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Abstract

In the case of a land constraint economy such as the Philippines, the efficient allocation of land to its various uses is essential. This constraint is further intensified by the growing population and increased demand for commercial land. The process of land classification is only the first step in managing land resources. A computable general equilibrium (CGE) model based on ORANI, a multi-sectoral model belonging to the Johansen class of CGE models was employed to ascertain the economy-wide effects of the reduction in forestry production due to conservation efforts. The paper also attempts to show the relative contribution of population growth and trade policies on deforestation in the case of the Philippines. The study evaluated some of the forestry policies recommended by the Philippine Master Plan for Forestry Development (1991-2015). In theory, the policies formulated would be viable and effective. The problem lies in the implementation especially of reforestation activities, which is the core of the Master Plan. The Philippine forests require intensive regeneration programs to revive the domestic logging industry and conservation programs to protect sensitive areas as well as the establishment of tree plantations. The study evaluated four policies from the Master Plan, namely the implementation of selective logging, imposition of stumpage tax on the forestry sector, lowering of forestry discount rates and the establishment of set-aside areas. The study found that moving into a selective logging regime and the establishment of set-aside areas would achieve forest conservation with little reduction in economic growth. Moreover, the results show that (domestic) population per se would not significantly increase deforestation. Whilst, export taxes are ineffective tools in reducing deforestation, trade liberalisation policies are beneficial to the economy as a whole.

Keywords: CGE modelling, Simulations, Philippines, Deforestation, Reforestation and Trade

I. Introduction

The deterioration of forest resources and poor economic performance in the Philippines call for a serious rethinking of economic policies addressing both environmental and economic objectives. The recent economic literature suggests the possibility of attaining both macroeconomic growth and sustainability in natural resource use. The Philippines has exploited its forest resources at least for the last 100 years. Evidence of economic growth and development could have justified the negative effects on the environment of extensive logging activities at least before the 1980s when environmental issues are non-existent.

The Philippine population stood at 1.5 million in 1799 and at 7.6 million in 1903. It grew to 19.2 million by 1948 and by 1960 it stood at 27 million. The Philippines' average annual population growth rate was around 2 per cent from 1918 to 1948. From 1960 to 1980, the average annual growth rate was around 2.8 per cent. The period where the growth rate of the population started to reach almost 3 per cent was in 1960. This is the same period when log exports started to rise to 57.5 per cent, indicating that factors other than an increase in (domestic) population were affecting forest cover.

The Philippine government maintains that classified forestland, which is considered in the public domain, should remain at 40 per cent of the total land area in the country despite the fact that forested land only amounts to around 13 per cent of total land or 27 per cent of classified forestland[2]. Land use issues are crucial in the face of increasing population and demand for commercial uses of land, especially in land constraint economies. Hence, the Philippine government should determine the right balance between forest areas subjected to logging, and national parks as well as lands for agricultural and other non-forestland activities.

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[2] Forestland is not necessarily an area with tree cover. The land classification is based on a slope criterion that is, a land with slope 18 per cent and over is considered as forestland regardless of tree cover.

To address the problem of massive deforestation in the country, which has occurred since the start of the 20th century, the Master Plan for Forestry Development was implemented in 1991. It is a 25-year program, which is projected to be completed by 2015. Based on the policies brought forward by the Master Plan[3], it is clear that the key instruments are extensive reforestation by natural and assisted means and the establishment of plantations in order to achieve the goals set under the Master Plan. Nevertheless, reforestation activities in the Philippines have been dismal (Korten 1994) whereby from 1989 to 1998 stood at 745,395 hectares. Moreover, the Philippine forests have been subjected to land clearing since the 16th century. Stenberg and Siriwardana (2002) provide a comprehensive review of historical developments of deforestation in the Philippines.

This paper is not concern about deforestation per se. Its emphasis is on the possibility of achieving forest conservation with minimum economic impact in terms of reduction in Gross Domestic Product (GDP). The paper evaluates the economic implications of selected policies included in the Master Plan designed to propagate forest resources in the Philippines. Due to modelling constraints, only four policies from the Master Plan are considered. They are the implementation of selective logging, the collection of stumpage taxes, the establishment of set-aside areas and the provision of more secure tenure in forestlands. The paper attempts to quantify the economic cost (as well as benefit) of forest conservation in the Philippines. It also examines the general equilibrium effects of population growth and export taxes on forestry.

The paper is organised as follows: Section II discusses in detail selected policies within the Master Plan and population and trade policy simulations, which are incorporated in the computable general equilibrium (CGE) model presented in Section III. Section IV explains the

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[3] We will refer to the Master Plan for Forestry Development as Master Plan in the remainder of this paper.

parameterisation of the forestry sub-model. Section V summarises the results of the simulations while Section VI concludes the discussion.

II. Policy Simulations

There are four major recommendations in the Master Plan that are incorporated in the CGE model presented in this paper. Firstly, selective logging has been implemented in the Philippines since the 1950s. It assists in the future regeneration of old growth and second growth forests. This is in contrast to clear-cutting, which is best practised in plantation forests, though this cutting technique was the practice in all forestlands prior to 1950s in the Philippines. In general, the selective logging technique is employed to meet an environmental-services (non-timber values) target for forest areas. In the case of the Philippines, old growth and second growth forests are still the main source of timber. The establishment of plantation forests has not been successful in the past two decades (Forest Management Bureau 1998). Hence, the effects of selective logging on the forestry sector as well as on the non-forestry sectors in the economy can be significant.

To simulate selective logging or increased selectivity in the logging regime, the authors make use of α_{min}, the minimum age at which trees can be harvested. The minimum age requirement can be used to meet a certain level of timber volume left standing in the area, which in turn helps in the natural regeneration, maintains biodiversity and other environmental services provided by forests. The increase in the minimum age at which trees can be harvested is calibrated to increase the volume of standing timber after harvest by 41.4 million cubic meters per year. This is equivalent to one year's worth of deforestation during 1981-1990[4]. It is

[4] Although this paper is not concerned with deforestation per se, to calibrate conservation efforts, we used the rate of deforestation between 1981-1990 to assess the economic impacts of forest conservation. Moreover, since deforestation is a land-use change phenomenon, we acknowledge the fact that forest conservation is not the same as a reduction in deforestation.

expected that an increase in the minimum age would increase the price of domestically produced forest products. It is also expected that the volume of timber per harvest per rotation would decline and the cost per unit of log harvested would increase.

Secondly, the Philippine forest charges, in the past, were very minimal in comparison to the revenue derived from timber production. That is, only 11.4 per cent of rent was captured by royalties (Boado 1988; Vincent 1990). It is recommended in the Master Plan that the stumpage tax rate be increased by 25 per cent of the market price of logs. In the model simulation, the stumpage tax is increased by 25 per cent. The stumpage tax in the model is treated as a tax on net forestry revenue. Dee (1991) found that a tax on forest output lengthens the rotation period. This is intuitively true, with fixed cost per harvest per rotation, an additional output tax increases logging costs. Increasing the rotation period results in bigger trees, more timber harvest and less harvesting costs. Nevertheless, the tax increment cannot meet the timber volume target (i.e., 41.4 million cubic meters). The target is not reached even by increasing the tax to 50 per cent. This might be brought about by the diminished status of the Philippine forests.

Thirdly, the Philippines has delineated protected areas by the legislation of the National Integrated Protected Area System (NIPAS). In 1996, the area designated as national parks was 1.3 million hectares, which was 13 per cent of classified total timberland.[5] The Philippine Agenda 21 has specified a concrete target, that is, the delineation of 2.5 million hectares of productive forest for 1998-2005 (Bartelmus 1999). Since the establishment of national parks in the Philippines involves forested areas (old and second growth forests) and forested areas are estimated to be less than 4 million hectares, Agenda 21 implies that almost 40 per cent of total forested areas can be set-aside as national parks. To make the model simulations consistent, the

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[5] *Timberland* as quoted from the 1998 Philippine Forestry Statistics refers 'to land of the public domain which have been the subject of the present system of land classification determined to be needed for forest purposes'.

increase in the set-aside areas is calibrated to meet the timber volume target. With increased selectivity or increased set aside area for national parks, the tendency of the forest sector is to reduce the rotation period and the volume harvested per hectare per rotation (Dee 1991). In addition, however, the outcome for annual output depends on the extent to which the smaller harvests are offset by the greater frequency of harvest.

Lastly, security of land tenure is represented by the discount rate in forestry. It is assumed that a higher discount rate applied to the forestry sector reflects insecure land tenure in forestlands. Whilst, a lower discount rate implies a more secure tenure, it also suggests that there is a small risk and uncertainty involved. In contrast, production activities with a high discount rate involve higher risk and more uncertainty about the future. The tenure length in the Philippines is 25 years. This is considered ineffective in encouraging conservation efforts amongst logging concessionaires. Simulations conducted by Stenberg and Siriwardana (2006) shows that rotation periods should be around 30 years at least to encourage conservation efforts given harvest age of around 50 years. In the simulations in Section V, the reduction in the discount rate is also calibrated to meet the timber volume target. It is expected that when land is immobile between agriculture and forestry, the required reduction in the discount rate would be greater compared to when land is mobile. This reflects the characteristics of the land market in the Philippines. Land immobility would attract a much higher discount rate due to uncertainty about the future of land use in the country.

The fact that the deforestation rate in the Philippines accelerated in the early 20th century and coincide with log exports discounts the argument that population pressure is the main cause at least in the domestic front. Nevertheless, with the rising population pressure in the Philippines, land use decisions are becoming more important. In this study the effects of population and trade practices in general are examined using a CGE model. In order to simulate population growth, a population variable representing the number of households is increased. In addition, the labour-abundant nature of the Philippine economy is simulated using a technological coefficient, which increases the labour-capital input. The effects of trade liberalisation and imposition of export taxes on timber volume (deforestation) are also examined using tax variables and shifters.

Population Growth

The household population variable in the model is increased by 3 per cent. This is consistent with the annual population growth rate in the Philippines. The purpose of this simulation is to examine the probable effects of population growth on the forestry sector, in particular and on the whole economy, in general. It is anticipated that there would be a reduction in the volume of timber in forested areas when population increases.

Technological Progress

Forest extraction or logging is generally a capital-intensive activity. This is consistent with the 1990 Philippine I-O table data where capital costs amount to 60 per cent of total forestry production costs. The capital-intensive nature of log production implies that the substitution of labour for capital in logging might lead to less deforestation (Repetto and Gillis 1988; Angelsen and Kaimowitz 1999). By using less machinery, the damage on saplings, in particular and on the area, in general can be reduced, notwithstanding the employment generated by changing from a capital-intensive to a labour-intensive technology.

The model has variables to measure the technological coefficients of capital and labour inputs. However, due to the production function employed in aggregating the production inputs (i.e., constant elasticity of substitution) as well as the values of the elasticity of substitution between the primary factors, it is not advisable to increase the value of the technological coefficient for capital inputs only. Instead, the technological coefficient of the capital-labour composite in the forestry sector is increased. This implies that more units of capital-labour inputs are needed for each unit of log output produced. The value of the technological coefficient is increased by 10 per cent.

Export Tax

An export tax has the effect of reducing the domestic price as producers expand domestic sales. In the case of the Philippines, there is no export tax on log exports per se but there is a log ban imposed on the forestry sector particularly to the export of logs harvested from old growth forests. It is assumed that an export log ban is equivalent to an infinite export tax. Hence, in order to examine the general equilibrium effects of an export ban on log products, the value of the tax is increased by 100 per cent from an initial value of zero per cent.

Removal of Assistance to Industries

There is enough evidence in the literature to suggest that export taxes on logs are ineffective in reducing deforestation in timber producing countries. The inefficiencies associated with trade restriction support a more liberalised trade among nations. As world globalisation is embraced by most nations, the push for trade liberalisation is attracting more support. The interaction between trade liberalisation and deforestation has been renewed and given emphasis in recent times. There are three simulations in the model concerning the removal of assistance to industries. Particularly, the possible effects on the economy of a removal of assistance in the agricultural sector and the forestry sector are examined. The economic effects of a uniform reduction in tariffs across all sectors are also examined. The level of tariffs on these sectors is reduced by 10 per cent. The target set by the Philippine government was to reduce overall tariff rates to 8.16 per cent by year 2000 (Tariff Commission 1995).

It is worth noting that in this study, non-timber values of forestlands are not accounted for explicitly. It is has been recognised that forest areas have multiple uses, which are not confined to timber production. Forestlands offer services such as recreation, carbon sequestration and biodiversity. Unfortunately, environmental services, in this study, are crudely represented by the volume of timber left standing after each harvest, which is determined by the minimum age at which trees can be harvested.

III. CGE Model

The model used in this study is a static CGE model of a small open economy with a forestry sub-model adopted from Dee (1991). It is based on ORANI, the multisectoral CGE model for Australia (Dixon et al, 1982). Stenberg and Siriwardana (2005) reviewed other CGE models used in analysing the forestry sector and discussed their advantages and disadvantages. This study incorporates two usages for land (i.e. agricultural and forestry) and the indirect relationship between forestland and non-agricultural land, in particular land devoted to mining and real estate. The pressure of non-agricultural land usage on agricultural land results in additional conversion (or destruction) of forestland to sustain agricultural production. For simplicity, when comparing different land usages, it is assumed that non-agricultural use pertains to real estate, forestry and mining. The land requirements of, say, households for residential purposes are provided by the real estate sector. Hence, the model assumes that there are four producing sectors that use land intensively namely, agriculture, forestry, mining and real estate.

In this section, selected equations to guide the readers in understanding the core equations of the model are included. The full list of equations, variables, parameters and coefficients are given in Appendix A (Tables 1A, 2A and 3A). Eq. (1) describes a typical representation of each industry's demands for labour, capital, land and various material inputs from both domestic and imported sources.

$$x_{(is)j} = z_j + a_{ij} - \sigma_{ij}\left(p_{(is)j} - \sum_{s=1}^{2} S_{(is)j}\, p_{(is)j} \right) \qquad (1)$$

These industries are assumed to maximise profit (or minimise cost) subject to constant returns to scale production functions. The relationship between inputs and output in each industry is given by a Leontief production function and the aggregation of domestic and imported intermediate inputs is described by a Constant-Elasticity of Substitution (CES) production function. The aggregation of different types of labour (Eq. 2) and the aggregation of factors of production (i.e. capital, labour and land) for non-forestry sectors[6] (Eq. 3) are also described by CES production functions.

$$x_{(g+1,L,m)j} = x_{(g+1,L)j} - \sigma_{(g+1,L)j}\left(p_{(g+1,L,m)j} - \sum_{m=1}^{10} S_{(g+1,L,m)j}\, p_{(g+1,L,m)j} \right) \qquad (2)$$

$$x_{(g+1,v)j} = z_j + a_{(g+1)j} - \sigma_{(g+1)j}\left(p_{(g+1,v)j} - \sum_{v=1}^{3} S_{(g+1,v)j}\, p_{(g+1,v)j} \right) \qquad (3)$$

There are 10 occupational groups in this model. Unfortunately, farmers, fishermen and forestry workers are lumped into one occupational group.

The forestry sector is modeled differently. The standard input demand and zero profit equations are replaced by a set of steady state production relationships. The core equations of the forestry sub-model are described in Section IV. The non-land input bundle of the forestry sector combines each intermediate input and a composite of capital and labour in fixed proportions. Land mobility is modelled by the variable f^{vj} (Eq. 23). That is, when sectoral land is mobile, f^{vj} 's are treated in the model as exogenous variables and vice versa.

$$v_{(g+1,N)j} = v_{(N^*)} + f^{vj} \qquad (23)$$

[Place Table 1 here]

There are eight production sectors and nine commodities in the model as shown in Table 1. All the sectors except for agriculture produce only one commodity. Considerable detail has already been accorded to the agricultural sector in many of the previous CGE models of the Philippines. In this model, the agricultural sector as a whole is disaggregated into two sectors (i.e. agricultural crops and services; and livestock, poultry and fisheries).

Unlike ORANI and Dee (1991) which only have a single representative consumer, this model has three household demand groups, which are based on the classification in the 1990 Social Accounting Matrix (SAM). The three household group aggregation is based on the fact that roughly around 50 per cent of the households in the Philippines live below the poverty line. Hence, the first five deciles in the SAM comprise the first household group, the second household group consists of the sixth to eighth deciles, and the ninth and tenth deciles are grouped into the third income group. To account for income distribution issues, the authors make use of the SAM's 10 household income groups. This further classification of households is needed since the three household classifications exhibit very similar household expenditure shares. Consumers' maximisation of utility and the resulting demand is defined by the Stone-Geary linear expenditure system (Eq. 26). Consumers are assumed to maximise utility subject to their income. The consumption function of household *k* depends on the share of household *k*'s consumption in total household disposable income.

$$x_{ik}^{H} - q_k = \varepsilon_{ik}(c_k - q_k) + \sum_r \eta_{(ir)k}\, p_{rk}^{H} \qquad (26)$$

[6] The forestry sector aggregates labour and capital only.

There is a foreign sector (Eq. 32) and a government sector (Eq. 33) in the model. The government derives its income from direct taxes, indirect taxes, stumpage taxes and ownership of forestland (Eq. 34).

$$x_{(id)}^{E} - f_{(Qi)}^{E} = -\gamma_i p_{(id)}^{E} + f_{(Pi)}^{E} \tag{32}$$

$$x_{(is)}^{G} = c_R + h_{(is)}^{G} + f_{(is)}^{G} \tag{33}$$

$$\begin{aligned} y_G = {} & \sum_{i=1}^{g} t_{(M,i)} G_{t(M,i)} + \sum_{i=1}^{g} \left(p_{(im)}^{M} + \phi + x_{(im)}^{M}\right) J_{(M,i)}^{G} + \sum_{i=1}^{g} t_{(E,i)} G_{t(E,i)} + \sum_{i=1}^{g} \left(p_{(id)}^{(0)} + x_{(id)}^{E}\right) J_{(E,i)}^{G} \\ & + \sum_{k=1}^{3}\sum_{i=1}^{g}\sum_{s=1}^{2} t_{(H,is)} G_{t(H,is)k} + \sum_{k=1}^{3}\sum_{i=1}^{g}\sum_{s=1}^{2} \left(p_{(is)}^{(0)} + x_{(is)k}^{H}\right) J_{(H,is)k}^{G} + \sum_{i=1}^{g}\sum_{s=1}^{2} t_{(G,is)} G_{t(G,is)} + \sum_{i=1}^{g}\sum_{s=1}^{2} \left(p_{(is)}^{(0)} + x_{(is)}^{G}\right) J_{(G,is)}^{G} \\ & + \sum_{j=1}^{h}\sum_{i=1}^{g}\sum_{s=1}^{2} t_{(Ip,is)j} G_{t(Ip,is)j} + \sum_{j=1}^{h}\sum_{i=1}^{g}\sum_{s=1}^{2} \left(p_{(is)}^{(0)} + x_{(is)j}\right) J_{(Ip,is)j}^{G} + \sum_{j=1}^{h}\sum_{i=1}^{g}\sum_{s=1}^{2} t_{(K,is)j} G_{t(K,is)j} + \sum_{j=1}^{h}\sum_{i=1}^{g}\sum_{s=1}^{2} \left(p_{(is)}^{(0)} + x_{(is)j}^{K}\right) J_{(K,is)j}^{G} \\ & + \sum_{k=1}^{3} \left(t_{(H,Y)k} + y_{Hk}\right) J_{(H,Y)k}^{G} + \left(p_{(g+1,N)j=2} + x_{(g+1,N)j=2}\right) J_{(g+1,N)j=2}^{G} + p_{(id)j=2}^{(0)} + x_{(g+1)j=2} - t_{for}^{(1)} G_{(stump)} \end{aligned} \tag{34}$$

Zero pure profit conditions are specified for each industry to allow non-industry specific inputs to move between industries while also determining the rental prices of factors that are industry-specific. There is no attempt to explain aggregate private investment in fixed plant, machinery and buildings. Only labour is considered mobile. Capital and land are treated as industry-specific, particularly in the short-run and medium-run. The supply of labour, capital and land are assumed to be fixed and exogenously given. Furthermore, for factor markets to clear, these supplies must equal the demands for these factors. The difference between domestic supply and demand for goods is assumed to be equal to net export of those goods to ensure that the market for those goods will clear. A fixed exchange rate regime is assumed since it approximates the managed float exchange rate regime, which has dominated the Philippine foreign exchange market in the past. The economy is treated as a price taker in the world market. The domestic producer price of a tradable good is equal to the world price of an identical good. The domestic user price of goods produced in the non-tradable sector is given by the domestic producer price plus taxes. The Armington assumption is applied to the imports where imported goods are differentiated from their domestic counterparts, which makes their prices differ. The model has equations which provide useful macro-indices. These indices assist in the interpretation of the model results.

IV. Data Base and Model Assumptions

The 1990 Input-Output (I/O) table is the benchmark used in this study. It is supplemented by the 1990 Social Accounting Matrix (SAM). The values of the elasticity parameters are taken from the literature. The model has nine commodities, eight producing sectors and 10 household income groups. Sensitivity analysis is conducted and suggests that the simulation results are robust. The model is constructed and solved using GEMPACK[7]. The model size was 1,760 endogenous variables, 1,207 equations and 553 exogenous variables.

In addition to the I-O table and SAM, data on forestry are based on the *1998 Philippine Forestry Statistics* published by the Department of Environment and Natural Resources (DENR), *1998 Philippine Asset Accounts* published by the National Statistical Coordination Board (NSCB) and the Philippine Natural Resources Accounting Project headed by DENR. The forestry sub-model used in this study identifies seven forestry growth parameters (i.e. maximum growth, maximum volume, current volume, current age, minimum volume, minimum age, and exponent). The parameterisation of the forestry sub-model is discussed below.

To make the forest sector model operational, a logistic functional form is chosen to describe the physical growth of the forest (Wilen, 1985)

$$F(T) = \frac{M}{(1-[1-M/F(0)]e^{-gT})} \qquad \text{(A)}$$

[7] Refer to Harrison and Pearson (1996).

where M is the maximum possible volume of timber per hectare and where g is the maximum intrinsic growth rate of trees.

The equations in the forestry sub-model are converted to log-linear form and are parameterised as follows. The maximum stocking rate is set at 247 cubic meters per hectare, equal to the stocking rate in the remaining old growth forests of the Philippines (Philippine Asset Accounts 1998). Along a logistic growth curve, the partial derivative of the timber volume with respect to age is given by

$$\partial F/\partial T = gF(1 - F/M)$$

The maximum intrinsic growth rate is found by solving this expression for g, given M = 247, F = 161.625, the current average stocking rate across all forests, and $\partial F/\partial T$ = 1.3 cubic meters per year (Philippine Asset Accounts 1998). The resulting value is g = 0.02327, equivalent to just over 2 per cent per year. $F(0)$, the stocking rate at t = 0, is a set value of 100 cubic meters per hectare. Adequately stocked forest is defined as forest area with at least 100 cubic meters per hectare of standing timber. With average harvest assumed at 85 cubic meters per hectare per year[8], F is set at 185 cubic meters per hectare. The values for F, $F(0)$, g and M are substituted into (A) to derive a value for the rotation period of about 24 years. This seems reasonable, given that the stipulated rotation period in the Philippines is 25 years. However, earlier entry is known to have occurred.

[8] Harvest is allowed from 60 cubic meters to 110 cubic meters per hectare per year. These figures are gathered during an interview with Dr. Antonio Carandang, one of the members of the Philippine Natural Resources Accounting Project.

V. Results of Policy Simulations

The model simulations are conducted using two land mobility scenarios[9] and where there is no ban imposed on log exports. With regard to selective logging, set-aside areas and the reduction in the discount rate, the target is to achieve a specified increase in the volume of standing timber, which is set at 41.4 million cubic meters. In the model, this is the equivalent of a 5.6 per cent increase in the volume of timber.

Macroeconomic Results

The model is calibrated using 1990 as the benchmark year. The share of the forestry sector in the gross domestic product (GDP) in 1990 was around one per cent. It is expected that the effects on GDP of the reduction in the supply of logs brought about by any of the policy variables in question will be small. Table 2 shows the impacts on nominal and real gross domestic product (GDP) for both land mobility scenarios.

[Place Table 2 about here]

When sectoral land is mobile, reducing the discount rate in forestry increases GDP by around 0.20 per cent both in nominal and real terms. The reduction in the discount rate in forestry, which is assumed to be equivalent to a more secure tenure coupled with an unrestricted land use policy, may have contributed to the reduction in the uncertainty involving timber production. The government cannot readily confiscate land since it is not considered in the public domain. Instead, land is subjected to the market forces prevailing in the land market. In contrast, when land is immobile the effect of the forestry policies on GDP except for stumpage tax reduction is negative. The reduction in discount rate and the establishment of set-aside areas

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[9] In this section, *land is mobile* or land mobility means that sectoral land is mobile and *land is immobile* or land immobility means that land between agriculture and forestry is fixed.

yield similar reduction in real GDP (i.e., almost 0.4 per cent). The imposition of an export tax on logs results in a slight rise in GDP (i.e. 0.02 per cent).

The apparent importance of more secure property rights is consistent with the nature of forestland ownership in the Philippines and land ownership in general. Logging concessions are 25-year licences and these licences can be renewed for another 25 years. Prior to 1970, the concession was only given for a period of one to four years. Ackerman (1994) argued that in order to achieve forest conservation objectives, the interest rate must stay below a critical level. The presence of risk and uncertainty in forestry, to the extent that the government might revoke timber licenses, imposes a higher discount rate on logging activities relative to other production activities in the economy. Hence, it is suggested that a lower discount rate that approximates a more secure tenure in forestry can allow for more rational and efficient production decisions, such as longer rotation periods achieved by increasing the logging concession period. Moreover, land mobility allows the market to determine the rental price of land, which is in contrast to an ad hoc land classification process. For example, the land reform programs implemented in the 1970s and 1980s in the Philippines have resulted in premature conversions of agricultural lands to non-agricultural uses. The land reform programs artificially reduced the price of agricultural land, as the Philippine government purchased these lands at a price much lower than the prevailing market price. In order to avoid coverage under the land reform program, landowners resorted to premature conversion of agricultural lands into non-agricultural uses (Medalla and Centeno 1994). This argument can be extended to the forestry industry where over-harvesting can occur due to the uncertainty of the length of timber licenses.

Regardless of the land mobility condition, the forestry-specific policies such as selective logging and the establishment of set-aside areas result in lower GDP. This implies that forest conservation is not a straightforward objective. Some economic growth has to be sacrificed in order to implement conservation policies. The removal of assistance across all producing sectors in the economy appears to be the most beneficial in terms of national income improvement.

Table 3 summarises the economic structure of the Philippines. This will aid us in analysing the model results in the succeeding discussion. It is interesting to examine the effects on employment and the balance of trade of the three policy variables (i.e. selective logging, reduction in the forestry discount rate and set-aside areas). The results for the stumpage tax simulation are not included since the numbers are very small.

[Place Table 3 about here]

Employment Effects

In the model simulations, the aggregate level of employment is held fixed, however the number of people employed in each occupational group can still vary with a policy change. The emphasis in this section is on the employment effects in the sixth occupational group (Farmers, Forestry and Fisheries workers or FFF), since it comprises almost 25 per cent of total employment in the Philippines as shown in Table 3. In addition, forest conservation efforts would have direct effects on the level of employment in this group. Notice that with the imposition of selective logging as shown in Table 4, the percentage of people employed as FFF has increased relative to the other groups, regardless of the land mobility condition, although by a very small percentage. This is because forestry workers comprise only a small percentage of the total FFF employment. Although selective logging would reduce timber production, in the long-run this ensures that logging activities will continue in the future and timber production might increase depending on the silvicultural methods employed. Moreover, the FFF group benefited from the policy since selective logging is labour-intensive. Specifically, the logging technique requires more labour to properly mark trees for harvesting purposes and to properly impose the minimum age requirement.

[Place Table 4 about here]

[Place Table 5 about here]

Table 5 shows that the reduction in forestry discount rate has a positive effect on the level of employment of FFF when land is mobile. This corresponds to the improvement in the real GDP shown in Table 2. Restricting the movement of land between agriculture and forestry outweighs the more secure land tenure that might have been brought about by the reduction in the discount rate in forestry. As a result, the employment level of FFF as a whole declined when land is fixed between forestry and agriculture. The converse is true when set-aside areas are increased. That is, the employment level of FFF is improved with the increase in national parks provided that land use policies are strictly implemented as shown in Table 6. The results in Tables 5 and 6 suggest that the reduction in forestry discount rate is relatively more effective when land is allowed to move between the four land-using sectors in the model while the establishment of set-aside areas is effective when the Philippine government can implement its land use policy.

[Place Table 6 about here]

In terms of employment and regardless of the land mobility condition, however, the uniform reduction in tariffs across all sectors in the economy has a negative effect on the employment level of farmers, forestry workers and fishermen (l_6), craft and related workers (l_7), and plant and machine operators and assemblers (l_8) (and has a positive effect on the other occupational groups) as shown in Table 7. In theory, tariff cuts would reduce the price of imported commodities. Since the industries (i.e. agriculture and manufacturing) where these labour groups would most probably be employed have to compete with cheaper imports, resulted in employment reduction in these industries.

[Place Table 7 about here]

Balance of trade effects

The indicator for the balance of trade movement in the model is represented by the ratio of the change in the balance of trade to GDP, *delB*. Given that a long-run closure is employed in the model, *delB* is treated as an exogenous variable. It is assumed that in the long-run, the ratio of the balance of trade to GDP will remain constant. The sensitivity of real GDP to the treatment of the ratio of the trade balance to GDP (i.e. set endogenously) is evaluated and suggested that the model results are robust. Since the ratio of the trade balance to GDP is determined outside the model, imports tend to move with the level of exports in order to maintain the trade deficit at the 1990 level. Note, in particular, that the results reflect the required changes in the real exchange rate in order to maintain the trade deficit. Hence, the emphasis of the following discussion would be on the level of exports.

It is expected that with selective logging the volume of timber exports would be reduced with the decline in timber production. To satisfy the reduction in timber exports, the export volume index declines and the real exchange rate appreciates as shown in Table 4. This is followed by a similar reduction in the import volume index. The reduction in imports is not due to the exchange rate appreciation but by the constraint imposed on the model. In contrast, the reduction in the discount rate in forestry (when sectoral land is mobile) results in increased export levels and a depreciation of the real exchange rate as shown in Table 5. In the case of the establishment of set-aside areas as shown in Table 6, exports are reduced as the real exchange rate appreciates. If it is true that depreciation of the exchange rate leads to more deforestation (Wiebelt 1995), then the implementation of selective logging and the establishment of national parks might be able to limit forest denudation in the Philippines. These policies are not only designed to maintain a certain area of forestlands but can assist in reducing the incentive to harvest excessive amounts of timber for exports. The removal of assistance across all sectors results in the highest increase in export volume index coupled with the real exchange rate depreciating by 2.5 per cent as shown in Table 7.

Sectoral employment and production

The effect of population growth on the forestry sector is minimal, although negative. As expected, the increase in the export tax on logs results in the decline in the employment level in forestry as the price of timber declines. The removal of assistance in all sectors and in forestry results in a negative effect on forestry employment however, when tariffs in agriculture are reduced by 10 per cent, forestry employment increases by 0.25 per cent. The removal of industry assistance as a whole only benefits the non-tradable sectors (i.e. construction and services) except for the real estate sector.

An increase in population levels favours the agricultural sector both in terms of sectoral employment and production. The reason might be that almost 30 per cent of the labour force are employed by this sector. The export tax on logs tends to reduce the level of forestry output but increases wood and paper manufactures. This is consistent with the findings in the economic literature that export taxes tend to encourage more value-added in log production (Barbier et al. 1995; Manurung and Buongiorno 1997; Repetto and Gillis 1988). The uniform reduction in the import tariffs across all industries results in the decline in output for all the land-using sectors in the model. Moreover, the removal of assistance in the agricultural and in the forestry sectors tends to have negative effects on these sectors. This suggests that these sectors benefit from the import tariffs.

VI. Conclusion

This paper analyses the economy-wide effects of four policies included in the Master Plan for Forestry Development in the Philippines as well as population growth and trade liberalisation. The model adopted in this study is a static CGE model of a small open economy with a forestry sub-model adopted from Dee (1991). To implement the model, the 1990 Input-Output table, the 1990 Social Accounting Matrix and various data publications on forestry resources in the Philippines are employed.

The study found that selective logging, set-aside areas and the level of the discount rate in forestry have the greatest effect on timber harvests. In particular, selective logging regardless of land mobility conditions can achieve specific targets on timber volume. In contrast, the establishment of national parks is more effective when land use policies are enforced while lowering the discount rate in forestry has more impact when land is mobile between forestry and agricultural uses. The stumpage tax is only an indirect conservation tool.

Addressing population and trade issues, firstly, the study found that the uniform removal of tariffs has a negative effect on the employment of farmers, forestry workers and fishermen but has a positive effect on real GDP. Secondly, sectoral production and employment in agriculture benefits from population increase. Lastly, the uniform removal of tariffs benefits sectoral employment in the non-tradable sectors (except real estate) but reduces sectoral production in all land-using sectors in the model.

The study also supports the feasibility of attaining forest conservation without sacrificing economic growth. Specifically, selective logging and set-aside areas are found to assist forest conservation with only a small reduction in GDP. Furthermore, employment by farmers, forestry and fishery workers is increased with the implementation of these two policies. Generally, the

Philippines should suffer only a small decline in national income (less than one per cent) if the conservation policies, as defined in this study, are implemented.

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