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Article

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GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE

Assessing the COVID-19 impacts on the coffee industry in Laos: An input-output modelling approach

Somvang Phimmavong^{1,2*}, Rodney J Keenan³, Viengvilay Phimmavong⁴, Jerry Maroulis⁵ and Tek Maraseni^{6,7}

Abstract: This paper employs an input-output modelling approach to quantify the impact of decreases in coffee exports between 2019 and 2020 resulting from the implementation of various COVID-19 policies in Lao PDR. The analysis was undertaken at two levels in investigating the effects of these policies on (1) the regional economy in the main coffee producing region of Champasak Province in Southern Laos, and (2) the national economy of Lao PDR. Results were rather mixed at both the regional and national levels, for four reasons: (1) reduced production in other countries increased demand for green bean exports, resulting in a 1.8% (US\$12 million) increase in the total value of gross outputs of the provincial economy; (2) reduced local demand and declines in processed coffee consumption and export in the food industry sector, resulted in a 1.5% decrease (US\$10 million) in gross provincial production; (3) at the national level, more green bean exports increased the gross production output of the economy by 0.2% (US\$24 million) while reduced processed coffee in food industry exports led to a reduction in gross production of 0.13% (US\$19.6 million); and (4) the overall effects of COVID-19 restrictions are potentially positive for the coffee sector in Lao PDR in the short term but may have longer-term implications for the coffee sector due to shift away from processed coffee exports to green beans. Future policies to mitigate the impact of COVID-19 will be instrumental in stimulating investment and enhancing the benefits for the coffee sector in Laos.

Subjects: Agricultural Economics; Asian Economics; South East Asian Economics

Keywords: coffee; crop sector; food sector; COVID-19; input-output analysis; Laos

1. Introduction

The global outbreak of the novel coronavirus (COVID-19) pandemic since January 2020 resulted in many countries deploying a variety of COVID-19 mitigation measures including home confinement, travel restriction, business closure, trade restriction, and border closures (Gentle et al., 2020; Laudari et al., 2021; Maraseni et al., 2022). These measures resulted in serious negative impacts on societies and economies around the world (Dixon et al., 2021; World Bank, 2021). Globally, the economic impact of the COVID-19 outbreak on national economies resulted in policies designed to target recovery whilst ensuring the long-term sustainability of economies (Malliet et al., 2020).

Lao PDR is a small, open economy in Southeast Asia with a heavy economic dependence on agriculture, forests, and tourism (Maraseni et al., 2018; Phimmavong et al., 2019). An analysis of the likely impact of the COVID-19 pandemic in Laos indicated that the outbreak would have a detrimental economic impact on the Laos economy. For example, the World Bank (2021) reported that the Laos GDP was projected to shrink to -0.6% in 2020, potentially resulting in the worst economic depression since the Asian financial crisis in 1998. The public debt of Laos in 2020 was projected to grow from 65% to 68% of GDP but since 2019, it increased markedly to 88% in 2021 (World Bank, 2022) due to the sudden decrease in national revenue collection caused by the COVID-19 pandemic and its impact on commodity exports. Lockdown policies had major impacts on the Lao PDR economy through border closures and restrictions on product movement within the country, particularly during the lockdown period, which were compounded by a 2% increase in inflation (~10% to April 2022).

Coffee production has grown rapidly in Lao PDR, and the coffee sector makes a significant contribution to regional and national economy with potential flow-on benefits to the economy. The International Trade Centre (ITC, 2020b) carried out a rapid assessment of the impact of COVID-19 on private entrepreneurs in the coffee sector in Laos. ITC identified decreasing sales, temporary lockdown resulting in restrictions on cross-border movement, and sourcing production factors. Analysis of the impacts of COVID-19 on the world coffee sector early in the outbreak in April 2020 based on annual GDP growth rates and growth in coffee consumption of 20 countries (ICO, 2020), indicated that a 1% decrease in GDP growth is likely to reduce the growth of global demand for coffee by 0.95% or 1.6 million 60-kg bags. For coffee exporting countries, the impact of COVID-19 resulted in coffee producing countries experiencing reduced employment, income, trade, and domestic consumption, whilst social distancing and lockdown measures have caused instant disruption to the downstream coffee value chains (ICO, 2020). Since then, policy responses have been implemented to enhance economic recovery. These include, for example, monetary and fiscal measures to address liquidity constraints in Rwanda, the promotion of an agricultural code of practice and e-commerce in coffee production trading in Vietnam. Since the most severe impacts of the pandemic have receded, the global coffee sector has recovered and enjoys an increase in production and consumption (ICO, 2021). Consequently, the impact of COVID-19 responses on the coffee producers was varied, with impacts evident on supply capacity, trade, and local and international consumption.

Previous economic analysis of the coffee sector in Laos has focused on investment analysis, and simple estimation of production, consumption, and trade (Phimmavong et al., 2023). There has been little examination of the interaction of the coffee sector with the rest of the domestic economy. This paper employed an input-output modelling approach to assess the economic impact of restrictions associated with the COVID-19 pandemic on the regional and national economies, primarily trade restrictions on coffee exports. Analysis included the impact on coffee exports and consumption in 2020–21 due to various COVID-19 mitigation measures. Input-output models provide a useful framework for an analysis of the inter-relationships between sectors and within the Laos economy.

The study was carried out in Champasak Province, specifically the Bolaven Plateau (located between longitude 105°00'E–107°00'E and latitude 14°00'–16°00' N in four provinces of Laos, namely, Champasak, Saravan, Xekong, and Attapeu Province), the main region for coffee plantations in Laos, comprising about 55% of the total coffee production area (Figure 1). In 2021, Champasak Province produced >60% of total Lao coffee bean production.

2. Coffee production and consumption in Laos

2.1. Development of coffee production in Laos

Coffee has been grown in Laos for almost a century. Coffee plantations were introduced by French colonialists through the *Commerciale du Laos*, founded in (Gunn, 1990 cited in Stuart-Fox, 1995).

Figure 1. Map showing Laos and Southeast Asia. The coffee-producing areas in Laos is in southern Laos especially in Champasak Province source: Toro (2012).



Most coffee plantations during the French colonisation (1887–1945) were planted at a small scale, primarily for trials. In 1935, only 30,000 tonnes of coffee were exported to Vietnam. The coffee production area remained at <7,000 ha between the mid-1960s and the early 1980s during the Indochina war (Figure 2).

Since 1985, coffee development has been strongly shaped by a shift in Laos' economic reform from a centrally planned to a more market-oriented economy, officially called the “New Economic Mechanism” (NEM) (Bourdet, 1994; World Bank, 2007). With the introduction of the NEM, the government structure of Laos reformed trade policy, and this resulted in increasing coffee production and trade with neighbouring countries. The area of coffee plantations harvested steadily increased from 3500 ha in 1975 to 17,066 ha by 1990, and then to 30,000 ha by the early 2000s. In 2014, the area had increased dramatically to >70,000 ha with most coffee plantations owned by smallholders in Southern Laos (Figure 2). In 2019, the area of coffee was nearly 170,000 ha across the country, with 93,000 ha on the Bolaven Plateau, 60% of which is Robusta coffee (*Coffea canephora*), with the remainder being high-yielding Catimor dwarf-variety, Typica and Arabica Java Specialty Arabica coffee (*Coffea arabica*) (ITC, 2020a).

In this expansion, Laos has developed a successful coffee plantation model with high green coffee yield of, on average, 1.7 tonne per ha.¹ Green coffee bean exports increased from only 90

Figure 2. Coffee plantation development in Laos during 1960–2019.

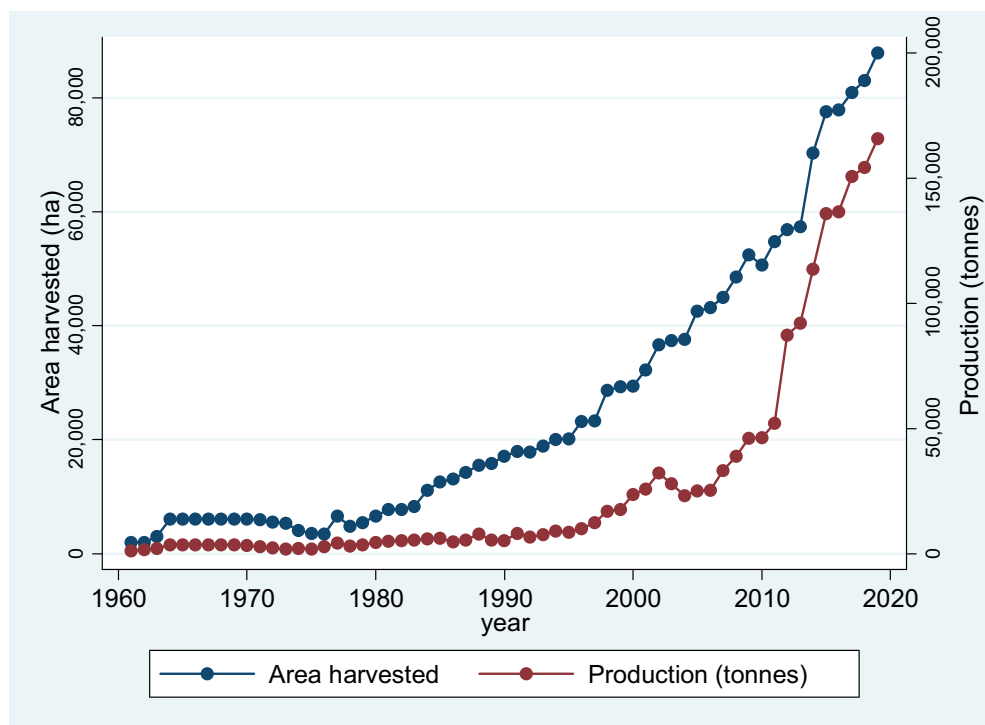
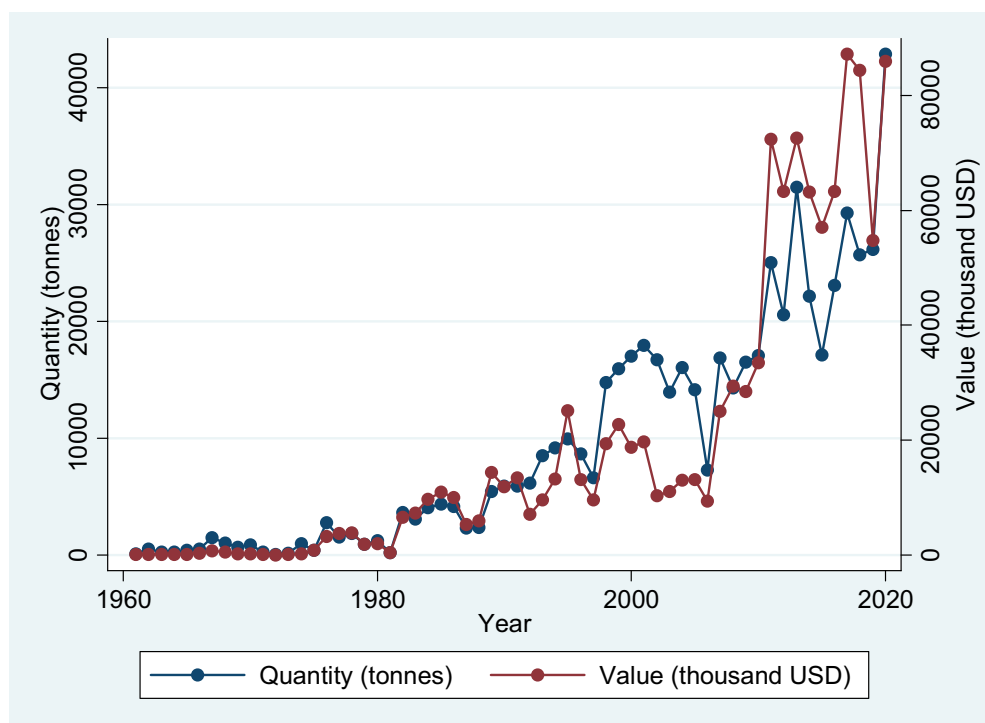


Figure 3. Green coffee export quantity and value in Laos during 1960–2020.



tonnes in 1961 to 42,856 tonnes in 2020 (Figure 3). Coffee now ranks as the third most important agricultural export by value from Lao PDR (UNCTAD, 2020)

Figure 3. Coffee production and export over time from Lao PDR. Data from FAO STAT (FAO, 2021) and the Ministry of Industry and Commerce (MoIC, 2021)

Table 1. Laos' top five coffee importing countries between 2019 and 2020

Green coffee value (US\$)			
	Countries	2019	2020
1	Vietnam	34,702,998	55,486,699
2	Thailand	10,023,990	6,860,126
3	Belgium	5,236,060	5,803,638
4	Cambodia	3,393,000	5,575,100
5	Japan	4,839,356	2,885,371
Processed coffee value (US\$)			
1	Thailand	3,922,066	3,882,217
2	China	527,389	349,611
3	Arab Emirates	223,800	305,700
4	Philippines	195,600	98,400
5	Vietnam	63,820	114,010

Consequently, since 2013, Laos has become a significant exporter of coffee to 60 countries of both green beans and processed coffee. Vietnam is currently the main market for green coffee beans, with this trade increasing in value from US\$35 million in 2019 to US\$55 million in 2020. Other markets include Thailand, Belgium, Cambodia, and Japan. Thailand, China, UAE, the Philippines, and Vietnam are the top five importers of Laos processed coffee (Table 1).

Coffee production in Laos is concentrated on the Bolaven Plateau, with Champasak, Sekong, Salavan, and Attapeu Provinces (Figure 1) combined representing 94% of the total area and 93% of the total production in 2019 (Lao Statistics Bureau, 2021). Since 2000, the area under coffee in the northern region (Luang Prabang, Oudomxay, Phongsaly, and Houaphan provinces) has increased more than 36-fold (Lao Statistics Bureau, 2021).

In general, the price of Laos agricultural products has displayed only minor fluctuations. For instance, cherries at the farm gate fluctuated between LAK1,500–3,300 (US\$0.16–0.34)² per kg depending on market demand over the past decade.³ Harvested cherries were transported to processing facility, yet the price of cherries stayed between LAK1,700–1,800 (US\$0.18–0.19) per kg during the first and third rounds of picking and increased to approximately LAK2,750 (US\$0.29) per kg at the peak season during 2018–2019; currently sold to traders between LAK3,100–3,300 (US\$0.32–0.35) per kg. By way of comparison, the price of parchment beans of Arabica bought by cooperatives varied between LAK28,000–30,000 (US\$3.28–3.51) per kg for organic coffee and LAK13,000–29,000 (US\$1.38–3.07) for non-organic coffee (UNCTAD, 2020).

2.2. Overview of Laos domestic coffee consumption

The growth of the coffee sector in Laos over the last couple of decades has resulted in increase in domestic coffee consumption. Domestic coffee consumption is relatively small compared to international exports, as many of the coffee-producing companies mainly produce for export. Coffee consumption in Laos has fluctuated between 8,400 tonnes in 2006 and 9,420 tonnes in 2020 (ICO, 2023).

Galindo et al. (2007) conducted a survey on the typology of 170 coffee consumers in Vientiane Capital and Pake Capital of Champasak Province. The study found there are three main types of coffee produced by roasters: instant coffee, European style, and local/traditional style.

Laos's coffee consumption per capita is small comparing with the top coffee-consuming countries (such as Finland with the national average of 12 kg/person), with a yearly consumption per

capita of around 1.29 kg in 2020. In total, the Lao domestic market consumes around 9,420 tonnes of green coffee per year, about 25% of the total coffee production (ICO, 2023).

Prior to 2010, the majority of the Lao population preferred to purchase traditional style coffee mainly from the local market, which is either ground coffee in transparent cellophane packaging, or directly in beverages with sweetened condensed milk; but since 2017, the number of coffee shops has increased in several cities of Laos due to an increasing number of foreign visitors and residents, as well as local Lao residents where coffee shops have become socio-cultural centres. Several well-known coffee shops in Laos have been established, namely, Sinouk Coffee, Cafe Amazon business, Joma Bakery Café, Saffron Coffee and, more recently, Starbucks Coffee Company that serves both coffee and bakery products.

3. Methods

3.1. Input-output modelling approach

Input-output analysis has played an important role for applied work in policy simulation, prediction, and the analysis of the structure of an economy (Richardson, 1972), and has been a feature in the economics literature since Wassily Leontief developed the first input-output model for the United States economy (Leontief, 1936). Many empirical academic studies using this system have been reported (Bhattarai, 2007; Hara, 2008; Isard, 1951; Jensen & West, 1986; Jensen et al., 1979; Richardson, 1972; Santos, 2020; Sim et al., 2007; Thomassin & Baker, 1985; West et al., 1982; Zhai et al., 2018).

The central aspect of input-output analysis is the input-output transaction table (Table 2), which provides inter-industry linkages between different aggregated industries or sectors within an economy. While each row of the table shows the flow of sales by each industry to each other industry, to final demand (household, government expenditure, export, other final demand), and itself, each column gives the flow of input by each industry to each other industry, to primary inputs (i.e., imports, wages, and other value added).

Based on the input-output convention, the table is basically divided into four main quadrants. Quadrant I is called the “intermediate” quadrant, which illustrates flows of goods and services sold and purchased by intermediate sectors.

Quadrant II or the “final demand” quadrant displays flows of goods and services exchanged by intermediate sectors and final demand. Final demand represents personal consumption (households), capital formation, government expenditure, and export.

Quadrant III or the “primary” quadrant records values of inputs and outputs exchanged by intermediate sectors and primary inputs. The primary inputs consist of payments to households as wages, other value added (OVA), and imports. Value-added input denotes labour cost, tax, and depreciation cost. Also, valued added is the contribution of an enterprise to the gross national product.

Quadrant IV or the “transfer” quadrant lists any primary inputs absorbed by the final demand.

All equations used in an input-output modelling approach, including the details of data sources, model specification and analysis, have been extensively explained in Phouththavong et al. (2020) and will not be elaborated here. The standard Leontief equation is written as follows:

$$X = (I - A^d)^{-1} \cdot Y^d \quad (1)$$

where X denotes the vector of the production level, I is an identity matrix, A^d is the “direct input-output matrix”, Y^d is the vector of external demand, and $(I - A^d)^{-1}$ is the Leontief inverse matrix.

Table 2. The input-output transaction table															
	Industry 1	Industry ... j ...	Industry n	Households	Government expenditure	Exports	Other final demand	Total gross output							
Industry 1	Quadrant I Z_{ij}	Quadrant III	Quadrant IV	X_j	Y_i	X_i									
Industry ... i ...															
Industry n															
Import															
Labour															
Other value added															
Total gross input	X_j														

The central aspect of input-output analysis is the input-output transaction table which provides inter-industry linkages between different aggregated industries or sectors within an economy. A policy change in one sector will not only affect its sector but also affect other sectors of the economy. By using the well-known Leontief inverse matrix, this model can be used to assess the impact of specified policy change on final demand and exports. Furthermore, by manipulating the input-output table, this model can be employed to solve the different types of multiplier effects and backward and forward linkages of the economic sectors.

Equation (1) is the so-called Leontief Inverse (Leontief, 1936), which is a solution to the problem of calculating the total effect of specified changes in final demand and exports. Furthermore, by manipulating the input-output table, one can solve for the different types of multiplier effects. This formula is valid under certain assumptions (Richardson, 1972) such as:

- (1) *No joint products exist, since each commodity is supplied by a single industry and via one method of production;*
- (2) *The linear input functions assumption means constant returns to scale and no substitution between inputs;*
- (3) *Additivity exists, i.e. the total effect of production is the sum of the separate effects, which rules out external economies and diseconomies;*
- (4) *The system is in equilibrium at given prices; and*
- (5) *In static versions of the input-output model, no capacity constraints exist so that the supply of each good is perfectly elastic, thereby ignoring problems of the capital.*

3.2. Regional input-output model for Champasak Province

As indicated, Champasak Province (Figure 1), is the region for analysis in this paper. While more localised impacts may provide further insights, such disaggregated data are not available.

The data for the analysis is based on an input-output table developed by the Asian Development Bank in 2006 (Asra et al., 2006). This shows transactions between different sectors in Lao Kip, with initial values beginning in 2002–2003 for 20 sectors of the Champasak economy: three agricultural sectors (Crop; Livestock, poultry, and fishery; Forestry and logging), 10 industrial sectors, and 7 service sectors. The most recent national input-output table was developed by the Asian Development Bank in 2017 and was used in the analysis (ADB, 2017).

Input-output tables reveal that the Lao PDR economy has distinct backward and forward linkages⁴ and indices on power of dispersion and sensitivity for dispersion (Table 3). For example, in terms of dependency, the construction sector is highly dependent on the output of the whole economy, but the crop and food sectors have relatively low dependency ratios, indicating a relatively low demand for intermediate inputs to these sectors.

Forward linkages indicate the relationship of a certain sector to those to which it sells its output. For example, wood, paper, and related product sectors have the highest forward linkage values, indicating a high reliance of the total system compared with relatively low value (Hoang et al., 2019; Maraseni et al., 2017), i.e., crop sector and food sector indicating a relatively low supply for intermediate inputs to the entire production system. It is noticeable that the coffee-related sectors (crop and food sectors) depend slightly on many other sectors of the economy, thus any changes in these sectors will affect other sectors but only marginally.

The direct and indirect effects of the pandemic caused a shock to the Laos economy from changes to exports, domestic consumption, and processing. The COVID-19 policy scenario explored in this analysis was the impact on coffee exports on the crop sector and processed coffee consumption and export in the food sector. Trade data⁵ reveal that the value of green bean exports increased between 2019 and 2020 by US\$10.3 million (21%) (regionally) and US

Table 3. National backward and forward linkages of the Lao economy 2017

	Backward linkage	Power of dispersion	Forward linkage	Sensitivity for dispersion	Value-added multipliers
Crop	1.142	0.816	1.425	1.018	0.766
Mining and quarrying	1.136	0.812	1.287	0.920	0.732
Food, beverages, and tobacco (Food)	1.148	0.820	1.189	0.850	0.796
Textiles, garments, and leather products	1.405	1.004	1.190	0.850	0.610
Wood, pulp, paper, and paper products of wood and cork	1.117	0.798	4.227	3.021	0.057
Chemical, rubber, plastic, petroleum products	1.461	1.044	1.560	1.115	0.225
Other non-metallic minerals	1.454	1.039	1.154	0.825	0.222
Metal products, machinery, equipment & spare parts	1.259	0.900	1.429	1.021	0.694
Other manufacturing	1.812	1.295	1.203	0.860	0.313
Electricity, gas, and water supply	1.434	1.025	1.131	0.808	0.670
Construction	1.665	1.190	1.409	1.007	0.374
Motor vehicles and motorcycles	1.762	1.259	1.104	0.789	0.373
Trade	1.303	0.931	1.262	0.902	0.570
Hotels and restaurants	1.624	1.160	1.661	1.187	0.507

(Continued)

Table 3. (Continued)

	Backward linkage	Power of dispersion	Forward linkage	Sensitivity for dispersion	Value-added multipliers
Transportation	1.148	0.820	1.265	0.904	0.900
Post and telecommunications	1.410	1.007	1.264	0.904	0.716
Financial intermediation	1.457	1.041	1.058	0.756	0.662
Real estate & ownership of dwellings	1.457	1.041	1.010	0.722	0.662
Public administration	1.457	1.041	1.000	0.715	0.662
Other services	1.338	0.956	1.158	0.827	0.730

\$21.6 million (34%) (nationally), while processed coffee consumption and export reduced by US \$5.3 million (44%) (nationally) and US\$0.2 million (4%) (regionally).

4. Results

4.1. Regional level economic modelling: the impact of export restriction on the crop and food sector

COVID-19 measures in Laos and globally resulted in increased demand for green beans for export and less demand for processed coffee. At the provincial level, the increase in green bean export value in the crop sector was projected to have a small impact on the gross value of production of the Champasak economy (Table 4). Reduced production elsewhere and increased export demand for green beans in the crop sector led to a considerable increase in the value of the crop sector and sectors related to the crop sectors. Input-output linkages indicate output growth in the crop sector generates small increases in gross output from the livestock sector, forestry, and food sectors, by about US\$46,000, US\$23,000, and US\$14,000, respectively.

The sectors selling goods to the crop sector and those purchasing green beans receive the most benefit from the demand shifts associated with COVID-19 effects. The analysis shows that the sector benefiting the most from the shift in trade due to the COVID-19 induced policy changes is the “other services” sector, with an increase in production level of about US\$698,000 above the baseline, followed by wholesale and retail trade (US\$282,000), other manufactured goods sector (US\$33,000), banking, insurance, business services sector (US\$31,000), and electricity and water supply sector (US\$31,000) (Table 4). Overall, the gross production for all sectors grew by 1.8% or US \$12.1 million because exports from the crop sector grew by almost 22%, to become the largest sector in the provincial gross output. On the other hand, the food sector experienced a negligible increase in total value.

There were some changes in the value of other modelled sectors. Increases in the crop sector, being an export earner, aid both regional and national trade balances significantly. Furthermore, linkages and impacts on other sectors are relatively small for transportation (US\$1,200), food, beverage and tobacco (US\$14,000), and construction sector (US\$11,000), due to the weak relationships with and between the crop sector and these sectors (Table 4).

Overall, the aggregate value of gross production in this region suffered a loss of US\$10 million. The COVID-19 policy tended to have a small negative impact on the Champasak economy as GDP was projected to drop slightly by 1.5%, compared to the baseline scenario, with an economic loss of US\$5.3 million for the regional economy.

By contrast, reduced processed coffee production and export in food industry decreases output in this sector. These impacts will be felt more at the national level in the sectors with greater linkages to local coffee processors in the food sector. Analysis indicated that COVID-19 effects reduced national levels of production in the food industry sector by about 2.9% (US\$6 million) below the business as usual (BaU) scenario. Impacts were also felt in the livestock sector (about US \$3 million), crop sector (US\$704,000), wholesale and retail trade (US\$395,000), and other services (US\$90,000).

4.2. Impact of COVID-19-induced policies on the Laos economy

National-level analysis (Table 5) indicates that the increase in green bean exports, stimulated by the impacts of COVID-19 policies, initially affected the crop sector and crop-related sectors but changes in the gross output for all economic sectors were much smaller compared to regional levels largely because most provinces were not significant coffee producers and were relatively unaffected by the policy change. For example, the majority of green beans are produced in Champasak province, and most of these are exported (Table 5)—currently, export of green beans to Vietnam and Thailand account for 90% of the total coffee production in Laos. For this

Table 4. Impact on the GDP and quantities of production in all economic sectors in Champasak Province, Laos (change over baseline)

Economic sector	Crop sector		Food industry sector	
	US\$ Thousand	Percentage change	US\$ Thousand	Percentage change
Crops	10,915.1	21.8	-704.2	-1.4
Livestock	45.6	0.0	-2,914.9	-2.4
Forestry	23.4	0.3	-7.2	-0.1
Mining and quarrying	0.2	0.0	-0.1	0.0
Food	14.1	0.0	-5,847.9	-2.9
Textiles, garments, and leather products	9.6	0.2	-23.3	-0.4
Wood and paper products; printing/publishing	23.9	0.2	-7.8	-0.1
Chemical products; petroleum	3.3	3.3	-0.5	-0.5
Non-metallic mineral products	2.6	0.4	-0.5	-0.1
Metal prods, machinery, equipment, spare parts	22.7	0.3	-10.9	-0.1
Other manufactured goods	32.6	0.7	-8.4	-0.2
Electricity and water supply	30.7	0.6	-26.0	-0.5
Construction	11.0	0.0	-26.8	0.0
Transportation	1.2	0.2	-2.4	-0.3
Post and telecommunication	0.6	0.1	-0.4	-0.1
Wholesale and retail trade	282.3	0.5	-395.0	-0.7
Banking, insurance, business services	30.9	0.5	-80.9	-1.3
Real estate and ownership of dwellings	0.6	0.0	-0.2	0.0
Public administration	0.0	0.0	0.0	0.0
Other services	698.4	1.2	-89.8	-0.2
Gross Production	12,148.7	1.8	-10,147.2	-1.5
GDP	6,286.0	1.8	-5,250.3	-1.5

reason, the direct impact of coffee supply on the Lao PDR economy is generally low, but would increase if the coffee beans were processed in Laos, which cannot be included in this analysis due to data limitation.

Results reveal that the effect of COVID-19 measures increased gross outputs for all sectors by 0.2%, or US\$24 million (Table 5). Much of this is due to direct effects in the agriculture and

Table 5. Impact on the GDP and quantities of production in all sectors in Laos (change over baseline)

Economic sector	Agriculture sector		Food industry sector	
	US\$ Thousand	Percentage change	US\$ Thousand	Percentage change
Agriculture	22,817	1.0	-5,091	-0.23
Mining and quarrying	7	0.0	-28	0.00
Food, beverages, and tobacco	324	0.0	-12,275	-0.94
Textiles, garments, and leather products	42	0.0	-13	0.00
Wood, pulp, paper, and paper products of wood and cork	26	0.0	-88	-0.03
Chemical, rubber, plastic, petroleum products	120	0.1	-83	-0.05
Other nonmetallic minerals	3	0.0	-11	-0.01
Metal products, machinery, equipment & spare parts	6	0.0	-23	-0.02
Other manufacturing	8	0.0	-14	-0.01
Electricity, gas, and water supply	61	0.0	-197	-0.02
Construction	16	0.0	-19	0.00
Motor vehicles and motorcycles	58	0.0	-180	-0.07
Trade	340	0.0	-1,063	-0.07
Hotels and restaurants	8	0.0	-9	0.00
Transportation	64	0.0	-227	-0.06
Post and telecommunications	15	0.0	-21	-0.01

(Continued)

Table 5. (Continued)				
Economic sector	Agriculture sector		Food industry sector	
	US\$ Thousand	Percentage change	US\$ Thousand	Percentage change
Financial intermediation	47	0.0	-90	-0.03
Real estate & ownership of dwellings	60	0.0	-167	-0.02
Public administration	0	0.0	0	0.00
Other services	0	0.0	-1	0.00
Gross Production	24,023	0.2	-19,601	-0.13
GDP	14,818	0.2	-12,090	-0.13

agriculture-related sectors. Clearly, the sectors buying more goods from the agriculture sector gain the most from the COVID-19 policy change. Besides this sector the greatest beneficiary is the trade sector, with an increase in production of about US\$340,000, followed by the food, beverages, and tobacco sector (US\$324,000), chemical, rubber, plastic, petroleum products (US\$120,000), and transportation sector (US\$64,000). GDP increased slightly by 0.2% to US\$15 million, compared to the baseline scenario (Table 5). By contrast, the reduced processed coffee consumption and export in the food industry sector decreases production of both the food and food-related sectors.

The sectors with stronger linkages to the food sector were reduced the most from the COVID-19 policy change. Production in the food industry sector is about US\$12 million below the BaU scenario, followed by the agriculture (US\$5 million), trade (US\$1 million), and transportation (US\$227,000) sectors.

Overall, the aggregate gross value of production in Lao PDR will decline by US\$20 million, which is a relatively minor negative impact on the national economy. GDP is projected to drop slightly by US\$12 million compared to the baseline scenario (Table 5).

5. Discussion

This paper describes the impact of the COVID-19 induced policies on the coffee sector between 2019 and 2020 on the regional and national economy of Laos using an input-output modelling approach. Health and biosecurity measures introduced in response to COVID-19 resulted in the worst economic downturn in Laos since the Asian financial crisis in 1998 (World Bank, 2021). Analysis of the impacts on the coffee sector provides insights into how COVID-19 policy responses differentially impacted upon certain agricultural sectors. Results from the study indicate that there are positive and negative outcomes from the change in global and local coffee markets in Laos because of coffee export restrictions due to the pandemic. On the one hand, reduced production elsewhere has increased demand for green bean exports, leading to a small but positive impact on the Laos economy, mostly in coffee production, with limited impact on other sectors. However, the dramatic decrease in processed coffee exports led to a small negative impact on the provincial and national economy with most other sectors being slightly affected, while the food sector was the hardest hit. The economic impact of coffee export restrictions was more significant at the regional than at the national level.

The modelling indicated that the crop sector experienced a positive change with an increase of over US\$6 million to the Champasak economy (Table 4) and US\$14.8 million to the national economy (Table 5) due to increased export of green beans. Impacts on other sectors were relatively small. For instance, the increase in the value of food sector production in Champasak Province was only about US\$14 million (Table 4). The sector benefiting the largest from the COVID-19 policy is the wholesale and retail trade sector, with an increase of about US\$282 million.

The increase in employment at the coffee mill, in a region where unemployment and underemployment are high, can generate significant medium- and long-term social benefits, which are not necessarily picked up by the input-output modelling largely due to employment data constraints.

There has been surprisingly little economy-wide impact analysis of COVID-19 policy impacts on production and trade of coffee or other commodities with which to compare this analysis. Beyene et al. (2020) used a dynamic computable general equilibrium model to assess the potential economy-wide impacts of COVID-19 in Ethiopia. The analysis indicates that the pandemic was likely to have a negative economic impact on the Ethiopian economy by decreasing the production of several economic sectors. Impacts were more severe for export-intensive sectors including export-oriented agriculture, transportation services, accommodation and food services plus the coffee sector. The coffee sector was projected to be negatively affected when a decrease in export demand for coffee was included in the analysis. Miller et al. (2020) used an input-output analysis integrated with IMPLAN to examine the economic impact of disruptions in the main agri-food value chains to Michigan agricultural production. The results show that the impact of COVID-19 was likely to generate an adverse impact to all sectors and to employment. The crop sector was

projected to decline by US\$1.2 billion in total annualized output, while agricultural sector in Michigan is likely to suffer from a sudden decrease of >US\$2 billion in primary and secondary sales. This effect is quite different to our study because Laos is able to maintain production by exporting green beans to Vietnam plus the global demand for coffee remains high.

The International Coffee Organization (ICO, 2021), noted that global production and trade were only slightly affected by COVID-19 restrictions. Global coffee production increased by 1.9% from 168,678 in 2019 to 171,896 thousand 60 kg bags in 2020 and annual world exports (ending January 2021) of Arabica increased from 80 to 82 million bags. Robusta coffee exports decreased slightly from 49 million bags to 48 million bags in the same period. Thus, the COVID-19 lockdowns have had both slightly positive and negative outcomes for coffee production and consumption in different parts of the economy as both farmers and the service sector are negatively affected by reduced demand for speciality coffee, which is often consumed in coffee shops. Nevertheless, many people continued to consume coffee at home and there was increasing consumption of home-delivered coffee as a result of changing consumer behaviour and the business environment (McKinsey, 2020).

More broadly, the COVID-19 pandemic caused unprecedented impacts on the Laos economy, intensifying a slowdown in economic growth, and impacting many economic sectors, particularly the service sector with projected tourism income of just over US\$0.5 billion in 2020 resulting from a 4.5% decrease in production output in 2020. This study indicates that while these sectors have been severely impacted, parts of the agriculture sector have remained robust throughout the COVID-19 pandemic with a 1% increase in total output (Table 5). It should be noted that regional and national impacts could be more significant if the value of domestic consumption of processed coffee were included in the model. This is because the service sector was the worst affected sector of the economy (−4.5% in 2020), largely due to the loss of tourism income of >\$500 million in 2020 (World Bank, 2021).

Further studies are required to better understand the local impacts of the pandemic for coffee growers, traders, roasters, and consumers, including the impacts of reduced demand for coffee from international and local tourists and indirect impacts on forests and the environment. These can be used to target recovery measures while ensuring the long-term sustainability of the Lao PDR coffee sector. To promote small-holder participation in coffee industries and ensure wider economic benefits, it is important to develop a national coffee policy promoting local coffee processing to increase value adding and quality and improve the market reputation of Lao coffee. This can be facilitated by coffee plantation development models that are integrated with other local land uses or intercropping with coffee production to increase diversity in farm production, which can help manage the impacts experienced through the COVID-19 government policies. It is also crucial to facilitate transport and transit routes to borders for coffee export and ensure necessary sanitary measures are followed to reduce the impact from supply chain disruptions. For future research, it is also important to consider the relationship between the positive export trend of green beans during COVID-19 and the proximity of the importing country.

6. Conclusions

This paper uses provincial and national economic input-output data to quantify how changes in coffee demand, processing, and trade due to varied policy measures introduced in response to the COVID-19 pandemic affected the regional and national economy of Laos. Results indicated that the effects of these policy measures at both regional and national levels are two-fold: (i) reduced international production increased green bean export demand from Laos which boosted the value of the crop sector at both the regional and national levels leading to a small positive impact on the economy, but (ii) reduced local demand for processed coffee due to less tourism and local consumptions in cafes reduced local processing activity which had a small negative economic impact at the regional and national levels. Modelling indicated that the gross value of production of the Champasak economy rose by US\$12 million compared to US\$24 million for the national economy. These changes increased GDP by US\$6.3 million and almost US\$14.8 million of the

Champasak economy and national economies, respectively. Almost all this impact is in the coffee and coffee-related sectors, with limited linkages with other sectors. This is because the coffee sector mostly exports green beans and most of the increased economic benefit will go to foreign product purchasers or investors. The modelling revealed that the crop and food sectors have relatively weak linkages with other sectors of the economy. Impacts on the other sectors are relatively small, with much of it being for transporting coffee to Vietnam or Thailand.

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Notes

1. Average yields per ha between 2012 and 2019 (Lao Statistics Bureau, 2021).
2. Exchange Selling Rate: 1 US\$ = 9,444 LAK (Banque Pour Le Commerce Extérieur Lao Public (BCEL) on 01.06.2021).
3. Interview with staff and head of Provincial Office for Commerce and Industry, Champasak Province, on 12 January 2021.
4. Backward linkages indicate the strength where sector's production depends on intersectoral inputs while forward linkage indicates the relative importance of a sector as a supplier of raw materials to the entire production system.
5. Raw data from Department of Taxation, Ministry of Finance of Laos (personal communication 10 June 2020).

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