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SCALING UP INFRASTRUCTURE SPENDING IN THE PHILIPPINES: A CGE TOP-DOWN BOTTOM UP MICROSIMULATION APPROACH

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Abstract

In this paper we use a top-down bottom up microsimulation CGE model with endogenous labour supply to explore the impact of scaling up infrastructure in the Philippines. As the debate on the importance of scaling up infrastructure to stimulate growth and provide a push to growth, some analyst raise concern on financing these infrastructures after construction and that external funding can create major distortion and have a negative impact on the trade balance of these countries and adverse effect on poverty. This study aims to provide so insight into this debate. It draws from the infrastructure productivity literature to postulate positive productive externalities of new infrastructure and Fay and Yepes (2003) for operating cost associated with new infrastructure. We investigate on types fiscal tools to fund the new infrastructure and operation and maintenance costs. We compare our simulations to non productive investments.

JEL codes: C68, D68, E62, F35, H54.

Keywords: Investment externalities, foreign aid, fiscal reforms, poverty, CGE, microsimulation.

Introduction

Since Aschauer (1989) and Munnell (1990a, 1990b) stressed the important role of the public sector in funding infrastructure to stimulate economic development, a vast literature has dealt with this issue. Theoretical models and empirical studies have attempted to shed some light on this relationship. Some authors believed that a decline of productivity would be induced by slow expansion of the public infrastructure investment (Bergman and Suan 1996; Hakfoort 1996 and Binder and Smith 1997). In policy circles, this role was much less popular in the context of reforms and structural adjustment programs of the mid eighties and nineties. For many international institutions and developing countries the focus was directed at liberalizing trade, improving macroeconomic balances and reacting to various external shocks. With improvements on these grounds but with sluggish results for poverty reduction in many countries, the end of the nineties saw major changes in development strategies by international financial institutions (IFI), development partners and governments of developing countries.

According to Estache (2007), infrastructure seems to be returning to the agenda of development economists. The interest of the economists is the result of a change in focus from governments of developing country, IFI's and multi and bilateral donor agencies bringing back infrastructure at the top of the Agenda. The Asian Development Bank organized a major conference on Infrastructure Development, Private solutions for the Poor in October 2002 in Manila. This conference dealt with important issues such as making infrastructure projects pro-poor, increasing private sector participation to scale up infrastructure and strengthening and increasing pro-poor public-private infrastructure partnerships. This conference built on the May 2000 conference organized by Department for International Development (DFID-UK) and the

World Bank. The World Bank's world development report published in 2001 is an important illustration of this change as well as the implementation of the Poverty Reduction Strategy programs. More recently the Asian Development Bank (2009) published a report on investing in sustainable infrastructure to improve the lives. Since the turn of the century, poverty has been at the center of the development strategies. In many countries, growth is constrained by infrastructure bottlenecks in a large number of developing countries and this is reflected in many investment climate survey where infrastructure rank as top priority (Estache 2007)[1].

Governments from developing countries and various development partners have been investigating the determinants of poverty and most efficient roads out of poverty. One important determinant of poverty reduction is improvement of productivity. On one hand, education has received much attention to improve workers productivity and significant investments have been made and major reforms have been implemented to improve education of workers in developing countries. More and more analysts have raised the issue of faltering or obsolete infrastructure in development countries has a stumbling block for growth. In many countries, infrastructure growth has not followed the economic and demographic growth and in some instances the infrastructure wasn't even maintained. This situation has lead many analysts to return to the literature linking public expenditure on infrastructure. These stakeholders have argued that major investments to scale-up to levels of infrastructures would transform their role from a constraint to a motor for growth and indirectly would contribute in the long run to reducing poverty.

Some authors such as; Gupta et al (2006), Foster and Killick (2006), Mckinley (2005)), Rajan and Subramanian (2005) have suggested that scaling up aid could have negative

[1] Estache (2007) provide an interesting survey of the state of infrastructure for development and reviewing the main issues at stake for policy makers of developing countries and donor agencies.

macroeconomic consequences among which the spreading of the Dutch disease due to the risks of appreciation of the real exchange rate. It is important to note that scaling-up infrastructure is a subset of scaling up aid in general. These conclusions have been challenged by others in empirical studies such as Berg et al. (2007) for five Sub-Saharan African countries, Li and Rowe (2007) for Tanzania or Mongardini and Rayer (2009) for a panel of 28 Sub-Saharan African countries. Although this shows that the matter has not been settled, the concern for the risks associated with large scaling up of aid (for infrastructure or other expenditures) continues to prevail in many policy circles. A fair amount of authors have investigated the impacts or challenges of scaling up aid to achieve the Millennium Development Goals (MDG), namely Bourguignon and Sundberg (2006), Hailu (2007) and Serieux et al (2008). Others argue that significant infrastructure scaling-up will results in inflation and loss of competiveness. There is also an important body of literature on public investment dealing with eviction private investment. Finally, some authors have raised concerns over excessive burden created with scaling-up of infrastructure on operation and maintenance costs (O&M).

In a recent comprehensive report sponsored jointly by the African Development Bank, the World Bank and the Agence Française pour le Développement, edited by Foster and Briceño-Garmendia (2010) found that half of Africa's improved growth was generated by infrastructure. In the report, the authors argue that improved infrastructure will accelerate urbanization which has been the motor of growth in many countries and that will also improve regional integration. They focus on the potential for contribution to growth of various forms of infrastructure such as information and communication technologies, electricity, transport (in a broad sense), water, irrigation and sanitation. They further decompose the contribution of roads, railway, ports and airports. They also investigate the impact on poverty, the role of institutions and the various

function options available. The main contribution of this report is to provide a price tag to upgrading infrastructure in Africa to what would be needed to achieve optimal growth rates. This price tag is estimated 93 billion per year of which one third is required for operation and maintenance.

In this paper we provide a comparative analysis of funding mechanism to finance the new infrastructure and operation and maintenance cost. As described in Adam and Bevan (2006) Levy (2007) and Estache et al (2007) the literature shows that infrastructure investment can contribute to the so-called Dutch disease (i.e., in which a booming sector adversely affects performance in that country's other economic sectors—in particular, the non-booming tradable sector). In their 2006 paper, Adam and Bevan show that the negative economic effect can be attenuated if non-tradable sectors also benefit from infrastructure investment externalities. They construct an aggregated model to verify this and apply it to Ugandan data. We extend this idea by dropping the dichotomous classification of sectors as tradable and non-tradable and we also introduce an additional element by imposing increases in public expenditure to maintain and repair the new public infrastructure as in Estache et al (2007). These increases will be included in the government budget constraints while funding options will be investigated through fiscal policy and foreign aid. We further extend from these last authors by introducing a distributional analysis namely poverty analysis. For this purpose, a CGE micro-simulation model is required and we use a CGE top-down/bottom up micro-simulation approach.

The paper is structured as follow; we present a brief literature review of CGE microsimulation approaches to situate our methodology, we follow by a presentation of our model and the resolution strategy, we present our simulations and provide an analysis of macro

and sectoral variables and complete the analysis with the poverty impact analysis. We close the paper with our concluding remarks and possible extensions.

Review of CGE microsimulation

Three main approaches have been used to link macro reforms to changes in income distribution and poverty. The first one being the most commonly used is the representative household approach (CGE-RH), the second one is usually referred to as CGE integrated multi-household (CGE-IMH) approach and the third is generally referred to as the Top-down or micro-simulation sequential approach (CGE-MMS). The CGE-RH approach consists of using household subgroups in a CGE model and inferring changes in the income of all household within each groups based on the change of income of the representative household in the CGE model. With this approach the within-group redistribution of income is not taken into account and can lead to misleading conclusions[2]. The second approach first proposed by Decaluwé, Dumont and Savard in 1999, is the CGE integrated multi-household approach (CGE-IMH). This method relies on including a large number of household from household survey or all households of the survey into a CGE model. This approach has the advantage of being fully coherent between the micro and macro part of the model albeit data reconciliation can be very problematic [Rutherford et al. (2005)] and numerical resolution can also be challenging [Chen and Ravallion (2004)]. However, this approach takes into account the within-group distributional effects. The other drawback of the approach is that it can become constraining in terms of the types of behaviors that can be modeled. For example, regime switching behaviors such as employment-unemployment decisions are extremely difficult to model in this context. As employment type and unemployment are strong determinants of household welfare, a second micro-simulation

approach was proposed by Bourguignon, Robilliard and Robinson (2005) to rigorously integrate these behaviors. Their approach is referred to as the CGE micro-simulation sequential CGE-MSS method with rich household behavior. It consists of constructing a CGE module that feeds price changes into a micro-simulation household model[3]. As the previous CGE-IMH approach it allows to capture within-group distributional changes but it offers more flexibility in terms of household behaviors being modeled. The main drawback of this process is that it does not always fully take into account the feedback effect of household behavior being modeled in the micro-simulation module. In fact, when micro-household behavior aggregate perfectly, this approach implicitly integrates the feedback effect. However, when micro-household behavior does not aggregate perfectly, the aggregation error is lost in the process. The interesting question is to know the size of this aggregation error. If the aggregation error is small, not taking into account the aggregation error is unlikely to bias results but is the error is relatively large, there is a likelihood biasing the results by not taking into account the feedback effect. This critique of the CGE-MMS approach has been raised in two literature review of macro-micro modeling for poverty analysis (Hertel and Reimer (2005) as well as Bourguignon and Spadaro (2006).

To circumvent this problem, we propose a more flexible variant of the CGE-IMH which draws from the CGE-MMS approach. The basic idea is to push the CGE-MMS approach further by taking into account the feedback effect of the micro-household module. This allows taking into account the aggregation error of the micro-household model back into the CGE macro module. We refer to this approach as the "Top-down/bottom-up" approach (CGE-TD/BU). As we mentioned, the approach draws from the CGE-MSS approach insofar as its two modules provide flexibility to model household behavior but introduces a bi-directional link between the two

modules (macro CGE module and household micro-simulation module) to obtain a convergent solution between the two modules. The advantage vis à vis the EGC-MMS approach is that it takes into account the feedback effect from the micro-module but its main drawback is that convergence is not guaranteed and must be verified for each simulation. The approach has three main advantages over the CGE-IMH approach. First, there is no obligation of scaling the household data to national accounts, and no need to balance income and expenditure for each household. Consequently, it allows the modeller to use the exact income and expenditure structure found in the household income and expenditure surveys. The second advantage is that there is not limit to the level of disaggregation in terms of production sectors and number of households to be included in the model. This is likely to be a temporary constraint since computing power increases rapidly for the CGE-IMH approach, but it is presently a real constraint. These two problems are discussed in Rutherford et al. (2005) and Chen and Ravallion (2004). Finally, and most importantly, the degree of freedom in choices of functional forms used to reflect micro-economic heterogeneity of household behaviour is much higher in this approach[2].

The basic idea of the approach is to use the CGE model to generate a price vector (including wage rates) and a household micro-simulation (HHMS) model, to compute the response of household behaviours (consumption and labour supply) to these price changes. These micro-household responses are re-aggregated and these vectors are then fed back into the CGE model in which they are now exogenous shocks and the iteration process continues until the results, between two iteration processes for all variables, are equal to zero. In this context it is important to have the two models and data base as coherent as possible. It is important to note that nothing

[2] It draws this advantage from the EGC-MMS approach.

guarantees a converging solution to be found; therefore it must be validated and numerically checked for the introduction of each new hypothesis. Moreover to facilitate convergence, we introduce aggregate or macro functions mimicking the micro behaviour in the CGE module used in the first loop of the iterative process. In this application we used an aggregate household consumption function and a labour supply function.

The model

The basic model used for the analysis and the algorithm used for its resolution is presented in detail in Bourguignon and Savard (2008). We provide a summary of the model's hypothesis and present modification to this model drawn from Estache et al (2007) to capture the productivity of scaling up infrastructure investment and the operation and maintenance cost of the new infrastructure. We start with the CGE module for which we present the general model and move on to the special features to address the infrastructure externalities and the funding of operation and maintenance costs. We follow the presentation with a description of the microsimulation module and complete the presentation with a brief presentation of the resolution process.

The CGE module

The CGE model is disaggregated into 20 sectors and comprises 873 equations. The bottom part of the overall macro/micro model is based on all of the 39,520 households from the FIES. Production is determined in the first place through a 3-tier system: the total production of the branch (*XS*) is made up of a fixed share between value-added (*VA*) and intermediate consumptions (*CI*). *VA* is a combination of composite labour (*LD*) and capital (*KD*) which are related thanks to a Cobb-Douglas function. Producers minimize their cost of producing *VA*

subject to the Cobb-Douglas function. We introduce an externality parameter in this function which we describe in more detail below. Optimal labour demand equations are derived from this process. Labour is then decomposed into formal and informal labour, and the choice of combinations between these two factors is determined by a constant elasticity of substitution (CES) function[3]. This assumption allows for sector-specific elasticity of substitution. We assume that capital is not mobile between sectors, as it is quite difficult in the short to medium term to convert capital in order for it to be used in another production sector. Intermediate consumptions are combined with each other with the Leontief (fixed share) assumption as is commonly assumed in CGE modelling.

The labour market is quite original with respect to most macro/micro models. The dual labour market is not perfectly segmented. The nominal wage in the formal market is exogenous and it is also above the natural market wage: hence we have an excess supply of labour on this market. Workers choose to offer their labour on those markets or stay unemployed based on their reservation wage and on the prevailing wages on the two labour markets. The informal nominal wage is flexible to clear this market[4].

In the CGE module, we only have one representative household. Its income is composed of wage payments (from the two labour categories), capital payments, dividends, and transfers from other agents (households and remittances from abroad). As opposed to what we would find in the CGE-IMH approach, labour endowment is endogenous (as stated above) although this is only factored in the micro module. At an aggregate level (CGE module), workers can move in and out of unemployment as well as between the formal and informal markets. These movements will be computed into the micro module and transferred into the CGE module.

[3] Workers on the formal market are mostly skilled workers while workers on the informal market are mostly unskilled.
[4] Further details concerning the labour market will be given in the micro household module.

The key assumptions to capture impact of infrastructure spending rely on their positive externalities and the government budget constraint. Hence, it is important to look at the series of equations directly related to these elements. We can first look at the government income sources (equation 1.1). The government draws its revenues from indirect taxes on output (*Ti*), direct taxes on household (*Td*) and firms (*Tde*) and import duties (*Tim*).

$$1.1 \quad Yg = \sum_{im} Tim_{im} + Td + Tde + \sum_{m} Ti_{m} + Trg + Teg + Tgm$$

The others sources of income are transfers from other agents; these transfers can be negative or positive depending on the observed data of the country. The three other agents provide transfers from other agents—namely the households (*Tgm*), the firms (*Teg*), and the rest of the world (*Trg*). The rest of the world transfers mainly comprise foreign aid to the Philippines. This source of funding will be used to fund infrastructure investments.

This first equation (1.1) does not provide the full picture because the investment will also be linked to government expenditure on public services. The next equation (1.2) is the budget constraint for the government, which will spend part of its income (*Yg*) on public services or expenditure (*G*) and the other part on government savings (*Sg*), which will be used entirely for public investment.

$$1.2 \quad Sg = Yg - G$$

At this point, the closure rule[5] used to balance this budget constraint will be central to our analysis. We introduce an additional assumption that percentage increases in public infrastructure investment will generate higher operation and maintenance costs for the government. Hence, the level of government expenditure will be a function of its original

[5] The closure rule consists in determining the variable of adjustment to reach an investment objective and hence the government savings will be exogenous.

expenditure (*Go*) plus the operation and maintenance of the new infrastructure. We compute imposed increases in expenditure by computing the increase in public investment (*Itp* - *Itpo*) and multiplying the increase by a parameter ω, which is the ratio of the maintenance cost over investment expenditure. The government expenditure (*G*) will be determined with the following equation:

$$1.3 \quad G = Go + \omega(Itp - Itpo)$$

An average parameter is used drawn from the Fay and Yepes (2003) figures[6]. This assumption for public expenditure is equivalent to having an exogenous variable since the only element that will change in simulations is the level of investment given the objective. Given this situation the government savings will also be implicitly exogenous given the identity of equation 1.3.

$$1.4 \quad Itp = Sg$$

Given these assumptions, only one element can be adjusted so as to balance out the government budget constraint (equation 1.2). The only variable we can use to adjust the budget constraint is the government income *Yg*. As this variable is not free in the model (it is determined by the income generated from all sources of income), one variable of this equation will need to be rendered endogenous. One option would be to leave the *Trg* endogenous, which would mean the objectives for public investment will be met by more foreign aid. The other option would be to endogenize one of the tax rates (household income tax, firms' income tax, production tax, or import duties). An intermediate option that could be simulated is to assume an exogenous rise in foreign aid (*Trg*) and let an internal tax rate adjust for the rest of the funds needed to meet the public investment objectives.

[6] We used the average of road, electricity, water, sanitation and telecom infrastructure that provides for a ω value of 1.03.

The externality equation (1.4) is the other important element, along with is its role in increased total productivity of factors of the value added equation (1.5). For this, we draw on the vast literature linking public infrastructure to private sector factor productivity, such as that modeled by Dumont and Mesplé-Somps (2000) in a CGE context—although our externality function does not use the private investment. This function was also used in Estache et al (2008) The function defining the externality is defined with the following function:

$$1.5 \quad \theta_i = \left(Itp / Itpo \right)^{\xi_i}$$

where θ_i is the externality or sectoral productivity effect, which is a function of the ratio of new public investment (*Itp*) over past public investment (*Itpo*) with a sector-specific elasticity (ξ_i)[7]. We do not model direct private sector eviction effect tied to increased public investment but this is captured indirectly since the funding comes from private agents in the economy that are forced to reduce their level in savings. The externality of public infrastructure investment produces an increase in total factor productivity. This link to the value added (*Va*) is taken into account in the Cobb-Douglas function of the following equation:

$$1.6 \quad Va_m = \theta_i A_m Ld_m^{\alpha_m} Kd_m^{1-\alpha_m}$$

where *A* is the scale parameter, *Ld*, the labour demand, *Kd*, the capital demand, and α the Cobb-Douglas parameter. Hence, an increase in θ_i represents in Hicks's neutral productivity improvement, like the one modeled in Yeaple and Golub (2007).[8] With this formulation, the infrastructure investment can act as a source of comparative advantage because the function is sector specific. The commodity market is balanced by adjusting the market price of each commodity. The current account balance is fixed; accordingly, the nominal exchange rate varies

[7] The values for this parameter were constructed by using a combination of information from Estache et al (2008) and Harchaoui and Tarkhani (2003). In general, the values of our parameters are conservative with respect to this literature.

[8] This formulation is also commonly used in the literature estimating parameters of the externalities of public infrastructure on total factor productivity such as Ashauer (1989), Munnell (1990a), Gramlich (1994), and Dessus and Herrera (1996) among others.

to allow the real exchange rate to clear the current account balance. The GDP deflator is used as the numeraire in the model. We also assume in a standard manner that the Philippines is a small open economy. Armington's (1969) assumption for the demand of imported goods (imperfect substitution with constant elasticity of substitution function (CES)) and constant elasticity of transformation (CET) functions are used to model for export supply[9].

The household micro-simulation module (HHMS)

The construction of the micro household module (HHMS) relies on data from the FIES-1997 and from three rounds of the LFS between 1997 and 1998. The household module (HHMS) comprises a representation of the households' income structure and expenditure behaviour as well as their labour supply decision. Household consumption is modelled with a linear expenditure demand system (LES). We use the calibration method proposed by Dervis *et al*. (1982). Savings and income tax rates are calibrated according to the observed data in the survey. All transfers received and paid are exogenous. We consider the capital endowment as fixed according to the level observed in the FIES-1997.

Households are endowed with formal or informal labour, based on the information found in the LFS and FIES-1997. Our labour market mechanism is described below. This labour market hypothesis is drawn from the Roy (1951) model, which was revisited by Heckman and Sedlacek (1985) and further enriched by Magnac (1991). We selected the non competitive version of the models presented by Magnac (1991), as it includes a formal and informal market with unemployment. The formal market in non competitive; it has a rigid nominal wage and requires a cost of entry into this market. The fixed formal wage is above the market equilibrium wage, which will create excess supply on this market. The rigid wage can reflect various interventions

[9] The complete set of equations and variables can be provided upon request.

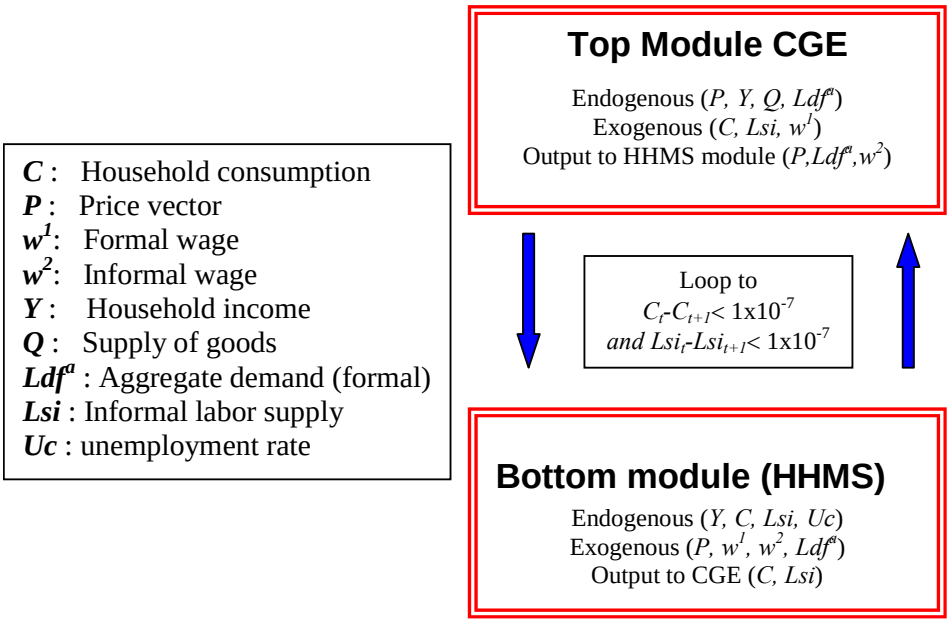
on the labour market such as labour union contracts, efficiency wages and regulated wages[10]. The labour supply model is estimated –more details on the results of the estimation can be found in Bourguignon and Savard (2008). This labour supply model enables us to establish ranking criteria for our labour supply function. The supply function for the formal market will be based on the workers' qualification and the supply of the informal market will be based on the workers' estimated reservation wages. On the informal market, the wage is flexible and the endogenous supply can be cleared with the endogenous demand. As mentioned earlier, we suppose there is a cost of entry into the formal sector which results in the segmentation of the two labour markets. The econometric model enables us to estimate the general household specific reservation wage and cost of entry in the formal sector. It is useful to present the underlying hypothesis concerning the labour market. We assume that firms recruiting formal sector workers have perfect information on them: in a recruiting campaign, they will hire out the most qualified workers available, and will lay off the least productive ones when downsizing. In the informal sector, workers will only offer their labour if their reservation wage is inferior to the prevalent nominal wage on the market. The labour market mechanisms described above are found in the CGE modeling context in Fortin, *et al* (1997), Savard and Adjovi (1998), Devarajan, *et al* (1999), Agénor, *et al* (2003) among others. All these applications with endogenous labour supply and unemployment are conducted with the CGE-RA approach. Let us give a graphic representation of the labour market (it is similar to the model presented in Thomas and Vallée (1996)):

The resolution of the macro loop and passage to the micro loop is the Top-down approach of the CGE-MMS spirit. The innovation here is the integration on the feedback effect of the micro to macro loop "bottom-up" segment of the iterative process. This is a cobweb type

[10] In the Philippines, formal wages are fixed by regional wage boards.

resolution of market equilibrium. The TD loop identifies the price vector for iteration m whereas the BU loop determines the demand of iteration *m+1*. We know that there exists conditions that satisfy the stability of the cobweb resolution approach and these conditions are also present for the resolution of the TDBU approach.

Figure 1: Resolution procedure of the-TD/BU approach



In our application of the CGE-TDBU approach to the Philippines is programmed in the GAMS software. Our top EGC-module has 873 equations and endogenous variables and the bottom household micro-simulation module has 829 920 equations with 829 920 endogenous variables.

The simulations

In order to analyze the macro, sectoral and poverty impact of scaling up infrastructure investment and different funding mechanisms, we apply two types of infrastructure investments, a non productive one and a productive one. We perform an increase of 30 percent of public

investment on infrastructure with respect to the reference period level of investment. To fund the increase in infrastructure, we use three methods, the first one consists in raising the value added tax, in the second, income tax are used to fund the increase in investment and finally foreign aid is used in the final case.

Productive externalities will contribute to increased economic activity, which will increase government revenues. It is important to highlight this fact. Hence, the funding requirements are not equal to the direct investment and operation costs. This comparative analysis allows us to highlight the most efficient funding mechanism and to explore the effect on different macroeconomic and sectoral variables in addition to the distributional impact. We present the simulations with their respective code in a synthetic form in the following table:

Table 8: Presentation of the simulation

Simulation	Funding scheme	Code
Nonproductive investment of 30%	VAT funding	NPIVAT
	Income tax funding	NPIIT
	Foreign Aid funding	NPIFI
Productive investment of 30%	VAT funding	PIVAT
	Income tax funding	PIIT
	Foreign aid funding	PIFI

Impact analysis of the scenarios

In this section, we concentrate on the macroeconomic variables and to simplify the presentation; we highlight only a few sectoral effects for three funding options for each type of investment. We concentrate our sectoral impact analysis to the key variables contributing to welfare changes for households namely rental rate of capital and market prices. We also analyze the impact on output/production in each sector. For this we use the value added variable. This is equivalent to the total output as we assume a fixed share between value added and total output. We will undertake the comparative analysis between funding

options throughout the section. We begin by presenting the nonproductive investment option as the baseline scenario. When looking at results, keep in mind a key hypothesis: our current account balance is fixed. The current account is balanced by adjusting the nominal exchange rate. Finally, in the tables, we present the nominal exchange rate. But this rate can also be interpreted as the real exchange rate because our price index is exogenous. So the variation in the nominal exchange rate is equivalent to the variation in the real exchange rate.

Before moving to the specific simulations, we can extract of few general comments from our results. First, the impact of our scenarios on GDP and most macro variables are relatively modest. This comes from the fact that in nominal terms, the 30% increase in public investment is not large compared to size of the economy. However, this is not an important problem as we are mostly interested by the comparative analysis between the different scenarios. The second point is that all simulations produce a positive impact on GDP albeit the non productive simulations produce a very small impact. The positive effect originates from the imperfect labour market assumption.

Table 1: Macroeconomic results
Variations are presented as percentage changes

			Value added tax		Income tax		Foreign Aid	
Variables	Definition	Base	Non productive investment	Productive investment	Non productive investment	Productive investment	Non productive investment	Productive investment
Yh	Household income	86476.9	0.15	0.74	0.17	0.75	0.14	0.73
Sh	Household savings	9651.8	-2.2	-3.24	-1.98	-2.99	-3.41	-4.21
w2	Informal Wage	0.5	0.43	0.98	0.49	1.05	0.39	0.94
Yg	Government income	20367	3.94	3.94	3.94	3.94	3.94	3.94
Ye	Firms' income	26172.9	-0.14	0.52	-0.17	0.49	-0.17	0.51
Sg	Government savings	13369	30,00	30,00	30,00	30,00	30,00	30,00
G	Government expenditure	16818.8	2.38	2.38	2.38	2.38	2.38	2.38
It	Private investment	23161.2	-1.23	-0.54	-1.86	-1.07	-1.54	-0.82
Se	Firms' savings	7810.5	0,00	0.95	-0.31	0.9	-0.3	0.92
ui	Unemployment rate	16.8	-1.05	-1.95	-1.14	-1.95	-0.9	-1.84
e	Nominal exchange rate	1	0.69	0.39	0.06	-0.13	-1.2	-1.18
GDP	Gross domestic product	104510.7	0.16	0.79	0.17	0.8	0.15	0.79

* Values computed by the author

The expansion of the construction sector creates employment directly and indirectly with the increase in the real informal wage. The impact on the aggregate household is positive for all simulations and we observe an eviction effect of private investment in all scenarios. The reduction for unemployment rate is present across the board and the increase in nominal informal wage is also a uniform results. The increase in government income is the same in all simulations as this is implicitly directly tied to the simulated increase in public investment and operation and maintenance cost associated with the investment. Other variables such as nominal exchange rate, firms' income and savings exhibit qualitative and quantitative differences.

The investment in nonproductive infrastructure

We use this simulation as the baseline scenario, which can be interpreted as an investment in the construction of monuments, in the army (if the country is not in conflict), or other types of nonproductive investments by the government. We look at three funding options to increase the nonproductive public investment. The first is an increase in the value added tax, and the second is an increase in income tax and the last is funded by foreign aid.

Investment funded by the value added tax

In this simulation, we increased the nonproductive public investment (investment that does not produce production externalities for other productive sectors); the increase in spending by the government is funded by a uniform increase of the effective value added tax. At the reference period, the value added tax (VAT) is not uniform and the differentiated structure remains after simulation. We apply a uniform tax increase so the percentage adjustment is the same for all sectors—if the tax rate in the sector is positive at the reference period. We hold exogenous the other public expenditure made by government but assume as was explained earlier that the new investment will require some new operational expenditure. Hence the 30 percent increase in government saving and the new public expenditure for operation cost of the new investment is funded by the increase in value added tax.

The first observation is that this option seems to favor households over firms, because wages increase and than the average rental rate of capital decreases. Since firms' income originate essentially from capital income and for households' it is a mixture of the two sources. The increase in government income derives mainly from the increased VAT to fund new investment and operation and maintenance cost (+3.94) and it is identical by definition in all simulations. As the investment in public expenditure does not produce externalities, the government benefit only slightly from increased income from economic growth. Therefore, the rise in income can be attributed almost exclusively to the VAT increase to fund the operation costs of new public investments. For comparative purposes, this will be useful in the following scenarios to see how growth influences government income. As we have said, the other common feature is that the simulation produces an increase in the informal wage (+0.43%). This comes from the fact that public services (+1.86 from table 2) must grow to meet the operational needs created by new investment. The construction sector also expends (+1.01%) to build the new infrastructure. Given the capital/labour ratio of these two sectors, their expansion produces more pressure on demand for labour versus capital.

The increase in household income is very slight at the aggregate level (+0.15%) and it is explained mainly by the reduction in unemployment and increase in nominal informal wage. The total private investment falls (-1.23%) which is one of the strongest impact at the macro level and this illustrates an form of eviction of private investment. The nominal exchange rate increases by 0.69% which respresents a depreciation of the real exchange rate. Given the fixed current account balance, this reflects a response to counter pressures of an implicit deterioration of current account balance and hence a slight dutch disease effect.

At the sectoral level, we have already mentioned the growth of public services and construction sector. The logging and timber sector and finance sectors are the other two sectors benefiting the most from this scenario. It can be explained by the lower relative use of informal workers in these two sectors compared to formal labour and capital. The strongest decrease is observed in the food manufacturing and coconut sector. The market price and rental rate of capital variations exhibit stronger impact compared to

macro and production variables. Not surprisingly the strongest positive effect (+2.03%) for the rental rate of capital is observed in the construction sector. The logging and timber, followed by the transport and communication sector are also positively affected (+1.3 and +0.55% respectively). For market prices, all prices increase with the exception of palay and corn sector. This is coherent to inflationary pressures associated with scaling up of infrastructure when no externalities are present (see Montelpare 2009). The strongest price increase is observed in the finance sector (+2.2%).

Table 2: Sectoral results: Value added
Variations are presented as percentage changes

			Value added tax		Income tax		Foreign Aid	
Variables	**branches**	**Reference**	**Non productive investment**	**Productive investment**	**Non productive investment**	**Productive investment**	**Non productive investment**	**Productive investment**
Va (value added)	Palay & corn	**5197.9**	**-0.17**	**0.25**	**-0.14**	**0.27**	**-0.08**	**0.33**
	Fruit & vegetable	**4210.7**	**-0.26**	**0.06**	**-0.26**	**0.07**	**-0.11**	**0.19**
	Coconut	**1789.5**	**-0.35**	**0.42**	**-0.33**	**0.43**	**-0.57**	**0.23**
	Livestock	**4473.5**	**-0.24**	**0.27**	**-0.29**	**0.22**	**0.1**	**0.55**
	Fishing	**3996.8**	**-0.17**	**0.23**	**-0.19**	**0.2**	**-0.13**	**0.27**
	Other agriculture	**1845.8**	**-0.22**	**0.09**	**-0.31**	**0.01**	**-0.62**	**-0.25**
	Logging & timber	**856.5**	**0.19**	**0.82**	**0.07**	**0.71**	**0.14**	**0.77**
	Mining	**1604.3**	**0.01**	**0.91**	**-0.18**	**0.74**	**-1.23**	**-0.14**
	Manufacturing	**13112.5**	**-0.16**	**0.9**	**-0.14**	**0.91**	**-0.82**	**0.34**
	Rice manufacturing	**2022.9**	**-0.17**	**0.27**	**-0.13**	**0.3**	**-0.07**	**0.36**
	Meat industry	**2081.2**	**-0.12**	**0.55**	**-0.19**	**0.48**	**0.25**	**0.87**
	Food manufacturing	**3696.2**	**-0.54**	**0.06**	**-0.49**	**0.1**	**-0.36**	**0.21**
	Electricity, gas & water	**2341.3**	**0.06**	**0.85**	**0.1**	**0.88**	**0.15**	**0.93**
	Construction	**6848.2**	**1.01**	**1.81**	**0.93**	**1.74**	**1.56**	**2.27**
	Commerce	**15149.5**	**-0.18**	**0.66**	**-0.17**	**0.67**	**-0.54**	**0.36**
	Trans. & comm.	**5206.4**	**0.07**	**0.79**	**-0.12**	**0.62**	**0.22**	**0.91**
	Finance	**3580.5**	**0.13**	**0.7**	**0.2**	**0.76**	**-0.02**	**0.57**
	Real estate	**7314.2**	**-0.2**	**0.48**	**-0.55**	**0.16**	**0.14**	**0.76**
	Services	**6960**	**-0.12**	**0.72**	**0.11**	**0.91**	**-0.09**	**0.75**
	Public services	**12222.8**	**1.86**	**1.87**	**2.2**	**2.15**	**2.33**	**2.26**

* Values computed by the author

Investment funded by income tax

For the income tax funding option we will analyze both the macro and sectoral results. In this case, we let the household income tax rate adjust from the reference situation. The macro results are quite similar to the previous simulation with main differences observed for the nominal exchange rate with a 0.06% compared to 0.69% in the previous simulation. The total investment decreases more -1.86 compared to -

1.23%. The slightly stronger negative impact on firms' income is at the source of this difference. The other macro level results largely resemble the VAT-funded scenario.

Table 3: Sectoral results : rental rate of capital
Variations are presented as percentage changes

			Value added tax		Income tax		Foreign Aid	
Variables	branches	Reference	Non productive investment	Productive investment	Non productive investment	Productive investment	Non productive investment	Productive investment
r (rental rate of capital)	Palay & corn	1	-0.76	2.13	-0.49	2.36	-0.16	2.66
	Fruit & vegetable	1	-1.24	0.17	-1.16	0.24	-0.34	0.94
	Coconut	1	-0.45	1.68	-0.34	1.79	-1.05	1.16
	Livestock	1	-0.71	1.66	-0.87	1.49	0.79	2.92
	Fishing	1	-0.5	0.92	-0.57	0.84	-0.33	1.07
	Other agriculture	1	-0.11	0.79	-0.29	0.65	-1.15	-0.09
	Logging & timber	1	1.3	4.33	0.79	3.9	1.03	4.09
	Mining	1	0.33	1.14	-0.06	0.81	-2.49	-1.25
	Manufacturing	1	-0.1	-0.26	-0.04	-0.2	-1.46	-1.4
	Rice manufacturing	1	-0.26	0.86	-0.05	1.03	0.09	1.15
	Meat industry	1	-0.01	-0.32	-0.19	-0.49	1.12	0.62
	Food manufacturing	1	-1.41	-1.82	-1.2	-1.64	-0.87	-1.38
	Electricity, gas & w ater	1	0.32	-0.39	0.49	-0.27	0.65	-0.11
	Construction	1	2.03	2.62	1.96	2.56	2.9	3.34
	Commerce	1	-0.18	0.67	-0.14	0.7	-1,00	-0.02
	Trans. & comm.	1	0.55	0.98	0.16	0.67	0.82	1.22
	Finance	1	0.5	1.3	0.72	1.48	0.07	0.94
	Real estate	1	-0.48	-0.55	-1.33	-1.31	0.34	0.14
	Services	1	0.07	0.14	0.51	0.52	0.09	0.17

* Values computed by the author

For the impact on value added, the qualitative effects are the same for all but three sectors (mining, transport and communication and services). The quantitative effects for the latter are almost the same. For the three sectors, very small positive effect were reversed for the mining and transport and communication sectors with the income tax scenario and the negative effect in the services sector becomes positive (from -0.12 to 0.11%). For rental rate of capital, the quantitative differences are larger compared to value added differences but only one sector (mining) exhibits a qualitative change going from 0.33% increase with the VAT to a 0.06% decrease with the income tax. The market price is the sectoral variable of interest with the largest difference with seven cases of qualitative differences. The biggest differences between the two

simulations are observed for services sector, going from 2.1% increase to a 0.2% increase and the meat industry, going from 0.7% increase to a 0.15% decrease. These stronger differences at the market price will have an impact household welfare for the poverty analysis.

Investment funded by foreign aid

At the macro level, this simulation produces results between the two previous ones presented. The main difference is observed for the nominal exchange rate which is not surprising insofar as the current account balance is fixed and an increase in foreign aid requires an appreciation of the exchange rate to balance out. The GDP and household aggregate income increase less and the unemployment rate decrease of smaller compared to the previous two simulations.

Table 4: Sectoral results : rental rate of capital
Variations are presented as percentage changes

			Value added tax		Income tax		Foreign Aid	
Variables	**branches**	**Reference**	**Non productive investment**	**Productive investment**	**Non productive investment**	**Productive investment**	**Non productive investment**	**Productive investment**
Pq (market price)	Palay & corn	**1.01**	**-0.09**	**1.65**	**-0.24**	**1.52**	**-0.21**	**1.55**
	Fruit & vegetable	**1.02**	**0.25**	**0.77**	**-0.55**	**0.1**	**-0.19**	**0.4**
	Coconut	**1.02**	**0.62**	**1.61**	**0.01**	**1.11**	**-0.45**	**0.71**
	Livestock	**1.01**	**0.45**	**1.33**	**-0.31**	**0.68**	**0.17**	**1.09**
	Fishing	**1.01**	**0.19**	**0.81**	**-0.24**	**0.43**	**-0.16**	**0.51**
	Other agriculture	**1.03**	**0.57**	**0.76**	**0.06**	**0.33**	**-0.6**	**-0.23**
	Logging & timber	**1.01**	**1.12**	**2.38**	**0.46**	**1.83**	**0.32**	**1.71**
	Mining	**1.01**	**0.69**	**0.42**	**0.08**	**-0.09**	**-1.07**	**-1.06**
	Manufacturing	**1.08**	**0.83**	**0.4**	**0.07**	**-0.23**	**-0.61**	**-0.8**
	Rice manufacturing	**1,000**	**0.16**	**1.27**	**-0.11**	**1.04**	**-0.2**	**0.97**
	Meat industry	**1.01**	**0.7**	**0.91**	**-0.15**	**0.19**	**0.21**	**0.5**
	Food manufacturing	**1.03**	**0.47**	**0.47**	**-0.24**	**-0.12**	**-0.37**	**-0.24**
	Electricity, gas & w ater	**1.01**	**0.97**	**-0.02**	**0.25**	**-0.63**	**0.05**	**-0.79**
	Construction	**1.01**	**1.13**	**0.82**	**0.52**	**0.31**	**0.33**	**0.15**
	Commerce	**1.05**	**1.02**	**0.8**	**0.06**	**-0.01**	**-0.39**	**-0.38**
	Trans. & comm.	**1.01**	**1.08**	**0.68**	**0.18**	**-0.07**	**-0.03**	**-0.25**
	Finance	**1.05**	**2.2**	**1.92**	**0.35**	**0.37**	**-0.18**	**-0.08**
	Real estate	**1,000**	**0.03**	**-0.68**	**-0.61**	**-1.23**	**0.19**	**-0.54**
	Services	**1.04**	**2.1**	**1.4**	**0.2**	**-0.18**	**0.32**	**-0.09**
	Public services	**1,000**	**0.51**	**0.5**	**0.17**	**0.23**	**0.05**	**0.12**

* Values computed by the author

For value added (implicitly sectoral output), we observe positive effects in 8 sectors compared to 5 and 6 sectors for NPIVAT and the NPIIT simulations respectively. The differences between sectors are also more pronounced for this scenario. When excluding public services, we have an increase of 1.56% for the construction sector at one extreme and a 1.23% decrease in the mining sector at the other extreme. The market price and rental rate of capital are also more sensitive to this funding scheme and we have many qualitative changes compared to the first two non productive investment scenarios. These stronger differences should have a distributional impact.

The investment in productive infrastructure

Moving on to the productive investment scenarios, we note a stronger positive effect on GDP, household income and firms' revenues. This is not surprising as we built in this growth effect. The funding schemes do not have a significant impact of these variables. On the other hand, the unemployment decreases less for the PIFA (-1.84%) compared to the two other simulations (-1.95%). The impact on the informal wage is greatest with the income tax scenario and weakest with the foreign aid. The variable producing the largest differences between simulations is the nominal exchange rate. It depreciates with the VAT (0.39%), appreciates slightly with the income tax ((-0.13) and a stronger appreciation is observed for the foreign aid. In this last case, we have identified the source of this effect in the non productive investment. In fact, the appreciation is almost identical to the NPFA scenario. Finally, the private investment eviction effect observed in the non productive investment scenearios is reduced by almost half in all three options. The strongest decline between the non productive and productive scenarios is for the VAT case where cut by more than half going from -1.23% to -0.54%.

For sectoral impact of productive public investment we observe a clear positive effect for value added (output) in all sectors of the economy for all three scenarios. For price variations (market price and rental rate of capital) the effects are quite different from one simulation to the other within the productive group and between the productive and non productive ones. We will first compare productive and non

productive simulations before comparing between funding options. For the VAT funding option the rental rate of capital variations are very different with the productive investment compared to the non productive one. Nine out of nineteen sectors exhibit a qualitative change. For all agricultural sectors, the improvement is strong ranging from 0.9% improvement for other agriculture to a 2.89% improvement in the palay and corn sector. The logging and timber sector is the most improved with an increase of 3.03% between the two simulations. This will lead to improvement in household income for some households but for others, the situation will deteriorate as we observe a decrease in positive effect of increase in negative effect in five sectors. The pattern of differences between the income tax scenarios is similar to the VAT simulations. This leads us to conclude that the growth effect predominates. The productive foreign aid simulation produces closer results compared to the non productive one where only five sectors exhibit qualitative differences. Moreover, the quantitative gap between the productive and non productive scenarios is weaker. When comparing between productive simulations we note minor differences between the VAT and income tax and more differences with the foreign aid option. We have five cases of qualitative differences with this option.

As for market price variations we observe many differences between productive and non productive option with five (VAT) to eight (foreign aid) qualitative differences. There is not clear trend either with half of the effects being stronger and half being weaker. When comparing between funding option, in this case we observe more differences between options compared to output and rental rate of capital. The differences are observed on the qualitative and quantitative front.

Poverty analysis

The diagnostic of poverty changes is based on the most commonly used indices in the context of macro-micro modeling. The poverty index chosen is the additively decomposable Foster, Greer and

Thorbecke (FGT, 1984) P_α [11]. We use the change in households' welfare measured by the equivalent variation to measure the impact of the policy on each household. This approach has the advantage of taking into account the price and income effect simultaneously. This approach is quite standard in the context of macro-micro CGE analysis. The CGE-top-down/bottom up model generates post simulation changes in welfare at the household level which are used for poverty analysis. Target groups are defined independently of the CGE modeling exercise and poverty analysis can be performed for the base period and after simulations.[12] For our application we decomposed households based on education level of head of household.

The first point we can make is that poverty impact are relatively small. As we have highlighted, in the macro analysis, this comes from the relatively small nominal increase in public investment but we can still drawn interesting conclusions on relative impact between productive and non productive investments and between the three funding schemes. Starting at the national level, we observe a decrease in poverty only for the VAT scenario when considering the non productive investment. This reduction is almost the same for the three poverty indices ranging from -0.26% for the headcount index (FGT-0) and -0.30% for poverty severity (FGT-2). The income tax and foreign aid scenarios for non productive investment produce an increase in poverty. This increase is over up to 1.33% for the poverty severity for the income tax option and 0.88% for the poverty severity of the foreign aid. This is interesting insofar as the GDP and aggregate household income increased in both those scenarios. This illustrates the importance of using a microsimulation approach to conclude on the distributional and welfare impact of such reforms. The option generating the most negative results for poverty is the income tax option.

The productive investments produce a similar pattern insofar as the best option is the VAT which produces reductions in poverty ranging from -0.86% for the headcount index to -1.57% for the severity index. The least positive option is the income tax option with poverty reduction around 0.2% for all three

[11] FGT poverty indices are interesting within the framework of this analysis and make it possible to measure the proportion of the poor among the population but also of this poverty depth and severity. For detailed information on the FGT index family, see Ravallion (1994).

[12]No groups are found in the CGE model but all households of the survey.

indices. The foreign aid option provides an intermediary option with reductions of 0.41% for the headcount index and a drop of 0.60% for the severity index.

Table 5: Poverty indices results

Variations are presented as percentage changes

			Value added tax		Income tax		Foreign Aid	
Poverty index	Code-education	Base	Non productive investment	Productive investment	Non productive investment	Productive investment	Non productive investment	Productive investment
FGT-0	National	0.311	-0.26	-0.86	0.67	-0.19	0.49	-0.41
FGT-1	National	0.096	-0.27	-1.29	1.05	-0.20	0.68	-0.52
FGT-2	National	0.04	-0.30	-1.57	1.33	-0.22	0.88	-0.6
FGT-0	0	0.564	-0.36	-1.08	0.51	0.07	0.71	0.2
	1	0.501	-0.37	-0.89	0.31	-0.26	0.27	-0.61
	2	0.384	-0.29	-0.8	0.70	-0.26	0.3	-0.42
	3	0.317	0.35	-0.71	1.52	0.27	1.38	-0.30
	4	0.184	-0.34	-0.94	0.85	-0.33	0.2	-0.54
	5	0.092	-0.47	-0.83	1.58	-0.35	1.35	0.40
	6	0.021	-0.42	-0.42	-0.42	-0.42	3.54	-0.42
FGT-1	0	0.185	-0.19	-0.99	0.96	-0.05	0.92	-0.09
	1	0.168	-0.24	-1.19	0.94	-0.20	0.61	-0.50
	2	0.116	-0.30	-1.36	1.05	-0.23	0.62	-0.61
	3	0.090	-0.32	-1.37	1.15	-0.17	0.79	-0.51
	4	0.048	-0.31	-1.56	1.29	-0.22	0.71	-0.71
	5	0.022	-0.26	-1.65	1.60	-0.11	1.05	-0.57
	6	0.005	-0.49	-1.87	1.43	-0.24	1.51	-0.20
FGT-2	0	0.08	-0.25	-1.32	1.25	-0.09	1.14	-0.18
	1	0.075	-0.27	-1.48	1.23	-0.23	0.82	-0.58
	2	0.048	-0.32	-1.64	1.34	-0.26	0.82	-0.70
	3	0.035	-0.36	-1.66	1.41	-0.20	0.95	-0.64
	4	0.018	-0.31	-1.78	1.57	-0.23	0.93	-0.76
	5	0.007	-0.28	-2.01	1.92	-0.19	1.22	-0.78
	6	0.002	-0.38	-1.83	1.83	0.00	2.12	0.24

* Values computed by the author

Moving to the decomposition analysis, we observe a relatively uniform qualitative impact across household types for non productive investment. We only observe two cases of qualitative differences namely for the VAT simulation, where the poverty headcount increases for group 3 where other households benefit from a reduction in poverty indices. The headcount for the group 6 household also varies in a different direction with a 0.42% reduction when other households experience an increase in poverty indices. For the VAT simulation, we can identify a weak trend

favoring the most educated households. For the income tax option, the most educated groups (4, 5 and 6) have the largest poverty increase when using the poverty depth and severity indices. For the foreign aid funding scheme the groups suffering the least are groups 1 and 2 for the three indices with one exception for FGT-0 where the most favored group is group 4. The productive investment provides more interesting results. For the VAT option, the headcount index indicates that the least educated would be most advantaged, while the depth and severity indices reveal a more regressive option where most educated households benefit the most[13]. In the second scenario (PIIT), we cannot find a clear trend. Each indicator provides a different picture. The headcount index seems to favor the most educated and group 3 is faced with an 0.27% increase in poverty. The poverty depth (FGT-1) group 6 and 2 benefit the most and group 0 the least and the poverty severity favors group 2, 1 and 4 and group 6 and 1 are the losers. For the foreign aid simulation, we seem to have a clearer winner with group 4 being top or second in terms of positive impact and group 0 is last of second to last for all indices. Interestingly, group 5 has the worst situation for the headcount index and the best when using the severity index.

When comparing each funding option we can clearly conclude that the VAT is the most favorable option either at the national level and when using household decomposition. Moreover, all groups benefit for all indices. In addition, the poverty reduction impact is quite large given the weak changes in macro and sectoral variables. The foreign aid option also dominates the income tax option for the poverty depth and severity indices. For the headcount index, two groups (group 0 and 4) suffer more with the foreign aid compared to the income tax option. For the other groups, the foreign aid option is more favorable.

[13] The poverty indices at reference period reveal that the more educated the head of household, the lower the poverty indices are.

Comparing the micro distributional results with poverty results illustrates the importance of using a CGE microsimulation approach since the income tax option is the most favorable with looking at aggregate variables such as GDP, aggregate household income, informal wage and unemployment whereas it is the least favorable one in terms of poverty impact.

Conclusion

The ambitious modeling exercise has allowed us to analyze the impact of scaling up infrastructure investment on macroeconomic, sectoral and poverty in the Philippines. To achieve this we apply a CGE top-down/bottom up approach with endogenous labour supply and unemployment. The approach allows us to capture numerous issues surrounding infrastructure expansion among which we have; productivity externalities, relative price changes, investment eviction issues, Dutch disease, funding issues, fiscal contraints and distributional analysis. We extend on papers such as Adam and Bevan (2006) and Estache et al (2008) by introducing rigorous distributional analysis. Our macro results are similar to these authors with the presence of slight Dutch disease effect that is attenuated with the production externality assumption. We also present a framework that allows the analyst to conclude on poverty impact of such programs. As in Estache et al (2008), we do not observe strong differences at the macro level when comparing funding options to scale-up infrastructure but our poverty analysis has clearly allowed us to rank the performance of each funding option where the VAT is clearly more favorable followed by the foreign aid option and completing with the income tax option.

In our analysis, our static modeling framework does not allow us to fully capture the negative impact of the private investment eviction issue. Another issue is the returns on investment might come in the medium to long term. To improve the analysis on this front, a

sequentially dynamic framework would be a more appropriate tool. In our future research we will extend this model in this direction. The major challenge for this work program will be to introduce a capital reallocation mechanism at the micro level. To our knowledge, only one set of authors (Annabi et al (2005)) applied a dynamic CGE microsimulation model. In their model, they do not fully resolve the issue of capital reallocation. They assume that the new capital growth is uniformly redistributed to household endowed with capital at the reference period. This assumption with grossly underestimate the distributional impact of the growth elements in the model.

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Appendix Externality parameter

Table A.1 Externality elasticities by sector

branches	ξ value
Palay & corn	**0,01**
Fruit & vegetable	**0,015**
Coconut	**0,019**
Livestock	**0,011**
Fishing	**0,012**
Other agriculture	**0,018**
Logging & timber	**0,003**
Mining	**0,027**
Manufacturing	**0,038**
Rice manufacturing	**0,01**
Meat industry	**0,025**
Food manufacturing	**0,025**
Electricity, gas & w ater	**0,039**
Construction	**0,021**
Commerce	**0,022**
Trans. & comm.	**0,018**
Finance	**0,013**
Real estate	**0,027**
Services	**0,01**

Table A.2: Educational code definition

Education Code	Level of education
1	Elementary undergraduate
2	Elementary graduate
3	1st to 3rd Year High school
4	High School Graduate
5	College Undergraduate
6	At least College graduate
0	Not reported or no grade