM for the year 2007 was provided by (Channing et al., 2010). The national SAM is based on newly estimated supply-use tables, national accounts, state budgets and balance of payments. The SAM reconciles these data using cross-entropy estimation techniques. The final SAM is a detailed representation of Vietnam's economy. It separates 63 activities and commodities; rural/urban labor by different education levels; households by rural/urban areas and farm/nonfarm expenditure quintiles. Labor and household information is drawn from the Vietnam Household Living Standards Survey (GSO, 2015). Based on the information from various sources, we set up a SAM data sheet of Vietnam in 2020 to conduct the analysis in the context of the epidemic in the following years.

3.2. Structured Path Analysis (SPA)

Structured Path Analysis is a consumer account-based technique that breaks down analytics metrics into unlimited total paths. SPA can be used to analyze the contribution rates of different paths. More specifically, it is used to describe the complexity of an economy in economics and it can analyze the path of various influencing factors in environment and energy (Rui Xie et al., 2020). SPA is an important method to study the transfer effect and path relationship between different factors in the energy supply chain. It captures the inter-sectoral linkages between individual SAM accounts and identifies the paths that cost effects go through. This method was introduced in the early 1980s (Defourny et al., 1984). Recently, SPA has seen increasing widespread use such as Treloar (1997), Treloar et al., (2001) and in more general areas such as the trade modeling by Peters et al. (2006a). The basic idea behind a Structural Path Analysis is the unraveling of the Leontief inverse (Waugh, 1950). It allows the analysis to investigate impacts that are caused directly by final consumption (emissions from gas cooking) to those caused in the first order away from the consumer (emissions in electricity generated for the consumer) to those in higher orders (for example, emissions in electricity for steels; steels for a train; a train for a train journey; a train journey taken by the consumer). The use of Structural Path Analysis has only been applied statically for extracting the main upstream impacts of products or organizations.

It should be noted at the outset that the present structural path analysis applied to a SAM does not yield the same results as applied to only the input-output matrix. In a SAM-type framework, a production activity can influence another one through the intermediate effects on factors. Institutions and households are considered exogenous in the input-output framework. This method offers an alternative way of decomposing multipliers and identifying the paths of influences. In other words, the whole network which influence is transmitted through can be identified and specified through structural path analysis. The influence can be categorized into three interpretations: direct influence, total influence and global influence.

3.3 Direct Influence

The direct influence of i on j, through an elementary path, is the change in the income of j caused by a unitary injection in i, where the only incomes that are allowed to change are those of the poles in the elementary path. The direct influence from i to j through the elementary path p is given by the product of the intensities of all arcs constituting the path. For example, the direct influence caused by the elementary path $i \to l \to h \to j$ is given by $I^D_{(i \to j)} = a_{il} a_{lh} a_{hj}$

Table 1. Basic Structure of the Vietnamese SAM

Total	Activity income	Total demand	Factors earnings	Household income	Enterprise earnings	Government income	Savings	Foreign exchange outflow	
Rest of the world		Exports	Foreign factor earnings	Foreign remittances received	Foreign enterprise receipts	Foreign grants	Foreign savings		Foreign exchange inflow
Investment		Investment expenditure							Investment
Governme nt		Final government consumption		Transfers	Interest payments (governmen t transfer to		Government saving		Government expenditure
Enterprise				profits, social security and other transfers		Production tax	Enterprise saving		Enterprise expenditure
Household		Final private consumption				Income tax	Household saving		Household expenditure
Factors				Factor income to enterprises	Factor income to enterprises	Factor income to enterprises		Transfers to ROW	Factor expenditure
Commoditi es	National domestic product					Export and import duties		Imports	Total supply
Activities		Inter-mediate inputs	Value added			Producer taxes			Gross output
	Activities	Commodities	Factors	Household	Enterprise	Government	Saving	Rest of the world	Total

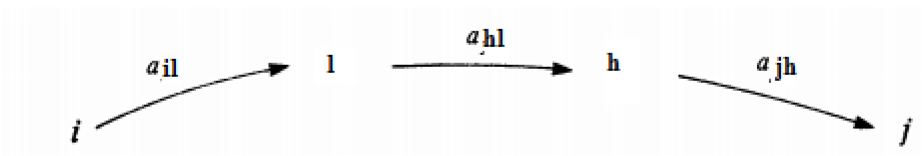

Figure 1. Elementary path

3.4 Total Influence and Global Influence

According to (Thorbecke, 1984), in most structures there exists a multitude of interactions among poles. In particular, poles along any elementary path are likely to be linked to other poles and other paths forming circuits which amplify the direct influence of that same elementary path. Given an elementary path p from *i* to *j*, the total influence of *i* on *j* is the influence transmitted along the elementary path including all indirect effects imputable to that path. Total influence accumulates for a given elementary path p, the direct influence transmitted along the latter and the indirect effects induced by the circuits adjacent to that same path. This definition can be better understood through an example. Considering the structure described in Figure 1 above, in order to compute the total influence, we need to include all possible ways of going from *i* to *j* in the structure. First, influence from *i* to *l* and from h to *j* is given by the respective direct influences. The total influence from *l* to h requires further explanation. One way to go from *l* to h is to travel along the elementary path; the influence attributed to that path is the direct influence a_{lh}. Another way to go involves the circuit between *l* and h along with the circuit that connects l and h through r. After one round of feedback, the influence from *l* to h is given by $a_{hl}^2(a_{lh}+a_{rh}a_{lr})$. After n rounds of feedback, the influence is given by $a_{hl}[a_{hl}(a_{lh}+a_{rh}a_{lr})]^n$. Finally, any influence has to be transmitted from *h* to *j* with an influence of a_{jh}. Using a geometric series argument, the total influence is given by

$$I^N_{(i\rightarrow j)p} = a_{li}a_{hl}a_{jh}[1- a_{hl}(a_{lh}+a_{rh}a_{lr})]^{-1} \quad (1)$$

Note that the first product is just the direct influence along the path *p*. The second term is called the *path multiplier* Mp. It can be seen that the first term on the right-hand side represents the previously defined direct influence, $I^D_{(i\rightarrow j)p}$, the second term is the path multiplier M_p

$$I^N_{(i\rightarrow j)p} = I^D_{(i\rightarrow j)p}M_p \quad (2)$$

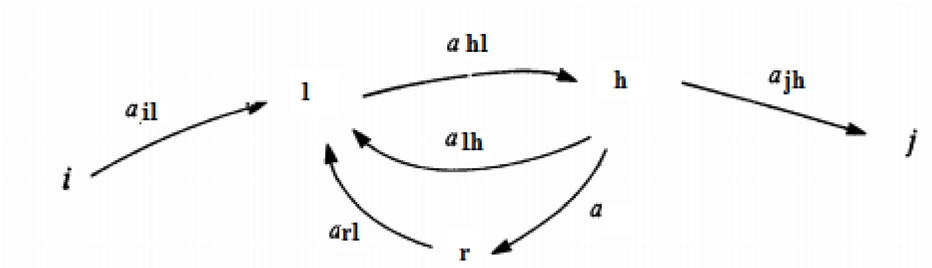

Figure 2. Elementary path with adjacent circuits.

Global influence measures the total effects on income or output of pole j consequent to an injection of one unit of output or income in pole i. Global influence accumulates all induced and feedback effects resulting from the existence of circuits.

3.5 Path Multiplier

Path multiplier (M_p) measures the degree of amplification conferred to these paths by adjacent circuits. In general, the size of these multipliers varies as a function of the length of a path. The more poles there are in a path, the higher the probability that adjacent circuits will include one or more poles being present. An alternative way of presenting the path multiplier is to calculate its inverse, that is, the ratio of direct influence to total influence $M_p = I^D_{(i\rightarrow j)p} / I^T_{(i\rightarrow j)p}$). This ratio indicates the proportion of the total influence transmitted along an elementary path which is accounted for by the immediate effects, namely the direct influence. This parameter can be quite relevant in a policy context by indicating the extent to which an initial injection into a given pole will generate rapidly or only after a long period of time will there be any increase in the production or the income of other poles in the economic structure.

Before turning to comparing the structural path analysis with conventional decomposition to SAM, it should be noted at the outset that it is important to understand clearly the distinction between global influence and direct influence; close-loop effect and total influence; open-loop effect and direct effect; multiplier accounting and global effect; decomposition multiplier and structural path analysis.

- **Simulation scenarios**

Scenario 1 (S1) this scenario simulates a situation in which the government restriction is 10% -15% on the energy supply chain due to COVID-19

Scenario 2 (S2) this scenario simulates a situation in which the government restriction is 20% -25% on the energy supply chain due to COVID-19

Scenario 3 (S3) this scenario simulates a situation in which the government restriction is 34% on the energy supply chain due to COVID-19

4. Research result

It is assumed that because COVID-19 directly affects industrial production activities, the productivity of the industry will change immediately. Namely, reducing 1 unit of production in the industry sector will affect the supply chain of electrical energy through industries such as machine manufacturing (trade) and service (service). The corresponding effect on the electrical supply chain is amplified by 0.29 in 2020. The impact of industry on electricity is 10 times higher than that of agriculture. Similarly, when reducing 1 unit of production due to the industry, the coal supply chain will be affected with an amplifier level of 0.65. The service sector also significantly affects the electric sector and the coal sector by 0.38 and 0.01 respectively. COVID-19 has a high impact on the energy supply chain via the three main sectors during 2020. To consider the impact on the economy in the period before COVID-19, we ran a test model with the 2015 data. In 2015, there was no significant impact or in other words there was no production fluctuation. The situation is therefore still under control both in the production supply chain and the energy supply chain. With that in mind, this data can change drastically during the period of COVID-19. Economic activities can be strongly impacted, including the energy supply chain and the manufacturing supply chain.

Table 2. Decomposition of multiplier - the impact of energy shock on enterprise groups

		Accounting Multiplier		**Open-loop Effects**		**Closed-loop Effects**	
Origin	**Destination**	**2020**	**2015**	**2020**	**2015**	**2020**	**2015**
Agriculture	Electricity	0.0020	0.0046	0.0001	0.0002	0.0020	0.0045
	Coal	**0.650**	0.4278	0.4599	0.3602	0.1051	0.0676
	Petroleum	0.0019	0.0045	0.0002	0.0005	0.0017	0.0040
Industry	Electricity	**0.2944**	**0.2273**	0.2050	0.1688	0.0894	0.0585
	Coal	**0.560**	**0.365**	0.0001	0.1742	0.0006	0.0169
	Petroleum	**0.290**	**0.186**	0.2464	0.0001	**0.2110**	0.0011
Service	Electricity	**0.858**	**0.358**	0.0000	0.0000	0.0015	0.0028
	Coal	0.0152	0.0000	0.7759	0.7359	0.0823	0.0723
	Petroleum	1.0009	0.0000	0.0001	0.0231	**0.1410**	0.0006
farm households	Electricity	0.0008	1.9516	0.0016	19.1596	0.0015	0.0028
	Coal	0.0006	1.4991	0.0009	10.5535	0.0823	0.0723
	Petroleum	0.0015	1.2235	0.0018	**9.9472**	0.0008	0.0006
Nonfarm households	Electricity	0.0011	1.5829	0.0017	20.7728	0.0015	0.0028
	Coal	0.0027	1.4784	0.0040	**8.3440**	0.0823	0.0723
	Petroleum	0.0012	1.2191	0.0014	5.7796	0.0008	0.0006

Note: The open-loop effects are zero because the account of origin and destination is in the same block; transfer effects are zero since origin and destination sectors belong to different account categories.

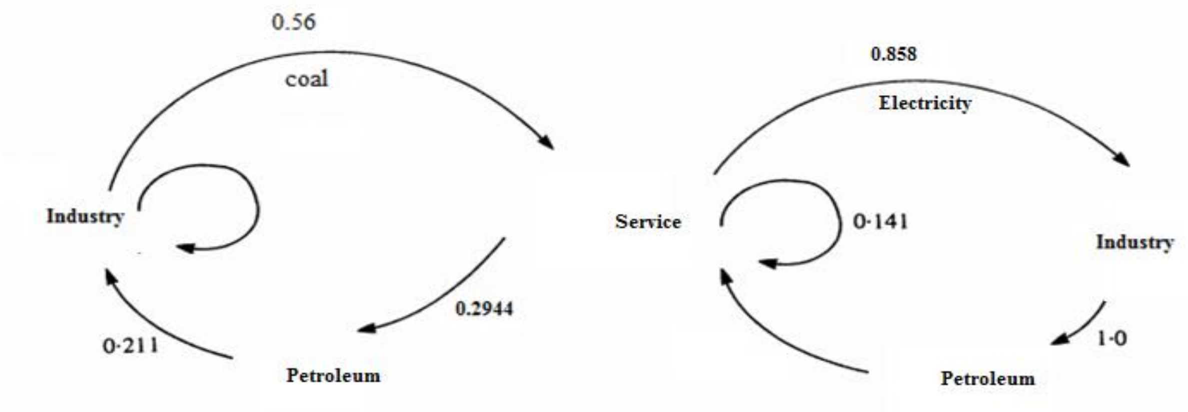

Figure 3. Accounting Multiplier 2020

Figure 3 presents the impact of changing the input structure under COVID-19. Accordingly, the amplifier level increases the image level in case that 1 production unit of an industrial sector is changed. The coal supply chain effect is 0.56, going through the power supply chain with near 0.3 and through the petro chain hitting close 0.2 before returning to the industry itself. The total amplifier through coal, electric and Petroleum will be close to 1 unit. The same goes for service input changes that will amplify for the industry itself: 0.14 -> via electricity amplifier 0.8 -> through Industry increase to a new level -> entering Service. Note that the amplifier level of the Service industry has little effect on the overall supply chain compared to the industry.

The traditional multiplier decomposition in regards to the impact of COVID-19 on the energy supply chain is presented in Table 3. The alternative structural path analysis decomposition presented in Tables 3 and 4 are also clarified as background. The effects of an insertion in agriculture, industry and service sectors on the energy supply chain including coal, electricity and petroleum are presented via machine, Service and trade sectors with 50% (**Total/Global)**. Note the decomposition of the multipliers into transfer effects, open loop effects, and closed loop effects. For instance, each unit change in the industry sector to Coal sector in 2020 led to 0.7012 unit change via the wood, machine, and Service sectors. In contrast, each unit change in the services sector to coal generated only 0.2273 via the machine sector. Similarly, the fluctuation of households on coal, petroleum, electricity led to changes of 0.85, 0.08, 0.015 respectively.

Table 3 presents the structural path analysis and the decomposition of the impact of COVID-19 shock on the economic and energy supply chain during 2020. In general, the total impact when changing 1 production unit during COVID-19 will have a strong impact on the main manufacturing and household industries, thereby directly affecting the energy supply chain as well as the production supply chain of Industry, agriculture and services in which coal will have the strongest influence through service and machinery industries. Accordingly, the decrease in industrial output will strongly affect the Petroleum industry (Total/Global = 96%). Meanwhile, Agriculture has a strong impact on Electricity (Total/Global = 58.3%). Electricity sector is greatly affected when 1 unit of the service industry decreases with (Total/Global = 99%). Machine and manufacturing have a higher impact on the coal industry than other energy sources with Total/Global at 74% and 44% respectively. Regarding the energy consumption of farm households, Nonfarm households have a huge impact on electricity although the influence of farm households on the electricity industry is lower than that of Nonfarm households. However, the impact is still very high compared to other energy sectors with Total/Global of farm households and nonfarm households at 64% and 74% respectively.

Going back to the three scenarios we mentioned in the previous section, specifically the first scenario in case of a complicated COVID-19 translation forces the government to limit production and reduce the energy supply chain by 10-20%. Accordingly, industries related to public services, mining, transportation and tourism services are more affected than that of other fields with a range of 1.03% - 3.9%. The country's energy situation is still under control. However, when the government limit of the energy supply chain is at 20-25%, some industries such as trade, services and transportation, and tourism and services are affected uncontrollably. The special 4% trade affected more than 11%. Therefore, the government should be cautious in limiting the supply within the allowed limit from 10-20%. In the case of the government limited energy to over 30% as planned until 2025, the impact is going to be abysmal on the economy, possibly leading to deflation. Specifically, the trade sector is affected by over 13%. In addition, the rest industries such as construction and machinery manufacturing are reduced by over 10%. The COVID-19 situation is complicated and may adversely affect the economy in the next 5 years. Overcoming the consequences of COVID-19 for the economy is not an easy task, especially in Vietnam where energy security is not always guaranteed. The coal industry has been the strong point of Vietnam and this sector has been exporting for many years bringing foreign currency to the country. However, in the current situation the government is forced to cut back on domestic supplies as well as limit exports caused by COVID-19. Research results show that in cases where the government limits the supply chain of coal, oil and electricity during the COVID-19 epidemic by 10-15%, it will not have much impact on the economy. But if the limitation goes between 20-25%, it will negatively impact the main industries of the economy, seriously affecting the tourism service sector, trade, construction, transportation and public services. With the scenario of limited energy supply (coal) by 34% until 2020, it will lead to many unpredictable consequences for the economy. The government should thereby consider limiting the supply outside the safe range from 25% -34%.

Table 3. SPA and the decomposition of the impact of energy shock on enterprise groups

	Origin	Destination	Global Influence	Elementary Paths	Direct Influence	Path Multiplier	Total Influence	Total/Global (Influence %)
Covid-19 (2020)	Agriculture	Electricity	0.0020	Ag / machine / trade / householde / elec	0.0000	1.3755	0.0000	**58.3590**
		Coal	0.0038	Ag / machine / trade / Coal	**0.2691**	1.2550	0.3378	**39.9541**
		Petroleum	0.0041	Ag / Petro	0.0250	1.8761	0.0468	**33.1822**
	Industry	Electricity	0.1911	In / machine / Service /trade / Elec	**0.0890**	1.0709	0.0954	49.8943
		Coal	**0.7012**	In / awood / machine / Service / Coal	0.0000	1.7846	0.0000	3.1366
		Petroleum	0.1638	In / fcap-na / Petro	**0.7160**	1.0564	0.7564	**96.0313**
	Service	Electricity	0.7638	Ser / fcap-na / Elec	**0.7160**	1.0564	0.7564	**99.0313**
		Coal	**0.2273**	Ser / machine / Coal	**0.0858**	1.2491	0.1072	47.1558
		Petroleum	0.0019	Ser / acomm / afish /fcap-ag / Petro	0.0000	1.2483	0.0000	2.0931
	machine	Electricity	0.0080	machine / Service /coal/ Elec	0.0000	1.4755	0.0000	1.3590
		Coal	**0.5650**	machine / service / Coal	**0.3262**	1.2836	0.4186	**74.0926**
		Petroleum	0.3676	machine / Industry / Petro	0.0593	1.7655	0.1048	**28.5004**
	Manufacturing	Electricity	0.0007	manuf / Service /coal/ Elec	0.0000	1.8621	0.0000	5.6188
		Coal	0.2816	manuf / service / Coal	**0.0924**	1.3632	0.1259	**44.7009**
		Petroleum	0.4274	manuf /Petro	0.1710	1.6742	0.2864	**37.0091**
	farm households	Electricity	0.0015	household / Service /coal/ Elec	0.0001	1.2080	0.0001	**64.7263**
		Coal	**0.8582**	household / Service / Coal	**0.7606**	1.1046	0.8402	**57.8975**
		Petroleum	0.0829	household / Service / Petro	0.0192	1.4369	0.0276	33.2951
	Nonfarm households	Electricity	0.0025	household / Service /coal/ Elec	0.0003	1.2080	0.0001	**74.7263**
		Coal	**0.9072**	household / Service / Coal	**0.8612**	1.1046	0.8402	38.7945
		Petroleum	0.1829	household / Service / Petro	0.0232	1.4369	0.0276	34.2951

Table 4. Impact on energy supply and production chain in Vietnam by COVID-19

	2015			2020- covid19		
Output	**S 1**	**S 2**	**S 3**	**S 1**	**S 2**	**S 3**
Crops	-0.63%	-0.59%	-1.49%	-1.77%	-3.37%	-4.77%
Livestock	-0.22%	-0.38%	-2.20%	-1.33%	-2.23%	-3.13%
Fishery	-0.24%	-0.31%	-1.16%	-1.26%	-2.33%	-2.93%
Forestry	-0.15%	-0.09%	-1.04%	-1.06%	-2.32%	-2.32%
Construction	-0.18%	-0.49%	-3.37%	-1.51%	-3.93%	-3.93%
travel services	**-0.38%**	-0.59%	**-4.51%**	-1.05%	**-4.24%**	**-4.74%**
transportation services	-0.44%	-3.01%	**-4.60%**	-1.61%	**-3.87%**	**-4.57%**
trade and repair services	-2.78%	-5.69%	**-6.07%**	-3.91%	**-11.44%**	**-13.24%**
real estate business	-0.57%	-3.58%	-1.51%	-1.60%	-4.45%	-4.34%
Mining	-0.32%	-2.31%	**-1.27%**	-1.34%	**-2.31%**	**-3.21%**
Textiles	-0.09%	-1.01%	1.10%	-1.05%	**-1.07%**	**-2.07%**
public services	-0.14%	-1.03%	**-3.02%**	-1.03%	**-1.12%**	**-3.12%**
Machine	-0.32%	-0.61%	-1.09%	-1.30%	-1.91%	**-12.91%**
other manufacturing	-0.23%	-0.75%	-1.09%	-1.10%	-1.61%	-2.61%
Farm household	-3.23%	-4.34%	-3.48%	-3.95%	**-8.39%**	**-10.39%**
Nonfarm household	-2.41%	-3.45%	-3.28%	-2.45%	**-7.23%**	**-9.32%**

5. Conclusion

It would be advisable for Vietnamese policymakers not to look down on the indirect impacts of energy shock due to COVID-19 on the production chain that can oftentimes be more influential than direct ones. By recognizing such patterns, government policymakers could formulate tax policy to control capital and high consumption by consumers in order to reduce the impact of coal and gas shock on the industry sector. It is operationally useful for policymakers to know this path of change and therefore make adjustments in taxes or regulations customized for specific enterprises. This is especially important for the enterprises which distribute energy to household groups. Of course, policymakers should investigate whether their interventions with those enterprises are responding positively. This research has attempted to carry out the necessary steps. Firstly, the multiplier analysis method is used to analyze the impact of production input fluctuations on the production chain and the energy chain under the influence of COVID-19. Secondly, the SPA method is applied to analyze sectors that are obstacles on the way when an industry is affected. It can be said that this particular method is very effective in solving detailed problems that the previous methods have not been concerned with. It is going to help the policy maker solve bottlenecks in the economy. Finally, the Constrained Fixed Price Multiplier method is used to find the endurance of the economy with 3 main scenarios in limiting production as well as energy supply. It also pointed out the limitation of the energy supply chain within the allowed threshold of 10-15% in the Vietnamese economy. The study also recommends the policy maker to limit the reduction of the energy supply chain into production from 20-34% that the government set forth before.

Overall, the Vietnamese government needs to formulate policies and adopt strategies to effectively control the nation's energy. Nowadays, not only oil and natural gas need continued attention and investment, but policymakers and planners also need to build energy sources for the future, not just for a 1-3 year short-term, but 10 to 20 years into the future. Therefore, the Vietnamese government needs to invest more heavily in renewable sources such as solar and wind energy instead of fossil fuels that are gradually depleting.

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