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**Working Paper**

# Poverty Impacts of Government Expenditure from Natural Resource Revenues

ADB Working Paper Series on Regional Economic Integration, No. 51

**Provided in Cooperation with:**
Asian Development Bank (ADB), Manila

*Suggested Citation:* Warr, Peter; Menon, Jayant; Yusuf, Arief Anshory (2010) : Poverty Impacts of Government Expenditure from Natural Resource Revenues, ADB Working Paper Series on Regional Economic Integration, No. 51, Asian Development Bank (ADB), Manila, https://hdl.handle.net/11540/1950

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Peter Warr, Jayant Menon, and Arief Anshory Yusuf

No. 51 | June 2010

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Peter Warr,[+] Jayant Menon,[++] and Arief Anshory Yusuf[+++]

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The authors are grateful to Nina Fenton, Elizabeth Mann, and Jin Cyhn for useful comments; and to Anna Cassandra Melendez, Salika Chanthalavong, and Sitthiroth Rasphone for valuable research assistance. The views expressed herein are those of the authors' alone and should not be taken to represent the views or policies of the Asian Development Bank (ADB), its Board of Directors, or the governments that ADB members represent.

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June 2010
Publication Stock No.

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## Abstract

This study analyzes the effects on poverty incidence and other economic variables resulting from government expenditures associated with natural resource revenues, using the Nam Theun II hydroelectric power project in the Lao People's Democratic Republic (Lao PDR) as a case study. The analysis uses a multi-sector/multi-household general equilibrium model of the economy of Lao PDR. The conceptual framework distinguishes between *official* and *marginal* expenditures financed by project revenues, recognizing that some of the former still might have been undertaken without the new revenues generated by the project. A range of assumptions is considered regarding the direct distributional impact of the marginal expenditures. The analysis also incorporates the project's indirect distributional effects, operating through the "Dutch disease" mechanism. We find that poverty incidence declines under the entire range of distributional assumptions considered. Nevertheless, the most important determinant of poverty impact is the degree of rural bias. Even the most regressive of the pro-rural distributions reduces poverty incidence by seven times as much as the most progressive of the pro-urban distributions.

*Keywords:* Poverty incidence, general equilibrium, natural resource revenues, Dutch disease, Lao PDR

*JEL Classification:* D58, I32, Q25

# 1. Introduction

Natural-resource-based projects often produce benefits primarily or even entirely in the form of foreign exchange revenues in the hands of the government since it is the government that possesses ownership rights over these resources. From the point of view of the local population, these projects inevitably produce some environmental and social costs, but the benefits depend to a large extent on the way the government chooses to spend project revenues. Different patterns of government expenditure generate different patterns of benefits across households. Moreover, regardless of the composition of the government expenditure, macroeconomic absorption of the foreign exchange revenues into the domestic economy can also be expected to produce indirect effects. In particular, they will normally generate "Dutch disease" effects, which may or may not have important distributional implications.

This paper explores these issues in the context of the Nam Theun II hydroelectric dam project in the Lao People's Democratic Republic (Lao PDR), subsequently referred to as the NT2 project.[1] It is the largest of several hydroelectric dam projects either constructed, under construction, or planned within Lao PDR. Construction of the dam and associated infrastructure involved an investment of almost US$1.5 billion, which is equivalent to around half of the country's annual gross domestic product (GDP), spread over the years 2004–2010. Full operation of the project is expected to commence in the latter part of 2010. The dam stores water that will be used for generating electricity, primarily for sale to neighboring Thailand. These sales will produce foreign exchange revenues that are to be shared by the investors—a consortium of international institutions and private investors—as well as the government of Lao PDR. The government's agreed share of these revenues is projected at roughly US$50 million per year.

Hydroelectric power projects in Lao PDR have always been controversial. In the case of the NT2 dam, much debate has focused on the environmental costs arising from the large intervention in water flows that it entails, along with the social costs of relocating the villages inundated by the dam, which covers a large area. In the design of the project, efforts were made to minimize costs of this kind and to compensate groups negatively affected, but some such costs are inevitable and must be measured against the benefits that will eventually derive from the revenues received by the government. Yet, even these expected benefits have also been disputed, in particular the degree to which the poor can be expected to benefit from the revenue generated by the project. The present study focuses on analyzing these distributional issues.

Two different kinds of distributional concerns have been discussed in the development economics literature dealing with the impacts of large natural resource projects, including the NT2 dam. First, there is the *direct* distributional impact of a government spending these revenues, most notably the extent to which the spending produces benefits for poor households. Second, there is an *indirect* distributional impact arising

[1] A much smaller dam was previously constructed on the same river and it is now known as Nam Theun I.

from the absorption of foreign exchange into the domestic economy. Whether this absorption occurs through government spending or private spending, and whether or not it is pro-poor, absorption of the foreign exchange inflow can be expected to generate a Dutch disease effect within the domestic economy, which may also have distributional consequences.[2]

The Dutch disease effect arises as follows. To be absorbed domestically, foreign exchange must ultimately be spent on traded goods, resulting in a combination of additional imports and reduced exports equal in value to the foreign exchange being absorbed. In macroeconomic terms, the revenues from the project are a capital inflow (capital account surplus), which produces a combination of an increase in international reserves (non-absorption of the revenues) and a current account deficit (absorption of the revenues) relative to the initial situation. Non-absorption means that the revenues are saved in the form of foreign exchange reserves to be used later. Until they are absorbed, they have no impact on the domestic economy and thus produce no immediate benefits. Full absorption means that reserves remain constant and the capital account surplus (capital inflow) is equal to the current account deficit. The combination of absorption and non-absorption that occurs is policy-determined.

To the extent that absorption occurs, the domestic effect is a real appreciation, in which the prices within the domestic economy of traded goods (tradables) decline relative to the prices of non-traded goods and services (non-tradables). As a result of this real appreciation, domestic tradables industries, including much of the agriculture and manufacturing industries, will be disadvantaged relative to non-tradables industries, including most services and utilities. That is, there will be a movement around the domestic production possibility frontier in favor of non-tradables and away from tradables. If the production of tradables were more labor-intensive than that of non-tradables, the result would be a decline in real wages (the Stolper–Samuelson effect) and a possible worsening of poverty. The opposite would occur if the factor intensities were the reverse of those just mentioned. Much of the literature on resource revenue effects in developing countries seemingly assumes that the Dutch disease effect potentially worsens poverty, presumably because tradables production is more labor-intensive than that of non-tradables, but it is not obvious whether this assumption is valid.

A central objective of the NT2 project agreed to by all parties involved in the consortium is to contribute to poverty reduction within Lao PDR, one of the least developed countries in Southeast Asia. In its agreements with the project financiers, the government promised that the revenues arising from the project would be spent in ways consistent with the country's Poverty Reduction Strategy Report (PRSP). This requirement leaves considerable latitude for the expenditures that will be financed from these revenues. It is of course possible to point to specific expenditures that are to be paid for using the dollar inflows resulting from the project. To put it crudely: here is a list of items that will be purchased using this particular pile of dollar bills originating from the

[2] The term "Dutch disease" refers to the effect on the Dutch economy of absorption of foreign exchange earned from exports of North Sea gas in the 1960s. Tradables industries such as manufacturing and agriculture contracted and non-tradables industries such as services expanded (Corden, 1982). Whether this effect deserves the epithet "disease" is debatable.

new project. These can be called the *official expenditures*. Their magnitudes can be found in project documents, which say that the revenues will be spent on purchasing a specified list of things.

However, these are not necessarily the *new* expenditures that were really made possible by the new revenues because some of these expenditures might have occurred anyway, even without the new revenues. Rather, the impact is the *marginal expenditures,* the ones made affordable by the existence of the new revenues and which would not have been undertaken in their absence. These could conceivably be quite different from the expenditures ostensibly being financed by the project revenues, as described in project agreements. Even though the official expenditures might be fully consistent with agreed-upon criteria such as those outlined in the PRSP, this may or may not apply to the marginal expenditures actually being financed with project revenues. In this respect, the NT2 project raises issues common to many natural-resource-based projects in which the benefits accrue, in the first instance, to the government.

An elementary illustration may clarify the point. Mr. Khampout increases his son Tay's allowance from $20 to $30 and tells him that he must spend the extra $10 on school books. Tay takes the $10 note just given to him and duly purchases a $10 school book, obtaining a receipt that he can show to Mr. Khampout. However, unknown to Mr. Khampout, this is a $10 book that Tay would have had to purchase out of his $20 allowance anyway. The increase in Tay's allowance frees up the $10 he would have had to spend on the book, enabling him to spend it now on whatever he really wants – say a movie ticket. The official expenditure is the new school book; the marginal expenditure is the movie ticket. It is impossible to identify Tay's marginal expenditure simply by looking at where the new $10 bill went, say by checking his receipt for the school book. It is necessary to compare Tay's total pattern of expenditures after the increased allowance with some estimate of what that pattern *would have been* without the increased allowance. The marginal expenditure is the difference between the two. But identifying it is not easy.

Similarly, the marginal expenditures arising from the new revenues available to the government from a project imply a distribution of direct benefits across members of the society, which defines their direct distributional impact. But the nature of these marginal expenditures, along with their true distributional impact, is not easily discovered and neither official project documents nor the pattern of past expenditures necessarily provide a reliable guide. These direct benefits then induce changes in household expenditure behavior that change relative commodity prices and through them change factor returns. These indirect price effects and their consequences arising from the expenditure of project revenues are the essence of the Dutch disease phenomenon. They imply that many people may be affected indirectly by the project, through commodity and factor price effects, even if they are not direct beneficiaries of the marginal expenditures and even if they are unaffected by the project's costs.

There is no question that the official expenditures associated with the NT2 project are carefully poverty-targeted. But the discussion above implies that the incremental expenditures actually financed by NT2 revenue inflows might be different from these official expenditures. Suppose they were different, does this matter? In this paper we

explore the extent to which the ultimate poverty-reducing capacity of the true marginal expenditures depends on their direct distributional characteristics. The paper draws upon a multi-household, multi-sectoral general equilibrium model of the Lao PDR economy to analyze the impact of these expenditures.

In Section 2, we describe the Nam Theun II project and provide a brief overview of poverty in Lao PDR. Section 3 of the paper presents a simple summary of the theory of Dutch disease, including its implications for the effect of absorption of capital inflows on the real exchange rate (ratio of tradables to non-tradables prices). It then presents data for Lao PDR that broadly confirms the existence of such an empirical relationship. The general equilibrium model to be used in the analysis is described in Section 4. Three features of the model are important. First, it distinguishes between rural and urban households, based on the Lao PDR government's household income and expenditure survey data for 2003. Second, based on the same survey data, each of the categories of households (rural and urban) contains 100 household sub-categories, arranged by real expenditures per household member, giving a total of 200 household sub-categories within the model. Third, the production side of the economy is divided into 20 industries, based on an input– output table previously constructed for a major province of Lao PDR. The details of the simulations and their results are presented in Section 5. Finally, Section 6 draws out the major conclusions that follow from the study.

# 2. The Nam Theun II Project and Poverty in Lao PDR

## 2.1 The Nam Theun II Project

Table 1 shows that the NT2 project involves the construction and operation of a US$1.45 billion hydropower facility that will generate 1,080 megawatts of electricity. About 93% of the electricity generated by NT2 will be exported to Thailand, from which revenues will be generated through taxes, dividends, and royalties (or concession fees). The remaining 7% will be for domestic consumption. As of December 2009, project construction was essentially complete. NT2 is only one of several hydroelectric dam projects due to be completed in Lao PDR by 2015. Their total investment cost is approximately US$4 billion, while each project generates benefits to Lao PDR primarily in the form of government revenues through foreign exchange earnings.

Structured as a build-own-operate-transfer project, NT2 is being developed by the Nam Theun II Power Company Ltd. (NTPC), a private company owned by a French–Thai–Lao consortium. Twenty-seven other partners are involved in the project, including the World Bank and the Asian Development Bank (ADB). The financing structure of the project is summarized in Table 2. The project has a concession period of 31 years, at the end of which all assets will be transferred to the Government of Lao PDR.

The main benefit to Lao PDR from NT2 will come from the revenues that the project will generate during the 25-year operation period (2009–2034). It is estimated that the government will receive a cumulative nominal sum of US$1.95 billion in revenue over this period. Revenues from the project are projected to rise gradually in the early years,

averaging US$30 million per year during 2010–2020 and then increasing to about $100 million per year for the remaining period up until 2034. Once all of the assets are transferred to Lao PDR at the end of the concession period, NT2 could generate US$6 billion–US$7 billion in profit for the government. These future revenues will provide continuing opportunities for the government to pursue its social development and poverty reduction objectives.

**Table 1: Lao PDR, Large Hydroelectric Dam Projects to be Operational by 2015**

| Dam | Installed capacity (MW) | Production (GWh/year) | Cost (US$ million) |
|---|---|---|---|
| Nam Theun II | 1,080 | 5,936 | 1,450 |
| Xeset 2 | 76 | 227 | 138 |
| Nam Ngum 2 | 615 | 2310 | 771 |
| Xe Kaman 3 | 250 | 970 | 278 |
| Theun Hinboun Expansion | 210 | 518.3 | 288 |
| Nam Ngum 3 | 460 | 1,919 | 630 |
| Nam Ngiep 1 | 252 | 1,274 | 340 |
| Total | 2,943 | 13,154 | 3,895 |

GWh = gigawatt–hour, MW = megawatt.

Source: International Monetary Fund (2007).

Revenues generated by NT2 are officially targeted to fund poverty reduction initiatives under the government's National Growth and Poverty Eradication Strategy (NGPES). Thus, programs eligible for funding with NT2 revenues will be based on NGPES priorities. In June 2009, the Lao PDR National Assembly approved the allocation of NT2 revenues as part of the fiscal year 2009/10 budget cycle. Subsequently, the Ministry of Finance provided the following indicative allocations for priority sectors: (i) education (35%), (ii) rural roads (30%), (iii) health (20%), and (iv) environment and forestry (15%). Sector ministries have begun finalizing the list of specific programs and expenditures, although these allocations could be revised in the future to take account of performance and changing policy priorities (World Bank, 2009a).

**Table 2: Financing Structure of Nam Theun II Project**
(US$ million)

| | |
|---|---|
| Project Cost | |
| | 1,450 |
| Base cost | 1,250 |
| | 200 |
| Contingency | |
| Financing | |
| | 1,450 |
| Equity | 450 |
| Private | 338 |
| Eletricite de France International | 158 |
| Electricity Generating Public Company Ltd | 113 |
| Italian-Thai Development Public company | 68 |
| Government (NTPC) | 112 |
| Debt | 1,000 |
| Official creditors | 160 |
| International Banks | 340 |
| Thai commercial banks (THB loans) | 500 |

Note: US dollar amounts are approximate due to exchange rate movements.
Source: World Bank (2009a).

The World Bank has been working closely with the Lao PDR government to ensure that revenues are carefully managed and employed for poverty reduction programs. These programs may be implemented, in part, through statutory funds such as the Road Maintenance Fund and the Poverty Reduction Fund, which offer additional fiduciary safeguards in terms of financial reporting and oversight arrangements. The Poverty Reduction Fund is initially being financed by the International Development Association (IDA), but will eventually be funded by NT2 revenues. In keeping with the NGPES, the Poverty Reduction Fund is targeted to the 72 priority districts (see below) and its use is demand-driven. Projects are identified by the villagers themselves and village volunteers are trained to implement and monitor the projects in cooperation with project staff (World Bank, 2009a and 2009b).

It is possible that NT2 revenues could, at least in part, replace IDA funds or other forms of official capital inflow that are currently targeted towards poverty reduction. To the extent that this occurs, the expenditures derived from NT2 revenues would merely replace poverty-targeted expenditures that would have occurred even if the NT2 revenues had not been received. The net addition to public spending resulting from the inflow of NT2 revenues would then be smaller than the revenue inflow. Moreover, even if

IDA funds do not decline as a result of the inflow of NT2 revenues, some of the NT2 funds could be used to finance other poverty-related expenditures that would have occurred anyway, freeing public revenues for new expenditures, which may or may not be poverty-targeted.

All this implies that, to some extent at least, both the size and the composition of the true marginal expenditures could be different from the size and composition of the official expenditures associated with the NT2 revenues, despite adherence to the agreed allocation of official expenditures associated with the project. It follows that both the size and composition of the true marginal expenditures are, to some extent, uncertain. This point has possible relevance for the extent to which the inflow of NT2 revenues actually reduces poverty. The uncertain nature of the true marginal revenues will be drawn upon in the design of our simulations, which are presented below.

## 2.2 Poverty and Inequality in Lao PDR

Lao PDR is one of the poorest countries in Asia, with a per capita income of only around US$475. Close to 70% of its people live in rural areas, almost one fourth of adults are illiterate, life expectancy at birth is 65 years, 7 in 100 children die by the age of five, and only 60% of the population has access to an improved water source (Table 3). However, years of continuously strong growth have led to an appreciable decline in poverty incidence, particularly over the past decade. Poverty incidence (headcount) declined from about 46% to approximately 34% of the population over the decade 1992/3 to 2002/3, and to below 28% in 2007/8. The Gini coefficient, however, reveals widening income disparities over the same period, especially in the urban sector (Table 4).

**Table 3: Lao PDR Social Indicators**

| Indicator | Latest Available Year | |
|---|---|---|
| GDP per capita (constant 2000 US$) | 475 | (2008) |
| Rural population (% of total population) | 69 | (2008) |
| Literacy rate, adult total (% of people ages 15 and above) | 73 | (2005) |
| Life expectancy at birth, total (years) | 65 | (2008) |
| Mortality rate, under-5 (per 1,000) | 70 | (2007) |
| Improved water source (% of population with access) | 60 | (2006) |

GDP = gross domestic product.
Source: World Bank, (2009c).

**Table 4: Lao PDR Poverty Rate and Gini Index**
(disaggregated by location and ethnic group)

| | Poverty Headcount | | | | Gini Index | | | |
|---|---|---|---|---|---|---|---|---|
| | **1992/3** | **1997/8** | **2002/3** | **2007/8** | **1992/3** | **1997/8** | **2002/3** | **2007/8** |
| Lao PDR | 46.0 | 39.1 | 33.5 | 27.6 | 30.5 | 34.9 | 32.6 | 35.4 |
| Area | | | | | | | | |
| Urban | 26.5 | 22.1 | 19.7 | 17.4 | 30.9 | 39.7 | 34.8 | 36.3 |
| Rural | 51.8 | 42.5 | 37.6 | 31.7 | 29.0 | 32.1 | 30.3 | 33.4 |
| Rural with road | 42.8 | 31.7 | 31.3 | 29.9 | 29.3 | 32.1 | 30.3 | 33.2 |
| Rural w/o road | 60.4 | 50.8 | 46.2 | 42.6 | 27.5 | 30.9 | 29.4 | 33.3 |
| Region | | | | | | | | |
| Vientiane M | 33.6 | 13.5 | 16.7 | 15.2 | 29.7 | 36.9 | 36.0 | 38.0 |
| North | 51.6 | 47.3 | 37.9 | 32.5 | 26.9 | 34.5 | 30.7 | 35.2 |
| Central | 45.0 | 39.4 | 35.4 | 29.8 | 31.5 | 32.5 | 31.0 | 34.0 |
| South | 45.7 | 39.8 | 32.6 | 22.8 | 32.3 | 32.4 | 31.4 | 32.2 |
| Border | | | | | | | | |
| Inland | 47.2 | 37.5 | 32.3 | 29.2 | 30.2 | 34.6 | 33.5 | 34.5 |
| Thailand | 33.4 | 29.4 | 22.5 | 16.1 | 28.9 | 35.2 | 30.9 | 35.4 |
| Vietnam | 58.4 | 66.3 | 61.1 | 54.5 | 34.2 | 28.9 | 25.8 | 29.4 |
| China-Myanmar | 49.1 | 46.4 | 28.1 | 28.2 | 21.1 | 31.1 | 25.9 | 29.6 |
| Cambodia | 68.1 | 38.5 | 39.8 | 23.1 | 26.8 | 29.3 | 28.0 | 29.8 |
| District slope | | | | | | | | |
| Mostly flat | 42.2 | 30.3 | 27.4 | 18.9 | 31.5 | 34.7 | 33.7 | 34.6 |
| Somewhat steep | 38.4 | 40.5 | 37.1 | 31.9 | 29.3 | 38.5 | 31.4 | 35.9 |
| Mostly steep | 56.2 | 50.9 | 40.4 | 38.8 | 28.1 | 31.4 | 30.1 | 33.5 |
| Village altitude | | | | | | | | |
| Lowland | | | 28.2 | 20.4 | | | 33.3 | 35.0 |
| Midland | | | 36.5 | 29.1 | | | 31.1 | 35.2 |
| Upland | | | 43.9 | 42.6 | | | 29.4 | 32.4 |
| Priority district | | | | | | | | |
| First priority | 56.1 | 63.0 | 49.4 | 43.5 | 29.9 | 29.7 | 27.9 | 31.9 |

| | Poverty Headcount | | | | Gini Index | | | |
|---|---|---|---|---|---|---|---|---|
| | 1992/3 | 1997/8 | 2002/3 | 2007/8 | 1992/3 | 1997/8 | 2002/3 | 2007/8 |
| Second priority | 58.2 | 41.7 | 41.2 | 36.2 | 31.9 | 29.6 | 32.0 | 32.7 |
| Other | 40.5 | 30.5 | 26.3 | 19.9 | 30.1 | 34.9 | 32.7 | 35.1 |
| Ethnic groups | | | | | | | | |
| Lao-Tai | | | 25.1 | 18.4 | | | 33.0 | 35.0 |
| Mon-Khmer | | | 53.7 | 47.3 | | | 27.0 | 31.1 |
| Chine-Tibet | | | 40.0 | 42.2 | | | 23.0 | 26.3 |
| Hmong-lu Mien | | | 45.8 | 43.7 | | | 29.0 | 31.7 |
| Other | | | 48.1 | 22.0 | | | 29.0 | 25.8 |

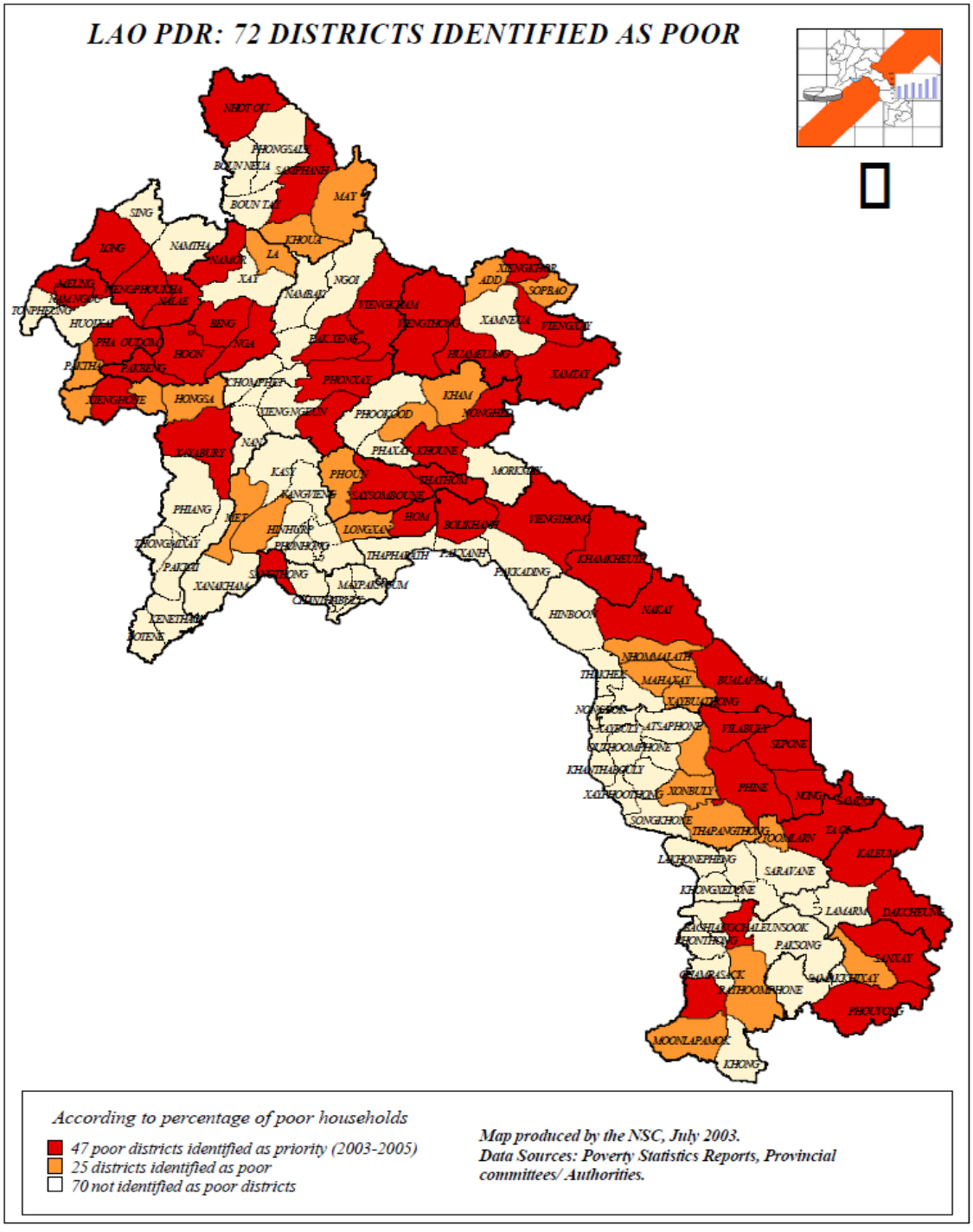
Source: LECS 4 (Government of Lao PDR, 2009).

Poverty in Lao PDR is strongly influenced by geography (Figure 1). Although poverty incidence has declined in both urban and rural areas, it fell sharply in the latter. Nevertheless, it continues to be significantly higher in the rural areas, especially those without road access (Table 4). Variations both within and across regions are likewise remarkable. Poverty rates were highest in the northern provinces, which are more remote and have lower population densities. The sharpest decline in poverty rates occurred in the South, falling from 32.6% in 2002/03 to 22.8% in 2007/08 (Table 5).

Poverty trends across border regions are likewise varied. Although poverty rates have declined significantly across all border regions since 1992/93, the poverty rate in the Lao PDR–Viet Nam border region remains huge at 54.5% as Table 4 shows. In view of these disparities, the NGPES has targeted poverty reduction interventions to 72 priority districts (47 first priority and 25 second priority districts) that were chosen using a set of basic needs indicators at the local level. All of these 72 priority districts can be considered to be mainly rural in composition. Thus, there is a clear preference, in terms of stated policy, to direct all kinds of expenditures targeted at poverty reduction, including those derived from NT2 revenues, predominantly towards the rural sector. Although the poverty headcount in first priority districts has declined from 49% in 2002/03 to 44% in 2007/08, this is still reportedly 100% higher than poverty rates in non-priority districts, while poverty severity is 180% higher.[3] Furthermore, enrolment rates are about 20% lower than in other districts, which is partly a reflection of the fact that the first priority districts are less urbanized and have inferior road access (World Bank, 2006).

[3] Poverty severity is measured as squared poverty gap, which itself is a measure of the depth of poverty.

**Figure 1: Geographical Distribution of Poverty in Lao PDR,—2003**



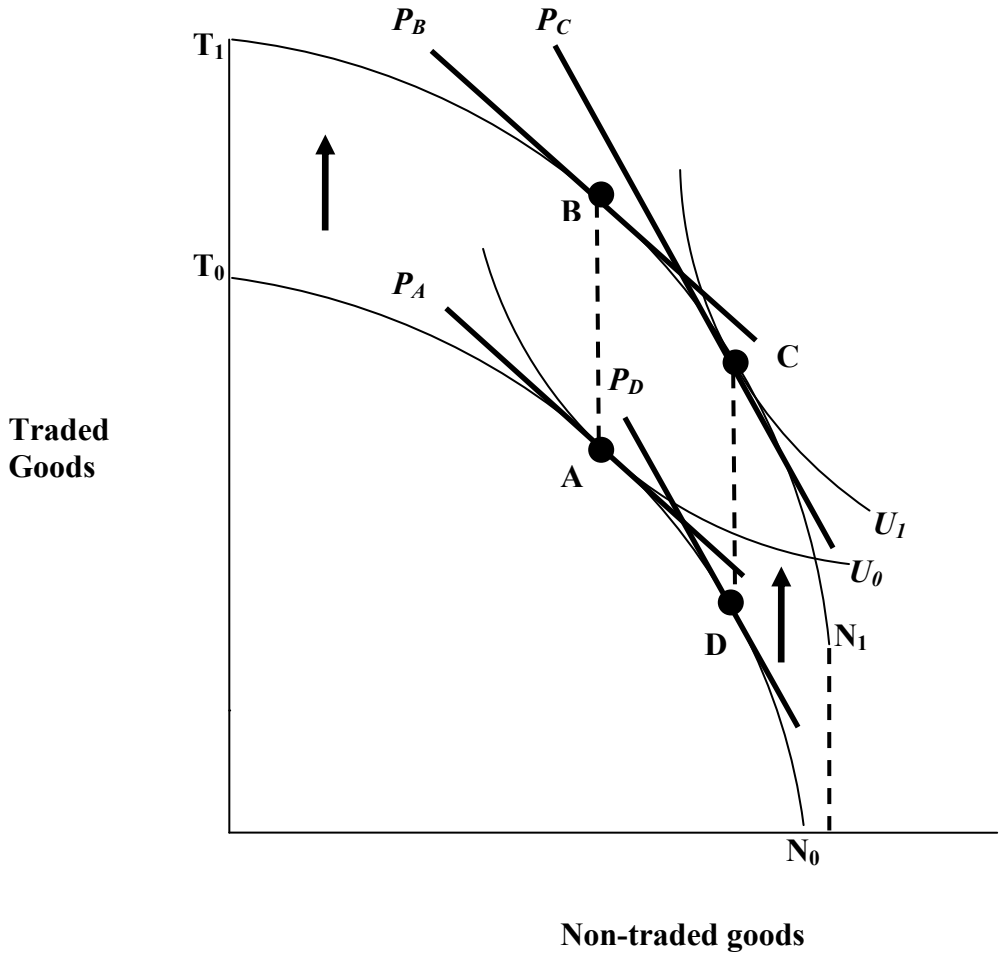

Source: Government of Lao PDR (2008).

# 3. Dutch Disease and its Relevance for Lao PDR

## 3.1 Dutch Disease Economics

The economic analysis underlying the Dutch disease phenomenon is summarized in Figure 2, which draws upon Salter (1959), Gregory (1976), Snape (1977), Corden (1981), and Warr (2006). For the sake of convenience, in this section of the paper we assume a single consumer. Suppose the initial equilibrium is at point A where the market for non-tradables clears, as it must, since non-tradables can be obtained only by producing them domestically. At A, the market for tradables also clears, implying that the current account is exactly in balance since the production of tradables exactly matches their consumption. At this point, the price of non-tradables relative to tradables—the inverse of the real exchange rate—is given by the slope of the production possibility frontier at A and also the slope of the indifference curve $U_0$ tangential to A, $P_A$.

**Figure 2: The Dutch Disease Effect**




Source: Authors' analysis,based on Warr (2006).

Revenues received from the project are a component of the foreign exchange earningcapacity of the domestic economy. It is assumed that the project does not directly affect production possibilities elsewhere in the economy, implying that the project uses few if any resources shared by other sectors. These features are represented by a vertical shift in the production possibility frontier from $T_0N_0$ to $T_1N_1$. Now consider point B, lying vertically above A. By construction, the slope of the new production possibility frontier $T_1N_1$ at B, $P_B$, is the same as $P_A$. But point B is not an equilibrium in the diagram as shown, because the valuation placed by the consumer on non-tradables relative to tradables—the slope of the indifference curve $U_1$ passing through B—exceeds $P_B$.

The consumer has a higher real income at B than at A. At this higher real income and at the relative prices $P_B$, he desires to consume more non-tradables as well as more tradables than at A, rather than merely more tradables as would be the case at B. Point B would be an equilibrium if and only if the expenditure elasticity of demand for non-tradables was zero. Provided non-tradables are a normal good, he attempts to substitute non-tradables for tradables, moving in a southeast direction from B. In the process, the price of non-tradables is bid up, because more will be produced only at a higher relative price. Suppose the new equilibrium is at C, lying on the highest attainable indifference curve, $U_2$. At this point, the price of non-tradables relative to tradables has risen to $P_C$. The real exchange rate—the inverse of this price ratio—has declined, corresponding to a real appreciation.

Now consider what this means for the rest of the economy, still characterized by the original production possibility frontier $T_0N_0$. Relative prices are now given by $P_D = P_C$ and production is at point D. The non-tradables sector has expanded relative to point A and the tradables sector (not including the new project) has contracted. The contraction of the non-booming exporting and import-competing industries that make up the tradables sector, and what it implies for the people deriving their incomes from them, is the essence of the Dutch disease.

The general class of economic phenomena for which this analysis is a special case is as follows. Suppose one group in the society receives a windfall gain from the outside.[4] When it spends that gain there may be indirect economic effects on other members of the society who did not receive the windfall. These indirect effects may in some cases be positive, in others negative. In the Dutch disease example, the owners of specific factors used in the non-tradables sector will be indirect beneficiaries of the spending, by others, of their windfall gains. But the owners of specific factors used in the tradables sectors will suffer.

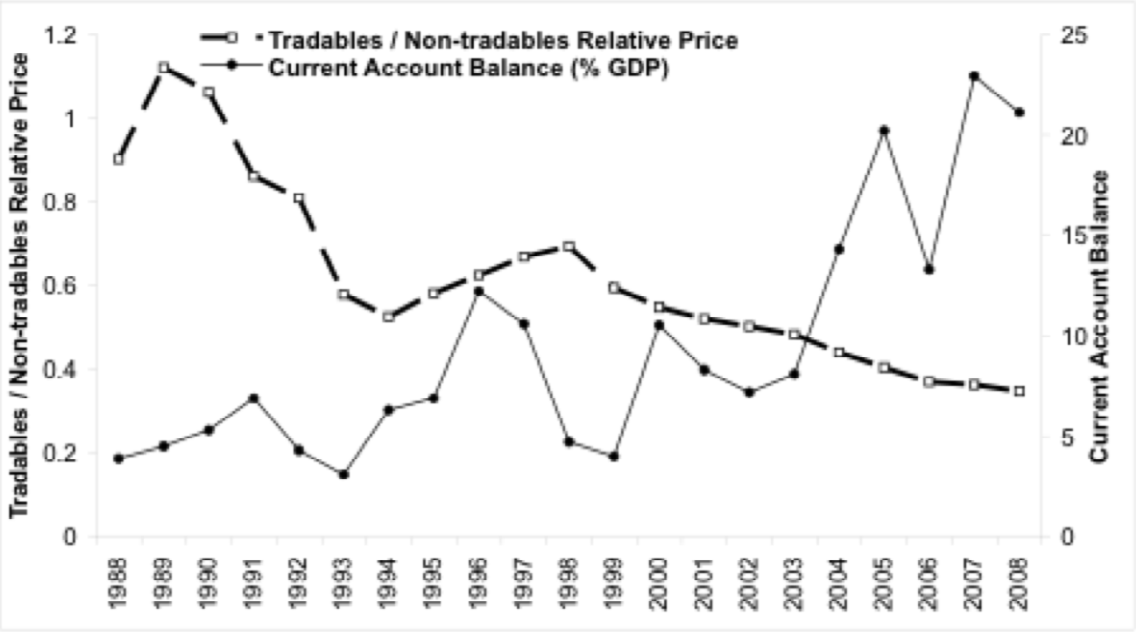
## 3.2 Relevance for Lao PDR

Do the data for Lao PDR support the existence of a Dutch disease effect? This question is explored below as follows. First, we construct an index of tradables/non-tradables relative prices. The only price data available on a consistent time series basis for Lao PDR relate to consumer prices. These data are assembled by the government's National

[4] The analysis applies equally in reverse for a windfall loss, such as a natural or man-made disaster.

Statistical Center for the purpose of constructing the consumer price index (CPI) and were kindly made available for the purposes of the present study for the years 1988–2008. The commodities defined in the data were divided into tradables and non-tradables categories and aggregated using their weights in constructing the CPI, which are based on the country's household income and expenditure survey. Monthly data were used, but were aggregated into annual form for the purpose of this study. The resulting relative price series is shown in Figure 3.

**Figure 3: Lao PDR Tradables/Non-tradables Price Ratio and Current Account Balance**




Source: For relative prices, authors' calculations using consumer price data from National Statistical Center, Vientiane; for current account balance, International Monetary Fund (2007) and subsequent updates.

Capital flows are treated as follows. Consider the balance of payments accounting identity

$$\Delta R = CAB + KAB, \tag{1}$$

where $\Delta R$ denotes the change in the level of official reserves; $CAB$ denotes the current account balance (positive if the current account is in surplus, negative if in deficit); and $KAB$ denotes the balance of the capital account. Alternatively, rearranging this expression,

$$KAB = \Delta R - CAB = \Delta R + CAD, \quad (2)$$

where $CAD = -CAB$ denotes the level of the current account deficit (positive if the current account is in deficit).

Now suppose there is an exogenous inflow of external resources. This inflow could be foreign aid, foreign investment, or as in the case of this study royalty payments for electricity exports. This increases the left-hand side of equation (2). This inflow may have effects on productivity and output in the medium term, but in the short term the inflow of foreign capital will be reflected in the two right-hand components of equation (2): there will be some combination of an increase in foreign exchange reserves of the central bank and a current account deficit. Official reserves will increase to the extent that the inflow is sterilized by the domestic monetary authority and thereby not absorbed into domestic spending, while the current deficit will increase to the extent that this does not happen and the capital inflow is absorbed into the domestic economy. It is therefore possible to interpret the change in the current account deficit as that part of the surplus of the capital account that is absorbed domestically, rather than saved in the form of an increase in official reserves.

The saved part of an exogenous capital inflow has no effect on the domestic real exchange rate, or any other domestic variable, because it does not affect domestic spending. So far as current macroeconomic effects are concerned, the relevant part of the capital inflow is the absorbed component, rather than the saved component. To see the magnitude of the absorbed component of a capital inflow, it is possible to look at the change in the current account deficit. In what follows, we interpret the magnitude of the capital account surplus and decisions on official reserves as exogenous. We wish to see the extent to which the absorption of capital inflows resulted in real exchange rate appreciations and thus, potentially, to Dutch disease effects on the domestic economy.

Figure 3 shows the relationship between the tradables/non-tradables price ratio for Lao PDR, as described above, and the current account deficit. The Dutch disease hypothesis implies a negative relationship. Figure 3 seemingly provides some support for such an effect, but the relationship is far from perfect. To analyze the time series data more systematically, the regression equation

$$\ln(P_t^T / P_t^N) = a + b\ln(CAD/GDP)_t + u_t \quad (3)$$

was estimated for the years 1988–2008, using the data shown in Figure 3. The results are summarized in Table 5. The estimated coefficient $b$ was negative as expected and its magnitude was significant at the 95% confidence level. The other diagnostic indicators reported seemingly support the existence of this relationship.

These results provide rough support for the existence of a Dutch disease effect for Lao PDR. Nevertheless, analysis for a short period of trending time series data is fraught with statistical pitfalls. Moreover, many events other than changes in capital inflows were

occurring during the two decades covered by the data, with possible relevance for real exchange rates. These events included trade policy reform efforts beginning in 1987 and extending to the middle of the 1990s, followed by hyperinflation and significant nominal exchange rate depreciation in the late 1990s. For this reason, statistical analysis such as that above is inherently inconclusive. In any case, the existence of a Dutch disease effect does not in itself tell us anything about its implications for poverty. The next section constructs a multi-sector, multi-household computable general equilibrium (CGE) model of the Lao PDR economy to analyze the issues discussed in the paper, with a focus on the consequences for poverty incidence.

**Table 5: Estimated Relationship between Real Exchange Rate and Current Account** (1988–2008)

| Variable | Log-Log Form (t-statistic) |
|---|---|
| Dependent Variable $P_t^T / P_t^N$ | |
| $a$ (constant term) | 4.43 (22.7) |
| $b$ (coefficient on CAD/GDP) | -–0.32 (–3.48) |
| R square | 0.66 |
| F value | 22.04 |
| D-W test | 1.54 |
| ADF-t | –3.68 |
| LM test | 5.63 |
| BP test | 4.74 |

Source: Authors' calculations.

# 4. A General Equilibrium Model of the Economy of Lao PDR

This section describes *LaoGEM* (Lao General Equilibrium Model), a 20-sector, 200-household general equilibrium model of the Lao PDR economy, constructed specifically for the analysis of the way changes in economic policy and other economic shocks affect poverty incidence in Lao PDR. Unless otherwise stated, the database of the model refers to 2002–03. The model's main features are as follows.

## 4.1 Model Structure

The theoretical structure of *LaoGEM* is relatively conventional. It belongs to the class of general equilibrium models that are linear in proportional changes, sometimes referred

to as Johansen models. The highly influential *ORANI* general equilibrium model of the Australian economy (Dixon et al., 1982) also used this approach.[5] However, this general structure is adapted to reflect the specific objectives of the present study and important features of the Lao PDR economy.

The microeconomic behavior assumed within *LaoGEM* is competitive profit maximization on the part of all firms and competitive utility maximization on the part of consumers. Each industry has constant returns-to-scale technology and there is at least one industry-specific factor present in each industry. In the simulations reported in this paper, the markets for final outputs, intermediate goods, and factors of production are all assumed to clear at prices that are determined endogenously within the model.[6] The nominal exchange rate between the Lao kip and the US dollar is fixed exogenously and its role within the model is to determine, along with international prices, the nominal domestic price level. The model is homogeneous (degree one for prices and degree zero for quantities) with respect to this exchange rate. This means that because domestic prices adjust flexibly to clear markets, a 1.0% increase in the kip–dollar exchange rate will result in a 1.0% increase in all nominal domestic prices, leaving all real variables unchanged.

## 4.2 Industries

The model contains 20 industries listed in Table 6 below. They include three agricultural industries: crops, livestock and poultry, and forestry and logging. Non-agricultural industries include mining and quarrying, seven manufacturing industries, and nine services and utilities industries. Each industry produces a single output and the set of commodities therefore coincides with the set of industries. Exports are not identical with domestically sold commodities. In each industry the two are produced by a transformation process with a constant elasticity of transformation.

The core of the production side of the model is a 20-sector, input–output table for Lao PDR that is estimated especially for this study. The input–output table constructed for the present study is the first publicly available input–output table for the country. The table is based on information from two sources. First, there is a 20-sector, input–output table for Savannakhet province of Lao PDR, relating to the year 2003 and recently constructed in a detailed study by researchers at ADB (Sim et al., 2007). This table is then adjusted using data from the Lao PDR National Accounts for 2002. The method of adjustment may be understood as follows. The value added totals for the various sectors of the Savannakhet table are compared with those for Lao PDR, derived from the National Accounts. The Savannakhet table is then amended using a method called RAS (row and column sum) to force the value added totals to match those for Lao PDR.

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[5] The structure of LaoGEM also draws on elements of a revised version of the ORANI model of the Australian economy called ORANI-G (Horridge, 2004).

[6] Variations to this assumption are possible. For example, the possibility of unemployment can be introduced by varying the closure to make either real or nominal wages exogenous, thereby allowing the level of employment to be endogenously determined by the demand for labor.

The resulting table reflects the industry structure of Lao PDR, as reflected in its National Accounts, but within each industry the input–output technology reflects that of Savannakhet province. The method thus assumes that the input–output technology for each industry in Lao PDR is similar to that of Savannakhet, even though the relative importance of these various industries in Lao PDR is quite different from that of Savannakhet. Fortuitously, Savannakhet province seems a suitable basis for this kind of exercise in that it is roughly intermediate within the provinces of Lao PDR in terms of its level of technology. The resulting table seems to make sense. When a properly constructed input–output table for Lao PDR becomes available, it should presumably replace the table estimated above. In the meantime, this table is considered the best available. The cost structures of these 20 industries, derived from the estimated input–output table, are summarized in Table 6.

**Table 6: Cost Structure of Industries in *LaoGEM* model**

| | Intermediate Inputs | Market Margin | Indirect Tax | Wage Labor | Non-Wage Labor | Capital | Land | Total |
|---|---|---|---|---|---|---|---|---|
| Crops | 1.74 | 0.39 | 0.06 | 47.63 | 25.91 | 13.58 | 6.48 | 100 |
| Livestock | 3.15 | 2.51 | 0.31 | 17.60 | 21.03 | 17.48 | 9.01 | 100 |
| Forestry | 2.41 | 0.84 | 0.23 | 41.45 | 16.74 | 23.61 | 11.16 | 100 |
| Mining | 65.74 | 10.09 | 1.14 | 1.47 | 0.09 | 1.55 | 0.79 | 100 |
| Food | 2.67 | 4.61 | 0.87 | 8.92 | 3.22 | 14.97 | 0.00 | 100 |
| Textile | 14.36 | 5.35 | 0.47 | 16.21 | 3.74 | 30.36 | 0.00 | 100 |
| Wood | 17.99 | 11.35 | 3.82 | 3.92 | 1.61 | 7.73 | 0.00 | 100 |
| Chemicals | 71.13 | 10.57 | 0.91 | 1.15 | 0.00 | 3.52 | 0.00 | 100 |
| Minerals | 23.42 | 7.11 | 0.86 | 16.22 | 1.64 | 29.23 | 0.00 | 100 |
| Metals | 56.83 | 8.86 | 0.67 | 7.85 | 0.79 | 14.32 | 0.00 | 100 |
| Other manuf. | 37.25 | 6.08 | 0.29 | 14.22 | 12.88 | 25.42 | 0.00 | 100 |
| Elect./water | 8.41 | 3.32 | 1.51 | 16.81 | 0.00 | 43.71 | 0.00 | 100 |
| Construction | 35.83 | 11.46 | 0.65 | 11.21 | 6.81 | 9.31 | 0.00 | 100 |
| Transport | 10.22 | 1.87 | 0.22 | 40.77 | 7.27 | 33.27 | 0.00 | 100 |
| Post and comm. | 19.07 | 3.02 | 0.32 | 26.52 | 2.20 | 39.27 | 0.00 | 100 |
| Trade | 11.45 | 2.67 | 0.37 | 26.62 | 21.83 | 28.95 | 0.00 | 100 |
| Banking | 1.50 | 4.18 | 0.52 | 6.52 | 0.00 | 70.74 | 0.00 | 100 |
| Estate | 0.12 | 0.23 | 0.24 | 16.67 | 0.00 | 74.54 | 0.00 | 100 |
| Government | 13.39 | 3.54 | 0.69 | 55.10 | 0.00 | 0.00 | 0.00 | 100 |
| Other services | 44.56 | 9.57 | 0.68 | 10.36 | 7.34 | 9.70 | 0.00 | 100 |

Note: The data relate to 2002–03.
Source: Authors' calculations, using data from Sim et al. (2007) amended as discussed in the text.

## 4.3 Commodities

Although the sets of producer goods and consumer goods have the same names, the commodities themselves are not identical. Each of the 20 consumed goods consists of a composite of the domestically produced and imported version of the same commodity, where the two are imperfect substitutes. The proportions in which they are combined reflect consumer choices and depend on both (i) the relative prices of these imported and domestically produced versions of the good and (ii) the (Armington) elasticity of substitution between them.

## 4.4 Factors of Production

The mobility of factors of production is a critical feature of a general equilibrium system, where the term mobility here means the capacity to move across economic activities (industries) and not necessarily the capacity to move geographically. The greater the inter-sectoral factor mobility that is built into the model, the greater the flexibility of the economy as reflected in its simulated capacity to respond to changes in the economic environment. It is essential that assumptions about the mobility of factors of production be consistent with the length of run that the model is intended to capture. The analysis period of this paper is the short run, which should be understood as an adjustment period of around 3 years.

Labor is assumed to be of two kinds: paid and unpaid. Wage labor is fully mobile across all sectors, implying that wages must be equal in all sectors and must move together. Non-wage labor means primarily family labor, which is not paid a formal wage and is much less mobile across industries than paid labor. The most important form of non-wage labor occurs in agriculture, in the form of family farm labor, but important examples also exist in many service industries and in petty trading. Non-wage labor is assumed to be immobile between industries in the short run. There are two kinds of capital: agricultural and non-agricultural. Agricultural capital is mobile across industries within agriculture, but immobile between agriculture and non-agriculture. Non-agricultural capital is similarly mobile across non-agricultural industries, but immobile between non-agriculture and agriculture. Finally, land is assumed to be immobile across agricultural industries.

In this treatment, fixed capital in agriculture is thought of as meaning land as well as some light machinery and equipment of an industry-specific kind. Mobile capital in agriculture includes some land as well as machinery, such as light tractors and draft animals that can be used in the production of a range of agricultural commodities. Neither agricultural land nor agricultural capital (machinery and draft animals) are usable in non-agricultural industries. Non-agricultural capital is thought of as including industrial machinery and buildings.

## 4.5 Technology

In every sector there is constant elasticity of substitution (CES) production technology with diminishing returns to scale to variable factors alone. However, there is also a sector specific fixed factor (immobile capital or land) in every sector. For convenience,

we shall refer to the set of specific factors in the agricultural sectors as land and to the set of those in the non-agricultural sectors as fixed capital. However, for the reasons described above, this language is accurate only in an approximate way. The assumption of constant returns means that all factor demand functions are homogeneous of degree one in output. In each sector, there is a zero profit condition, which equates the price of output to the minimum unit cost of production. This condition can be thought of as determining the price of the fixed factor in that sector.

## 4.6 Households

The model contains two major household categories: urban (24% of the population) and rural (76% of the population). The incomes of these two household types depend on their ownership of factors of production, the returns to those factors, and their non-factor incomes, mainly consisting of transfers from others. Since our focus is on income distribution, the sources of income of the households are of particular interest. These differ between the two household categories. The data are extracted from the 2002–03 household income and expenditure survey, the Lao PDR Expenditure and Consumption Survey (LECS 3).[7] The Social Accounting Matrix is based on data from this survey, the input–output table described above, Lao PDR National Accounts for 2002, and Lao PDR trade data.

Within the *LAOGEM* model, each of the two household categories is sub-divided into a further 100 sub-categories (centile groups), each of the same population size and arranged by real consumption expenditures per capita, giving a total of 200 sub-categories.[8] The consumer demand equations for the various household types are based on a Cobb–Douglas demand system, using data on expenditure shares extracted from the LECS 3 survey. Within both of the two major categories, the 100 sub-categories thus differ according to (i) per capita expenditures, (ii) budget shares in consumption, and (iii) sources of factor and non-factor incomes. Table 7 summarizes the expenditure shares of urban and rural households. Within each of these categories the data also show average expenditure shares of households below the poverty line. The sources of factor incomes of the households play an important role in distributional analysis and these factor income shares are summarized in Table 8.

[7] The "3" in LECS 3 signifies that it is the third (and most recent) such survey to be conducted. The previous two surveys (LECS 1 and LECS 2) were for 1992–93 and 1997–98, respectively.

[8] The population sizes of the two major categories are not the same, but within each of the two categories the population sizes of the 100 sub-categories are the same.

## Table 7: Expenditure Shares of Poor and Average Households —Urban and Rural (%)

| | Urban Poor | Rural Poor | Urban | Rural |
|---|---|---|---|---|
| Crops | 9.75 | 49.19 | 7.35 | 22.81 |
| Livestock | 0.23 | 0.35 | 0.16 | 0.24 |
| Forestry | 0.18 | 0.54 | 0.12 | 0.34 |
| Mining | 0.00 | 0.00 | 0.00 | 0.00 |
| Food | 76.40 | 36.96 | 64.98 | 54.80 |
| Textile | 1.67 | 2.79 | 2.07 | 3.20 |
| Wood | 0.16 | 0.66 | 0.31 | 0.39 |
| Chemicals | 0.42 | 1.14 | 2.06 | 1.69 |
| Minerals | 0.00 | 0.01 | 0.04 | 0.04 |
| Metals | 0.32 | 0.74 | 1.25 | 1.24 |
| Other manuf. | 0.05 | 0.14 | 0.52 | 0.58 |
| Elect./water | 2.00 | 0.45 | 2.34 | 0.36 |
| Construction | 0.00 | 0.01 | 0.08 | 0.12 |
| Transport | 0.30 | 0.46 | 0.35 | 0.55 |
| Post and comm. | 0.00 | 1.19 | 1.02 | 0.35 |
| Trade | 1.10 | 0.22 | 1.57 | 0.41 |
| Banking | 0.00 | 0.00 | 0.07 | 0.05 |
| Estate | 3.11 | 0.33 | 4.50 | 2.38 |
| Government | 0.10 | 0.43 | 0.77 | 0.91 |
| Other services | 4.21 | 4.38 | 10.45 | 9.55 |
| Total | 100 | 100 | 100 | 100 |

Source: Authors' calculations, using data from Sim et al. (2007) and National Statistical Centre, Lao Expenditure and Consumption Survey, 2002-03, Vientiane. The data relate to 2002-03.

**Table 8: Factor Income Shares of Poor and Average Households —Urban and Rural** (%)

| | Urban Poor | Rural Poor | Urban | Rural |
|---|---|---|---|---|
| Wage Labor | 64.00 | 35.22 | 55.64 | 31.32 |
| Non-wage Labor | 12.93 | 23.27 | 15.94 | 24.67 |
| Agriculture capital | 6.11 | 10.99 | 7.53 | 11.66 |
| Non-agriculture capital | 13.90 | 25.01 | 17.13 | 26.52 |
| Land | 3.05 | 5.50 | 3.76 | 5.83 |
| Total | 100 | 100 | 100 | 100 |

Note: The date relate to 2002–2003.
Source: Authors' calculations, using data from Sim et al. (2007) and National Statistical Center; and Lao PDR Expenditure and Consumption Survey (2002–2003).

### 4.7 Elasticity Estimates

The elasticity estimates used in *LaoGEM* for the factor demand systems were taken from empirical estimates derived econometrically for a structurally similar model of the Thai economy, known as *PARA*. These parameters were amended to match the differences between the databases for *LaoGEM* and *PARA* so as to ensure the homogeneity properties required by economic theory. All export demand elasticities were set equal to 20. The elasticities of supply of imports to Lao PDR were assumed to be infinite and import prices were thus set exogenously. All production functions are assumed to be CES in primary factors with elasticities of substitution of 0.5, except for the paddy production industry where this elasticity is set at 0.25, reflecting the empirical observation of low elasticities of supply response in this industry. The Armington elasticities of substitution in demand between imports and domestically produced goods were set equal to 2 for all commodities.

## 5. Simulations and Results

### 5.1 The Shocks

We analyze the effects of a capital inflow of US$50 million per year, which is subsequently spent by the government. Our analysis focuses on the distributional characteristics of this spending.

Following from the discussion in the Introduction and Section 2, two forms of uncertainty arise in specifying the distributional impacts of public spending financed from NT2 revenues. First, it is not fully clear what the available data on official expenditures mean in terms of their distributional impact. For example, education and health make up more than half of the official proposed expenditures, but there is scope for a wide range of

distributional outcomes to be consistent with these broad categories of expenditure.[9] Second, the possibility exists that the marginal expenditures—the true incremental expenditures actually financed by these revenues—may be different from the official expenditures, because some of the official expenditures may have occurred anyway. Accordingly, we design a set of shocks that recognizes the uncertainty that exists over the true distributional impacts of the spending. This is done by considering shocks that cover a wide range of distributional possibilities. The simulations will determine the extent to which the effect of the expenditures on poverty incidence is sensitive to these distributional assumptions.

We simplify the marginal government expenditures arising from the project inflows, treating them as lump-sum income transfers to individual households. Of course, actual expenditures seldom, if ever, take this heavily simplified form, but this stylized treatment allows us to focus on the distributional characteristics of the marginal expenditures. In this treatment, when the government receives income from the project, it distributes it directly to households in lump-sum form with the distribution across households depending on two criteria:

(i) whether the household is rural or urban, and
(ii) the household's pre-transfer income.

We explore simple rules for applying these two criteria to determine the distribution of benefits across households and review the extent to which the poverty-reducing power of the project depends on these rules, while taking account of the Dutch disease arguments. Because the commodity and factor price effects referred to above could be important for the ultimate poverty impact of the spending, and are central to the Dutch disease phenomenon, the analysis necessarily involves general equilibrium issues.

Table 9 summarizes the nine simulations performed. First, we consider three forms of urban–rural bias:

(i) Pro-rural—all marginal expenditures go to rural households,
(ii) Neutral—marginal expenditures are divided in proportion to population, and
(iii) Pro-urban—all marginal expenditures go to urban households.

Second, we consider three forms of distributional bias within regions:

(i) Progressive—marginal expenditures are allocated in inverse proportion to income,
(ii) Neutral—marginal expenditures are allocated independently of income, and
(iii) Regressive—marginal expenditures are allocated in proportion to income.

Simulation 1 is presumably the most pro-poor allocation of marginal expenditures and Simulation 9 is presumably the most pro-rich. It is not clear *a priori* how the other seven

[9] As noted in Section 2, "rural roads" is another official expenditure category. In an earlier study of Lao PDR, Menon and Warr (2008) developed a general equilibrium approach to estimating the distributional impact of this category of expenditures.

simulations should be ranked in this respect. We will explore this issue by determining how the nine possible combinations of marginal expenditure allocations implied by this classification each affect poverty incidence, along with other variables of interest.

**Table 9: Summary of Simulations**

| | | Within Regions | | |
|---|---|---|---|---|
| | | **Progressive** | **Neutral** | **Regressive** |
| Between regions | Pro-rural | SIM1 | SIM2 | SIM3 |
| | Neutral | SIM4 | SIM5 | SIM6 |
| | Pro-urban | SIM7 | SIM8 | SIM9 |

Source: Authors' assumptions.

## 5.2 Model Closure

Since real household consumption expenditure is chosen as the basis for welfare measurement, the macroeconomic closure must be made compatible with both this measure and the single-period horizon of the model. This is done by ensuring that the full economic effects of the shocks are channeled into current-period household consumption and do not leak in other directions, whereby real-world, inter-temporal welfare implications are not captured by the welfare measure. The choice of macroeconomic closure may be seen, in part, as a mechanism for minimizing inconsistencies between the use of a single-period model to analyze welfare results and the multi-period reality that the model depicts.

To prevent inter-temporal and other welfare leakages from occurring, the simulations are conducted with balanced trade (exogenous balance on current account), including the capital inflows. This means that the capital inflow is fully absorbed. Balanced trade means that the change in the value of net exports (gross exports minus gross imports) is equal to the magnitude of the capital inflow. This ensures that the potential benefits from the inflow do not flow to foreigners through a current account surplus and also that increases in domestic consumption are not achieved at the expense of borrowing from abroad, leading to a current account deficit in excess of the magnitude of the capital inflow. For the same reason, real government spending on each good is fixed exogenously. The government budget deficit is held fixed in nominal terms, meaning that the magnitude of the receipt of revenues from abroad is exactly matched by the total magnitude of government transfers to households. This is achieved by endogenous across-the-board adjustments to the sales tax rate in order to restore the base level of the budgetary deficit. The combined effect of these features of the closure is that the full effects of changes in policy are channeled into household consumption and not into effects not captured within the single-period focus of the model.

## 5.3 Results

Table 10 summarizes the short-run macroeconomic effects of the capital inflow that are transferred to households according to the simple rules outlined above. In this table, as in each subsequent table of results, except Table 12, the results refer to the percentage change in the variable shown relative to its base level.

The capital inflow of US$50 million per year is equivalent to just under 1.0% (0.91%) of GDP, but real GDP is virtually unaffected by the inflow because the capital inflow has no short-run effect on production capacity within Lao PDR. Our macroeconomic closure ensures that the capital inflow is reflected in increased household consumption. Real household consumption increases by about 1.27% in each simulation, reflecting the fact that household consumption is about 72% of GDP. The absorption of the foreign exchange is accompanied by a contraction in exports and expansion of imports, causing a moderate improvement in the terms of trade.

The real exchange rate is measured here as the average purchaser price of traded goods (the eleven industries listed from “crops” to “other manufacturing” in Table 6, using total purchases as weights) relative to the average purchaser price of non-traded goods and services (the nine industries listed from “electricity and water” to “other services,” weighted similarly). The real exchange rate appreciates significantly in each simulation (the negative sign indicates a decline in the $P_t^T / P_t^N$ price ratio), consistent with the Dutch disease analysis. Real wages rise only in the most pro-poor allocation (Simulation 1). Moving across the table, the declines in real wages become progressively larger. This outcome is a consequence of the spending patterns of poor rural households at one extreme and rich urban households at the other. Poor rural households purchase goods and services that are more labor- and land-intensive, bidding up real wages and real returns to land. Rich urban households purchase more capital intensive goods and services, bidding up returns to capital.

The above spending story carries over to Table 11, which shows changes in industry outputs. The output of crops rises in Simulations 1, 2, and 4 (the most pro-poor patterns of marginal expenditures), but decline in all others. The greater the pro-rich bias in expenditures, the greater the decline in the output of crops. Rich households spend a small proportion of their incomes on staple foods such as crops. The reverse outcome occurs with livestock.

## Table 10: Changes in Major Macroeconomic Variables
(% change from base)

| Between Region | Pro-Rural | | | Neutral | | | Pro-Rural | | |
|---|---|---|---|---|---|---|---|---|---|
| **Within Region** | **Progressive** | **Neutral** | **Regressive** | **Progressive** | **Neutral** | **Regressive** | **Progressive** | **Neutral** | **Regressive** |
| | **SIM 1** | **SIM 2** | **SIM 3** | **SIM 4** | **SIM 5** | **SIM 6** | **SIM 7** | **SIM 8** | **SIM 9** |
| Real GDP | 0.016 | 0.016 | 0.016 | 0.017 | 0.017 | 0.018 | 0.019 | 0.020 | 0.021 |
| Real household consumption | 1.271 | 1.270 | 1.268 | 1.273 | 1.272 | 1.271 | 1.279 | 1.279 | 1.279 |
| Export volume index | (4.381) | (4.355) | (4.299) | (4.408) | (4.384) | (4.333) | (4.481) | (4.465) | (4.427) |
| Import volume index | 1.328 | 1.339 | 1.361 | 1.318 | 1.327 | 1.347 | 1.288 | 1.294 | 1.310 |
| GDP price index | 2.815 | 2.804 | 2.774 | 2.843 | 2.829 | 2.793 | 2.920 | 2.900 | 2.848 |
| Consumer price index | 2.418 | 2.410 | 2.386 | 2.444 | 2.433 | 2.403 | 2.515 | 2.497 | 2.451 |
| Terms of trade | 1.13 | 1.12 | 1.10 | 1.13 | 1.13 | 1.11 | 1.15 | 1.15 | 1.14 |
| Real exchange rate | (2.74) | (2.73) | (2.70) | (2.76) | (2.75) | (2.72) | (2.84) | (2.82) | (2.77) |
| Real factor returns: | | | | | | | | | |
| Wage | 0.014 | (0.013) | (0.067) | (0.028) | (0.050) | (0.092) | (0.146) | (0.155) | (0.161) |
| Agric. Capital | (0.430) | (0.492) | (0.652) | (0.490) | (0.551) | (0.700) | (0.659) | (0.716) | (0.837) |
| Non-agr.capital | 0.058 | 0.170 | 0.428 | 0.188 | 0.292 | 0.522 | 0.555 | 0.635 | 0.784 |
| Land | (0.140) | (0.223) | (0.420) | (0.225) | (0.302) | (0.482) | (0.460) | (0.525) | (0.653) |

Source: Authors' calculations.

## Table 11: Changes in Industry Outputs
(% change from base)

| Between region | Pro-Rural | | | Neutral | | | Pro-Urban | | |
|---|---|---|---|---|---|---|---|---|---|
| Within Region | Progressive | Neutral | Regressive | Progressive | Neutral | Regressive | Progressive | Neutral | Regressive |
| | SIM 1 | SIM 2 | SIM 3 | SIM 4 | SIM 5 | SIM 6 | SIM 7 | SIM 8 | SIM 9 |
| Crops | 0.08 | 0.03 | (0.07) | 0.02 | (0.02) | (0.11) | (0.16) | (0.18) | (0.22) |
| Livestock | 0.10 | 0.13 | 0.17 | 0.15 | 0.16 | 0.19 | 0.27 | 0.27 | 0.25 |
| Forestry | (1.92) | (1.91) | (1.89) | (1.93) | (1.92) | (1.90) | (1.98) | (1.96) | (1.92) |
| Mining | (3.14) | (3.15) | (3.19) | (3.20) | (3.22) | (3.25) | (3.39) | (3.40) | (3.42) |
| Food | 0.17 | 0.20 | 0.25 | 0.23 | 0.25 | 0.28 | 0.39 | 0.38 | 0.36 |
| Textile | (1.30) | (1.29) | (1.28) | (1.36) | (1.34) | (1.33) | (1.50) | (1.49) | (1.48) |
| Wood | (3.08) | (3.07) | (3.03) | (3.10) | (3.09) | (3.05) | (3.16) | (3.14) | (3.11) |
| Chemicals | (3.58) | (3.61) | (3.66) | (3.68) | (3.70) | (3.74) | (3.94) | (3.95) | (3.97) |
| Minerals | (0.07) | (0.06) | (0.05) | (0.07) | (0.07) | (0.05) | (0.07) | (0.07) | (0.06) |
| Metals | (2.38) | (2.40) | (2.42) | (2.45) | (2.46) | (2.47) | (2.65) | (2.65) | (2.62) |
| Other manuf. | (0.32) | (0.30) | (0.18) | (0.34) | (0.32) | (0.20) | (0.40) | (0.37) | (0.25) |
| Elect./water | (0.99) | (0.98) | (0.96) | (0.96) | (0.94) | (0.90) | (0.87) | (0.83) | (0.73) |
| Construction | 0.03 | 0.03 | 0.04 | 0.03 | 0.03 | 0.04 | 0.03 | 0.03 | 0.04 |
| Transport | 0.71 | 0.71 | 0.73 | 0.71 | 0.72 | 0.73 | 0.72 | 0.73 | 0.74 |
| Post and comm. | (0.14) | (0.11) | 0.03 | (0.11) | (0.05) | 0.12 | (0.02) | 0.11 | 0.35 |
| Trade | 0.06 | 0.07 | 0.10 | 0.07 | 0.08 | 0.11 | 0.11 | 0.12 | 0.14 |
| Banking | (0.35) | (0.33) | (0.26) | (0.34) | (0.32) | (0.26) | (0.33) | (0.31) | (0.25) |
| Estate | 0.13 | 0.16 | 0.24 | 0.20 | 0.22 | 0.28 | 0.40 | 0.40 | 0.39 |
| Government | 0.13 | 0.16 | 0.23 | 0.14 | 0.16 | 0.22 | 0.16 | 0.18 | 0.20 |
| Other services | 0.90 | 0.98 | 1.17 | 0.89 | 0.97 | 1.18 | 0.86 | 0.96 | 1.22 |

Source: Authors' calculations.

## Table 12: Changes in Poverty Incidence and Inequality

| Between Region | Pro-Rural | | | Neutral | | | Pro-Urban | | |
|---|---|---|---|---|---|---|---|---|---|
| Within Region | Progressive | Neutral | Regressive | Progressive | Neutral | Regressive | Progressive | Neutral | Regressive |
| | SIM 1 | SIM 2 | SIM 3 | SIM 4 | SIM 5 | SIM 6 | SIM 7 | SIM 8 | SIM 9 |
| Poverty incidence (%) (ex post level minus ex ante level) | | | | | | | | | |
| Urban | 0.36 | 0.37 | 0.38 | (0.12) | (0.08) | 0.08 | (0.54) | (0.42) | (0.21) |
| Rural | (2.86) | (2.77) | (2.21) | (2.62) | (2.54) | (1.98) | (0.34) | (0.35) | (0.36) |
| Total | (2.01) | (1.94) | (1.53) | (1.96) | (1.90) | (1.44) | (0.39) | (0.37) | (0.32) |
| Gini Index (%) (ex post level minus ex ante level) | | | | | | | | | |
| Urban | 0.13 | 0.13 | 0.12 | (0.27) | (0.09) | 0.17 | (1.36) | (0.69) | 0.31 |
| Rural | (1.13) | (0.60) | 0.35 | (0.80) | (0.41) | 0.29 | 0.14 | 0.13 | 0.12 |
| Total | (0.92) | (0.67) | (0.16) | (0.73) | (0.49) | (0.05) | (0.17) | 0.02 | 0.27 |

Source: Authors' calculations.
Note: Initial (ex ante) values in 2007–08 were poverty incidence: urban (17.4%), rural (31.7%), and total (27.6%); and Gini coefficient: urban (36.3%), rural (33.4%), and total (35.4%).

Finally, Table 12 shows the estimated changes in rural and urban poverty incidence and inequality. The method of calculating changes in poverty incidence is illustrated by Figure 4, which reproduces the result for Simulation 1. The two vertical lines in the figure depict the official poverty lines for rural and urban areas. The rural poverty line is lower, reflecting lower living costs in rural areas. The solid and dashed lines show the cumulative density functions of real household expenditures deflated by household-specific consumer price indices before the transfers (*ex ante*), as captured by the observed survey data (solid lines), and the simulated (*ex post*) distribution with the transfers (dashed lines). The intersection of each of these cumulative density functions with the poverty line indicates poverty incidence. The difference between the two is the impact of the transfers. Since Simulation 1 entails transfers that are biased towards the poorest rural households, it is not surprising that rural poverty incidence falls and urban poverty incidence is affected only slightly. The effect on urban poverty is not zero. There is a small positive effect because some of the goods and services purchased by the urban poor increase in price as a result of the spending of the rural poor and this effect outweighs the increase in real wages that also occurs.

From the changes in poverty incidence, one simple conclusion emerges. The most important characteristic of the marginal expenditures, in so far as effects on poverty incidence are concerned, is its degree of rural bias. This is far more important than the within-region distribution. That is, whether the distribution within rural areas is progressive, neutral, or regressive is far less important than its rural–urban bias. Among the pro-rural distributions, even the most regressive distribution (Simulation 3) reduces poverty incidence by seven times as much as the most progressive of the pro-urban distributions.

## 6. Conclusion

This study analyzes the effects on poverty incidence and other economic variables that arise from increases in public expenditures. The expenditures of interest are those financed by resource inflows from outside the country, rather than from tax revenues collected within the country. We focus in particular on government expenditures financed by foreign exchange revenue inflows derived from the operation of natural resource projects such as the NT2 hydroelectric dam project in Lao PDR. The analysis is conducted with a multi-sector/multi-household general equilibrium model of the economy of Lao PDR.

The analysis distinguishes between the official expenditures—those that are officially said to be financed by the project—and the marginal expenditures—those incremental expenditures actually made possible by the addition to government revenues. These are the expenditures which occur with the new revenues and would not have occurred in the absence of these revenues. The two might be different if some of the official expenditures would have been undertaken anyway, even in the absence of the new revenues. The analysis also takes account of the indirect distributional effects of the absorption of foreign exchange revenues operating through the Dutch disease mechanism of real appreciation.

The official expenditures associated with the NT2 project are carefully targeted towards poor people within Lao PDR. The present study analyzes the effects of a wide range of marginal expenditures, whose distributional characteristics may differ from those of the official expenditures. The aim is to assess how much the distinction between official and marginal expenditures matters for the poverty-reducing effects of the revenue inflow.

The results confirm that the new expenditures financed by natural resource projects can be expected to reduce poverty incidence within the country. Poverty incidence declines under the entire range of distributional assumptions that are considered. Nevertheless, the magnitude of the poverty reduction that occurs is highly sensitive to these distributional assumptions. By far the most important determinant of the poverty-reducing power of government spending is the degree to which it is focused on rural rather than urban areas.

The results have implications for the poverty-reducing capacity of additions to government expenditures, such as those arising from natural resource revenues. The results imply that it is appropriate to consider the government's full spending program and not just the expenditures officially associated with the particular revenue inflow under consideration. Put simply, the important question is not which expenditures are officially associated with the new revenues. Rather, the important and much more difficult question is what are the incremental government expenditures that are made possible by the new revenues and that would not have occurred without them.

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Printed in the Philippines