DEFORESTATION IN THE PHILIPPINES: A CGE MODELLING APPROACH

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Abstract

The Philippine forests have encountered massive destruction since the start of this century. There was no comprehensive program initiated by the government to protect these resources. However, in 1990, the Philippine government formulated the Master Plan for forestry development. The Master Plan is 'a nationwide and aggregate blueprint for the development of the forestry sector across a 25-year horizon' i.e., 1991 to 2015. Through CGE modelling, the general equilibrium effects of various policies such as an increase in the stumpage tax rate, allocation of fund for reforestation purposes and implementation of set-aside programs for environmental considerations as proposed in the Master Plan can be evaluated.

DEFORESTATION IN THE PHILIPPINES: A CGE MODELLING APPROACH

Maria Luz N. Centeno*

I. Introduction

The Philippines was once a country abundant in forest resources. In 1920, 64 percent of the total land area was forested. In 1994, this figure was reduced to 13.5 percent. Virgin forests amounted to less than one million hectares or approximately three percent of total land area in 1988[1]. In spite of the massive forest loss, the Philippine government has failed to transform the profits from its forestry exports into economic development.

In the past, as the various forestry-related legislation would suggest, the perception towards forest resources is purely for timber production that is, the forests' primal purpose is to supply timber (Glück 1987). However, as the natural resource base of the country becomes fragile, the Philippine government has advocated the sustainable use of the country's natural resources. In 1991, the Philippine government in cooperation with the Finnish International Development Agency and the Asian Development Bank formulated the Master Plan for Forestry Development.

This research study aims to analyse some of the recommendations of the Master Plan (e.g., increase in the stumpage tax rate, budget provision for reforestation projects, etc.) using computable general equilibrium (CGE) modelling. The paper is organised as follows: Section II provides a discussion on the nature of deforestation in the Philippines while section III summarises some environmental studies which involve CGE modelling. Section IV describes the Master Plan for Forestry Development and the general features of the Philippine model is discussed in section V. The data requirements are in section VI and section VII summarises the discussion.

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[1]The Philippine government maintains that forestlands should comprise 40 percent of the total land area. At present, in the official statistics, classified and unclassified forestlands stand at 50 percent of total land area. However, these lands are not necessarily forested lands. These lands were classified as forest as they have slope of 18 percent and above.

II. Philippine Deforestation

Deforestation is the process of felling of trees which results in the destruction of forest areas. When the occurrence is minimal, justified by agricultural expansion and urbanisation, without being destructive, deforestation is an integral part of the economic process. However, if it is occurring in an uncontrolled destructive fashion then stopping deforestation, for the purpose of saving ecology, meeting present and future demands for forest products and reducing carbon dioxide emission, is a challenging and worthwhile endeavour[2].

At present, deforestation is occurring in Asia, Latin America and Africa. Deforestation is not a new phenomenon however, it is being associated with population growth and poverty as countries experiencing deforestation *at present times* are less developed countries (LDCs) such as Brazil, Indonesia and the Philippines plagued by overpopulation and extreme poverty. In addition, the lack of comprehensive data on forest resources prior to the 1970s made it impossible for scientists and researchers to measure the extent of deforestation in the past.

2.1 Definition

There are two accepted and widely used definitions of deforestation. Familiarisation of the definitions can help in further understanding deforestation issues. On one hand, the Food and Agriculture Organization (FAO) defines deforestation as a change of land-use with the depletion of tree crown cover to less than 10 percent (Brown & Pearce 1994, p. 8). On the other hand, Myers (in Brown & Pearce 1994) defines deforestation as the complete destruction of forest cover through clearing for agriculture of whatever sort (cattle ranching, smallholder agriculture whether planned or spontaneous, and large scale commodity crop production through, e.g., rubber and oil palm plantations). The

[2]Myers (1993) claimed that with the current trend of deforestation in less developed countries (LDCs), the carbon stock on forests contribute roughly about 30 percent of all anthropogenic emissions of carbon dioxide.

definition used by the Philippine Department of Environment and Natural Resources (DENR) generally follows that of FAO.

Definitions between countries may differ depending on the size of the original (virgin) forest area and the native vegetation. However, FAO's definition as well as Myers' is misleading. Myers' definition implies that not a tree remains and that the land is given over to permanent non-forest purposes. This definition already rules out the possible contribution of logging concessionaires in the creation of denuded secondary forests, without any replanting program. However, Myers (in Brown & Pearce 1994, p.28) claimed to include in his definition the incident of 'over-logging' as practiced in the dipterocarp forests of Southeast Asia[3]. The definition by FAO[4] seems to be questionable. Is there any scientific study stating that 10 percent crown cover is enough for trees to regenerate by themselves or 10 percent is enough provided there are reforestation programs to be undertaken? In any case, clearly, there seems to be an overemphasis on the contribution of agriculturalists to deforestation, whereas loggers' contribution is under emphasised.

2.2 Causes

Causes of deforestation can vary between countries, however, the major issues related to forest destruction are population growth and poverty, and activities such as logging, agriculture and urbanisation. Firstly, population growth and poverty are considered to induce deforestation. Not only that population growth and poverty add pressure to the forest resource as the demands for forest and agricultural products (as well as subsistence agriculture) increase, there is also an increase in demand for housing. This requires

[3]Over-logging results in severely depleted forest biomass due to very heavy and unduly negligent logging, where the remaining cannot survive.

[4]This definition should be compared to FAO's definition of degradation. Degradation refers to the 'changes within the forest class (from closed to open forest), which negatively affect the site or stand, and in particular, lower the production capacity'. It seems that FAO's differentiation of the two processes allows logging concessionaires' activities to be considered as resulting in degradation instead of deforestation.

more agricultural land converted into non-agricultural use (e.g., residential/commercial)[5]. As the available agricultural land diminishes, more and more agricultural production is transferred to the uplands (Cruz & Gibbs 1990; Cruz & Cruz 1990)[6].

In the case of the Philippines, poverty is primarily caused by landlessness. The fact that forestlands in the Philippines are owned by the government and leased to concessionaires coupled with urbanisation which reduces the available agricultural land, poverty is not an evil in itself. People who used to live and survive in the uplands were displaced when the government assumed ownership of all forest lands in the Philippines. These traditional forest dwellers were pushed out of their lands and treated as squatters (Makil 1984).

Secondly, logging activities in Southeast Asia and cattle ranching in Latin America also contribute to the process of deforestation. The incentives provided by Southeast Asian and Latin American governments to logging concessionaires and cattle ranchers created massive destruction in the tropical forests of the Philippines, Indonesia and Brazil (Repetto & Gillis 1988; Repetto 1987). It should be stressed that when the world population was small, logging concessionaires dominated forest activities. Compounded by the long regeneration period of forests say, 80 years, the unsustainable extraction of these resources in the past has a significant contribution to its present dismal state. Logging concessionaires should be made responsible by contributing significantly to reforestation programs.

With regard to logging concessionaires in the Philippines, they exploited the Philippine forests and benefited during the 'timber boom' in the first half of this century. Their activities left the forests denuded and abandoned without any intention of

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[5]The construction of buildings also requires wood products as inputs. This also adds pressure on forest resources.

[6]In the Philippine context, the upland refers to forestlands classified into two, i.e., marginal and *forest lands*. Marginal land is defined as an area with slope between 18 and 30 percent while *forest land* has a slope above 30 percent. See footnote 1.

undertaking reforestation programs. The presence of abandoned (public) forest lands enticed the landless and the unemployed to establish agricultural plantations in the uplands (Repetto 1987; Kummer 1992).

It should be recognised that deforestation is a land use problem especially if there are many *competing* land uses. As population increases, land allocation should reflect the best possible land use, which meets society's various demand for land. In other words, land use is no longer divided into two that is, agriculture and forestry. The increasing demand for real estate may have at least an indirect contribution to deforestation.

Deforestation, Government Policies and Property Rights

The Philippine government, the owner of forestlands, has encouraged logging activities to promote economic development for more than 50 years. Makil (1984) analysed various forest policies enacted and implemented in the Philippines. The abundance of forestry related legislation would overwhelm even an avid reader. Nevertheless, it is evident in all forestry-related legislation on one hand, the bias for logging activities and on the other hand, the bias against traditional forest dwellers and smaller farmers.

The fact that the Philippine government owned and controlled the Philippine forests, the survival and sustainable management of these forest resources rest mainly on the government. Moreover, since the Philippine government assumed ownership of all forestlands, then it can be said that they have 'rights' over these resources. Granting timber licenses to logging concessionaires is equivalent to 'leasing' forestlands to these companies. It is doubtful to believe that massive deforestation could have been avoided if the Philippine government made property rights secure by granting *right away* 25-year leases to logging concessionaires instead of the original 1-to-4 years lease[7]. For one, some would suggest that the cutting cycle should be at least 30 years (Tomboc &

[7]Prior to 1970s, timber licenses are only valid from 1-to-4 years (Boado, in Repetto & Gillis 1988).

Mendoza 1993; Wiedelt 1996)[8]. Another is, due to the long interval in between harvest concessionaires try to maximise their return by increasing the volume of timber cut and the area coverage. Without explicit commitment to sustainable forestry and conservation from the government, logging concessionaires, in the case of the Philippines, covered huge land areas, and engaged in excessive allowable cuts (Repetto & Gillis 1988; Tomboc & Mendoza 1993).

Eggertsson (1990) argues that the exclusive rights regime does not necessarily eliminate spill-over effects of previous common ownership arrangement. This is mainly due to high and prohibitive transactions costs. In addition, the distribution of wealth in society is affected by the assignment of property rights and liabilities. The structure of the property rights reflects the interests, values, and constraints of those who control the state (Eggertsson 1990, p. 102). This directly points out to the Philippine government's forestry policies.

Since the Philippine forest was considered traditionally as common property by the Filipino people, its conversion to State property (public domain) by the Philippine government created the 'present' *open-access nature* of the resource. Traditionally, the forests are managed by the local community. The conversion removed local community involvement and placed the resource under government jurisdiction. This arrangement proved to be inefficient since the Philippine government does not have the capability to carefully monitor forestry activities. Moreover, the government action disregarded the prevailing norm within the communities and weakened local cooperation. As a consequence, displaced and landless people are attracted to occupy and establish agricultural cultivation in public forests, specifically those that are abandoned and left idle.

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[8]The cutting cycle 'is the interval between timber harvests in a polycyclic system' while rotation 'indicates the time a tree needs to grow from a seeding to harvestable dimensions'. The length of the cycle depends on the growth rate of the stand, biological and management considerations (Wiedelt, in Schulte & Schöne 1996).

Deforestation, upland population and squatting

Prior to government ownership of forestlands in the Philippines, there was no such phenomenon as squatting. The Philippines has an area of approximately 30 million hectares, 14.1 million hectares have slope less than 18 percent, 8.6 million have slope between 18 and 30 percent and 6.5 million have slope above 30 percent (Cruz & Repetto 1992, p. 37). When the Philippine government assumed ownership of all forestlands, no individual is allowed to live in these areas unless a proof of ownership can be established[9]. Clearly, the people who lived for hundreds of years in the forest were deemed as squatters. This is compounded by the fact that these people do not have a piece of paper to show proof of ownership. Hence, many were displaced and relocated.

At present, the upland population is estimated to be around 22 million given that average population growth rate of 2.3 percent per annum and the estimated upland population in 1988 stood at 17.8 million. This figure is 31 percent of the total population in 1998, occupying 50 percent of the total land area of the Philippines. Relocating these people in the lowlands or non-forestlands implies that 14.1 million hectares have to be divided among 70 million Filipinos. This also implies a population density of 50 persons per square meter notwithstanding the fact that land is unevenly distributed in the Philippines. Moreover, there are groups of people that traditionally live in the forest areas. The complete absence of people in forestlands is inevitable specially taking into consideration the process of delineation of forestlands in the Philippines.

Reforestation Efforts in the Philippines

Reforestation efforts in the Philippines lagged behind timber extraction. The contribution of timber companies to the whole reforestation process is small and even disappointing when compared to the number of hectares deforested or even the area under timber licence agreements. In 1976, the area under timber licenses is more than eight million hectares while the reforested area (by timber licenses) stood only at 0.1 percent of the

[9]Over time, indigenous people (tribal groups) were allowed to occupy their ancestral lands.

total area under timber licenses. Over time the area under timber licenses has declined, in 1995, this area stood at 1.5 million hectares while reforested area was only two percent. Due to the long history of timber extraction and the process of land classification, not all forestlands in the Philippines have forest cover. In 1991, 4.9 million hectares of classified forestland is without cover. Assuming that from 1992 to 1995 timber companies reforested a total of 64,223 hectares of land, this is only 1.3 percent of 4.9 million hectares as of 1995.

Reforestation programs in the Philippines have not been successful (Boado 1988; Hurst 1990). Reforestation activities started since 1916 when it was introduced by the American colonial government. According to Korten (1994) from 1916 to 1987, the Bureau of Forest Development (BFD) introduced a total of 184 reforestation projects targeting one million hectares of which only 272,000 hectares of denuded forest lands were *actually replanted.* In comparison to 15 million hectares of classified forest land and 6.5 million hectares of forested land (with actual cover) as of 1987, the replanted area only accounted for 1.8 and 4.2 percent, respectively. In addition, in 1988 a German-based study sampled the replanted area and found that only 26 percent or 70,000 hectares could be *considered reforested.*

Given the unimpressive performance in reforestation activities in the Philippines, there seems to be some room for improvement. Moreover, the fact that 36.5 percent of the forestlands in the Philippines has no forest cover, reforestation is the only viable and logical course of action to regenerate these forest resources.

III. Some Relevant Literature

During the last decade, the CGE modelling has been used primarily in taxation and international trade studies (Shoven & Whalley 1984). General equilibrium analysis has also been used in issues other than taxation and trade policies as evidenced by the various

literature surveys (Siriwardana 1985; Bergman 1985; Bergman 1988; Devarajan 1988; Bandara 1991; and Wajsman 1994).

Increasingly in the 1990s, CGE modelling has been used in resource pricing and allocation problems such as water and energy (Goldin & Roland-Holst 1995; Clarke & Winters 1995). Carbon dioxide emission and global warming studies also employ CGE models to derive optimal levels of carbon tax and CO_2 emission (Kokoski & Smith 1987; Glomsrod, Vennemo & Johnsen 1992). The use of CGE modelling also spread to environmental regulation analyses (Bergman 1990; Hazilla & Kopp 1990; Hrubovcak, LeBlanc & Miranowski 1990). At present, the application of CGE analysis on environmental problems is still increasing.

Deforestation and CGE models

There are a few studies on deforestation using CGE models (Dee 1991; Persson & Munasinghe 1995; Persson 1994; Thiele & Wiebelt 1994; Wiebelt 1995). These studies attempted to analyse four types of policy instruments (i.e., equalisation of incentives, output and input taxation, ban on log exports and property rights).

The equalisation of incentive across all the sectors in the economy is shown to have not induced deforestation to the extent that it reduced over all land use in the case of Brazil (Wiebelt 1995) and increased volume of standing timber in the case of Indonesia and Cameroon (Dee 1991; Thiele & Wiebelt 1994). However, in Brazil, the reduction in overall land use resulted in lower GDP while in the case of Indonesia and Cameroon, the increase in the volume of standing timber is brought about by the assumption that there is land mobility across producing sectors.

The imposition of taxes on land, labour, capital and forestry output is also analysed. Wiebelt (1995) suggests that a 10 percent tax on land use, uniformly applied across all primary sectors in the Amazon except forestry leads to a reduction in

deforestation rate without hampering economic activity[10]. Wiebelt and Thiele (1994) impose different tax rates on land, i.e., 10 percent for forestry, 20 percent for export crops and 25 percent for food crops. The rates are based on the relative contribution of these processes to deforestation[11]. The differential taxation results in reduced (overall) output and land use. In the case of Indonesia, the tax on forestry output does not lead to significant beneficial effects (Dee 1991). Persson (1994) analyses the effects of taxes on the production factors in Costa Rica. The tax on labour does not affect consumption and savings decisions since the tax is assumed to be distributed back to the consumer in the form of a lump sum tax. A tax on capital in period 0 results in both squatting and logging industries experiencing a boom while, in period 1, the production in the industry sector is reduced. A tax on logs does not affect domestic production and consumption patterns while a subsidy on land reduces total deforestation. An tax increase on agricultural products induces deforestation. Another study in Costa Rica (Persson & Munasinghe 1995) suggests that taxes on unskilled labour and on agricultural products induce deforestation.

Dee (1991) analyses the effects of lifting the log export ban, in the form of removing the export tax on raw log exports, on the volume of standing timber. The results show that when land is immobile, the lifting of the ban on log exports would reduce the volume of standing timber. This is equivalent to penalising (in a relative sense) all other sectors except for forestry thus, the forest sector increases its output by shortening rotation periods and cutting trees down sooner. With land mobility, the pressure for shorter rotation periods can be offset by a greater area of land devoted to forestry hence, increases the volume of standing timber. Aggregate real income is reduced by removing the log export ban. This suggests that the log export ban may have succeeded in increasing the value added to Indonesian logs at world prices. In the case of Cameroon, the elimination of import tariffs and export taxes on agricultural goods

[10]There is a biased for agricultural activities specifically cattle ranching in Brazil. Hence, the imposition of the tax eliminates the implicit biased against forestry.

[11]The authors assume that food crop production contributes more to deforestation than exports crop production while forestry contributes the least.

results in the reduction of the standing timber volume while eliminating import-tariffs across the board increased both the volume of standing timber and real GDP (Thiele & Wiebelt 1994).

The issue on property rights is brought up by all five studies. The studies generally show that the assignment of property rights (i.e., securing property rights of logging concessionaires over the forest resource via the market/discount rate) leads to a reduction in deforestation.

None of the studies explicitly incorporated in their analyses the possible effects of urbanisation, in terms of the demand for real estate (for residential and/or commercial use), on deforestation. The emphasis is on the relationship between agriculture and forestry. In a land scarce country like the Philippines with high population growth rates, the possible contribution of urbanisation to deforestation could be significant.

Philippine CGE Models

There are quite a few CGE models constructed for the Philippines. Some models are primarily for evaluation of various agricultural policies (Bautista 1986; Habito 1986; Coxhead & Warr 1991; Warr & Coxhead 1993), taxation and international trade (Boyd, Doroodian and Udomvaech 1994; Clarete & Roumasset 1987), and other issues (Ito 1987; Go 1994; Liu, Yao and Greener 1996).

None of these studies looked at the possible relationship among sectors in the economy, where agriculture, forestry and real estate are explicitly specified. Forestry, most often than not, is aggregated into the agricultural sector while the real sector is included in the services sector. By making forestry and the real estate sectors explicit in the model, the changing land use as it affects the process of deforestation might be brought into light. In sum, the model outlined in this paper is different from the existing

deforestation models by incorporating an explicit real estate and forestry sector and by emphasising on reforestation instead of property rights.

IV. Master Plan for Forestry Development

The Master Plan is "a nationwide and aggregate blueprint for the development of the forestry sector across a 25-year horizon". The planning period is from 1991 to 2015. The goals and objectives of the plan are quite benevolent and ambitious. It aims to conserve, properly manage forest resources and ensure wood supply. It also hopes to promote social justice, equity and employment generation.

Institutional Development

The Master Plan has called for some changes in the policy and legal framework concerning forestry in the country. At present, there is a plethora of legislation pertaining to forestry. The Plan argues that there is a need to review these existing policies to enable the enactment of appropriate laws. The Plan also advocates the improvement of the capability of DENR in implementing the Master Plan's objectives. Research and Development in forestry is also given emphasis. At the same time, forestry education, training and extension are utilised to upgrade the knowledge in forestry. Furthermore, monitoring and evaluation throughout the project is necessary to ensure that the different programs are being implemented in accordance to their respective goals.

Investment Costs of the Master Plan

Any program involves financing. Although the financial consideration is only one of the important factors that can affect the effectiveness of any program, ensuring that there are enough funds for each component is vital.

The total cost of the Master Plan primary development programs is estimated to be ₱192.6 billion or A$7.7 billion (A$1 = ₱25) over the 25-year period. The government is

expected to shoulder 22.5 percent while the private sectors' share is around 32.3 percent. The remaining 45.2 percent will be sourced from foreign donors.

Policies Derived

To date, there are six policies derived from the Master Plan. They are as follows:

(a) Recognition and operationalisation of access by common people to the natural resources;

(b) Ban on logging of the virgin dipterocarp forests and in critical areas such as those with slopes higher than 50 percent and with elevations higher than 1000 meters;

(c) Increase in economic rent (stumpage price) to 25 percent of the market price of wood from natural forests;

(d) Creation of a national protected areas system;

(e) Rationalisation of the forest industries and;

(f) Strengthening of support institutions.

Some of the simulations in this study will be based on policies (b), (c) and (d). In order to do so, a stumpage tax variable is incorporated in the net revenue function of the forestry sector (refer to 1.15 in Table 1). The stumpage tax is a tax on logs harvested on natural forests[12]. It is used by the government to increase the economic rent it can potentially receive from logging activities[13]. The simulation of protected areas and the ban (on logging) on virgin forests is done by setting aside a certain number of hectares in which any economic activity is prohibited. This is equivalent to reducing the total available land in the economy by restricting the amount of land allocated to each producing sectors (refer to 1.49). The minimum size of trees that can be harvested (via

[12]Under RA 7161, a law which raised forest charges, only those logs harvested from natural forests receive these charges. Logs harvested from plantations are exempted. Nonetheless, this study assumes that logs harvested from forest plantations are minimal hence, forest charges will be applied to all logs harvested regardless of the source.

[13]In the Philippines, the forest revenue system is comprised of forest charges, which is defined as 'a levy being imposed by the government on naturally growing timber and other forest products cut by the permitee/licensee and from plantations established in compliance with TLA reforestation obligations'.

the variable minimum age) may also be used as a tool to meet set-aside targets (refer to 1.9). In addition, the model attempts to simulate reforestation and establishment of plantations. Reforestation is modelled by setting aside a budget for replanting trees through government and private sources (refer to 1.36).

The Master Plan has finally recognised the rights of the common people to use forest resources. The government has decided not to renew existing timber license agreements (TLA) with logging concessionaires. Under the Master Plan, all TLAs are only valid until 2012. This shows the present commitment of the government towards community based forestry.

V. The General Features of the Model

This study treats deforestation as a land use problem. It incorporates varying land use, i.e., agriculture, forestry, mining and commercial/recreational. It departs from studies, which only look at either the conversion between forestry and agriculture or between agriculture and non-agricultural use. In so doing, the indirect relationship between forestland and non-agricultural land is addressed.

For simplicity, when comparing different land usage, it is assumed that non-agricultural use pertains to real estate, forestry and mining. The land requirements of say, manufacturing industries and commercial services are provided by the real estate sector. Hence, the model assumes that there are four producing sectors namely, agriculture, forestry, mining and real estate that use land intensively.

The model is a static CGE model of an open small economy. It draws heavily from ORANI, the multisectoral CGE model for Australia. To simulate the unique characteristics of the Philippine economy, the model also draws from two Philippine CGE models i.e., Bautista (1986) and Habito (1986; 1989). With regard to modelling the forestry sector, the forestry sub-model constructed by Dee (1991) is adopted.

The model gives a representation of each industry's demands for labour, capital, land and various material inputs from both domestic and imported sources. These industries are assumed to maximise profit (or minimise cost) subject to constant returns to scale production functions. The relationship between input 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 factors of production as well as the aggregation of the different types of labour is also described by CES production functions.

Unlike ORANI and Dee (1991) which only have a single representative consumer, this model has three classifications of households based on the 1990 Social Accounting Matrix (SAM). Consumers maximise utility and demand is defined by the Stone-Geary linear expenditure system. Consumers are assumed to maximise utility subject to their income levels. Household k's consumption budget is defined by (1.30) as shown in Table 1, i.e., the percentage change in the consumption budget of household k is given by the sum of the percentage changes in the disposable income and the ratio of consumption to disposable income of household k. Its level form is given by

$$C_k = \psi_k^H Y_k^H$$

where: ψ_k^H - ratio of consumption to disposable income of household k

Y_k^H - disposable income of household k

There are three domestically mobile factors of production i.e., unskilled and skilled labour and land. Land can be treated as mobile to the extent that its use can vary. It is assumed that after logging companies have cleared and abandoned the area, the land becomes idle. Local communities seize this opportunity and establish agricultural plantations. As agricultural lands are being converted into non-agricultural use[14], the

[14]This conversion is subject to one specific characteristic of the area, that is flatness. Most agricultural lands (in the low lands) are flat. This resulted in the competing nature of land usage between agriculture and real estate development. In addition, the road network along agricultural lands increases their attractiveness for development.

presence of abandoned forestland poses to be an alternative source of farm income. This implies that land use changes from forestry to agricultural use then from agricultural use to non-agricultural use. The conversion from *agricultural to forestry* use can be treated as the establishment of plantation areas (Dee 1991). Nonetheless, this type of conversion is rare due to the fact that reforestation programs, which include the establishment of plantation forestry, occur in areas classified as forest area[15]. The supply of labour, capital and land are assumed to be fixed and exogenously given. Capital is treated as an industry-specific factor of production.

There is a government sector and a foreign sector. The government derives its income from direct and indirect taxes and direct government transfers from abroad. The government only consumes domestically produced goods. Hence, government demand is represented by (1.28), where the percentage change in government demand is given by the sum of the percentage changes in the share of good i in the total government consumption, the ratio of total government consumption to disposable income and government disposable income. The level form is given by

$$X_i^G = \varpi_i^G \psi^G Y^G$$

where: ϖ_i^G - share of good i in the total government consumption expenditure

ψ^G - ratio of consumption to disposable income of government

Y^G - disposable income of government

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 assumed to be a price taker in the world market. The domestic producer price of a tradable good is then equal to the world price of an identical good. The domestic user price of a good produced in the non-tradable sector is given by the domestic producer price plus taxes. The Armington assumption is applied to the imports,

[15]Recall that forest areas in the Philippines are not necessarily forested.

where imported goods are differentiated from their domestic counterparts. The difference between the domestic supply and demand for a good is assumed to be equal to net export of that good to ensure that the market for that good will clear. Zero pure profits 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.

Special treatment in terms of modelling is conferred to the forestry sector (1.8-1.23). The standard input demand and zero profit equations are replaced by a set of steady state production relationships adopted from Dee (1991). The non-land input bundle of the forestry sector combines each intermediate input and a composite of capital and labour in fixed proportions. Dee's forest model is employed since the equations allow for selective logging to be simulated as well as the other programs in the Forestry Master Plan. The model assumes that restrictions on the minimum size of trees are enforceable and binding, as they can be determined ex post. Hence, set-aside programs can be achieved through delineation of forestlands to be protected from any logging or economic activities and the specification of minimum tree size. In order to maximise the discounted value of net returns from forestry, rotation periods are allowed to adjust. It also assumes that non-land inputs into forestry are fixed per rotation and so allows for economies of scale in forestry.

The demand for real estate can be a function of urbanisation, the price of agricultural land, the price of commercial land and the relative returns in agricultural production and non-agricultural activities. However in this study, the demand for housing is divided into two, the demand for capital and demand for land, following Muth-Casetti-Solow (MSC) models. Therefore, it is assumed here that the real estate sector buys agricultural land and construction products as inputs to produce commercial land (real estate).

Investment is assumed to be equal to savings as represented by (1.34). It is also assumed that each industry has a fixed share on the total investment in the economy. The model assumed that reforestation is a form of investment. Hence, total investment allocated to each industry is equal to the difference between the total investment and reforestation funding multiplied by each industry's respective shares which is given by

$$Y_j=\theta_j(TY-\mathrm{Re}f)$$

The linear percentage form is given by (1.36). Since the reforestation variable is assumed to be exogenous in the model, the effect of increasing the available fund for reforestation on investment allocation as well as on the whole economy can be analysed.

Considerable detail has already been accorded to the agricultural sector in many of the previous CGE models for the Philippines. In this model, the agricultural sector as a whole is disaggregated only into two sectors, i.e., agricultural crops and services and livestock, poultry and fishery. Forestry is modelled as a separate sector. The complete model is shown in Table 1.

VI. Data

The basic source of data is the 1990 input-output (I-O) table. It is supplemented by the 1990 social accounting matrix (SAM), Philippine statistical yearbook 1994 and the 1995 forestry statistical yearbook. The 1990 I-O table is aggregated into 11 producing sectors and 12 commodities. The producing sectors are agriculture, forestry, mining, food manufacturing, non-food manufacturing, wood and paper manufacturing, construction, real estate services, financial services, electricity, gas and water services, and other services. The benchmark year is 1990 since the most recent available social accounting matrix for the Philippines has been constructed using 1990 data. This year is chosen to be the benchmark period due to the following reasons: (a) ban on export of timber and raw lumber was imposed (volume of logs and lumber exported declined tremendously between 1990 and 1995); (b) the exchange rate was at its highest value; (c) the Philippine

economy was heading into a recession and; (d) the implementation of the IMF/World Bank stabilisation policies started in the 1980's.

VII. Summary

Problems concerning the use of natural resources are, most often than not, related to the issue of property rights. There is a consensus that private assignment of property rights can solve the open-access problem concerning natural resources. This might not be the case for the Philippines. It should be made clear that common property rights regime is not equivalent to open-access regime. Common property rights involves a group of people say, a community, in contrast to private property regime, where the owner is usually an individual or a company.

Property rights concerning Philippine forests are rather clear. All forestlands are government-owned and the government has leased these lands to logging concessionaires. Unfortunately, this resulted in decreased welfare for majority of the Philippine population. It is mainly due to the fact that the government disregarded the prevailing norm within local communities. Prior to State control, local communities had jurisdiction over forest resources. In other words, forest resources were under a common property regime, where local communities had the right over these resources. The assumption of ownership by the government disrupted and weaken local community control over these resources, thus, creating an open-access problem.

Nonetheless, the issue of secure property rights is still relevant to the problem of natural resource degradation. In the case of the Philippines, common property rights might solve the open-access problem. Hence, the rights to forest resources should be transferred back to local communities in order to encourage community reforestation projects. This will provide incentives to local communities to protect their livelihood and environment. Hence, this study puts emphasis on reforestation and the establishment of plantation forestry involving the community.

Table 1
List of equations, a linear system in percentage changes

Identifier	Equation	Subscript Range	Number	Description
(1.1)	$x_{(is)j} = z_j - \sigma_{ij} [p_{(is)j} - \sum_s S_{(is)j}\ p_{(is)j}] - a_{ij}$	i=1,..., g s=1,2 j=1,..., h	2gh	Intermediate input demand
(1.2)	$x_{(g+1, L, m)j} = x_{(g+1,L)j} - \sigma_{(g+1, L, m)j} [p_{(g+1, L, m)j} - \sum_m S_{(g+1, L, m)j}\ p_{(g+1, L, m)j}]$	m=1,2 j=1,..., h	Mh	Demand for labour by occupational groups
(1.3)	$x_{(g+1, s)j} = z_j - \sigma_{(g+1, s)j} [p_{(g+1, s)j} - \sum_s S_{(g+1, s)j}\ p_{(g+1, s)j}] - a_{ij}$	s=1,2,3 $j \neq 2$	3(h-1)	Demand for primary factors (non-forestry)
(1.4)	$x_{(g+1, s)j} = z_j - \sigma_{(g+1, s)j} [p_{(g+1, s)j} - \sum_s S_{(g+1, s)j}\ p_{(g+1, s)j}] - a_{ij}$	s=1, 2 j = 2	2	Demand for primary factors (forestry)
(1.5)	$p_{(g+1, L)j} = \sum_{m=1}^{2} p_{(g+1, L, m)j}\ S_{(g+1, L, m)j}$	j = 1, ..., h	h	Price of labour
(1.6)	$x^K_{(is)j} = y_j - \sigma^K_{ij} [p^K_{(is)j} - \sum_{s=1}^{2} S^K_{(is)j}\ p^K_{(is)j}]$	i=1,...,g j=1,..., h	2gh	Inputs to capital creation
(1.7)	$x^{(0)}_{(rd)j} = z_j + \sigma^{(0)}_{rj} [p^{(0)}_{(rd)j} - \sum_{i=1}^{g} R_{(id)j}\ p^{(0)}_{(id)j}]$	$j \neq 2$	gh-1	Supply of commodities by industry
(1.8)	$vol_{tim} = Svol_{tim}\ \alpha$	j = 2	1	Timber volume per hectare as a % of harvest age
(1.9)	$Vol_{stand} = Svol_{env}\ \alpha_{min}$	j = 2	1	Timber volume per hectare that must be left standing
(1.10)	$vol_{harv} = Svol_{harv} vol_{tim} + (1-Svol_{harv}) vol_{stand}$	j = 2	1	Harvest volume per hectare per rotation
(1.11)	$T = S_{rot}\alpha + (1- S_{rot})\ \alpha_{min}$	j = 2	1	Rotation period
(1.12)	$vol_{grow} = Svol_g\ vol_{tim}$	j = 2	1	Partial derivative of timber volume w.r.t age

Identifier	Equation	Subscript Range	Number	Description
(1.13)	$p(\tilde{N})_j = \sum_{i=1}^{g}\sum_{s=1}^{2} H_{(is)j}\, p_{(is)j} + \sum_{s=1}^{2} H_{(g+1,s)j}\, p_{(g+1,s)j}$	$j = 2$	1	Price index of non-land inputs into forestry
(1.14)	$c_{rot} = p(\tilde{N})_j + x(\tilde{N})_j$	$j = 2$	1	Forestry non-land costs per hectare per rotation
(1.15)	$rev_{rot} = S_{rev}\,[p^{(0)}_{(rd)j} + vol_{harv}] + (1 - S_{rev})\, c_{rot} - S_{\tau j}\, \tau^{(1)}_j$	$j = 2$	1	Forestry net revenue per hectare per rotation
(1.16)	$rev_{grow} = p^{(0)}_{(rd)j} - S_{\tau j}\, \tau^{(1)}_j$	$j = 2$	1	P.d. of timber volume w.r.t. harvestable volume
(1.17)	$rev_{grow} + vol_{grow} = r + f_j + rev_{rot} - S_{opt}\,[r + f_j + T]$	$j = 2$	1	F.O.C. for optimal rotation
(1.18)	$x^{(0)}_{(rd)j} = vol_{harv} + x_{(g+1,\,s)j} - T$	$j = 2$ $s = 3$	1	Forestry total output per year
(1.19)	$z_j = x(\tilde{N})_j + x_{(g+1,\,s)j} - T$	$j = 2$ $s = 3$	1	Forestry total non-land inputs per year
(1.20)	$p^{(0)}_{(rd)j} + x^{(0)}_{(rd)j} = S_{\tilde{N}}\,[p(\tilde{N})_j + z_j] + (1 - S_{\tilde{N}})\, p_{(g+1,\,s)j} + x_{(g+1,\,s)j}]$	$j = 2$ $s = 3$	1	Zero-pure profits in forestry
(1.21)	$v_{(g+1,\,s)j} = rev_{rot} - S_v\,[r + f_j + T] - S_{opt}\,[r + f_j + T]$	$j = 2$ $s = 3$	1	Stock value per hectare of forestland
(1.22)	$v_{(g+1,\,s)j} = p_{(g+1,\,s)j} - S_{\tau j}\, \tau_{(g+1,\,s)j} - r$	$j \neq 2$ $s = 3$	(h-1)	Stock value per hectare of non-forestland
(1.23)	$v_{(g+1,\,s)j} = v_{(N^*)} + f^{vj}$	$s = 3$ $j=1,\ldots, h$	h	Allocation of mobile land
(1.24)	$x^H_{(is)k} = x^H_{ik} - \sigma^H_{ik}\,[p^H_{(is)} - \sum_{s=1}^{2} S^H_{(is)k}\, p^H_{(is)}]$	$i=1,\ldots,g$ $s=1,2$ $k=1,2,3$	2kg	Household k's demand for good i by source
(1.25)	$p^H_i = \sum_{s=1}^{2} S^H_{(is)k}\, p^H_{(is)}$	$i=1, \ldots, g$	g	Price paid by household

Identifier	Equation	Subscript Range	Number	Description
(1.26)	$x^H_{ik} = \varepsilon_{ik}\, c_k + \sum_{h=1}^{g} \eta_{(ih)k}\, p^H_h$	i,h=1,..,g k=1,2,3	kg	Household k's demand for good i
(1.27)	$x^E_{(id)} - f^E_{(Qi)} = -\gamma_i\, p^e_{(id)} + f^E_{(Pi)}$	i = 1,..., g	g	Foreign demand
(1.28)	$x^G_i = \varpi^G_i + \psi^G + y^G$	i = 1,..., g	g	Government demand
(1.29)	$y^H_k = \Sigma_k\, y^H_{(g+1)k}\, S^H_{(g+1)k} + y^H_{REMk}\, S^H_{REMk} + y^H_{cTk}\, S^H_{cTk} + y^H_{Pk}\, S^H_{Pk} - S_{(H,Yk)}\, t_{(H,Yk)}$	s,k = 1, 2, 3	k	Household k's disposable income
	$y^H_{(g+1)k} = \Sigma_j \Sigma_s [p_{(g+1,s)j} + x_{(g+1,s)jk}]\, S^H_{(g+1,s)jk}$	k = 1, 2, 3	k	
(1.30)	$c_k = y^H_k + \psi^H_k$	k = 1, 2, 3	k	Household k's consumption budget
(1.31)	$c = \sum_{k=1}^{3} c_k\, S_k$	k = 1, 2, 3	1	Aggregate household consumption
(1.32)	$c_R = c - \xi^H$		1	Aggregate real household consumption
(1.33)	$y^G = y^G_{IT}\, S^G_{IT} + y^G_{cT}\, S^G_{cT} + y^G_P\, S^G_P - S_{(G,Y)}\, t_{(G,Y)}$		1	Total government income-
	$y^G_{IT} = y^G_I\, S^G_I + y^G_K\, S^G_K + y^G_H\, S^G_H + y^G_G\, S^G_G + y^G_E\, S^G_E + y^G_M\, S^G_M$		1	from indirect taxes
	$y^G_I = \Sigma_i \Sigma_s \Sigma_j\, S^G_{I\,isj} [p_{(is)j} + x_{(is)j} + t_{(I,isj)}]$		1	from intermediate use
	$y^G_K = \Sigma_i \Sigma_s \Sigma_j\, S^G_{K\,isj} [p^K_{(is)j} + x^K_{(is)j} + t_{(K,isj)}]$		1	from capital creation
	$y^G_H = \Sigma_i \Sigma_s \Sigma_k\, S^G_{Hisj} [p^H_{(is)} + x^H_{(is)k} + t_{(H,is)}]$		1	from HH consumption
	$y^G_G = \Sigma_i\, S^G_{Gi} [p^G_i + x^G_i + t_{(G,i)}]$		1	from gov't consumption
	$y^G_E = \Sigma_i\, S^G_{Ei} [p^e_i + x^E_i + t_{(E,i)}]$		1	from exports
	$y^G_M = \Sigma_i\, S^G_{Mi} [p^M_i + x^M_i + t_{(M,i)}]$		1	from imports

Identifier	Equation	Subscript Range	Number	Description
(1.34)	$ty = \Sigma_k\ [\omega_k + y^H{}_k]\ S^H{}_{ty,k} + [\omega_G + y^G]\ S^G{}_{ty} + [K^F + \phi\ ]\ S^{KF}{}_{ty}$		1	Total investment
(1.35)	$i_R = ty - \xi^K$		1	Real private investment expenditure
(1.36)	$y_j = \theta_j + ty\ S^Y{}_{ty} - ref\ S^Y{}_{ref}$	j=1,..., h	h	Allocation of investment by industry
(1.37)	$\sum_{r=1}^{g} p^{(0)}_{(rd)} H^{(0)}_{(rd)j} = \sum_{i=1}^{g}\sum_{s=1}^{2} p_{(is)j}\ H_{(is)j}$ $+ \sum_{m=1}^{2} p_{(g+1,\ L,\ m)j}\ H_{(g+1,\ L,\ m)j}$ $+ \sum_{s=2}^{3} p_{(g+1,\ s)j}\ H_{(g+1,\ s)j} + \sum_{i=1}^{g+1} a_{ij}\ H_{ij}$	$j \neq 2$	h-1	Zero pure profits in production
(1.38)	$\pi_j = \sum_{i=1}^{g}\sum_{s=1}^{2} p^K_{(is)j}\ H^K_{(is)j}$	j = 1, ..., h	h	Zero pure profits in capital creation
(1.39)	$p^{(0)}_{(im)} = p^m_{(im)} + \phi + t_{(M,i)}$	i = 1, ..., g	g	Zero pure profits in importing
(1.40)	$t_{(M,i)} = f_{(i,0)} + f_{(Mi,u)}$	i = 1, ...,g	g	Flexible handling of tariff rates
(1.41)	$(P^e_{(id)} + \phi) = p^{(0)}_{(id)} + t_{(E,i)}$	i = 1, ..., g	g	Zero pure profits in exporting
(1.42)	$t_{(E,i)} = f_{(i,0)} + f_{(Ei,u)}$	i = 1, ..., g	g	Flexible handling of export taxes(subsidies)
(1.43)	$p^{(u)}_{(is)j} = p^{(0)}_{(is)} + t_{(u,isj)}$	i=1,...,g j=1,...,h s,u=1,2	4gh	Zero pure profits in the
	$p^H_{(is)} = p^{(0)}_{(is)} + t_{(H,is)}$	i = 1,..., g s = 1, 2	2g	distribution of goods to
	$p^G{}_i = p^{(0)}_{(id)} + t_{(G,i)}$	i = 1,..., g	g	domestic users

Identifier	Equation	Subscript Range	Number	Description
(1.44)	$t_{(u,isj)} = f_{(i,0)} + f_{(u,isj)}$ $t_{(H,is)} = f_{(i,0)} + f_{(H,is)}$ $t_{(G,i)} = f_{(i,0)} + f_{(G,i)}$	i=1,...,g j=1,...,h s,u=1,2 i = 1,..., g s = 1, 2 i = 1,..., g	4gh 2g g	Flexible handling of taxes (subsidies) on sales to domestic users
(1.45)	$x^{(0)}_{(rd)} = \sum_{j=1}^{h} x_{(rd)j} B_{(rd)j} + \sum_{j=1}^{h} x^{K}_{(rd)j} B^{K}_{(rd)j} + \sum_{k=1}^{3} x^{H}_{(rd)k} B^{H}_{(rd)k} + x^{G}_{(rd)} B^{G}_{(rd)} + x^{E}_{(rd)} B^{E}_{(rd)}$	r = 1,..., g	g	Demand equals supply for domestically produced goods
(1.46)	$x^{(0)}_{(rd)} = \sum_{j=1}^{h} x^{(0)}_{(rd)j} B^{(0)}_{(rd)j}$	r = 1,..., g	g	Total output of good (rd)
(1.47)	$l_m = \sum_{j=1}^{h} x_{(g+1, L, m)j} B_{(g+1, L, m)j}$	m = 1, 2	M	Demand equals supply for labour of each skill group
(1.48)	$k_j(0) = x_{(g+1, K)j}$	j = 1, ..., h	h	Demand equals supply for capital
(1.49)	$n_j = x_{(g+1, N)j}$	j = 1, ..., h	h	Demand equals supply for land
(1.50)	$l = \sum_{m=1}^{2} l_m \Psi_{Lm}$		1	Aggregate employment
(1.51)	$k(0) = \sum_{j=1}^{h} k_j(0) \Psi_{Kj}$		1	Aggregate capital stock
(1.52)	$n = \sum_{j=1}^{h} n_j \Psi_{Nj}$		1	Aggregate land

Identifier	Equation	Subscript Range	Number	Description
(1.53)	$x^{M}_{(rm)} = \sum_{u=1}^{2}\sum_{j=1}^{h} x^{(u)}_{(rm)j} B^{(u)}_{(rm)j} + \sum_{k=1}^{3} x^{H}_{k(rm)} B^{H}_{k(rm)} + x^{G}_{(rm)} B^{G}_{(rm)}$	$r = 1, \ldots, g$	g	Import volume
(1.54)	$m = \sum_{r=1}^{g} [p^{m}_{(rm)} + x^{M}_{(rm)}] M_{(rm)}$		1	Foreign currency value of imports
(1.55)	$e = \sum_{r=1}^{g} [p^{e}_{(rd)} + x^{E}_{(rd)}] E_{(rd)}$		1	Foreign currency value of exports
(1.56)	$100\Delta B = Ee - Mm$		1	Balance of trade
(1.57)	$\xi^{H} = \sum_{s=1}^{2}\sum_{i=1}^{g} w^{H}_{(is)} p^{H}_{(is)}$		1	Consumer price index
(1.58)	$\xi^{K} = \sum_{j=1}^{h} w^{K}_{(is)j} \pi_{j}$		1	Capital-goods price index
(1.59)	$p_{(g+1, L, m)j} = h_{(g+1, L, m)j} \xi^{H} + f_{(g+1, L)} + f_{(g+1, L)j} + f_{(g+1, L, m)} + f_{(g+1, L, m)j}$	$m=1, 2 \quad j=1,\ldots, h$	Mh	Flexible handling of wages by occupation and industry
(1.60)	$gdp = \sum_{k=1}^{3} C_{k} S^{H}_{gdp,k} + \sum_{j=1}^{h} y_{j} S^{K}_{gdp,j} + ref\, S_{gdp,ref} + \sum_{i=1}^{g} x^{G}_{i} S^{G}_{gdp,i} + (e + \phi) S^{E}_{gdp} - (m + \phi) S^{M}_{gdp}$		1	Gross domestic product

Total number of equations
$= 13gh + 2Mh + M + 11h + 16g + 3kg + 3k + 31$

Table: 2 List of variables

Description	Variable	Number
Industry activity levels	z_j	h
Demands for inputs (domestic and imported) for current and capital creation	$x^{(u)}_{(is)j}$	4gh
Demands for labour inputs by skill group and industry	$x_{(g+1,\ L,\ m)j}$	Mh
Industry demands for labour, capital and land	$x_{(g+1,\ s)j}$	3h
Domestic commodity output levels by industry	$x^{(0)}_{(id)j}$	gh
Total supply of domestic commodities	$x^{(0)}_{(id)}$	g
Household demands for good by type and source	$x^{H}_{(is)k}$	2kg
Households demands for goods by type, undifferentiated by source	x^{H}_{ik}	kg
Government demand for goods	x^{G}_{i}	g
Export volumes	$x^{E}_{(id)}$	g
Capital creation by using industry	y_j	h
Purchasers' prices for produced inputs for current production and capital creation	$p^{(u)}_{(is)j}$	4gh
Prices paid by each industry for labour, capital and land	$p_{(g+1,\ s)j}$	3h
Prices paid by industries for units of labour of different skill category	$p_{(g+1,\ L,\ m)j}$	Mh
Purchasers' prices for consumer goods by household by type	p^{H}_{i}	g
Purchasers' prices paid for commodities by households by source	$p^{H}_{(is)}$	2g
Purchasers' prices paid for commodities by government	p^{G}_{i}	g
F.O.B. foreign currency export prices	$p^{e}_{(id)}$	g
Basic prices of both domestic goods and imports	$p^{(0)}_{(is)}$	2g
Costs of units of capital	π_j	h
C.I.F. foreign currency import prices	$p^{m}_{(im)}$	g
Exchange rate, (P per $A)	ϕ	1
Household expenditure	c_k	k
Ratio of total HH consumption to disposable income	Ψ^{H}_{k}	k
Aggregate household consumption	c	1
Aggregate real household consumption	cR	1
Household disposable income by source	y^{H}_{ks}	4k
Household disposable income	y^{H}_{k}	k
Share of good i in government consumption	ϖ^{G}_{i}	g
Ratio of total government consumption to disposable income	Ψ^{G}	1
Government disposable income	y^{G}	1
Government disposable income by source	y^{G}_{s}	3
Government income from indirect taxes by source	y^{G}_{ITs}	6
Household k income tax	$t_{(H,Yk)}$	k
Government income tax	$t_{(G,Y)}$	1
Current capital stocks	$k_j(0)$	h
Employment of labour by skill group	l_m	M
Use of land in each industry	n_j	h
Aggregate imports by commodity	$x^{M}_{(rm)}$	g
Foreign currency value of imports	m	1
Foreign currency value of exports	e	1
The balance of trade	ΔB	1
Consumer price index	ξ^{H}	1
Capital-goods price index	ξ^{K}	1
Aggregate real investment	i_R	1

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Description	Variable	Number
Aggregate investment	ty	1
Allocation of investment by industry	y_j	h
Share of industry j in total investment	θ_j	h
Ratio of total savings to disposable income	ω_k	k
	ω_G	1
Foreign capital inflow	K^F	1
Aggregate employment	l	1
Aggregate capital stock	$k(0)$	1
Aggregate land	n	1
Shifts in foreign exports demands	$f^E_{(Qi)}$ $f^E_{(Pi)}$	2g
Wage-shift variables	$f_{(g+1, L)}$	1
	$f_{(g+1,L)j}$	h
	$f_{(g+1,L, m)}$	M
	$f_{(g+1,L, m)j}$	Mh
Technical coefficients	a_{ij}	h-1
Import taxes (commodity-specific or user-specific)	$t_{(M,i)}$	g
	$f_{(i,0)}$	g
	$f_{(Mi,u)}$	1
Export taxes	$t_{(E,i)}$	g
	$f_{(Ei,u)}$	1
Sale taxes to industries	$t_{(u,isj)}$	4gh
	$f_{(u,isj)}$	2
Sale taxes to households	$t_{(H,is)}$	2g
	$f_{(H,is)}$	1
Sale taxes to government	$t_{(G,i)}$	g
	$f_{(G,i)}$	1
Price index for non-land inputs	$p^{(1)}_{(\tilde{N})}$	1
Reforestation	ref	1
Timber volume	vol_{tim}	1
Age	α	1
Timber volume remain standing	vol_{stand}	1
Minimum age	α_{min}	1
Volume of timber harvested	vol_{harv}	1
Rotation period	T	1
Partial derivative of timber volume with respect to age	vol_{grow}	1
Forestry non-land costs	c_{rot}	1
Composite of non-land inputs	$x^{(1)}_{(\tilde{N})}$	1
Stumpage tax	$\tau^{(1)}$	1
Land tax	$\tau_{j(g+1,N)j}$	h-1
Forestry net revenue	rev_{rot}	1
Partial derivative of forestry's net revenue w.r.t. harvestable volume	rev_{grow}	1
Real interest rate	r	1
Shift in discount rate in forestry	f_j	1
Stock value of land per hectare	$v_{(s)j}$	h
Economy wide stock price of land	$v_{(n^*)}$	1
Shift term in the stock price of land	f^{vj}	h
Gross domestic product	gdp	1

Total number of variables
= 13gh + 3Mh + 2M + 18h + 21g + 3kg + 9k + 50

Table 3: List of Exogenous Variables

Description	Variable	Number
C.I.F. foreign currency import prices	$p^{m}_{(im)}$	g
Technological change	a_{ij}	h-1
Current capital stocks	$k_j(0)$	h
Use of land in each industry	n_j	h
Shift term in the stock price of land	fv_j	h
Wage shift variables	$f_{(g+1, L)}$	1
	$f_{(g+1, L, m)}$	M
	$f_{(g+1, L)j}$	h
	$f_{(g+1, L, m)j}$	Mh
Shifts in foreign export demands	$f^{E}_{(Qi)}$ $f^{E}_{(Pi)}$	2g
Exchange rate, (P per $A)	ϕ	1
Minimum age	α_{min}	1
Reforestation variable	ref	1
Composite of non-land inputs	$x^{(1)}_{(\tilde{N})j}$	1
Stumpage tax	$\tau^{(1)}_{j}$	1
Land tax	$\tau_{j(g+1,N)j}$	h-1
Real interest rate	r	1
Shift in discount rate in forestry	f_j	1
Economy-wide stock value of land	$v_{(N^*)}$	1
Household disposable income by source	y^{H}_{sk}	3k
Government disposable income by source	y^{G}	2
Household income tax	$t_{(H,Yk)}$	k
Government income tax	$t_{(G,Y)}$	1
Share of industry j in total investment	θ_j	h
Foreign capital inflow	K^F	1
Share of good i in government consumption	ϖ^{G}_{i}	g
Ratio of total HH consumption to disposable income	ψ^{H}_{k}	k
Ratio of total gov't consumption to disposable income	ψ^{G}	1
Ratio of total savings to disposable income	ω_k	k
	ω_G	1
Shift terms in indirect taxes	$f_{(i,0)}$	g
	$f_{(Mi,u)}$	1
	$f_{(Ei,u)}$	1
	$f_{(u,isj)}$	2
	$f_{(H,is)}$	1
	$f_{(G,i)}$	1

Total number of variables	=	13gh + 3Mh + 2M + 18h + 21g + 3kg + 9k + 50
Total number of equations	=	13gh + 2Mh + M + 11h + 16g + 3kg + 3k + 31
Total number of exogenous variables	=	Mh + M + 7h + 5g + 6k + 19

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