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The Impact of the Hongsa Lignite Power Plant on the Lao Economy : Input-Output Approach

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Abstract

The focus of this study was to analyze the impact of the investment in the Hongsa Lignite Power Plant on the Lao economy in 2015 using an input-output approach and data from the investment project (including data from a factory pre-feasibility study), as well as data from the sectors involved. The study concludes that the impact of the investment, which was worth 4,288 billion kip, in the Hongsa Lignite Power Plant on the electricity, construction and transport sectors, as well as on other services, has increased the Lao economy's total output by 6.7% for a value-added amount of 7,245 billion kip. This study also finds that the main sectors impacted by the economy's output and backward linkages are the sectors of wood and paper, transport equipment, textiles and apparel, and food and beverages. The study concludes that the Hongsa Lignite Power Plants has contributed to the Lao economy. More generally, it shows that an input-output table could be a useful tool for finding the main sectors involved in the generation of an economy's output. The table is also a tool used to set priorities for the effective planning and achieving of economic growth and investment goals.

Keywords: Hongsa Lignite power plan; impact; input-output approach

Introduction

During the years 2000 to 2013, the number of hydropower plants in the Lao PDR increased from 7 to 23, and the total capacity increased from 860 MW to 2,980 MW. In order to continue to boost economic growth and to meet the target of electricity production, the Lignite Power Plant was

established in 2009 in the Hongsa District, Xayaboury Province, Lao PDR with a total installment capacity of 1,878 MW.

Upon the completion of the project in 2016, the Hongsa Mine Mouth Power Plant is expected to make Laos widely renowned as the "Battery of ASEAN" with its capacity to produce 1,473 MW of electricity for sale to the Electricity Generating Authority of Thailand (EGAT) and 100 MW to the "Electricité du Laos" (EDL). In terms of installed electricity capacity, the Hongsa Lignite will become the biggest power station in the Lao PDR, covering about 63% of the total generation capacity of the country.

The research study analyzes the impact of the Hongsa Lignite Power Plant on the Lao Economy in 2015 in terms of output by using the input-output table of the Lao PDR in 2011 compiled by the Centre for Integrated Sustainability Analysis, School of Physics A28, University of Sydney, and also using data from surveys, administrative reports and the Hongsa feasibility study, as well as the annual and five- year Lao National Socio-Economic Development Plans.

The Hongsa Lignite Power Plant will have the highest capacity of electricity generation among all the power plants in the country and will generate more than 70% of the country□s total electricity when all three units of the plant are operational by March 2016. However, the study does not focus directly on electricity production or on the production side, or on how much the company would benefit in other ways due to the lack of data for these aspects.

This study focuses on how much the plant will contribute to and the generated multiplier in all industry sectors on the basis of the input-output table. However, the IOT is not officially calculated by any Lao institutions. Therefore, the table will be not sufficient to show the real economic transactions. Moreover, in a least-developed country, such as the Lao PDR, the structure of the economy changes very quickly, affecting the input coefficient. Therefore, estimating the effects of the Hongsa Lignite Power Plant can result in under- or overvaluing the actual effects on the Lao economy. Therefore, a following study would be required to use the IOT from a Lao institutional agency.

Literature Review

Aroca, P. (2001) studied the impact of the mining sector on Chilean region II and evaluated the conditions that affect the magnitude of this impact. Employing an input- output matrix for region

II, he assessed the impact on output, income and employment. In addition, the study also compares the impacts of private and state-owned firms on the labor market. The findings show that the mining sector there is not important in terms of backward and forward linkages within the region, but is very important in terms of the volume of production. When the main linkages of the mining sector (with the three sectors that have the highest backward and forward linkages) are considered along with mining□s level of production, mining is by far the most important sector of Chilean region II. The analysis also finds that significant differences in the management system of each firm result in different costs and benefits for regional development

Ali Bekhet, H. (2011) investigated the success and failure of development policies for Malaysia□s economy over the period 1983-2000 by examining the multiplier indices. The study used four input-output tables published by the Department of Statistics of Malaysia. The study employs the Leontief Inverse model, which is open with respect to households for simple multipliers of output, income and employment. The study resulted in four findings. First, that there is still a high dependency on the primary sectors, such as oil palms, rubber and wood. Second, the output and income multipliers for the agricultural sector are still very weak, even though some success has resulted from planning policies. Third, the main result of the investment policy was to transform Malaysia from a country of surplus labor to one with a shortage. Fourth, there is no consideration of efficiency or comparative costs in the selection of „key□ sectors by reference to multiplier indices.

Al Zoubi, O.M (2013) assessed the impacts of different sectors in the Jordanian economy by using input-output multipliers analysis. The paper attempts to prove the impact of economic sectors by using input-output tables of the Jordanian economy for the years 1987, 2000 and 2009. The study applies input-output techniques to determine the economic effects and gauging the significance of Jordanian industries in generating output, income and employment. The multipliers were obtained in 2009. The manufacturing sector showed the highest output multiplier. The services sector (especially finance) gained the highest income multiplier. Finally, the construction sector had the highest employment multipliers.

Trinh, B. et al. (2010) measured and analyzed the interdependent economic relations between Thailand and Vietnam by constructing a bilateral input-output (I-O) table to estimate the

magnitude of an external "shock" on major macroeconomic indicators, such as output, value added, income and employment. Actually, unlike its single-regional counterpart, an IRIO table is able to capture and assess the inter-regional spillover and feedback effects arising from an exogenous change in demand for the output of any one of the study regions. In other words, constructing an IRIO table not only allows for the estimation of the stimulus to production outside a region benefiting from, say, an increase in foreign demand for its output, but also the resultant impact on its output arising from the production stimulus it causes in other regions. This study is deemed to be a prototype of what AREES would need to support its ongoing efforts to develop an integrated database for its proposed research project, titled: "Impact Analysis of Infrastructure Investment in the Indochina Region: An Input-Output (I-O) Approach."

Research Methodology

The present study lacks official country data, as there is no input-output table produced by the Lao PDR official organization. However, many international organizations and research institution, such as the Global Trade Analysis Project and the Centre for Integrated Sustainability Analysis of the School of Physics, University of Sydney, have analyzed the Lao PDR IO table. Due to the requirements of the analysis, this study used the Lao Input-Output Table compiled by the latter institution (http://worldmrio.com/national/co.jsp?tab=IOTABLE). The Table uses 2011 as the base year (Appendix 1).

The IO table consists of 25 industries. However, to focus on finding out the effects of the investment on the output by industry, the study has grouped the data into 22 sectors (Input-Output Table of 22x22), has converted the value from USD to the Lao currency (kip), and applied the RAS method on the maximum difference, or the balancing of the columns and rows of input and output (Trinh and Phong, 2013). Finally, the study compared the value added in the IO table to the Lao PRD□s official gross domestic products in 2011, which has a difference of less than 2%. According to the investment data derived from the Ministry of Energy and Mines, Electricité du Lao (EDL), the original Hongsa Lignite Power Plant website, the pre-feasibility study of the project, the Lao State Holding Enterprise and other sources, the investment in 2015 will concern three main industries: the electricity, gas and water sector for 304,757 million kip, the construction

sector for 3,524,097 million kip, the transport sector for 72,003 million kip, and other services for 387,872 million kip (Appendix 1.6).

Following the literature, this research uses an input-output table analysis to assess the impact of the Lignite Power Plan on the Lao economy (Aroca, 2001; Ivanova et al., 2007; Treloara, 1997; San Cristóbala and Biezmab, 2006).

In economics, an input-output model is a quantitative economic technique that represents the interdependencies among different regional economies or branches of a national economy. Since the input-output model is fundamentally linear in nature, it lends itself to rapid computation, as well as flexibility, of the effects of changes in demand. The structure of the input- output model has been incorporated into the national accounting of many developed countries, and so, can be used to calculate important measures, such as national GDP (Leontief, 1970).

The basic analysis of an input-output table can be explained as follows. Say that we have an economy with n sectors. Each sector produces x_i units of a single homogeneous good. Assume that in order to produce one unit, the ith sector must use a_{ij} units from sector j. Furthermore, assume that each sector sells some of its output to other sectors and some of its output to consumers (final demand). Calling final demand in the ith sector d_i, we can write:

$$x_i = a_{i1}x_1 + a_{i2}x_2 + \ldots + a_{in}x_n + d_i,$$

or total output equals intermediate use plus final demand. If we let A be the matrix of coefficients a_{ij}, be the vector of total output, and d be the vector of final demand, then our expression for the economy becomes:

$$x = Ax + d$$

which after re-writing becomes $(I - A)x = d$. If the matrix is invertible, then this is a linear system of equations with a unique solution, and so, given some final demand vector, the required output can be found. Furthermore, if the principal minors of the matrix $I - A$ are all positive (known as the Hawkins–Simon condition), the required output vector is non-negative.

x

The IO table model assumes that all goods and services produced will be used for intermediate goods, final consumption and export. Therefore, changes in final demand drive the whole economic system. Changes in final demand can be caused by changes in the consumption patterns of domestic residents, firms or governments, or by the export of goods and services. The impacts of the changes in final demand can be called direct impacts, direct shocks, direct effects or initial impacts, because this is the exogenous (external) shock that stimulates the entire economic system. When the shock is caused by a change in the final demand, the economy responds to it by producing up to a new level of total output through inter-industry transactions in the regional economy (Tadayuki, 2008).

This study uses the Leontief Inverse matrix model. Using the conceptual framework, we can write the formula:

$$(I-A)^{\wedge(-1)}\Delta Y=\Delta X.$$

Where:

ΔX is the level of output caused by gross fixed capital formation (investment) shock

ΔY is the change of gross fixed capital formation,

ΔX is the change of the output level, which responds to the change in the form of the investment.

ΔY is the level of change in investment by industry.

Research Results

The construction of the Hongsa Lignite Power Plant started in 2009 for a total investment of 3.71 billion USD or 30,021,320 million kip (8,092 kip/1 USD), and will be officially and fully operational for generating electricity in 2016. During the period of 2009 to 2015, the average investment per year is 4,288,760 million kip, which is about 4.27% of GDP. This investment will have a direct impact on infrastructures, such as roads, buildings, factories and transportation.

According to the IO table approach, the 4,288,760 million kip invested in three main sectors and other services in 2015 will contribute 7,245,039 million kip to the Lao PDR□s gross output in goods and service, or a gross output growth of 6.7% in 2015. This means that the direct impact is 4,288,760 million kip, and the indirect or multiplier impact is 2,956,039 million kip. The study

also finds that the investment in the Hongsa Lignite Power Plant has created the highest output in the construction sector with a value of 3,591,268 million kip, and the second highest output with a value of 659,666 million kip in chemical, mineral and metal products. For electricity, gas and water, and for transportation, the values are 399,596 million, 394,996 million and 241,803 million kip, respectively. In addition, if we look at the percentage growth caused by the investment in 2015 broken down by sector, the highest is other services with 64.4% growth, followed by construction with 50.7%. The electricity, gas and water sector is 12.7%. The mining and quarrying sector is 10.0%. The chemicals, minerals and metals sector is 9.2%, and the transportation sector is 5.7% (Table 1)

Table 1: The impact of investment in the Hongsa Lignite Power Plant on output in million kip

No	Sector	Hongsa Lignite Investment 2015	effect after shock	Percent change by Shock
1	Agriculture	0	14,731	0.3
2	Fishing	0	1,120	0.5
3	Mining and Quarrying	0	115,202	10.0
4	Food & Beverages	0	9,892	0.3
5	Textiles and Wearing Apparel	0	5,465	0.4
6	Wood and Paper	0	51,787	1.1
7	Chemical, Minera and Metal Produ	0	659,666	9.2
8	Electrical and Machinery	0	231,417	4.2
9	Transport Equipment	0	53,020	2.2
10	Other Manufacturing	0	52,570	5.5
11	Recycling	0	3,660	1.2
12	Electricity, Gas and Water	304,757	394,996	12.7
13	Construction	3,524,097	3,591,268	50.7
14	Maintenance and Repair	0	7,085	2.0
15	Wholesale Trade	0	234,241	3.6
16	Retail Trade	0	149,122	2.9
17	Hotels and Restraurants	0	26,819	0.7
18	Transport	72,033	241,803	5.7
19	Post and Telecommunications	0	116,762	2.9
20	Finacial Intermediation and Busine	0	819,896	3.5
21	Public Administration	0	64,918	0.4
22	Others service *	387,872	399,596	64.1
	Total	4,288,760	7,245,039	6.7

Backward Linkages

In the structure of the I-O table, the industrial sectors depend on each other because they need

inputs from other industrial sectors, including the same sectors (Tadayuki, 2008). This input can be named backward linkages or output multiplier. The backward linkage is a measure that is expressed in terms of a sector□s use of inputs from other sectors in the economy, and can be calculated for the direct demand of the inputs or for the total demand of the inputs, which includes the direct, indirect and induced demands of inputs. The larger this value is for a sector, the greater is the sector□s dependence on others in the economy for its inputs, and therefore, the higher the expectation of the economy being stimulated by an increase in this sector□s output (Aroca, 2001).

Table 2 shows that the most important sectors in terms of the output multiplier are wood and paper, transport equipment, textiles and wearing apparel, and food and beverages.

Forward Linkages

No	Sector	Coefficient	Rank
1	Agriculture	1.3193	20
2	Fishing	1.0579	22
3	Mining and Quarrying	1.3570	18
4	Food & Beverages	1.9166	4
5	Textiles and Wearing Apparel	1.9646	3
6	Wood and Paper	2.0212	1
7	Chemical, Minera and Metal Products	1.8267	5
8	Electrical and Machinery	1.7774	9
9	Transport Equipment	1.9867	2
10	Other Manufacturing	1.8103	7
11	Recycling	1.8194	6
12	Electricity, Gas and Water	1.3557	19
13	Construction	1.7298	11
14	Maintenance and Repair	1.2673	21
15	Wholesale Trade	1.3587	17
16	Retail Trade	1.3974	16
17	Hotels and Restraurants	1.6303	12
18	Transport	1.7313	10
19	Post and Telecommunications	1.5613	14
20	Finacial Intermediation and Business A(	1.4961	15
21	Public Administration	1.7972	8
22	Others service *	1.5759	13
	Average	1.6254	

Forward Linkages

The forward linkage or input multiplier indicates the proportion of a sector's output that serves as inputs to all sectors of the regional economy. The larger a sector is as a forward linkage, the more is its output used as an input to production in the regional economy. Thus, it can be argued that the larger a sector's forward linkage, the greater would be the stimulation of this sector by an increase in the regional economy's production (Aroca, 2001).

Table 3 shows that the sectors particularly relevant for the input multiplier are financial intermediation and business activities, chemical, mineral and metal products, and wholesale trade.

Table 3: Forward linkages/input coefficients and their ranks

No	Sector	Coefficient	Rank
1	Agriculture	1.3592	10
2	Fishing	1.0747	18
3	Mining and Quarrying	1.5684	8
4	Food & Beverages	1.2766	13
5	Textiles and Wearing Apparel	1.0713	20
6	Wood and Paper	1.2199	15
7	Chemical, Minera and Metal Prod	3.1970	2
8	Electrical and Machinery	1.9837	4
9	Transport Equipment	1.3038	12
10	Other Manufacturing	1.1493	17
11	Recycling	1.0318	21
12	Electricity, Gas and Water	1.6693	6
13	Construction	1.4677	9
14	Maintenance and Repair	1.0272	22
15	Wholesale Trade	2.0830	3
16	Retail Trade	1.2374	14
17	Hotels and Restaurants	1.1623	16
18	Transport	1.8851	5
19	Post and Telecommunications	1.6259	7
20	Finacial Intermediation and Busin	4.9564	1
21	Public Administration	1.3356	11
22	Others service *	1.0727	19
	Average	1.6254	

Conclusion and research application

The study on the impact on the Lao PDR economy of the investment in the Hongsa Lignite Power Plant is based on the Leontief Inverse model of the input-output table and its output multiplier

effect. One research finding is that in 2015, the estimated total investment of 4,288,760 million kip will be generating an output of goods and services with a value of 7,245,039 million kip, or in other words, an output increase of 6.7%. The direct effect contribution is 4,288,760 million kip and the indirect effect is 2,956,279 million kip. The higher growth output effect by sector is on other services with a 64.4% increase, followed by construction with 50.7%. The electricity, gas and water sector is 12.7%, while the mining and quarrying sector is 10.0%. The chemicals, minerals and metals sector is 9.2%, and the transportation sector is 5.7%. The study also finds that the main sectors affected in terms of increase in output by backward linkages or the output multiplier are wood and paper, transport equipment, textiles and wearing apparel, and food and beverages. In addition, it is interesting to note that the main sectors relevant for the input multiplier or forward linkages are financial intermediation and business activities, as well as chemical, mineral and metal products, and wholesale trade. Even though the government may invest much effort and funds to achieve the goals of the five annual National Social Economic Development Plans, the goals are not always reached as expected. To achieve the goals, the proper economic tools and models need to be utilized in the policy-making process in order to prioritize the sectors allocated for investment. As the study suggests, an input-output table is an efficient tool that can be used by the government when prioritizing national investments. Thus, it is recommended to take the table into consideration, especially, when the Lao PDR has a complete lack of knowledge of this tool.

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