Resource booms, growth and poverty in Laos : What can we learn from other countries and policy simulations?

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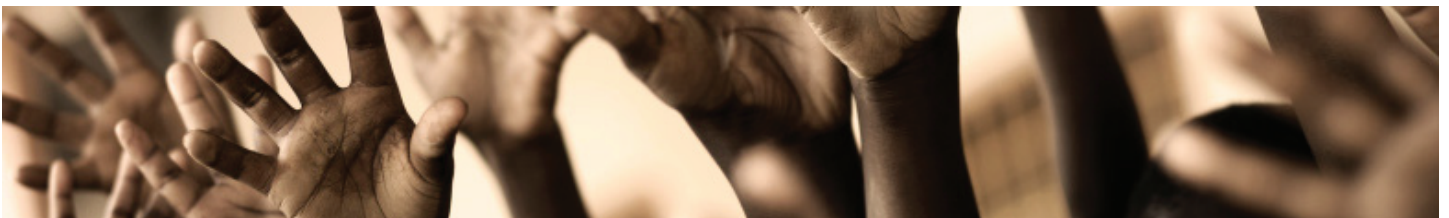
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Abstract

Laos is a small, open, least-developed country (LDC) in Southeast Asia. However, it is a resource-rich economy with over 570 identified mineral deposits. As a result, Laos has experienced massive inflows of foreign direct investment (FDI) in the mining and hydroelectricity sectors since 2003. Despite the likelihood that resource booms will carry both positive and negative impacts on the Lao economy, this issue has been under-researched in Laos. This study thus lays out a framework to quantify the impacts of resource booms on the macro economy and on poverty in Laos using a computable general equilibrium (CGE) model. We find that the higher capital stock and productivity led to increased value added, production, exports and investment in the mining sector, resulting in higher real GDP, exports and investment. Unfortunately, the associated Dutch disease effects (particularly real exchange rate appreciation) negatively impact real production and value added in agriculture, industry and government services.

JEL: D58; Q33
Keywords: Resource boom, CGE model, Dutch disease, Laos

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I. Introduction

Resource booms provide an important source of financing for low-income, developing countries. A boom can also negatively affect the economy, particularly when it is concentrated in one or a handful of sectors, or if the boom leads to a surge in government revenues. These negative Dutch disease effects occur when capital inflows lead to real exchange rate appreciation, negatively impacting the production of tradable goods (Gregory, 1976; Corden and Neary, 1982). Tradable goods such as agricultural and industrial goods are the engines of long-term economic growth, and declines in these tradable sectors negatively impact growth.

The national development goal of Laos is to exit from the group of LDCs by 2020 (GoL, 2004). In order to overcome poor infrastructure, human resources and productivity, the Government of Laos is enthusiastically promoting FDI, which has become an increasingly prominent source of capital in Laos. FDI inflows in 2007 were estimated at about US$950 million, a 60% increase over the previous year. About 90% of FDI is linked to the resource industry, and has accounted for much of the increase in FDI since construction began on the successful Sepon mine in 2003. Mining now accounts for the second largest share (after hydroelectricity) of accumulated registered capital, at 18.3% of the total.

The main impacts of the mining sector on the economic development of Laos occur through four channels (Kyophilavong, 2009a). First, this sector has both positive demand and supply side effects on GDP due to increased investment and capital stocks. Secondly, the small size of the domestic market means that most mining products are exported to other countries, helping to narrow trade deficits. Mining products are the primary Lao export, accounting for 37.4% of all exports over 2004-2006. Thirdly, royalties and taxes collected from mining projects have lowered the government's budget deficit. In 2006/2007, taxes on non-renewable resources, including the mining sector, accounted for 17.1% of total tax revenues; these revenues are expected to increase as other mining development projects are completed. Fourthly, mining development generates employment because it requires a significant input of labor. FDI in the mining sector also indirectly affects economic and social development in rural areas through the development of infrastructure, spillover effects on small and medium enterprises (SMEs) and new activity in agriculture, livestock farming and retail trade.

However, the mining sector could have a negative long term impact on the Lao economy if non-booming sectors, namely agriculture and industry, must compete internationally under real exchange rate appreciation. A number of studies have examined the impact of resource booms and foreign capital inflows in other developing countries, including Levy (2007), Devarajan et al (1993), Benjamin et al (1989) and Usui (1996). Despite the massive impact of foreign capital flows and the general boom in the Lao resource sector, research on the topic is scarce. One exception is Warr (2006), who used a multi-household CGE model to investigate Dutch disease effects associated with hydroelectricity generation projects. As the impacts of resource booms in the mining sector are not well understood, our main objective in this study is to use a CGE model to

quantify the potential impact of resource booms on poverty and to look for evidence of Dutch disease in the Lao economy.

II. Literature review

Many empirical studies suggest that naturally resource-rich countries experience lower growth than naturally resource-scare countries (Sachs and Warner, 1995; Papyrakis and Gerlagh, 2004; Leite and Weidmann, 1999). Failures to effectively transform natural resources into growth occur for many reasons, including Dutch disease[1] (Coden, 1981, 1982 and 1984; Coden and Neary, 1982).

Corden (1984) performed a widely cited survey of resource booms and Dutch disease across many countries. Corden and Neary (1982) and Corden (1984) developed a "core model" of economies affected by Dutch disease. This core model defines three sectors: the booming sector, a tradable sector (or a lagging sector with exports and import-competing industries) and a non-tradable sector which includes services, utilities and transportation. Potential Dutch-disease-type effects include: (1) improved technology in the booming sector; (2) an increase in foreign capital inflows; and (3) an increase in the international price of export products. The two main effects of a boom in this core model are the spending and the resource movement effects. Rising income resulting from the boom leads to increased spending on both tradable and non-tradable goods. The price of tradable goods is determined on world markets whereas the price of non-tradable goods is determined on domestic markets. The overall change in prices is greater for non-tradable goods, effectively discouraging the production of tradable goods. This is the spending effect. The resource movement effect refers to the movement of resources out of non-resource sectors and into the resource sector. Both of these effects lead to a contraction in the tradable goods sector, negatively affecting the level of industrialization (Corden and Neary 1982; Corden 1984).

There is a rich literature on Dutch disease, providing many economic tools to analyze it. Input-output analysis is one approach that a number of authors have used to evaluate the impact of mineral projects (including Bocoum and Labys, 1993 and Swisko, 1989). A popular approach is to use regression models to analyze the impact of resource booms on economic development (prominent examples include Sachs and Warner (2001), Fardmanesh (1991), Gylfasson (2001), Brunnschweiler (2007) and Nyatepe-Coo (1994). Macroeconomic models can also be used to analyze the impact of resource booms and

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[1] Many empirical studies suggest that natural resource rich countries have suffered from low economic growth compared to natural resource scare countries (Sachs and Warner, 1995; Papyrakis and Gerlagh, 2004; Leite and Weidmann, 1999). There are six main factors underlying low economic growth in natural resources rich countries: (1) Dutch disease; (2) insufficient economic diversification; (3) rent seeking and conflicts; (4) corruption and undermined political institutions; (5) overconfidence and loose economic policies; and (6) debt overhang.

to perform policy simulations (Lawler, 1991; Usui, 1996; Kyophilavong and Toyoda, 2009). Another commonly used tool to diagnose Dutch disease and the impact of government policy on the economy is time series analysis (see Al-Awadi and Eltony, 2001; Bjornland, 1998; Hutchison, 1994; Kutan and Wyzan, 2003; Oomes and Kalcheva, 2007; Raju and Melo, 2003). Finally, computable general equilibrium (CGE) models are very popular tools to analyze the impact of resource booms.[2]

We adopt the CGE model approach to analyzing Dutch disease. Devaranjan et al (1993) developed a 1-2-3 CGE model to estimate changes in the equilibrium real exchange rate following trade shocks and changes in foreign capital flows. This popular model is thus suitable for analyzing Dutch disease. Benjamin et al (1989) examine the impact of an oil boom on the Cameroonian economy, and found that one of the typical outcomes of Dutch disease can be reversed. The agricultural sector is most likely to be hurt, but production was not found to decline in all tradable sectors, and some manufacturing sectors even benefit. Benjamin (1990) introduced investment into the model by incorporating a two-period optimization into a multisectoral computable general equilibrium (CGE) model for Cameroon. This model is used to assess the impacts of foreign capital flows, and policies on tariffs and regarding public firms. The simulation results showed that import substitution was important in Cameroon, particularly in the manufacturing sector. Levy (2007) used a CGE model to study the impact of using Chad's annual oil revenue for public investment, which was primarily targeted on the development of road and irrigation infrastructure. The results showed that Dutch disease is not an unavoidable consequence of oil booms in Chad. A number of other studies used CGE models to investigate Dutch disease in other countries. Qiang (1999) and Clement, Ahammad and Qiang (1997) used CGE models to evaluate the impact of new mining and mineral processing projects in Western Australia on employment and the macroeconomy. The analysis showed both mining and mineral processing projects to have substantial knock-on benefits within the Western Australian economy. Chand and Levantis (2000) used a CGE model to investigate the mineral boom in Papua New Guinea.

There is a limited amount of research on this phenomenon in Laos. Kyophilavong (2007) used a CGE model to analyze the impact of the ASEAN Free Trade Area (AFTA) on the Lao economy. This model is based on two sectors and is a simple model which would be useful to have updated in the future. Kyophilavong and Toyoda (2008) used a macroeconomic model to investigate the impact of foreign capital inflows in the mining and hydroelectricity sectors. Warr (2006) used a 1-2-3 CGE model with a multi-household framework to investigate Dutch disease in Laos. This model is not adequate to identify Dutch disease, in part due to limitations of the model for simulating government behavior.

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[2] Bandara (1991) investigated Dutch disease by developing a three-sector CGE model following the 'core model' from Corden (1984) and Corden and Neary (1982). He confirmed that the CGE model is well-suited to analyzing Dutch disease-type effects.

These are vital questions as Laos develops its economy. The lack of studies on the impacts of resource booms on the Lao economy and on poverty in Laos means that the above questions have yet to be answered properly. This research will address this knowledge gap.

III. The Lao economy and mining sector

3.1. The current situation of the Lao economy

Since introducing the New Economic Mechanism (NEM) in 1986, [3] Laos has been transitioning from a centrally planned economy to a more market-oriented economy. As a result, except during the Asian financial crisis of the 1990s, Laos has been achieving high economic growth together with low inflation. Economic growth averaged about 6.53% over 2001-2006, faster than the 6.18% rate of growth over 1996-2000.[4] The average inflation rate was held to single digits over 2001-2006, marking a huge improvement over average inflation of 57% during 1996-2000. The exchange rate was also stable over 2001-2006 (table 3.1). Laos GDP in 2007 was 4.053 billion US$, dominated by the agricultural sector (40.3%), followed by industry (34.1%) and services (25.6%) (World Bank, 2008). The industrial sector has grown by more than 10% since 2003, causing the weight of agricultural in the economy to decline.

Even though Laos has been maintaining high economic growth, low inflation and a stable exchange rate, serious macroeconomic challenges remain. Firstly, Laos has faced chronic twin deficits in government spending and international trade. Over 2001-2006, the deficit-to-GDP ratio averaged 4.4% and the current account balance deficit-to-GDP ratio was 9.24% during the same period.[5] These deficits are mainly financed by official development assistance (ODA), foreign direct investment (FDI) and remittances. The fiscal situation is not strong in Laos, and continued increases in budget deficits could accelerate inflation and lower the value of the kip (Lao currency), potentially leading to the type of economic instability experienced during the Asian financial crisis. Secondly, there is a huge gap between savings and investment. The savings rate is low because average income is low—GDP per capita was about US$580 in 2007 (World Bank, 2008)—and because financial sectors are underdeveloped. The banking sectors are inhabited by the state commercial banks, which are not fully performing important banking functions.[6] Thirdly, Laos also faces a high external debt burden. Accumulated external debt totaled more

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[3] After establishing the Lao People's Democratic Republic in 1975, the Lao government adopted a planned economy, as did other socialist countries.

[4] The engine of growth during this period was FDI inflows in the mining and hydroelectricity sectors and mining production and exports. For a more detailed discussion of the impact of FDI in the mining and hydroelectricity sectors on the Lao economy see Kyophilavong and Toyoda (2008).

[5] It is important to note that the trade data used for this analysis originates from international organizations. The Lao government claimed that the trade deficit became a surplus in 2006.

[6] More details about financial issues, and monetary and exchange rate policies in Laos are discussed in Kyophilavong (2010).

than 60% of GDP in 2007. If Laos becomes too dependent upon foreign finance, potential difficulties meeting its debt obligations could cause an external debt crisis and lead to macroeconomic instability. Rapid expansion of the resource sectors in Laos must therefore be accounted for when considering macroeconomic management in Laos.

Table 3.1: Key macroeconomic indicators

Macroeconomic indicators	2001-2006	1996-2000	1990-1995
Population (million. person)*	5.46	4.86	4.40
Population growth (%)	2.12	2.06	2.52
GDP (current million US$) **	2,416	1,618	1,276
GDP growth (%)	6.53	6.18	6.46
GDP per capita (constant 2000 US$) **	379	307	248
GDP per capita growth (%)	4.04	3.68	3.80
Reserve Money (M2) (million US$)*	450,981	270,728	148,280
Money supply (M2) (%)*	21.14	65.99	30.92
In flation -CPI (%)	9.73	57.00	15.27
Trade Deficit (million. US$)***	-219.91	-263.21	-174.92
Trade Deficit /GDP (%)	-9.24	-16.06	-13.14
Foreign reserve (million. US$)***	220	127	48
External debt (million US$) *	2,640	2,410	1,965
External debt /GDP (%)	115	152	161
Buget Deficit (including grants)(million US$)	-104	-58	-100
Buget Deficit /GDP (%)	-4.42	-3.60	-7.61
Buget Deficit (exclude grants)(million US$)	-149	-121	-145
Buget Deficit /GDP (%)	-6.29	-7.58	-11.21
Exchange Rate (kip/US$) Official Rate***	10,163	4,094	727

Sources:

* Asian Development Bank (ADB), *Key Indicators for Asia and the Pacific 2008 www.adb.org/statistics*

** World Bank,*World Development Indicators CD-ROM (2005) and*

*** International Monetary Fund, *International Financial Statistics CD-ROM August 2008*

3.2.   Mining sectors

FDI has flowed into Laos since the country introduced market mechanisms in 1986. A total of 1547 FDI projects were carried out over 1989 to 2008 with a total value of 9,525.8 million US$ (Kyophilavong, 2009). FDI has increased sharply since 2003, and this FDI has been concentrated in the mining sector. In terms of registered capital accumulation, the energy (hydroelectricity) sector has the highest share, at about 54.4% of accumulated incoming capital. The mining sector comes next, with about 18.3% of total capital.

The largest shares of accumulated investment comes from Thailand (26.5%)[7]and France (18.2%), followed by Vietnam (Kyophilavong, 2009). The potential for mining development in Laos was not well recognized until construction began on the Sep on Mine[8] in 2003. There were 127 domestic and foreign companies (213 projects) involved in prospecting, exploration and feasibility study processes in October of 2008; 42 of these companies were domestic and 85 were foreign. Foreign companies are comprised of 48 Chinese (56.5%), 19 Vietnamese (22.4%), 6 Thai (7.1%), 4 Australian (4.7%), 2 Russian (2.4%), 2 North Korean (2.4%), 1 Canadian (1.2%), 1 South Korean (1.2%) and 1 Polish (1.2%) company.

The main drivers behind the natural resource boom can be explained as follows. First, Laos is a poor country and performance with respect to social indicators is lagging. For example, per capita GDP was $887 in 2008 compared to a regional average (East Asia and Pacific) of $3070. The national development goal of the Lao government is to exit from the group of least developed countries (LDCs) by 2020. In order to achieve this goal, top priorities include promotion of foreign direct investment, particularly in the mining and hydroelectricity sectors (GoL, 2004 and 2008). Secondly, Laos is a resource-rich economy with over 570 identified mineral deposits (DOG, 2008). The successful Sepon mine has begun to produce and export gold and copper. Thirdly, the increase in mineral prices prior to the global financial crisis is also an important driver behind the resource boom in Laos. As a result, since 2003, Laos has experienced massive foreign capital inflows in terms of foreign direct investment (FDI) in the mining sector.

There are about 35 operational mines in Laos, including the Sepon and Phubia mines. Only 2 of these mines have modern production systems. Of these mines, 13 belong to the Lao government: 7 are managed by the Ministry of Energy and Mines, 5 by the Ministry of Defense and one by the Ministry of Industry and Commerce. Foreign investors manage 12 mines, of which China has 6, Thailand has 3 and Vietnam has 2. This means that production and exports from the mining sector will increase substantially in the near future as these projects come online.

3.3. Contribution of mining sector

Since the NEM was introduced in 1986, Laos has been in transition from a centrally planned economy to a more market-oriented economy. As a result, with the exception of a period of negative growth following the 1997 Asian financial crisis, Laos has generally been achieving high economic growth and low inflation. Economic growth averaged 7%

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[7] There are three main reasons that the largest share of investment into Laos originates from Thailand. Geographical proximity and the long border between the two countries is an obvious reason, while similar culture and customs is another. The third has to do with differing levels of capital, technology and know-how, given that Thailand is more developed than other countries in this region and its firms thus have increased capacity to invest in Laos.

[8] For more details of the project, see the Sepon Gold Mine (http://www.ozminerals.com/ Operations/Mining-Operations/Sepon-Gold.html).

over 2000-2010. Inflation has been held to single digits since 2005, and was 5.4% in 2010 (IMF, 2011). Between 2005 and 2010, the exchange rate appreciated from 10,767 to 8,291 kip per US$, a 23% appreciation. The agricultural sector as a share of GDP declined from 35% in 2005 to 30% in 2010, whereas the weight of the industrial sector in the economy rose from 21% to 26% over this timeframe (table 3.2).

Even though Laos has been maintaining high economic growth, low inflation and a stable exchange rate, serious macroeconomic challenges remain. Laos faces chronic twin government and international trade deficits, largely financed by foreign sources. The deficit-to-GDP and current account deficit-to-GDP ratios were 4.9% and about 10% in 2010 (World Bank, 2010). Laos also faces high external debt, indicating that the overall macroeconomic situation is weak in Laos.

Since the Lao economy is constrained on both the demand and supply sides, the resources sector plays an important role in economic development. Firstly, the resources sector stimulates demand and supply through increased investment and capital stocks; FDI flowing into the Lao resource sector also increases aggregate demand, while rising capital stocks stoke supply. According to the World Bank (2010), the resources sector contributed about 2.5 percentage points to the growth rate over 2005 to 2010. Secondly, the expanding resources sector also contributes export growth. Given the small size of the domestic market, production in this sector is primarily exported abroad, lowering the Lao trade deficit. The resources sector accounted for about 70% of all exports in 2010, a share that is expected to increase under expected ongoing development in the hydroelectricity and mining sectors. Thirdly, given that Laos faces chronic budget deficits, it cannot go without mentioning that the resource sector helps lower the government deficit via increased royalties and taxes. Revenues from resource sectors as a share of total revenues rose to 2.6% of GDP in 2010, a share that is expected to rise under continued growth in the sector.

Table 3.2: Lao PDR: Macroeconomic and financial indicators (2005 to 2010)

	2005	2006	2007	2008	2009	2010
GDP and Price (percentage change)						
Real GDP growth	6.8	8.6	7.8	7.8	7.6	7.7
of which: resources*	2.9	2.6	0.2	1.9	2.8	3.7
CPI (Annual average)	7.2	6.8	4.5	7.6	0	5.4
Public finances(inpercentage of GDP)						
Revenue	12.1	12.5	13.9	14.4	14.9	15.5
Of which: resource	0.9	2	2.7	3.3	2.3	2.6
Grants	1.8	2	1.7	1.6	2.3	2.1
Expenditure	18.3	17.4	18.3	18.7	24.4	22.5
Current(includes contingency and discrepency	10.2	10.1	10.2	11.5	12.9	12.6
Capital and net lending	8.1	7.2	8	7.2	11.5	9.9
Overall balance(including grants)	-4.4	-2.9	-2.7	-2.8	-7.2	-4.9
Domestic financing	-0.1	-1.2	-1.1	-0.3	5	3.1
External financing	4.5	4.1	3.8	3	2.2	1.8
Balance of payments						
Exports(in millions of US dollars)	697	1133	1321	1605	1485	2125
In percent change	30.1	62.6	16.6	21.5	-7.5	43.1
Of which: resource	309	632	663	865	912	1459
share in total export (%)	44.3	55.8	50.2	53.9	61.4	68.7
Imports (in million US dollars)	1270	1602	2158	2829	2720	3031
In percent change	20.3	26.1	34.7	31.1	-3.9	11.5
Current account balance (in million US dolla	-492	-398	-672	-985	-984	-647
In percent of GDP	-18.1	-11.2	-15.9	-18.5	-17.6	-10.2
Gross official reserves (inmillion of US dollar	238	336	528	636	632	555
In moths of profective goods and service imports	2.2	2.5	2.8	3.3	2.8	2
External public debt and debt service						
Extenal public debt						
In million US	2203	2351	2521	2949	3109	3270
In percent of GDP	80.8	66	59.7	55.5	55.5	51.6
External public debt service						
In percent of Exports	7.4	3.6	4	4.3	5	4.8
Exchange rate						
Official exchange rate(kip per US end of peric	10767	9655	9341	8466	8476	8291

Source: IMF(2011) and World Bank (2010).

3.4. Dutch disease hypothesis, its impacts and policy responses

The two main effects of Dutch disease are (1) the spending effect and (2) the resource movement effect. The spending effect refers to increased government spending in the non-tradable sector, enabled by windfall revenues from the booming sector. The increase in government expenditures in the non-tradable sector stimulates demand in this sector,

causing prices in the sector to rise relative to prices in the tradable sector.[9] This causes real exchange rate appreciation. The resource movement effect occurs when increased profitability in the booming sector attracts resources (capital and labor), leading to an increase in the price of these factors. The associated decrease in factor intensity in the tradable sector causes a relative decline in this sector.

Four main aspects of Dutch disease can be detected: (1) real exchange rate appreciation; (2) declining input of factors into non-booming sectors; (3) declining exports and output in non-booming sectors, associated with; (4) declining real GDP (Corden, 1984; Corden and Neary,1982). Data constraints lead us to looks for the presence of Dutch disease in terms of real exchange rate appreciation and declining labor productivity.

The real exchange rate[10] has been trending upwards in Laos. We categorize data from 1989 to 2006 into three periods, following Warr (2005). Period 1 is called the post-reform adjustment period and runs from 1989-1994, period 2 is called the hyperinflation and exchange rate depreciation period and runs from 1995-1999, and period 3 is called the sustained growth and foreign capital inflows period and runs from 2000-2006. Period 1 saw the beginning of economic reforms in Laos. The first investment law was adopted in 1988, after which FDI and ODA inflows increased sharply. These inflows were associated with real exchange rate appreciation of about 4.3% during the first period. Period 2 (1995-1999) was a period of macroeconomic turmoil in Laos and Asian countries in general. The 1997 Asian financial crisis originated from Thailand and led to macroeconomic instability, hyperinflation and extreme nominal exchange rate volatility in Laos. Real exchange rate depreciation in this period mainly arose from elevated nominal exchange rate depreciation. The adverse impact of the crisis on Asian currencies was particularly strong for the Lao kip. Period 3 (2000-2006) is categorized as a high growth period with huge foreign capital inflows. Prices and the nominal exchange rate even stabilized under massive FDI into the Lao mining and hydroelectricity sectors. Several mining and hydroelectricity projects are currently under way (Kyophilavong, 2009). The size of the investment into "Name Theun 2," one of the biggest hydro development projects in Laos, totals about US$ 1.03 billion (about 35% of GDP in 2005). The most successful project in the mining sector is the Sepon mining project in the south of Laos. This project has been operated by Oxiana Resources Ltd. of Australia.[11] Massive inflows of foreign capital during this period led to real exchange rate appreciation of about 3.3% per year. This trend of rising real exchange rates continues: the real exchange rate appreciated by about 5% in 2007 and a further 15% in 2008. According to the World Bank (2010), the real effective exchange rate appreciated by a total of 50% between 2001 and 2009.[12]

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[9] In this context, the real exchange rate is defined as the price of goods in the non-tradable sector relative to the price of those in the tradable sector.

[10] Data limitations meant that we could not estimate the real exchange rate using price information on tradable and non-tradable goods. So, we define the real exchange rate as the nominal exchange rate*world price / domestic price. See more details in Kyophilavong and Toyoda (2008).

[11] In June 2009, Oxiana was sold MinMetals Group (MMG), a subsidiary of China MinMetals Corporation.

[12] It is important to note that the recent exchange rate appreciation may have arisen from other factors such as a weak US dollar, a government policy of de-dollarization, increased growth and improved term of trade.

Labor productivity in Laos was stagnant between 2005 and 2006 relative to other countries in the same income group (World Bank, 2010). Manufacturing exporters are less profitable than non-exports because exporters face elastic world demand and have more difficulty adjusting to higher labor and trade costs. Real wages have been growing in both the private and public sectors in recent years. In this sense, the natural resources boom can be said to have negatively impacted labor productivity, especially among manufacturing exporters. The symptoms of Dutch disease will become much more prominent as revenues from the resource sector increase over the medium run. As for agriculture and manufacturing, both of these sectors are important prospects for long term economic growth in Laos, and a high share of the population is engaged in these sectors. If these two sectors decline as a result of Dutch disease, this will curtail long run economic development in Laos, making it difficult to achieve the goal of exiting the group of LDCs by 2020. However, Dutch disease can be avoided or mitigated though various approaches, including adjustments to fiscal policy, exchange rate policy and foreign borrowing strategies (Usui, 1996; Pinto, 1987; Larsen, 2006; Coden, 1981, 1982 and 1984). However, the government has yet to formulate a comprehensive policy strategy to avoid or mitigate negative impacts of the booming resource sector on the Lao economy.[13] The Lao government should thus look into comprehensive and appropriate policy and strategies to cope with the effects of rising real exchange rates.

IV. Methodology

4.1. The Lao CGE model

We use a CGE model to analyze the potential impact of resource booms on the Lao economy. More specifically, we use the PEP 1-1 single-country static model, developed by Decaluwe et al (2009a).

The characteristics of the model are explained as follows:

(1) Static single-country CGE model with 5 sectors: mining, agriculture, industry, private services and public services; (2) Multi-period, constant returns to production technologies with substitution between inputs, including intermediate inputs; CES value added production function, investment demand distinguishes between gross fixed capital formation (GFCF) and changes in inventories; (3) Imperfect substitution between domestic and foreign commodities on both import and export markets (Armington assumption); (4) Competitive markets with neoclassical macroclosure and the small country assumption; (5) Production in the mining sector results from a combination of labor, capital and natural resources; (6) Sector-specific production function in the mining sector which incorporates natural resources as an input factor.

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[13] NT2 projects are regulated to allocate revenues to areas such as environment and conservation, education, health and others, but it is important to note that it is a project-based mechanism.

4.2.   Data requirements and sources

We needed a social accounting matrix (SAM) to build the CGE model, but there is no existing social accounting matrix (SAM), input-output table and national account for the Lao economy. This led us to build the Lao SAM from a variety of data sources. We first extracted the Lao SAM from the GTAP database[14] (version 7), following McDonald and Thierfelder (2004) and PEP (2011). Secondly, the 2004 Lao SAM was updated with 2009 data from sources including the Lao PDR National Statistic Center (NSC) (2008),[15] IMF (2011), ADB (2011) and the World Bank (2011). This intermediate SAM had to be adjusted to be consistent with the format of the SAM in the standard PEP model found in Decaluwe et al (2009). The resulting 2009 Lao macro SAM appears in appendix 4-1.

In order to use a SAM in a CGE model, it is important to disaggregate the SAM. There is no single way to disaggregate and categorize the data into a micro SAM. The number of accounts in each category reasonably vary according to the objectives of a given study and data availability. Data limitations forced us to make a number of assumptions in order to build a micro SAM for the Lao CGE model to analyze the impact of mining on the Lao economy. The data came from a number of different sources, so manual adjustments were required to balance the SAM.[16]

4.3.   Basic structure of the Lao economy as per the SAM

4.3.1.   Household

The main source of household income is from wages and capital income. Household spending is concentrated in the industrial and private services sectors (table 4.1).

Table 4.1: Sources of household income and household spending allocations

	Income
Wage income	38.8
Capital income	43.9
Land rent	12.0
Natural resources	5.4
Total	100.0

	Expenditure
Direct tax	4.1
Consumption	
Agriculture	11.8
Industry	55.6
Private services	24.8
Government services	0.7
Mining	0.0
Saving	3.0
Total	100.0

Sources: authors' computations.

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[14] The Lao SAM in GTAP data base was extension of Savannakhet input-output table built by ADB (2005).
[15] Because the Laos national account is not well organized, we used several data sources from international organizations, e.g. the World Bank and the Asian Development Bank, to build the macro SAM used in this study.
[16] Several methods can be used to balance the micro SAM, as shown in Fofana et al (2005) and Corong(2007). The choice of methods may have substantial impacts on the values in the SAM.

4.3.2. Production factors

In the previous section we saw that the two main sources of household income were from wages and capital, and the mining sector significantly impacts household welfare through both of these sources of income. We will examine the use of production factors in each sector in order to better understand this effect.

Wage remuneration to labor is primarily earned in the agricultural, industrial, private services and government services sectors, whereas capital income is mainly paid out in the industrial, private services and mining sectors (table 4.2).

Table 4.2: Sectoral factor remuneration and factor market shares

	Agriculture	Industry	Private services	Government services	Mining	Total
Wage income	20.9	7.9	38.3	32.5	0.4	100.0
Capital income	16.3	14.6	54.5	0.0	14.5	100.0
Land rent	100.0					100.0
Natural resources					100.0	100.0
Wage income	0.4	5.0	7.8	60.3	2.4	
Capital income	24.9	67.6	64.1	0.0	26.2	
Land rent	37.1	0.0	0.0	0.0	0.0	
Natural resources					71.4	
Total (value added)	100.0	100.0	100.0	100.0	100.0	

Sources: authors' computations.

4.3.3. Consumption and output

Mining constitutes about 10% of total output, and most of this production is exported. The impact of mining on household consumption mostly depends on household consumption allocations and changes in consumer prices. As seen in table 4.3, industrial goods feature most heavily in household spending allocations. Changing prices in the mining sector will thus change the structure of household consumption.

Table 4.3: Sectoral consumption and output shares

	Comsumption share	Output share	Import	Export	Import/ consumption	Export/ output
Agriculture	12.7	17.6	31.6	4.3	8.6	4.6
Industry	59.8	20.3	6.3	0.9	1.7	0.9
Private services	26.7	43.7	12.1	1.7	3.3	1.8
Government services	0.8	8.2	0.0	0.0	0.0	0.0
Mining	0.0	10.2	50.0	93.1	13.7	99.6
Total	100.0	100.0	100.0	100.0		

Sources: authors' computations.

4.3.4. Government

The mining sector is an important source of government revenues through taxes, royalties and dividends. About 50% of government income is collected in the form of import duties and a further 20% comes from income and production taxes (table 4.4). Expansion of mining activities can thus be expected to affect government revenues, most of which are spent in the government services sector.

Table 4.4: Sources of government income, and spending allocations

	Income
Income taxes	22.5
Production taxes	21.0
Imports duties	56.5
Export tax	0.1
Total	100.0

	Expenditure
Agriculture	0.0
Industry	20.4
Private services	2.4
Government services	76.2
Mining	1.0
Total	100.0

Sources: authors' computations.

V.   Simulation design and results

5.1.   Simulation

The impacts of mining on an economy can generally be divided into two phases: construction and production.[17] We focus on the production phase in this simulation in order to capture the impact of mining on the Lao economy, and proceed with the following simulation design.

Simulation 1: Increase capital stock in mining

Our simulation focuses on the production phase and assumes that mining activities lead to a higher level of investment through an increase in the capital stock, as per Lay, Thiele, and Wiebelt (2006). We follow Clements et al (1996) by grouping together mining and mineral processes.[18] Our simulation assumes that capital does not come online during the construction phase, so we model the capital stock as expanding during the production phase. We assume that the supply of capital in the mining sector will increase by about 10%.

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[17] Some of the studies considered both the construction and production phases (Cook and Lees, 1984; Clement, Ahammad, Qaing, 1997; Higgs and Powell, 1984).

[18] Some studies discern between mining and mineral process, including Qiang (1999). Higgs and Powell (1992) simulated the impact of mining projects by distinguishing between the construction and production phases in a typical year.

Simulation 2: Increase productivity

Most of mining investment in Laos comes in the form of FDI from neighboring countries with relatively limited technological capacity (Kyophilavong, 2009). However, the Lao government has given a green light to the European Union and developed countries such as Japan, Australia and Canada to invest in the mining sector. FDI from these more advanced countries is partnered with more advanced technology, know-how and experience than domestic mining firms or investors from neighboring countries.[19] We therefore assume that total factor productivity will increase by 5%.

Simulation 3: Impact of mining

Simulation 3 combines the first two simulations. We assume that capital flows into Laos originate from advanced countries with advanced mining technologies. Changing mineral prices are also accounted for.[20] The simulation design is summarized in table 5.1.

Table 5.1: Simulation design

	Capital inflow	Total factor productivity
Simulation 1	increase 10%	
Simulation 2		Increase 5%
Simulation 3	increase 10%	increase 5%

Source: the authors.

5.2.   Results

For brevity, we will focus on the results of simulation 3, a combination of simulations 1 and 2. The presented results pertain to the impact of the (booming) mining sector on the Lao economy. The impact of mining on macroeconomic variables is presented in table 5.2. The mining sector positively impacts real GDP (+1.7%), real investment (+5.9%) and imports (4%) along with a small increase in real exports. These positive economic impacts are countered by declining overall real consumption (4%) and output (0.2%). This result is consistent with previous studies (Benjamin, Devarajan and Weiner, 1989; Higgs and Powell, 1992).

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[19] The simulation is of the impact of the mining sector on the Lao economy and on poverty via increased employment of factors and improved TFP in the mining sector (Chand and Levantis, 2000).

[20] Mineral prices fluctuated by more than 30% (Davis and Tilton, 2005). More recently, mineral prices dropped sharply during the global financial crisis, negatively impacting the Lao economy. We thus do not account for a price effect in this study.

The mining sector has sector-specific effects, as shown in table 5.2. Improved productivity and a higher capital stock in the mining sector stimulates production in the mining and private services sectors, but output in the agriculture and government services sectors ultimately decline, a result that is consistent with factor movements expected in a situation of Dutch disease (Corden and Neary, 1982; Corden, 1984). Output in the mining sector increased by about 10%, compared to 0.5% in industry and 2% in private services.[21] This major difference in the impacts is not too surprising because the mining sector is relatively weakly linked to the industrial and private services sectors.

Table 5.2: Macro effects (percent change from baseline)

	Simulation 1	Simulation 2	Simulation 3
	Increase capital in mining sector 10%	Increase total productivity of mining sector 5%	Simulation 1+2
Price			
GDP deflator	-1.763	-0.943	-2.706
Consumer price index	0.820	0.445	1.265
Investment price index	-1.658	-0.904	-2.562
Export price	0.344	0.183	0.527
Import price	0.000	0.000	0.000
Output	1.267	0.681	1.948
Value added price	-10.113	-5.524	-15.637
Real variables			
GDP	1.107	0.633	1.740
Consumer	-2.818	-1.478	-4.296
Investment	3.812	2.082	5.894
Export	0.059	-0.018	0.041
Import	3.131	1.691	4.822
Output	-0.162	-0.085	-0.248
Value added	11.218	6.120	17.338

Source: authors' computations from model.

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[21] This result is consistent with the results found by Bandara (1991).

Table 5.2: Sectoral effects (percent change from baseline scenario)

	Simulation 1	Simulation 2	Simulation 3
	Increase capital in mining sector 10%	Increase total productivity of mining sector 5%	Simulation 1+2
Output			
Agriculture	-0.817	-0.433	-1.251
Industry	0.292	0.164	0.456
Private services	1.239	0.677	1.916
Government services	-1.966	-1.061	-3.027
Mining	6.775	3.634	10.408
Value added			
Agriculture	-0.817	-0.433	-1.251
Industry	0.292	0.164	0.456
Private services	1.239	0.677	1.916
Government services	-1.966	-1.061	-3.027
Mining	6.775	3.634	10.408
Total intermediate demand			
Agriculture	0.199	0.114	0.314
Industry	5.506	2.955	8.461
Private services	5.068	2.720	7.788
Government services	2.914	1.568	4.483
Mining	2.830	1.523	4.353
Consumption household			
Agriculture	-1.883	-0.993	-2.876
Industry	-2.071	-1.066	-3.137
Private services	-2.697	-1.415	-4.112
Government services	-2.998	-1.575	-4.573
Mining	-0.342	-0.119	-0.460
Investment			
Agriculture	1.080	0.597	1.677
Industry	2.405	1.315	3.719
Private services	1.281	0.710	1.991
Government services	1.022	0.576	1.598
Mining	4.982	2.692	7.673
Export			
Agriculture	-1.917	-1.042	-2.959
Industry	-1.556	-0.845	-2.401
Private services	-1.879	-1.018	-2.896
Government services	6.962	0.000	6.962
Mining		3.732	3.732
Import			
Agriculture	2.849	1.560	4.409
Industry	3.962	2.138	6.100
Private services	6.720	3.594	10.314
Government services	1.891	1.020	2.911
Mining	0.236	0.140	0.376

Source: authors' computations from model.

The influx of capital lowers the capital rental rate in the mining sector by about 90%. The capital rental rate increases in the agricultural, industrial, private services and government services sectors due to the reallocation of resources towards the mining sector.[22] The capital rental rate respectively increases by about 2%, 5%, 8% and 2% in the agricultural, industrial, private services and government services sectors. The mining boom also leads to generally higher wages (table 5.3).

The mining sector can also negatively impact household income. Household income declined by about 2%, largely due to a 6% decline in capital income that more than countered the 4% increase in wage income. The decline in household income leads to lower household savings, as shown in table 5.4. We find government income to increase by about 4%.

Table 5.3: Effects of simulation on capital rental and wage rates

	Simulation 1	Simulation 2	Simulation 3
	Increase capital in mining sector 10%	Increase total productivity of mining sector 5%	Simulation 1+2
Rental rate			
Agriculture	1.107	0.610	1.717
Industry	3.218	1.736	4.955
Private services	4.977	2.674	7.651
Government services	1.291	0.694	1.985
Mining	-62.751	-31.065	-93.816
Wage rate			
Agriculture	2.578	1.381	3.960
Industry	2.593	1.389	3.983
Private services	2.600	1.393	3.993
Government services	2.640	1.413	4.054
Mining	2.592	1.388	3.980

Source: authors' computations from model.

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[22] It is important to note that we assume that the capital stock is fixed in all sectors.

Table 5.4: Effects on income

	Simulation 1	Simulation 2	Simulation 3
	Increase capital in mining sector 10%	Increase total productivity of mining sector 5%	Simulation 1+2
Income			
Total income of households	-1.420	-0.714	-2.134
Capital income	-3.970	-2.051	-6.021
Labor income	2.601	1.393	3.994
Total government income	2.774	1.505	4.279
Saving			
Household savings	-1.420	-0.714	-2.134
Government savings	58.444	31.713	90.157

Source: authors' computations from model.

VI.   Conclusion and policy recommendations

The mining sector is booming in Laos, bringing important benefits to the Lao economy, but this rapid growth in the mining sector also adversely impacts the economy through a classic case of Dutch disease. The limited number of studies on this issue reflects the fact that the impacts of mining sector on the Lao economy have yet to receive significant attention and are therefore insufficiently well understood. Our main objective in this paper is therefore to attempt to assess the impact of the mining sector on the Lao economy using a CGE model in order to provide policy recommendations on how to mitigate the negative impacts of rapid growth in the mining sector. The mining boom positively impacts real GDP, real exports and real investment. The mining sector boom contributes to an increase in real GDP of about 2% relative to the baseline. The rapid expansion in the sector is seen in terms of greater output, value added and consumption (of inputs) in the mining sector. Unfortunately, it is also associated with declining output, value added and consumption of agricultural and government services, reflecting the movement of production factors due to the Dutch disease in the economy.

This study is characterized by several weaknesses which need to be covered in future research. Firstly, this static CGE model does not reflect mining investment flows. Secondly, the mining sector has diverse impacts on the Lao economy, whereas this study only focuses on increasing the stock and productivity of capital in the mining sector without considering other factors. Thirdly, this approach does not capture externalities associated with mining (Bridge, 2004; McColl, 1980). For instance, increased pollution from the mining sector can adversely impact the productivity of other firms, thereby decreasing household welfare (Xie and Saltzman, 2000). Fourthly, it is important to specify which households gain and those which lose as a result of the mining boom. Finally, it is important to research

options on how to manage or spend windfall revenues in order to achieve sustainable economic growth and poverty reduction (Same, 2008; Warr, 2006).

A number of policy options exist in the literature to mitigate Dutch disease, with important contributions from Hausmann and Rigobon (2002) and Rosenberg and Saavalainen (1998). The impact of fiscal policy, exchange rate policy and foreign borrowing strategies was discussed in Usui (1996) in the case of Indonesia. Larsen (2006) is another contributor research on policy options for Norway to avoid Dutch disease. Tax policy and subsidies, as well as exchange rate protection, were discussed in Coden (1981,1982 and 1984).

On the basis of lessons learned from other countries and the macroeconomic situation in Laos, we propose four strategies to mitigate or avoid Dutch Disease in Laos. First, given that rising windfall expenditures accelerate real exchange rate appreciation, negatively affecting production in sectors which are not booming, it is important for policymakers to strive to balance the budget and promote the production of tradable goods without neglecting important investments in human resource development, infrastructure and health care projects. Secondly, countries with rapid-growth sectors can more easily attract international finance or ODA. Increased foreign borrowing during the boom times will have a major impact on tradable goods as a result of real exchange rate appreciation. Therefore, it is important for Laos to reduce foreign borrowing during the resource boom. Any prospective borrowing should be spent on human resources, infrastructure and health care development projects. Thirdly, Laos has a high level of external debt, so any increase in domestic spending will lead to real exchange rate appreciation, negatively impacting non-boom sectors. Rapid repayment of any debts following eventual receipt of the windfall cannot be neglected. Finally, windfall revenues from this rapid growth resource sector will not flow indefinitely: setting up a windfall mining fund to set aside resources for emergency times and external shock is thus crucial.

VII.   Extensions and future research

This study should be extended upon in future research.We modified the standard PEP model to include three categories in the CGE model, as is appropriate for the economic situation in Lao. The first modification pertains to the labor market. About 80% of the population of Laos is engaged in the agricultural sector, and an important share of this labor shifts to the manufacturing and services sectors outside of the farming season. We thus define labor in the agricultural sector as being employed informally, whereas labor employed in the manufacturing, public services, private services and mining sectors are defined as being employed formally. The relationship between informal and formal labor can be expressed by the following equations:

$$LD_{FOR} = \sum_i \; LD_{FOR} \qquad\qquad (1)$$

$$\overline{LS} - \sum_i \; LD_{FOR} = LS_{INF} \qquad\qquad (2)$$

$LS_{INF} = LD_{AGR}$ (3)

$LS_{INF} = LD_{INF}$ (4)

where $\overline{LS}$ denotes total labor supply, $\sum LD_{FOR}$ denotes total labor employed in the formal sector (manufacturing, public services, private service and mining), LS_{INF} is the total informal labor supply and LD_{INF} is labor demand in the agricultural sector.

A second important extension is to account for natural resources in the mining sector. Production in the mining sector is treated as arising from the combination of three factors: labor, capital and natural resources.[23] We assume that natural resources in Laos are sufficiently abundant in the short run to consider the supply of natural resources as infinite, and the price of natural resources is fixed as 1 (see figure 1). However, we assume that the supply of natural resources is limited in the long run, implying rising prices of natural resources due to increasing production of natural resources.

$XS_{MIN} = f(L_{MIN}, K_{MIN}, NR_s)$ (5)

NR_s = infinite (in the short run) (6)

$NR_s = NR_D($ (7)

where XS_{MIN} denotes mining production and L_{MIN} is labor supply in mining sector, K_{MIN} is capital in the mining sector, NR_s is the supply of natural resources and NR_D is the demand for natural resources. It important to note that we assume NR_s to be infinite in the short run in order to reflect Laos' current abundance of natural resources.

Figure 1: Natural resources supply curve

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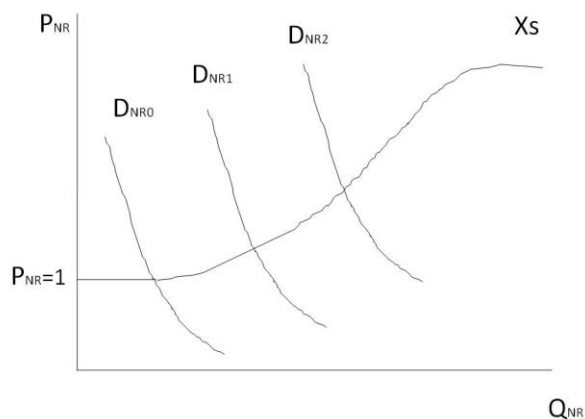
[23] Previous studies have not typically included natural resources as a production factor in the mining sector (for example, Corden and Neary,1982; Benjamin, Devarajan and Weiner (1989); Devaranjan Lewis, and Robinson (1990). Existing CGE models of the Lao economy did not include natural resources as a production factor in the mining sector (Warr, 2006; CIE, 2010).

A third important extension is to allow for capital mobility in the mining production function.[24] Fourth, we neglect to incorporate firms into our model because the GTAP database does not include data on firms, and other data on firms in Lao is scarce. This issue also appears in the studies produced by Warr (2006) and Warr, Menon and Yusuf (2010) who neglect firms in their models.

The closure of the model needs to reflect the actual economic situation of Laos and the objectives of this simulation. We proceeded as follows. First, since Laos uses a managed floating exchange rate regime, the Bank of Lao PDR issues a reference rate for the commercial banks to follow (Kyophilavong, 2010). This leads us to set the nominal exchange rate as the numeraire.[25] Second, the current account balance is held constant.[26] Third, we fix a minimum level of household consumption of commodities. Fourth, the Lao economy is sufficiently small that it does not significantly impact world markets: world prices of exported and imported products are thus exogenous. Fifth, the change in inventories is also exogenous. Sixth, the level of total investment expenditures is set as equal to total savings.

Parameters are one of the most important considerations in a CGE model. Some studies have found that different parameters lead to different policy outcomes (Abler et al, 1999). Some parameters for this study are calibrated from the SAM, but some other parameters are not available for Laos, so we refer to Warr (2006), Warr et al (2010) and CIE (2010)[27] to fill in these gaps.

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[24] However, the capital stock in mining is fixed in some studies (Cook and Lees, 1984; Higgs and Powell, 1984; Benjamin, Devarajan and Weiner, 1989) and Clement, Ahammad, and Qaing (1997) treated the capital stock in industry as fixed.

[25] Levy (2007) also treated the nominal exchange rate as exogenous and Benjamin, Devarajan and Weiner (1989) used the nominal exchange rate as the numeraire. In addition, the core Dutch-disease-effect model of Corden and Neary (1982) and by Corden (1982) used the exchange rate as numeraire. However, Dervis, Melo and Rosinson (1982) used the nominal exchange rate as endogenous.

[26] Levy (2007) and Dervis, de Melo and Rosinson (1982) do not treat the trade balance constrained: the trade imbalance adjusts via the real exchange rate.

[27] CIE (2010) used parameters from Thailand and Vietnam for their studies.

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