Asia-Pacific Social Science Review

Volume 21 | Issue 4 Article 18

12-30-2021

Examining the Economic Impacts of Restricted Energy Supply Chain on the Vietnamese Economy with Structure Path Analysis

Chung Van Nguyen
Quang Binh University, Vietnam, jacknguyen200826@gmail.com

Recommended Citation
Nguyen, Chung Van (2021) "Examining the Economic Impacts of Restricted Energy Supply Chain on the Vietnamese Economy with Structure Path Analysis," *Asia-Pacific Social Science Review*: Vol. 21: Iss. 4, Article 18.
DOI: https://doi.org/10.59588/2350-8329.1437
Available at: https://animorepository.dlsu.edu.ph/apssr/vol21/iss4/18

RESEARCH ARTICLE

Examining the Economic Impacts of Restricted Energy Supply Chain on the Vietnamese Economy with Structure Path Analysis

Chung Van Nguyen
Quang Binh University, Vietnam
jacknguyen200826@gmail.com

Abstract: The paper examines the impact of the restricted energy supply chain on key business sectors of Vietnam's economy during the COVID-19 period by using structure path analysis combined with constrained fixed price multiplier to examine energy price changes for key business sectors of the economy between 2019 and 2020. The result shows that the change in coal price will likely lead to a downward trend in the overall price of the production. In particular, when the government restricts 10% of the energy supplies chain, the travel services, transportation services, trade, and repair services sectors will have the strongest impact on the economy. Meanwhile, other key industries such as agriculture and construction were not significantly impacted by the restricted energy supply chain in 2020. The study also provides some important recommendations for the Vietnamese government to proactively seek energy under different scenarios of the energy supply chain. In consequence, policymakers will have appropriate policies for sustainable economic development, especially in the context of complicated COVID-19 adversely affecting the economies of many countries and territories all over the world.

Keywords: Energy supply chain, Business management, COVID-19, Vietnamese economy

Along with the worldwide increase in the price of crude oil, the recent cost of gasoline and oil in Vietnam has risen significantly, affecting major business sectors of the economy. In any event, efficiently utilizing energy will bring significant benefits to businesses as well as strategic economic sectors. For that reason, the Vietnamese government is making an effort to closely monitor and stabilize domestic gasoline prices as well as reduce pressure on major business sectors in the country. Authorities are looking for ways to introduce new minimum quotas for petroleum imports. This policy, however, has put domestic distributors under price pressure set by the government. As a result, petroleum businesses in Vietnam suffer considerable losses because of the government's "stabilizing gasoline" policy. Without a doubt, the increase in crude oil prices will greatly affect suppliers as well as many main business sectors of the Vietnamese economy. Therefore, it is necessary to carefully consider the impact of increasing energy prices on Vietnam's main business sectors, then make necessary recommendations for the government to manage the

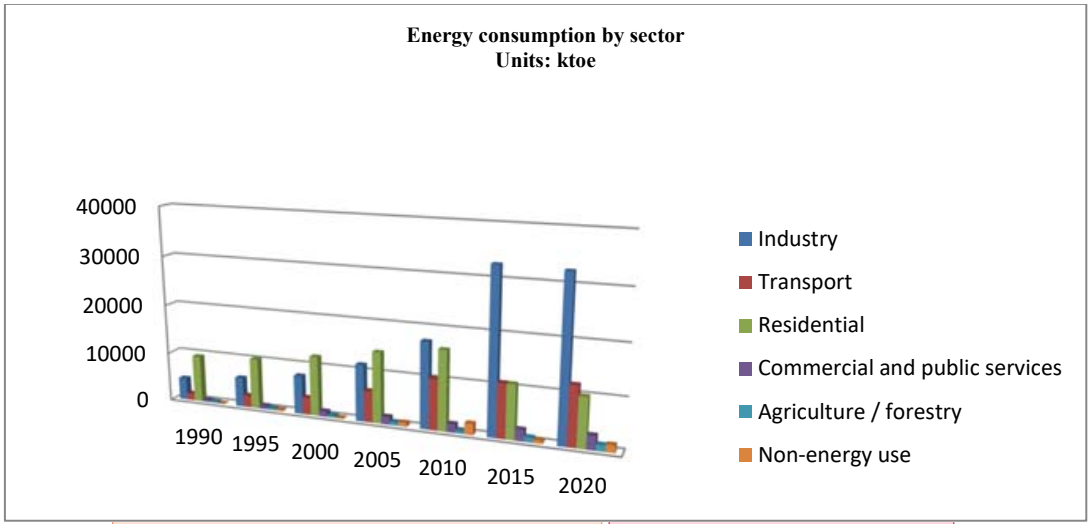
energy supply for the whole economy. Rioux et al.'s (2019) report on the economic impact of price controls on China's natural gas supply chain indicates that the price hike for industries with natural gas demand could drop by 4.7% ($1.4 billion) of the total system cost and a 14% reduction in the average supply cost for this country. This study applies the social accounting matrix (SAM) model to examine the impact of an increase in energy prices on the Vietnamese economy. I hypothesize the impact in question by performing a SAM-limited fixed price multiplier analysis. In this method, when the economy is affected by an external price shock, we can accurately measure the direct or indirect effects on key business sectors.

The Vietnamese government is facing many difficulties and challenges to ensure energy security for the rapidly growing economy during the COVID-19 pandemic. Specifically, refined oil products have to be imported in sizable volumes, and Vietnam does not have good strategic oil reserves; the power sector is still in the early stage of reform, so power shortages still occur frequently. In addition, investment in energy development, especially power generation, is not enough to meet the fast-growing needs of the economy Therefore, the Vietnamese government needs to recognize the key energy sectors and then propose more effective solutions and policies to develop the energy sector in a sustainable way (Do & Sharma, 2011).

In the coal sector, there are still many challenges because of the increasing requirements for environmental protection. Moreover, coal reserves are decreasing; coal mining enterprises often suffer losses. Although Vietnam has a relatively high potential for oil and gas discovery, the scale of these reserves is relatively small. Furthermore, large oil fields, which are currently being exploited with other declining production, will be depleted within the next 10 years. This will directly affect national energy security and reduce the growth momentum of some major business sectors.

However, in the increasingly complicated situation of the COVID-19 epidemic, should the Vietnamese government limit and takes control of the energy supply, especially coal? How will this affect the economy? What about the limited 10% of the energy supplies? Those are difficult questions that Vietnamese policymakers need to solve to push the national economy through the ongoing global crisis. Due to that reason, this study takes many different complex methods such as SPA to narrow down the path and the impact of energy on the following economic sectors in Vietnam. The constrained fixed price multiplier method (CFPM) will be comparing the impact of limiting energy supply between the ongoing COVID-19 period in 2020 and the prior duration in 2019 when the pandemic has not yet occurred.

Figure 1 shows the energy consumption of some key business sectors in Vietnam during the period 1990–2020. Energy demand for several key industries in Vietnam has increased dramatically from 2015 to



Source: IEA statistics (Data tables – Data & Statistics - IEA

Figure 1. Energy Consumption by Sector in Vietnam 1990–2020

2020, namely, industry, transport, commercial and public services, and agriculture. Notably, in 2020, due to complicated progressions in COVID-19 negatively affecting the world economy in general and Vietnam in particular, some key business sectors have decreased consumption. Regardless, the limited energy supply also greatly influences the growth of key industries, especially the service industries. The energy supply restriction scenarios presented at this time are essential to help policymakers and entrepreneurs respond proactively to the impact of the energy supply on their business plans concerning major business sectors.

Literature Review

In the process of industrialization and modernization of the country, Vietnam has been facing the problem of sustaining energy power, which is manifested by a large-scale lack of electricity, affecting the production growth of the economy. In particular, the key economic sectors and the people's lives are also affected. In recent events, the Vietnamese government has been largely dependent on hydropower and thermal power development, yet paid little attention to clean energy. Hence, problems related to the environment and sustainable development have arisen. To help the economy continue to develop sustainably, the government needs to deal with two main issues. The first is to meet the energy demand for the country's industrialization and socioeconomic development. Secondly, the government must pay attention to sustainable energy development, especially renewable energy and safety (Phat, 2012). However, it is not easy to do so because investing in energy requires a large amount of funding, which is a challenge for Vietnam as a developing country because the necessary resources are already focused on economic development. Seymore et al. (2009) mentioned that to balance the development of renewable energy to protect the environment, the South African government has imposed a tax on electricity prices to protect the environment. The report showed that the increase in electricity tariff has a positive impact on the exports of South Africa. By researching these reports, it will give the Vietnamese government reviewing materials in balancing electricity price and environmental protection as well as developing renewable energy.

Ding et al. (2016) analyzed the impact of coal price volatility on the volume and structure of China's economic output. The results showed that the coal price volatility had significant long-term positive and short-term negative effects on China's output variables.

Ding et al. (2011) performed the cointegration test and used the and used the error correction modelmodel to analyze the impact of coal price volatility on the effectiveness of the consumer price index CPI and its lagging effect. The results showed that the effect of coal price volatility on CPI, in the long run, was about 0.157%. The coal price volatility had no long-term impact on the CPI.

Wang et al. (2020) used a difference-in-differences model to evaluate the treatment effect of coal de-capacity policies on coal prices. The results showed that the capacity reduction policy in 2013 and 2016 increased coal prices by 3.24% and 3.44%, respectively. The strengthening of coal import and export management has accelerated the coal price reduction trend, limiting 276 working days per year, pedaling coal prices upward.

By the end of 2020, the revenue of the entire Vietnam Coal - Mineral Industries Group in 2020 reached VND 123,425 billion, contributing VND 19,500 billion to the State budget. Profit reached nearly 3,000 billion VND (Vietnam Government Portal, 2021) t can be said that the coal industry is making a huge contribution to the Vietnamese economy. Vietnam is expected to increase its coal-fired power generation capacity significantly to meet the rapidly growing electricity demand. However, as the COVID-19 situation is getting more complicated, the increase in coal mining will affect the climate, contrary to the policies of the Communist Party of Vietnam (Ira Irina Dorband et al., 2020). Should anything bad happens, the government is very likely to have to limit the energy supply, gravely affecting the Vietnamese economy in the short term, to make more reasonable adjustments in the long term. Nong (2018) used an overall equilibrium model to assess the impact of tax increases on the Vietnamese economy, focusing on energy. The results showed that a tax increase on petroleum products would affect the country with a massive decrease in real GDP to 1.99%. Exports and imports were also adversely affected. In this case, total emissions would be reduced by 7.12%. However, a tax increase on coal would allow Vietnam to suffer much lower adverse effects while

also significantly reducing emissions. Restricting the number of industrial sectors in the emissions trading market substantially affects Vietnam's economy, with a decline in real GDP by 4.57%. The coal mining and electricity sectors will be severely affected. However, the fields of exploitation of crude oil and natural gas will be expanded to replace coal (Nong et al., 2020). The trade-off for the tax increase on petroleum products is much higher than the increase in taxes on coal.

Real GDP in Vietnam decreases by 2.23% and 1.05% on a difference scenario. Scenario 1 is the trade-off of increasing taxes on petroleum products and scenario 2 is increasing taxes on coal. Vietnam's emissions decrease by 10.23% in Scenario 2 compared to a 7.62% decrease in Scenario 1. The higher taxation of coal would promote the faster expansion of the renewable energy sector than the effects of increased tariffs on petroleum products (Nong et al., 2019).

Akkemik (2019) studied the potential impact of electricity price changes on the local economy using the social accounting matrix analysis model. The research results showed that the change of the typical price would have a significant effect on the terrestrial economy, especially some key business sectors such as energy production, mining, and iron and steel production. Consumer prices are also slightly affected. Zhao and You (2008) used the SAM analysis model to analyze the impact of electricity price adjustment in China, showing that the adjustment of electricity prices has a huge impact on the production of electrical machinery manufacturing industries, petroleum processing industries, and chemical products. This led to a blow on the entire Chinese economy. Nguyen (2008) used an IO analysis method to examine the impact of electricity price increases on the prices of other products in Vietnam. Although the increase in electricity price has been negligible in recent years, its impact on other business sectors is on a sizable scale. In addition, the increase in electricity prices also influences the inflation rate, especially in the context that the Vietnamese government is currently facing a high inflation rate.

Norouzi et al., (2020) analyzed the impact of COVID-19 (coronavirus) on electricity and petroleum demand in China. The results showed that the severity of the pandemic affected electricity and petroleum demand, both directly and indirectly. The pandemic has significant impacts on energy needs, and its impact can be monitored. However, the imposition of restrictions on internal mobility and higher fiscal policy spending has a positive effect on the level of economic activity in relation to the level of economic activity Peterson and Thankom, 2020) . Sovacool et al. (2020) sought to provide clearer information and solutions on emerging linkages between COVID-19 and energy supply and demand, energy management, future low carbon conversion, social justice, and even the practice of research methods. Thus, it can be said that previous studies have focused on researching adverse effects on the economy during the limitation on energy supplies. But those studies have not mentioned how supply limitation will affect the economy in the context of increasingly complicated COVID-19. In which case, this study will examine the supply limitation in each specific situation and compare the impact of COVID-19 taking place specifically in 2019 and 2020 on the Vietnamese economy, including post and prior to the pandemic.

Methods

Constrained Fixed Price Multiplier Method (CFPM)

CFPM was built by Pyatt et al. (1979) to apply for the Sri Lankan economy. Resosudarmo et al. (1995) used this method to study the effect of environmental policies on household income with different socioeconomic classes for the Indonesian case. Parra and Wodon. (2009a) also used the CFPM method to compare the impact of the food and energy price shock on consumers, additionally using an analytical social accounting matrix for the case of Ghana. This particular method with many outstanding features is widely used in many countries and regions, and no other methods up until now can completely replace it. Therefore, my study will be using the CFPM method to calculate the economic impacts of restricted energy supply management on the Vietnamese major business sectors.

Table 1

The SAM With Constrained and Unconstrained Accounts

				Expenditures					
				Endogenous			Exogenous		
				Non-constrained	Constrained	Sum	Transaction	Sum	Total
Income	Endogenous	Non-constrained	Production activities	HNC	H_E	V_{NC}	X_{NC}	x_{NC}	y_{NC}
		Constrained	Factors Intuitions	H_F	H_C	V_C	X_C	x_C	y_C
	Exogenous		Government			L	T	t	y_U
		Total							

Algebraically the table above can be written as:

$$y_n = z + x \tag{1}$$

$$d_{yn} = dz + dx,\ dz = H_n d_{yn} \tag{2}$$

where H_n is a matrix of marginal expenditure propensities. The constrained fixed price method (CFMM) method is used to uncover changes in endogenous account outputs when limited impact on exogenous accounts limited by one factor can be illustrated as a model:

$$\frac{Y_{non-constrained}}{Y_{constrained}} = \left(\frac{V_{nc}}{V_c}\right) + \left(\frac{x_{nc}}{x_c}\right) \tag{3}$$

In which $Y_{non\text{-}constrained}$ is the vector of the unrestricted total income of key business sectors. $Y_{constrained}$ is the vector of the restricted total income of the industry. In this study, I consider $Y_{non\text{-}constrained}$ as the key sector of Vietnam's economy and $Y_{non\text{-}constrained}$ as the energy sector. V_{nc} is the endogenous vector of the unrestricted sector. V_c is the endogenous vector of the restricted sector. X_{nc} is the exogenous vector of the unrestricted sector. X_c is the exogenous vector of the restricted sector.

Structural Path Analysis (SPA)

SPA captures the inter-sectoral linkages between individual SAM accounts and identifies the paths between different factors factors (Defourny & Thorbecke, 1984). Keuning, & Thorbecke (1989) used a SAM multiplier to track the impact of government budget cuts on each of the ten socioeconomics in Indonesia. Lewis & Thorbecke (1992) used SAM to explore the nature and extent of economic linkages in Kenya. Parikh & Thorbecke (1996) used the SAM method to compare two relatively similar villages in India to clarify the impact of industrial decentralization on rural development. Recently, Chang and Kim (2020) . used SPA to scrutinize specific paths where the effects of a shock to a seafood industry are transmitted in both backward and forward directions. Frederick V. Waugh (1950) concluded that SPA is the unraveling of the Leontief inverse by means of a series of expansions of the direct requirements matrix. This study used SPA to show how influence is diffused from a given pole through which specific paths it is transmitted and the extent to which it is amplified by the circuits adjacent to these paths. In order to conduct the SPAs, my research uses SimSIP SAM software Parra & Wodon, 2009b . Direct effects are transmitted through an elementary path. The change in sector *j* income because of a small 1-unit change in sector *i* can be calculated as follows:

$$I^G_{i\to j} = a_{ij} \tag{4}$$

Total influence is the influence transmitted from pole *i* to pole *j* along the elementary path, which includes all indirect effects within the structure imputable to that path

$$I^T_{(i\to j)p} = a_{xi}a_{ji}a_{yx}\left[I - a_{yx}\left(a_{xy} + a_{zy}a_{xz}\right)\right]^{-1} \tag{5}$$

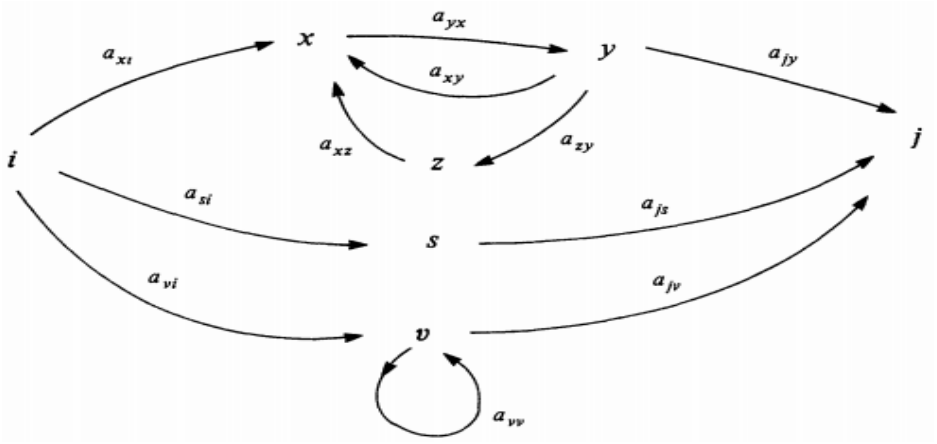


Figure 2. Poles, Elementary Paths, and Adjacent Circuits (Adapted from Defourny & Thorbecke, 1984)

Whereas any two-pole coherent global influence of a structure can be decomposed into a chain of total effects transmitted along each and all of the fundamental paths spanning *i* and *j*, the global effect from pole *i* to pole *j* is simply a measure of the sum of the effects on income or output of pole *j* due to the injection of a unit of output or income into pole *i*

$$I^T_{i\to j} = I^T_{(i,x,y,j)} + I^T_{(i,s,j)} + I^T_{(i,v,j)} \qquad (2c)$$

Sources of Data

The data for this study is provided by the Central Institute for Economic Management. The Vietnam Energy SAM data used in this study is based on the Vietnam Input-Output (IO) table made available at the Vietnam General Statistics Office (VN GSO) combined with National Accounts and State Budget. The GSO publishes the Vietnam IO every five years and has done so since 1986. As for the SAM, the disaggregated SAM

Table 2

Summary of the Main Functions in this Research

Transfer Effects	Capture an exogenous shock among activities block, commodities block, and institutions block. Transfer effects are zero because origin and destination sectors belong to different account categories.
Open-loop Effects	Demonstrate the interaction of the three groups of accounts. The open loop is zero when the origin and destination sectors are of the same type.
Closed-loop Effects	Measures the effect of an exogenous shock on an endogenous account after the SAM completion cycle.
The Direct Influence	The change in the income of sector *j* caused by a 1-unit change in sector *i*. This effect passes through an elementary path. The incomes of all other poles remain unchanged except the ones along the selected elementary path.
Total Influence	Cumulates the direct influence transmitted along with the latter and the indirect effects induced by the circuits adjacent to that same path.
Global Influence	Calculates the total effect on the income or the output of pole *j* due to an increase in output unit or income on pole *i.*
Path Multiplier	Captures the degree of direct influence along the p path amplified through the effects of neighboring feedback circuits.

based on the IO tables, Vietnam National Accounts, and State Budget is available from the Central Institute for Economic Management. For this paper, I used the SAM-price model introduced by Roland-Holst & Sancho (1995).

Simulation Scenarios

Scenario 1: This scenario simulates a situation in which the government restriction is 10% on the electricity sector.

Scenario 2: This scenario simulates a situation in which the government restriction is 10% on the petroleum sector.

Scenario 3: This scenario simulates a situation in which the government restriction is 10% on the coal sector.

Scenario 4: This scenario simulates a situation in which the government restriction is 10% on the crude oil sector.

Scenario 5: This scenario simulates a situation in which the government restrictions on electricity, coal, crude oil, and petroleum sector is 10%, respectively at the same time.

Results

The Impact of Coal and Crude Oil Price on the Economy

Table 3 presents the structural path and the decomposition results for unitary cost shock given to the coal generation sector by others in the economy sector. For simplicity purposes, only those paths with the strongest global influence are reported. The shock originated from the coal production sector. The paths are going to run from generation to transmission and then to distribution before reaching the final destination. The most notable was that more than 82% of the price changes in the rural farm household group in 2019 were the result of the changes in the coal generation costs. The direct impact of coal price change on urban farm households was also high, approximately 53% of global influence. However, its impact on the same household groups was only 38% and 19%, respectively. In other words, the impact of coal price changes on household groups tended to decrease during 2019–2020. The coal price shock influenced the power sector more than the economic sector in 2020 compared with 2019, as can be seen in Table 3. About 56% of global influence was directly transmitted from coal generation costs into machinery; 40% into food processing in 2020, whereas in 2019, only 41% and 25% of global influence were put into machinery and food processing, respectively. The exception was the agriculture sector, in which 37% of global influence in 2019 compared with only 8% of global influence in 2020. Generally speaking, coal price changes led to manufacturing sector price changes in 2020 in more powerful waves than in 2019. It is interesting to note that, in 2020, the impact of the coal price shock was rapid, but the influence upon the household group remained quite low. This occurrence may have benefited the household group, especially the rural non-farm household group with 17.7% of the global influence.

Table 4 reports the effects of crude oil price change on cost change in production activities and four household groups. In the presence of a unitary exogenous cost change in crude oil, the price of agriculture would rise to 0.001 of Vietnamese dong in 2020 and to 0.005 of Vietnamese dong in 2019. Most of the change can be attributed to the link along the arc (crude oil → petroleum → agriculture) connecting these sectors. The direct price influences of 0.0001 and 0.0012 in 2020 and 2019, respectively, are amplified by the price path multiplier 1.5625 and 1.815 to yield a total price influence of 0.0002 and 0.0021, which accounted for 16.74% (2020) and 41.98% (2019) of the overall price change in agriculture product. The impact of crude oil price change on household groups in 2020 was a stronger price influence than in 2019, whereas the price influence was stronger under a price change of coal. Namely, 32.4%, 37.9%, 28.7%, and 27.1% of the overall change in the rural non-farm household, rural farm household, urban non-farm household, and urban farm household respectively in 2020 with a 1 unitary crude oil change compared with 21.5%, 23.6%, 20.9%, and 19.45% in the year 2019. The impact of a crude oil change on construction, agriculture, and especially in the private sector tended to decrease during the period 2019–2020. More than 59% of the overall price change occurred in private services in 2019 in comparison with 36.5% in 2020. Similarly, a 1 unit change in crude oil change led to 41% (2019) of overall change in agriculture, whereas just only a 16.7% change in 2020. From the household perspective, the impact of coal price changes tended to increase, whereas the impact of crude oil tended to decrease.

Table 3

SPA and the Decomposition of Coal Price Influence

Origin		Destination	Global Influence	Elementary Paths	Direct Influence	Path Multiplier	Total Influence	Total/Global (Influence %)
2019	Coal	a1. Agriculture	0.0244	Coal / hhd-rf / flab-r-s / Ag	0.0050	1.8194	0.0091	37.2498
		a2. food processing	0.0222	Coal / hhd-rf/ flab-r-s / Ag /fpro	0.0021	2.5709	0.0053	23.8011
		a3. textile, closing	0.0124	Coal / hhd-rf / flab-r-s / textil	0.0008	2.4767	0.0020	15.8791
		a4. Construction	0.0282	Coal / Cement / Construction	0.0055	1.2842	0.0071	25.2524
		a5. machinery	0.0124	Coal / machinery	**0.0030**	1.7046	0.0052	**41.8219**
		a6. private service	0.0188	Coal / hhd-rf / flab-r-s /private service	0.0014	1.9627	0.0028	14.7915
		a7. public service	0.0196	Coal / hhd-rf / flab-r-t / public service	**0.0035**	1.5455	0.0054	**27.4368**
		a8. hhd-uf	0.0273	Coal / Urban farm households	0.0120	1.1958	0.0143	**52.4104**
		a9. hhd-un	0.0163	Coal / Urban non-farm households	0.0024	1.3800	0.0033	20.2174
		a10. hhd-rf	0.0402	Coal / Rural farm households	0.0234	1.4166	0.0332	**82.5192**
		a11. hhd-rn	0.0209	Coal / Rural non-farm households	0.0071	1.2242	0.0087	41.6764
2020	Coal	b1. Agriculture	0.0071	Coal mining / hhd-rf / flnd / Ag	0.0003	1.9696	0.0006	8.1185
		b2. food processing	0.0100	Coal / Processed foods	0.0019	2.0793	0.0040	40.0221
		b3. textile, closing	0.0061	Coal / Electricity/Textiles, clothing	0.0006	2.2969	0.0015	24.3111
		b4. Construction	0.0202	Coal / Cement / Construction	0.0058	1.3020	0.0075	37.3365
		b5. machinery	0.0094	Coal / machinery	**0.0032**	1.6514	0.0052	**55.5542**
		b6. private service	0.0085	Coal / Electricity/ Private services	0.0008	1.9516	0.0016	19.1596
		b7. public service	0.0081	Coal / Electricity / Government	**0.0006**	1.4991	0.0009	**10.5535**
		b8. hhd-uf	0.0091	Coal / hhd-uf	0.0015	1.2235	0.0018	**19.9472**
		b9. hhd-un	0.0081	Coal / Electricity / hhd-un	0.0011	1.5829	0.0017	20.7728
		b10. hhd-rf	0.0105	Coal / hhd-rf	0.0027	1.4784	0.0040	**38.3440**
		b11. hhd-rn	0.0090	Coal / hhd-rn	0.0012	1.2191	0.0014	15.7796

Note. hhd-uf = Urban farm households, hhd-un = Urban non-farm households, hhd-rf = Rural farm households, hhd-rn = Rural non-farm households.

Table 4

SPA and the Decomposition of Crude Oil Price Influence

	Origin	Destination	Global Influence	Elementary Paths	Direct Influence	Path Multiplier	Total Influence	Total/Global (in %)
2019	Crude oil	Agriculture	0.0051	Crude oil / fuel / Ag	0.0012	1.8159	0.0021	**41.9893**
		food processing	0.0048	Crude oil / fuel / Ag / food processing	0.0005	2.6072	0.0013	26.0059
		textile, closing	0.0033	Crude oil / fuel / textile	0.0003	2.1597	0.0007	20.6554
		Construction	0.0063	Crude oil / fuel / Construction	0.0017	1.3077	0.0022	34.8760
		machinery	0.0026	Crude oil / fuel / machinery	0.0004	1.8271	0.0007	28.2615
		private service	0.0072	Crude oil / fuel / private service	0.0024	1.8165	0.0043	**59.8452**
		public service	0.0052	Crude oil / fuel / public service	0.0007	1.3807	0.0010	18.4840
		hhd-uf	0.0047	Crude oil / fuel / hhd-uf	0.0007	1.2824	0.0009	**19.4500**
		hhd-rf	0.0044	Crude oil / fuel / hhd-rf	0.0006	1.5255	0.0009	**20.9590**
		hhd-un	0.0050	Crude oil /fuel / hhd-un	0.0008	1.4794	0.0012	**23.6986**
		hhd-rn	0.0044	Crude oil / fuel / hhd-rn	0.0007	1.3126	0.0009	**21.5445**
2020	Crude oil	Agriculture	0.0010	Crude oil / fuel / Agriculture	0.0001	1.5625	0.0002	**16.7473**
		food processing	0.0011	Crude oil / elec / Processed foods	0.0001	2.0953	0.0003	26.9610
		Textiles, clothing	0.0011	Crude oil / elec / Textiles and clothing	0.0003	1.9461	0.0005	46.1155
		Construction	0.0017	Crude oil / Construction	0.0005	1.0510	0.0005	30.9192
		machinery	0.0007	Crude oil / elec / machinery	0.0002	1.6693	0.0003	47.1963
		Private services	0.0015	Crude oil / elec / Private services	0.0003	1.6554	0.0005	**36.5776**
		Government	0.0014	Crude oil / elec / Government	0.0002	1.2702	0.0003	20.7375
		hhd-uf	0.0013	Crude oil / elec / hhd-uf	0.0003	1.2355	0.0003	**27.1157**
		hhd-rf	0.0012	Crude oil / elec / hhd-rf	0.0002	1.4865	0.0003	**28.7108**
		hhd-un	0.0015	Crude oil / elec / hhd-un	0.0004	1.3420	0.0006	**37.9092**
		hhd-rn	0.0014	Crude oil/ elec / hhd-rn	0.0004	1.2313	0.0005	**32.4854**

Note. hhd-uf = Urban farm households, hhd-un = Urban non-farm households, hhd-rf = Rural farm households, hhd-rn = Rural non-farm households.

The Impact of Petroleum and Electricity Price on the Economy

Considerations similar to those outlined above also apply to the analysis of the change in petroleum prices on production activities and four household groups, as presented in Table 5. The first notable observation is that the influence was stronger in agriculture (2020) under the petroleum price change compared with the crude oil and coal sectors. Specifically, 1 unitary change in 2020 on petroleum caused an increase of 0.0026 of Vietnamese dong in the agriculture sector. However, there was a 53.36% price influence on the agriculture sector, while in the same year, the influence on crude oil was 16.7% and 8% on coal, which was even higher than the overall price change in 2019 (48%). The changes in petroleum prices led to approximately 62% overall price change in the private sector and remained even a stronger influence in 2019 (68.8%). The influence of price changes on construction, machinery, and textile tended to decrease in the period 2019–2020 under the petroleum price change. Namely, a 1 unit change in the petroleum price sector led to a change of 34%, 40%, and 24% of the overall influence on machinery, construction, and textile sectors, respectively, in 2020. In 2019, the influences were similar in the sectors for construction (37%), machinery (44%), and textile (28%).

Similar to the impact of crude oil on household groups, the increase in petroleum price led to an increase in four household groups but only slightly larger than in 2019. The effect was a 1 unitary change in petroleum price led to changes of 34%, 43%, 37%, and 39% in the overall influence on urban farm households, urban non-farm households, rural farm households, and rural non-farm households in 2020, whereas in 2019 just only 23%, 28%, 25%, and 26% overall price influence occurred on those households. In other words, the impact of energy price changes on household groups tended to decrease except in relation to the coal sector.

Table 6 shows the structural path and the decomposition of electricity price influence on the Vietnamese economy during 2019–2020, especially the impact of the energy price shock on four household groups. The changes in electricity price influence were larger in the manufacturing sector than in the agriculture sector. For instance, with a unitary shock of electricity price change, the price of textile and closing sectors output would rise by 55 Vietnamese dongs and most of the change can be attributed directly from the electricity sector transmitting to textile & clothing industry with total price influence of 0.0105, which accounted for 61% (2019) and 60% (2020) of the overall price change in textile and clothing products.

Similarly, the total price influence on machinery was 62.6% (2020), which was slightly bigger than in 2019 (60%). In contrast, the total price influence of the electricity sector on agriculture was smaller than other sectors. It was 20% (2020) and less than 15% (2019) of the global price influence transmitted directly from electricity to agriculture sectors. Suppose that the Vietnamese government increased 1 unitary price on electricity in 2020, it would have led to an increase of 38% of the total price influence on urban farm households, 52% on urban non-farm households, 41% rural farm households, and 45% rural non-farm households. Meanwhile, the influence of a 1 unitary price change in electricity is less influential in 2019, ranking about 37%–38% of overall price change on household groups.

Price Multipliers and Their Decomposition

Decomposition of energy price influence on the Vietnamese economy in the period 2019–2020 is presented in Tables 7 and 8. The principle of accounting for the multiplier factor is divided into three parts—the direct impact, the closed-loop effect, and the open-loop effect (see Table 8 for more details regarding their function). The impact of energy price on the production activities and four household groups tended to decrease in the period 2019–2020. For instance, a 1 Vietnamese dong increase (a 1 VND increase) in the cost of coal distribution would increase the price of machinery in 2019 to 0.0124 VND, whereas the price of machinery in 2020 would increase by 0.0094 VND.

Similarly, 1 unitary change in petroleum led to an increase of 0.0126 in 2019 and 0.009 VND in 2020. The impact of petroleum on machinery from 2019 to 2020 decreased significantly. The global impact of the unitary (1%) increased petroleum generation cost, and the increase of the price of the machinery sector differed by 17 times. In other words, the global impact of the 1% increase in the cost of petroleum production will increase the price of the machinery sector by 0.0009% in 2020. Meanwhile, the global impact of the 1% increase in the cost of petroleum production will increase the price of the machinery sector by 0.162% in 2019. The impact of petroleum price changes also led

Table 5

SPA and the Decomposition of Petroleum Price Influence

	Origin	Destination	Global Influence	Elementary Paths	Direct Influence	Path Multiplier	Total Influence	Total/Global (Influence %)
2019	Fuel	Agriculture	0.0364	fuel/ Ag	0.0097	1.8152	0.0175	**48.2369**
		food processing	0.0334	fuel / Ag / food processing	0.0040	2.6063	0.0104	31.0351
		textile	0.0200	fuel / textile	0.0026	2.1589	0.0057	28.3731
		Construction	0.0414	fuel / Construction	0.0139	1.3072	0.0182	44.0066
		machinery	0.0162	fuel / machinery	0.0033	1.8264	0.0060	37.2939
		private service	0.0513	fuel / private service	0.0194	1.8160	0.0353	**68.8524**
		public service	0.0349	fuel / public service	0.0057	1.3802	0.0079	22.6291
		hhd-uf	0.0322	fuel / hhd-uf	0.0059	1.2819	0.0075	23.3553
		hhd-un	0.0335	fuel / hhd-un	0.0065	1.4792	0.0097	28.8608
		hhd-rf	0.0299	fuel / hhd-rf	0.0049	1.5250	0.0075	25.1796
		hhd-rn	0.0299	fuel / hhd-rn	0.0059	1.3121	0.0078	26.0454
2020	Fuel	Agriculture	0.0026	fuel / Agriculture	0.0009	1.5621	0.0014	**53.3657**
		Processed foods	0.0022	fuel / Agriculture/Processed foods	0.0004	2.2739	0.0008	36.1152
		Textiles, clothing	0.0012	fuel / Textiles and clothing	0.0002	1.6486	0.0003	24.1108
		Construction	0.0026	fuel / Construction	0.0010	1.0652	0.0010	**40.2977**
		machinery	0.0009	fuel / machinery	0.0002	1.4153	0.0003	**34.5236**
		Private services	0.0033	fuel / Private services	0.0015	1.4156	0.0021	**61.9683**
		Government	0.0024	fuel / Government	0.0004	1.0761	0.0004	17.0722
		hhd-uf	0.0026	fuel / hhd-uf	0.0008	1.0486	0.0009	**34.6710**
		hhd-un	0.0028	fuel / hhd-un	0.0011	1.1527	0.0012	**43.3819**
		hhd-rf	0.0025	fuel / hhd-rf	0.0007	1.2685	0.0009	**37.4879**
		hhd-rn	0.0028	fuel / hhd-rn	0.0010	1.0448	0.0011	**39.2981**

Note. hhd-uf = Urban farm households, hhd-un = Urban non-farm households, hhd-rf = Rural farm households, hhd-rn = Rural non-farm households.

Table 6

SPA and the Decomposition of Electricity Price Influence

	Origin	Destination	Global Influence	Elementary Paths	Direct Influence	Path Multiplier	Total Influence	Total/Global (Influence %)
2019	Electricity	Agriculture	0.0409	elec / Ag	0.0037	1.7196	0.0064	15.5663
		Food processing	0.0499	elec / food processing	0.0090	2.0177	0.0183	36.6134
		Textile	0.0549	elec / textile	0.0163	2.0494	0.0335	61.0691
		Construction	0.0541	elec / Cement / Construction	0.0080	1.3069	0.0105	19.3890
		Machinery	0.0383	elec / machinery	0.0134	1.7325	0.0233	**60.8150**
		Private service	0.0625	elec / private service	0.0188	1.7119	0.0321	51.4095
		Public service	0.0612	elec / public service	0.0141	1.3085	0.0185	30.1583
		hhd-uf	0.0519	elec / hhd-uf	0.0151	1.2163	0.0184	35.3466
		hhd-un	0.0592	elec / hhd-un	0.0212	1.3871	0.0294	**49.6862**
		hhd-rf	0.0480	elec / hhd-rf	0.0125	1.4390	0.0179	**37.3833**
		hhd-rn	0.0502	elec / hhd-rn	0.0156	1.2425	0.0194	**38.5935**
2020	Electricity	Agriculture	0.0406	elec/ Agriculture	0.0046	1.8375	0.0084	20.6002
		Processed foods	0.0491	elec / Processed foods	0.0092	2.0947	0.0192	39.1290
		Textiles, clothing	0.0525	elec / Textiles and clothing	0.0164	1.9454	0.0319	**60.6969**
		Construction	0.0537	elec / Cement / Construction	0.0079	1.3173	0.0104	19.3419
		Machinery	0.0360	elec / machinery	0.0135	1.6688	0.0225	**62.6277**
		Private services	0.0657	elec / Private services	0.0211	1.6549	0.0349	53.1605
		Government	0.0638	elec / Government	0.0144	1.2698	0.0183	28.7179
		hhd-uf	0.0592	elec / hhd-uf	0.0183	1.2351	0.0226	**38.1327**
		hhd-un	0.0690	elec / hhd-un	0.0269	1.3417	0.0361	**52.2855**
		hhd-rf	0.0542	elec / hhd-rf	0.0150	1.4860	0.0223	**41.0702**
		hhd-rn	0.0649	elec / hhd-rn	0.0240	1.2309	0.0296	**45.5497**

Note. hhd-uf = Urban farm households, hhd-un = Urban non-farm households, hhd-rf = Rural farm households, hhd-rn = Rural non-farm households.

Table 7

Decomposition of Price Multiplier (coal, petroleum)

Origin	Destination	2019				2020			
		Accounting Multiplier	Transfer Effects	Open-loop Effects	Closed-loop Effects	Accounting Multiplier	Transfer Effects	Open-loop Effects	Closed-loop Effects
Coal	Agricultural	0.0244	0.0020	0.0005	0.0219	0.0071	0.0020	0.0003	0.0048
	Food processing	0.0222	0.0060	0.0003	0.0159	0.0100	0.0060	0.0002	0.0038
	Textile	0.0124	0.0045	0.0000	0.0078	0.0061	0.0036	0.0000	0.0025
	Construction	0.0282	0.0164	0.0000	0.0118	0.0202	0.0165	0.0000	0.0037
	Machinery	0.0124	0.0084	0.0000	0.0040	0.0094	0.0082	0.0000	0.0013
	Private service	0.0188	0.0039	0.0000	0.0149	0.0085	0.0035	0.0000	0.0049
	Public service	0.0196	0.0025	0.0000	0.0170	0.0081	0.0022	0.0000	0.0059
	Urban farm households	0.0273	0.0000	0.0178	0.0095	0.0091	0.0000	0.0062	0.0029
	Urban non-farm households	0.0163	0.0000	0.0069	0.0094	0.0081	0.0000	0.0052	0.0029
	Rural farm households	0.0402	0.0000	0.0308	0.0094	0.0105	0.0000	0.0076	0.0029
	Rural non-farm households	0.0209	0.0000	0.0121	0.0088	0.0090	0.0000	0.0060	0.0029
Petroleum	Agricultural	0.0364	0.0172	0.0003	0.0189	0.0026	0.0013	0.0001	0.0012
	Food processing	0.0334	0.0182	0.0002	0.0150	0.0022	0.0012	0.0000	0.0010
	Textile	0.0200	0.0108	0.0000	0.0092	0.0012	0.0005	0.0000	0.0007
	Construction	0.0414	0.0284	0.0000	0.0130	0.0026	0.0016	0.0000	0.0010
	Machinery	0.0162	0.0109	0.0000	0.0052	0.0009	0.0005	0.0000	0.0004
	Private service	0.0513	0.0325	0.0000	0.0187	0.0033	0.0019	0.0000	0.0014
	Public service	0.0349	0.0132	0.0000	0.0216	0.0024	0.0007	0.0000	0.0017
	Urban farm households	0.0322	0.0000	0.0217	0.0105	0.0026	0.0000	0.0018	0.0008
	Urban non-farm households	0.0335	0.0000	0.0228	0.0107	0.0028	0.0000	0.0020	0.0008
	Rural farm households	0.0299	0.0000	0.0198	0.0102	0.0025	0.0000	0.0017	0.0008
	Rural non-farm households	0.0299	0.0000	0.0203	0.0097	0.0028	0.0000	0.0020	0.0008

to the changes in agricultural, food processing, textile, and construction which also increased significantly by 14, 15, 16, and 16 times respectively. Furthermore, the strong transfer effects between petroleum costs and agriculture, food processing, textile, construction, machinery, and private and public service sectors reflect the high level of integration among these sectors, especially in 2019.

In Table 8, the magnitude of the impacts of an increase in electricity led to an increase in the price of other production activities, which was even higher when compared with other energy sectors. For instance, a 1,000 unitary increase in the electricity sector led to an increase of 65.7 VND in the private sector in 2020 and 62.5 in 2019. This can also be seen in the report regarding the response of the cost of living for households group that 1 VND cost increase in electricity sectors led to an increase in the overall cost of household groups between 0.036 and 0.069 VND. The impact of price change in petroleum, coal, and crude oil tended to increase the cost of living for household groups going in the period 2019–2020.

Interestingly, the impact of an electricity price change on agricultural, food processing, textile, construction, and machinery tended to decrease during 2019–2020. In contrast, the impact of an electricity price change on private service, public service, and household groups had an inward trend in the same period except with the urban non-farm household group. The impact of a crude oil change on the Vietnamese economy was not significant during 2019–2020; however, the change of price on crude oil may hurt the economy in the near future. For instance, 1 VND increase in the cost of crude oil supply activities would increase the price of food processing in 2020 by 0.0011 VND, whereas the price of food processing in 2019 would increase by 0.0048 VND. Similarly, 1 VND increase in the cost of crude oil supply activities would increase the price of private service in 2020 by 0.0015 VND, whereas the price of private service in 2019 would increase by 0.0072 VND.

The Effect of Energy Supply on Vietnam's Economy in 2019–2020

In this section, I present the impact of energy price changes on the economy, specifically the impact of energy prices on each household group consisting of four groups of households. In addition, the study analyzes the impact of limited energy supply on key business sectors of the Vietnamese economy by using the constrained fixed price multiplier method. The analysis of the impact of energy prices on the Vietnamese economy in 2019–2020 is presented in Tables 9 and 10. The accounting multipliers (AM) are divided into direct, transfer effects (TF), closed-loop effects (CLE), and open-loop effects (OLE).

The impact of energy prices on production activities and four household groups tends to decrease in the period 2019–2020. Namely, the cost of supplying coal by 1 VND will increase the price of machinery in the machine manufacturing industry in 2020 by only 0.0094 VND, whereas the price of this industry in 2019 increased by 0.0124 VND. I assume this reduction is due to the COVID-19 epidemic.

In a similar fashion, a 1-unit change in petroleum leads to an increase of 0.009 VND in 2020 and 0.0126 in 2019. In particular, the impact of petroleum on the price of the machinery industry has decreased significantly by 2020. The global impact of a 1% increase in oil prices results in the cost of petroleum production and a 17-fold increase in the price of the machinery sector in 2019 compared to an increase in 2020 (0009% in 2020; 0.162% in 2019). The impact of gasoline price changes also leads to a significant increase in agricultural products, food processing, textile, and construction 14, 15, and 16 times in 2019 compared to 2020. Likewise, the dramatic shifting effect between the cost of petroleum, agriculture, food processing, textiles, construction, machinery, private service, and public service reflects the high degree of integration across sectors in 2019. COVID-19 has significantly reduced the impact of energy on key economic sectors of the Vietnamese economy. At this rate, Vietnam's economy will continue its growth momentum due to the relatively limited effects of the energy sector on the economy during COVID-19.

In Table 10, the increase in electricity prices on production costs of other business sectors causes a higher impact than that of other energy sectors. Namely, an increase of 1,000 VND in the electronics sector leads to an increase of 65.7 VND in the private sector in 2020 compared with 62.5 VND in 2019. Even so, the cost of living for the household group also decreases in 2020 with an increase of 1 VND of electricity price. To be specific, an increase of 1 VND in electricity prices leads to an increase in the total cost of the household group from 0.036 to 0.069 VND. The impact of fluctuations in gasoline, coal, and crude

Table 8

Decomposition of Price Multiplier (electricity, crude oil)

Origin	Destination	2019				2020			
		Accounting Multiplier	Transfer Effects	Open-loop Effects	Closed-loop Effects	Accounting Multiplier	Transfer Effects	Open-loop Effects	Closed-loop Effects
Electricity	Agricultural	0.0409	0.0097	0.0005	0.0307	0.0406	0.0123	0.0016	0.0268
	Food processing	0.0499	0.0249	0.0003	0.0247	0.0491	0.0258	0.0009	0.0224
	Textile	0.0549	0.0394	0.0000	0.0155	0.0525	0.0361	0.0000	0.0164
	Construction	0.0541	0.0324	0.0000	0.0217	0.0537	0.0306	0.0000	0.0232
	Machinery	0.0383	0.0294	0.0000	0.0089	0.0360	0.0274	0.0000	0.0086
	Private service	0.0625	0.0306	0.0000	0.0318	0.0657	0.0327	0.0001	0.0329
	Public service	0.0612	0.0244	0.0000	0.0368	0.0638	0.0244	0.0000	0.0393
	Urban farm households	0.0519	0.0000	0.0343	0.0176	0.0592	0.0000	0.0411	0.0181
	Urban non-farm households	0.0592	0.0000	0.0413	0.0179	0.0690	0.0000	0.0509	0.0181
	Rural farm households	0.0480	0.0000	0.0310	0.0170	0.0542	0.0000	0.0362	0.0180
	Rural non-farm households	0.0502	0.0000	0.0341	0.0162	0.0649	0.0000	0.0467	0.0181
Crude oil	Agricultural	0.0051	0.0023	0.0000	0.0028	0.0010	0.0004	0.0000	0.0006
	Food processing	0.0048	0.0026	0.0000	0.0022	0.0011	0.0006	0.0000	0.0005
	Textile	0.0033	0.0020	0.0000	0.0013	0.0011	0.0007	0.0000	0.0004
	Construction	0.0063	0.0044	0.0000	0.0019	0.0017	0.0012	0.0000	0.0005
	Machinery	0.0026	0.0018	0.0000	0.0008	0.0007	0.0006	0.0000	0.0002
	Private service	0.0072	0.0044	0.0000	0.0028	0.0015	0.0008	0.0000	0.0007
	Public service	0.0052	0.0020	0.0000	0.0032	0.0014	0.0005	0.0000	0.0009
	Urban farm households	0.0047	0.0000	0.0032	0.0015	0.0013	0.0000	0.0009	0.0004
	Rural farm households	0.0044	0.0000	0.0029	0.0015	0.0012	0.0000	0.0008	0.0004
	Urban non-farm households	0.0050	0.0000	0.0034	0.0016	0.0015	0.0000	0.0011	0.0004
	Rural non-farm households	0.0044	0.0000	0.0030	0.0014	0.0014	0.0000	0.0010	0.0004

Table 9

Decomposition of Price Multiplier (Coal, Petroleum)

Origin	Destination	2019				2020			
		AM	TE	OLE	CLE	AM	TE	OLE	CLE
Coal	Agricultural	0.0244	0.0020	0.0005	0.0219	0.0071	0.0020	0.0003	0.0048
	Food processing	0.0222	0.0060	0.0003	0.0159	0.0100	0.0060	0.0002	0.0038
	Textile	0.0124	0.0045	0.0000	0.0078	0.0061	0.0036	0.0000	0.0025
	Construction	0.0282	0.0164	0.0000	0.0118	0.0202	0.0165	0.0000	0.0037
	Machinery	0.0124	0.0084	0.0000	0.0040	0.0094	0.0082	0.0000	0.0013
	Private service	0.0188	0.0039	0.0000	0.0149	0.0085	0.0035	0.0000	0.0049
	Public service	0.0196	0.0025	0.0000	0.0170	0.0081	0.0022	0.0000	0.0059
	Urban farm households	0.0273	0.0000	0.0178	0.0095	0.0091	0.0000	0.0062	0.0029
	Rural farm households	0.0163	0.0000	0.0069	0.0094	0.0081	0.0000	0.0052	0.0029
	Urban non-farm households	0.0402	0.0000	0.0308	0.0094	0.0105	0.0000	0.0076	0.0029
	Rural non-farm households	0.0209	0.0000	0.0121	0.0088	0.0090	0.0000	0.0060	0.0029
Petroleum	Agricultural	0.0364	0.0172	0.0003	0.0189	0.0026	0.0013	0.0001	0.0012
	Food processing	0.0334	0.0182	0.0002	0.0150	0.0022	0.0012	0.0000	0.0010
	Textile	0.0200	0.0108	0.0000	0.0092	0.0012	0.0005	0.0000	0.0007
	Construction	0.0414	0.0284	0.0000	0.0130	0.0026	0.0016	0.0000	0.0010
	Machinery	0.0162	0.0109	0.0000	0.0052	0.0009	0.0005	0.0000	0.0004
	Private service	0.0513	0.0325	0.0000	0.0187	0.0033	0.0019	0.0000	0.0014
	Public service	0.0349	0.0132	0.0000	0.0216	0.0024	0.0007	0.0000	0.0017
	H1	0.0322	0.0000	0.0217	0.0105	0.0026	0.0000	0.0018	0.0008
	H2	0.0335	0.0000	0.0228	0.0107	0.0028	0.0000	0.0020	0.0008
	H3	0.0299	0.0000	0.0198	0.0102	0.0025	0.0000	0.0017	0.0008
	H4	0.0299	0.0000	0.0203	0.0097	0.0028	0.0000	0.0020	0.0008

Note. H1 = Urban farm households, H2 = Urban non-farm households, H3 = Rural farm households, H4 = Rural non-farm households.

Table 10

Decomposition of Price Multiplier (electricity, crude oil)

Origin	Destination	2019				2020			
		AM	TE	OLE	CLE	AM	TE	OLE	CLE
Electricity	Agricultural	**0.0409**	0.0097	0.0005	0.0307	0.0406	0.0123	0.0016	0.0268
	Food processing	**0.0499**	0.0249	0.0003	0.0247	0.0491	0.0258	0.0009	0.0224
	Textile	**0.0549**	0.0394	0.0000	0.0155	0.0525	0.0361	0.0000	0.0164
	Construction	**0.0541**	0.0324	0.0000	0.0217	0.0537	0.0306	0.0000	0.0232
	Machinery	**0.0383**	0.0294	0.0000	0.0089	0.0360	0.0274	0.0000	0.0086
	Private service	0.0625	0.0306	0.0000	0.0318	**0.0657**	0.0327	0.0001	0.0329
	Public service	0.0612	0.0244	0.0000	0.0368	**0.0638**	0.0244	0.0000	0.0393
	H1	0.0519	0.0000	0.0343	0.0176	**0.0592**	0.0000	0.0411	0.0181
	H2	0.0592	0.0000	0.0413	0.0179	0.0690	0.0000	0.0509	0.0181
	H3	0.0480	0.0000	0.0310	0.0170	**0.0542**	0.0000	0.0362	0.0180
	H4	0.0502	0.0000	0.0341	0.0162	**0.0649**	0.0000	0.0467	0.0181
Crude oil	Agricultural	0.0051	0.0023	0.0000	0.0028	0.0010	0.0004	0.0000	0.0006
	Food processing	0.0048	0.0026	0.0000	0.0022	0.0011	0.0006	0.0000	0.0005
	Textile	0.0033	0.0020	0.0000	0.0013	0.0011	0.0007	0.0000	0.0004
	Construction	**0.0063**	0.0044	0.0000	0.0019	0.0017	0.0012	0.0000	0.0005
	Machinery	0.0026	0.0018	0.0000	0.0008	0.0007	0.0006	0.0000	0.0002
	Private service	**0.0072**	0.0044	0.0000	0.0028	0.0015	0.0008	0.0000	0.0007
	Public service	0.0052	0.0020	0.0000	0.0032	0.0014	0.0005	0.0000	0.0009
	H1	0.0047	0.0000	0.0032	0.0015	0.0013	0.0000	0.0009	0.0004
	H2	0.0044	0.0000	0.0029	0.0015	0.0012	0.0000	0.0008	0.0004
	H3	0.0050	0.0000	0.0034	0.0016	0.0015	0.0000	0.0011	0.0004
	H4	0.0044	0.0000	0.0030	0.0014	0.0014	0.0000	0.0010	0.0004

Note. H1 = Urban farm households, H2 = Urban non-farm households, H3 = Rural farm households, H4 = Rural non-farm households.

oil prices decreases the cost of living of households in 2020 compared with 2019. In addition, the cost of crude oil increased by 1 VND, causing food processing prices to rise by 0.0011 VND in 2020, whereas food processing prices in 2019 amplified by 0.0048 VND (0.0037 higher than in 2020). The increase of 1 VND in crude oil supply raises the private service price by 0.0015 VND in 2020, whereas the private service price in 2019 increases by 0.0072 VND.

The impact of energy supply on key business sectors in 2019 is presented in Table 11. Scenario 1 shows that the income of all households decreases with a 10% limit on energy supply. In particular, household incomes massively drop when limiting gasoline, electricity, and crude oil to 10%. Scenario 5 simulates a situation in which the government limits electricity, coal crude oil, and gasoline by 10%, consequently dropping the trade and repair service sectors by 4%–19% in 2019. However, in the same scenario in 2020, the commercial sector only decreases by 1.1%–5%. One of the main sectors of Vietnam's economy in 2019 that was less affected than other industries is the textile industry, with a decrease of 0.072% compared to 0.827% in 2020 when the energy supply is reduced by 10%. In contrast, the impact of a 10% reduction in energy supply for the transport sector in 2019 is 2,868%, much higher than the 1,678% in 2020. It is noteworthy that the tourism industry is heavily influenced by the limitation on the energy supplies in 2019 as well as coal and oil at the rate of 0.508 and 0.582 in corresponding to coal (scenario 3) and oil (scenario 1).

The results on the impact of restricted energy supply on the Vietnamese economy in 2020 are presented in Table 12. During this period, household income has changed less than in 2019. Namely, the decreasing household income was between 1,833% and 3,279% in 2020. Meanwhile, the decrease in household income in 2019 was from 2,283% to 3,807%. It is noteworthy that when we limit the supply of the coal industry by 10%, then electricity, crude oil, and petroleum are less negatively affected than the other energy sectors. In 2020, household income was less likely to change than in 2019. To be precise, the decrease in household income was from 1,833% to 3,279% in 2020. In the case of limiting the supply of the coal industry by 10%, electricity, crude oil, and petroleum are less negatively affected than the other energy industries. Notably, in scenario 5 when there is a 10% limit on energy supply for the travel industry, which is a key business sector of Vietnam's economy, the impact of this sector in 2020 is larger than in 2019, meaning the travel service industry was most affected by the COVID-19. When 10% of the energy supply is withdrawn, the travel industry in 2019 decreases by 240%, whereas it was reduced by 1,790% in 2020. As in 2019, the impact of energy supply is quite heavily influenced by the reduction in energy supply. As in 2019, the impact of energy supply is quite heavily influenced by the reduction in energy supply. The decline in the output of production activities has reduced the impact of the lacking of energy supplies. With the ongoing epidemic, the negative impact on the tourism industry is much greater than the other industries.

It is clear that in 2020, due to the COVID-19 situation, the Vietnamese government will increase public services so that when the supply of coal is restricted, the impact will be 0.104% stronger than in 2019 (2019 is -0.023%, whereas 2020 is -0.127%). According to the plan from the beginning of the year, the Vietnam coal and mineral industries holding corporation plans to increase revenue from coal mining. However, with the decline in energy supply for various reasons such as the environment and COVID-19, the impact on the mining industry in 2020 will be 2.9% higher than in 2019 (-3,211% in 2020 in comparison with -266 % in 2019). In contrast, because trade and repair services and transportation services are two less affected sectors in 2020 than in 2019, the consumption of goods in 2020 will be much reduced, so there is a little impact when reducing coal supply. Specifically, the trade-repair sector and transportation services sector in 2020 will only be affected by -1.405% and -353%, respectively, whereas in 2019, the impact of these two industries is quite large when reducing the coal supply to 10% of the impact level. The corresponding dynamic for the trade services and transportation service sectors is -4.066% and -0.6%. In addition, the construction sector in 2020 is also less affected than in 2019 at 0.22%.

Table 11

The Effect of Energy Supply on Key Business Sectors in 2019

Output	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
crops	-0.826%	-0.689%	-0.491%	-0.768%	-2.774%
livestock	-0.322%	-0.282%	-0.195%	-0.328%	-1.127%
fishery	-0.269%	-0.234%	-0.164%	-0.261%	-0.928%
forestry	-0.171%	-0.052%	-0.041%	-0.057%	-0.321%
construction	-0.084%	-0.462%	**-0.371%**	-0.508%	-1.925%
travel services	**-0.582%**	-0.035%	**-0.508%**	-0.045%	**-0.240%**
transportation services	-0.639%	-1.014%	**-0.604%**	-0.611%	**-2.868%**
trade and repair services	-5.776%	-4.691%	**-4.066%**	-4.910%	**-19.443%**
real estate business	-0.765%	-1.580%	-0.506%	-0.595%	-3.447%
mining	-0.392%	-0.308%	**-0.266%**	-0.339%	**-1.305%**
textiles	-0.012%	-0.007%	-0.001%	-0.052%	**-0.072%**
public services	-0.037%	-0.032%	**-0.023%**	-0.032%	**-0.124%**
machine	-0.418%	-0.111%	-0.088%	-0.295%	-0.912%
other manufacturing	-0.273%	-0.153%	-0.085%	-0.097%	-0.608%
household	-3.807%	-3.354%	-2.283%	-3.950%	-13.393%

Table 12

The Effect of Energy Supply on Key Business Sectors in 2020

Output	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
crops	-1.044%	-0.676%	-0.548%	-0.721%	-2.990%
livestock	-0.257%	-0.184%	-0.155%	-0.202%	-0.799%
fishery	-0.170%	-0.154%	-0.100%	-0.140%	-0.563%
forestry	-0.189%	-0.048%	-0.021%	-0.030%	-0.288%
construction	-0.239%	-0.194%	**-0.143%**	-0.201%	**-0.777%**
travels services	-0.579%	-0.403%	**-0.354%**	-0.453%	**-1.790%**
transportation services	-0.322%	-0.732%	**-0.353%**	-0.271%	**-1.678%**
trade and repair services	-1.750%	-1.151%	**-1.405%**	-1.529%	**-5.836%**
Real estate business	-0.678%	-1.429%	-0.388%	-0.523%	-3.017%
mining	-5.544%	-4.209%	**-3.211%**	-4.528%	-17.493%
textiles	-0.238%	-0.175%	-0.158%	-0.254%	**-0.827%**
public services	-0.226%	-0.190%	**-0.127%**	-0.191%	**-0.734%**
machine	-0.369%	-0.057%	-0.055%	-0.243%	-0.724%
other manufacturing	-0.428%	-0.295%	-0.151%	-0.249%	-1.123%
household	-3.279%	-2.933%	-1.833%	-3.493%	-11.537%

Discussion

This study shows that structure path analysis is very useful for analyzing price formation and cost transmission mechanisms for a multi-sector economy. By analyzing structural components separately, the study provides a wealth of knowledge and important information about the price transmission mechanisms, as well as their impact on Vietnamese policymakers. My research also analyzes in detail the direct and indirect effects of limiting energy supply on key business sectors, thereby providing data that is immediately available to policymakers. Furthermore, price variations can be specifically disaggregated to clarify economic interdependence and price pass-through among economic sectors. The results of my analysis can be summarized as follows:

The impact of energy prices on production activities and four household groups tends to decrease gradually in the period 2019–2020. Limiting the energy supplies has, essentially, a negative impact on key sectors of the Vietnamese economy such as agriculture, food processing, textiles, construction, private machinery, and services. However, the impact of energy supply on key business sectors of the economy in 2020 is not significant. This proves that this limitation does not have much effect on the economy under the pressure of the COVID-19 epidemic. Notably, with scenario 5 when there is a 10% limitation on energy supply for the travel and tourism industry, which is a key business sector of the Vietnamese economy, the impact of the travel and tourism industry in 2020 is larger than in 2019. It is no question that COVID-19 has strongly affected the travel industry. Regarding further suggestions, it would seem prudent for the Vietnamese government to strive towards continually understanding and gradually acquiring closer control of the national energy production system. For example, the government can explore energy resources and support further research in related fields. Furthermore, the government can assist Vietnamese enterprises to build and sustain the manufacturing sectors internally in an attempt to close the cycle, which would make it less volatile and more predictive. More specifically, the Vietnamese government could also build up the appropriate central governmental units to monitor international oil prices and make reasonable predictions of future oil prices. Such a strategy will greatly help to identify the optimal times to buy or sell oil to avert energy shocks that might seriously affect the Vietnamese economy. Finally, the Vietnamese government should not overly restrict the energy supply as this will hurt the economy and make the income of household groups suffer. It is recommended that the government limits any restrictions to energy supply and promotes energy efficiency.

By comparing the analysis results, it can be concluded that due to the complicated situation of COVID-19 in 2020, the Vietnamese government has begun to enhance public services. So that when the coal supply is limited, the impact is made stronger than in 2019. Although the decline in energy supplies will make the impact on the mining industry in 2020 higher than in 2019, the trade services, repair services, and transport service sectors are less affected. In case the energy supply (coal) is reduced by 10% due to the impact of the COVID-19 epidemic, the consumption in 2020 is much less likely to change negatively. In addition, the construction industry is also less affected than in 2019. Because of that, going through the energy supply restriction scenarios, especially the coal supply, in the event that the COVID-19 epidemic continues to become more and more complicated, it is reasonable for the government to limit the energy supply. This will have a positive impact on the environment as well as reduce negative impacts on the economy.

Declaration of ownership:

This report is my original work.

Conflict of interest:

None.

Ethical clearance:

This study was approved by my institution.

References

Akkemik, K. A. (2019). Potential impacts of electricity price changes on price formation in the economy: Asocial accounting matrix price modeling analysis for Turkey. *Energy Policy*, *39*(2), 854–864. https://doi.org/10.1016/j.enpol.2010.11.005

Chang, K. S & Kim, D.H (2020). Examining Supply Chain for Seafood Industries Using Structural Path Analysis. *sustainerbility*, *12*(5),1-20. https://doi.org/10.3390/su12052061

Ding, Z., He, L., Feng, C., & Li, W. (2016). The impact of coal price fluctuations on China's economic output. *Applied Economics*, *48*(24), 2225–2237. https://doi.org/10.1080/00036846.2015.1117047

Ding, Z., Meihua, Z., & Bo, N. (2011). Research on the influencing effect of coal price fluctuation on CPI of China. *Energy Procedia*, *5*, 1508–1513. https://doi.org/10.1016/j.egypro.2011.03.258

Do, T. M., & Sharma, D. (2011). Vietnam's energy sector: A review of current energy policies and strategies. *Energy Policy*, 39, 5770-5777. https://doi.org/10.1016/j.enpol.2011.08.010

Defourny, J., & Thorbecke, E. (1984). Structural Path Analysis and Multiplier Decomposition within a Social Accounting Matrix. *Economic Journal*, *94*, 111-136. https://doi.org/10.2307/2232220

Dorband, I. I., Jakob, M., & Steckel, J. C. (2020). Unraveling the political economy of coal: Insights from Vietnam. *Energy Policy*, *147*. https://doi.org/10.1016/j.enpol.2020.111860

IEA statistics.(2021).Data tables – Data & Statistics - IEA https://www.iea.org/data-and-statistics/data-products

Keuning, S., & Thorbecke, E. (1989). The Impact of Budget Retrenchment on Income Distribution in Indonesia: A Social Acounting Matrix Application, Technical Paper No. 3, OECD Development Center, Paris.

Lewis, B., Thorbecke, E., (1992). District-level economic linkages in Kenya: Evidence based on a small regional social accounting matrix. *World Development*, 20, 881–897. https://doi.org/10.1016/0305-750X(92)90058-4

Norouzi, N., Zarazua, R. G., Choupanpiesheh, S., & Enevoldsen, P. (2020). When pandemics impact economies and climate change: Exploring the impacts of COVID-19 on oil and electricity demand in China. *Energy research & social science*, *68*, 101654. https://doi.org/10.1016/j.erss.2020.101654

Nong, D. (2018). General equilibrium economy-wide impacts of the increased energy taxes in Vietnam. *Energy Policy, 123*, 471–481. https://doi.org/10.1016/j.enpol.2018.09.023

Nong, D., Nguyen, T. H., Wang, C., & Khuc, Q. V. (2020). The environmental and economic impact of the emissions trading scheme (ETS) in Vietnam. *Energy Policy*, *140*. https://doi.org/10.1016/j.enpol.2020.111362

Nong, D., Siriwardana, M., Perera, S., & Nguyen, D. B. (2019). Growth of low emission-intensive energy production and energy impacts in Vietnam under the new regulation. *Journal of leaner Production, 225*, 90–103. https://doi.org/10.1016/j.jclepro.2019.03.299

Nguyen, K. Q. (2008). Impacts of a rise in electricity tariff on prices of other products in Vietnam. *Energy Policy*, *36*, 3145–5777. https://doi.org/10.1016/j.enpol.2008.04.013

Peterson, K. O and Thankom, A (2020). Spillover of COVID-19: Impact on the Global Economy. *SSRN Journal.* 10.2139/ssrn.3562570

Parra, J. C., & Wodon, Q. (2009a). *Comparing the impact of food and energy price shocks on consumers: A social accounting matrix analysis for Ghana*. Washington D. C.

Parra, J.C., & Wodon, Q. (2009b). *SimSIP SAM: A Tool for the Analysis of Input-Output Tables and Social Accounting Matrices*;The World Bank: Washington, DC, USAParikh, A., & Thorbecke, E. (1996). Impact of rural industrialization on village and economy: a SAM approach. *Economic Development and Cultural Change, 44,* 351-377. https://doi.org/10.1177/0973005213499222

Nguyen, T.P. (2012). Challenges of energy security to the industrialization and sustainable development in Vietnam. *Scientific Research*, *3*(3), 174–180. http://dx.doi.org/10.4236/ti.2012.33024

Pyatt, G. & Round, J. I. (1979), Accounting and Fixed Price Multipliers in a Social Accounting Matrix Framework, *The Economic Journal*, Vol. 94 (March 1979)

Rioux, B., Galkin, P., Murphy, F., Feijoo, F., Pierru, A., Malov, A., Li, Y., & Wu, K. (2019). The economic impact of price controls on China's natural gas supply chain. *Energy Economics*, *80*, 394–410. https://doi.org/10.1016/j.eneco.2018.12.026

Resosudarmo, B. P & Thorbeckke, E. (1995). The impact of environmental policies on household incomes for different socio-economic classes: The case of air pollutants in Indonesia. *Ecological Economics*, 17, 83-94. https://doi.org/10.1016/0921-8009(95)00113-1

Roland-Holst, D. W., & Sancho, F. (1995). Modeling price in sam structure. *The Reciew of Economics and Statistics*, 77, 361-371. https://doi.org/10.2307/2109871

Seymore, R., Adams, P. D., Mabugu, M., Heerden van, J. H., & Blignaut, J. (2009). The impact of environmental tax on electricity generation in South Africa. *Economic Research Southern Africa, 34*(2), 1–18. https://doi.org/10.1080/10800379.2010.12097204

Sovacool, B. K., Del Rio, D. F., & Griffiths, S. (2020). Contextualizing the COVID-19 pandemic for a carbon-constrained world: Insights for sustainability transitions, energy justice, and research methodology. *Energy Research & Social Science, 68*. https://doi.org/10.1016/j.erss.2020.101701

Vietnam Government Portal, (2021). the socialist republic of Vietnam online newspaper of the government. http://baochinhphu.vn/Doanh-nghiep/Nganh-than-bao-lai-gan-3000-ty-dong-trong-nam-2020/420275.vgp (in Vietnamese)

Waugh, F. V. (1950). Discussion: Reducing price variability confronting primary producers. *American Journal of Agricultural Economics*, *32*(2), 193–196. https://doi.org/10.2307/1233101

Wang, X., Liu, C., Chen, S., Chen, L., Li, K., & Liu, N. (2020). Impact of coal sector's de-capacity policy on coal price. *Applied Energy*, *265*. https://doi.org/10.1016/j.apenergy.2020.114802

Zhao, H. R., & You, P. P. (2008). The impact of electricity price adjustment on national economy based on SAM multiplier analysis. In *Proceedings of the 2008 International Conference on Risk Management & Engineering Management*, *36*, 1404–1419. doi: 10.1109/ICRMEM.2008.56