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Project Office Hampden Square, 4800 Montgomery Lane, Suite 600, Bethesda, MD 20814 • Telephone: (301) 913-0500
Telex: 312636 • Fax. (301) 652-3839

THE ECONOMICS OF FOREST POLICY: EXAMPLES FROM SOUTHEAST ASIA

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Author: Susan Lund, Food Research Institute

Prime Contractor: **Abt Associates Inc.**, 55 Wheeler Street, Cambridge, MA 02138 • (617) 492-7100

Subcontractors: **Harvard Institute for International Development**, Harvard University, One Eliot Street, Cambridge, MA 02138 • (617) 495-9779
Food Research Institute, Stanford University, Stanford, CA 94305-6084 • (415) 723-0693
North Carolina State University, Department of Economics and Business, Box 7645, Raleigh, NC 27695-7645 • (919) 515-3107
Abel, Daft & Earley, 1410 King Street, Alexandria, VA 22314 • (703) 739-9090
International Science and Technology Institute, 1129 20th Street, NW, Suite 800, Washington, D.C. 20036 • (202) 785-0831
International Food Policy Research Institute, 1200 17th Street, NW, Washington, D.C. 20036 • (202) 862-5600

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ABSTRACT

Forest resources can contribute greatly to national development objectives. To do so, these scarce resources must be used efficiently. Unfortunately, in many countries, market failures have led to a non-optimal use of forest products and services. Non-timber products, watershed protection, climate stabilization, biodiversity, genetic reserves, and tourism and recreation have not been adequately valued. The cost of destroying these goods is consequently ignored by both private users and investment projects. Government policies have also undervalued forest resources, subsidized logging concessions, encouraged inefficient processing industries, and failed to promote forest restoration. Lack of effective property rights and control over the remaining forest has left them vulnerable to exploitation by all.

Forests can also contribute to development in support of goals whose value is intrinsically difficult to measure. Sustainability and intergenerational equity are other valid objectives for resource management, neither of which is served by wasting forest resources.

Forests have been sold for a fraction of their worth, often in the interest of short-term objectives such as government revenues. Such short-term strategies cheat future generations and are ecologically unsustainable. By correcting the market and policy failures that undermine both efficiency and non-efficiency goals, governments can harness the full potential of tropical forests to meet development needs.

1. INTRODUCTION

Worldwide, our planet is losing 100 acres of tropical forest per minute. In Southeast Asia, some 25,000 square kilometers are being clear-cut each year and an equivalent area is being severely damaged (Hurst, 1990). The proximate causes of this forest destruction are well documented - logging, shifting cultivation, agricultural conversion, and fuelwood gathering are the most frequently mentioned (Gillis and Repetto, 1988; Repetto, 1988; Hurst, 1990; Erlich and Erlich, 1991). There is less consensus, however, on why the current approach to forest exploitation is undesirable. The answer lies in the often poorly defined objectives of forest management.

One goal of government policy is to achieve economic efficiency, in which society attains the greatest benefit from its productive resources. Free markets allocate resources efficiently when there is perfect competition, complete information, and well-defined markets for all goods. These conditions rarely hold, however, for natural resources. Market failures, such as lack of property rights, missing markets, externalities, and imperfect information, are common. Government policies which alter relative prices may inadvertently bias incentives against rational resource use. Without carefully tailored policies to correct such problems, markets will function inefficiently and forest resources will be wasted.

Economic efficiency, however, is not the only valid objective of resource management. Self-sufficiency in food, energy, and resource supplies is often a significant component of national security. Considerations for the future are also important. Sustaining forest reserves ensures its continuing ability to provide commercial products, ecological services, and options for future use. Fairness to future generations requires sharing today's resource stocks equitably.

These goals are often in apparent conflict. Conservationists claim that current forest stocks must be preserved while policymakers maintain that forest resources can be utilized to enhance economic growth. This debate clearly stems from different objectives. To resolve this debate and evaluate policy effectiveness, then, forestry objectives must be clearly defined and the appropriate role for government policy understood. To aid in this assessment, this paper will explore the underpinnings of both efficiency and non-efficiency objectives. Using examples from Southeast Asia, it will discuss the common reasons why current forest policies fail to meet these goals.

2. EFFECIENCY OBJECTIVES

Using forest resources efficiently insures that they will produce the greatest total benefit over time. For ordinary goods, efficiency requires that each user equate the price of a good to its marginal cost of production. Natural resources, however, have an additional economic rent incurred by consumption today (Fisher, 1981; Dasgupta and Heal, 1979). Exhaustible resources, such as oil and minerals, have a finite supply and cannot be produced by man. As a result, their economic rent reflects the value of foregone consumption tomorrow. Renewable resources, such as timber and fish, have a natural growth rate which depends on, among other things, the resource stock. Consequently, their rent includes the cost of both foregone consumption and the change in growth. For natural resources, efficiency therefore requires that each user equate the price of the resource with its marginal extraction cost plus its rent.

Under certain conditions, competitive markets efficiently allocate resources both among uses and across time. When markets are complete and competitive, agents have full information, no activities generate uncompensated spillover effects, and private discount rates reflect social discount rates, market allocations are efficient and government intervention is unneeded. The prices generated under these conditions reflect the full social value of the resource. Thus when markets operate efficiently, private prices equal social prices and private decisions are socially optimal.

There are many reasons, however, why the private and social price of a resource may diverge. Market failures, such as missing markets and externalities, allow private resource users to ignore part of the social cost or benefit generated by their actions. Uncertainty over the value of undiscovered uses causes private users to underestimate social value. Governments alter private prices through taxes and subsidies. Uncorrected market failures and misguided government policy can thus create private incentives to use forest resources in ways that are not socially efficient.

2.1 Market Failures

Particular physical characteristics of forests cause markets to malfunction and allocate resources inefficiently. Forests cover large, often inaccessible areas, making it difficult to determine the value of their products and services. They support complex ecosystems and perform ecological functions, such as climatic control, habitat provision, and hydrolic benefits that are not well-understood. At the same time, tropical forests in particular provide a variety of products beyond timber, most of which have never been identified or commercially exploited. Because of these factors, markets fail to exist for many of forest goods and services and the cost of their destruction is ignored. Private costs of forest utilization are likely to fall short of true social costs because some marginal costs and economic rents are disregarded.[1] To correct this divergence, policymakers must understand the different manifestations of market failure.

Externalities: One type of market failure is an externality, which occurs when the activity of one person imposes an uncompensated cost or benefit on others.[2] Forest clearing generates many external costs. Because forests hold upland soil in place and increase its water-

holding capacity, forest removal results in erosion, flooding, and drought. The economic costs can be quite high. In the Philippines, the increase in erosion and river siltation due to logging has halved the projected life expectancy of the Magat Dam, the country's largest hydroelectric facility (Myers, 1988). In Java, forest clearing led to the rapid sedimentation of the second-largest port and has caused severe flooding (Hurst, 1990). These costs have been borne by governments and local agricultural systems instead of private forest users. Likewise, reforestation projects generate many external benefits, such as erosion control, watershed regulation, and habitat creation, that accrue to society (Southgate and Macke, 1989). As a result, private actors undertake more forest clearance and less conservation than is socially optimal.

Although private and social prices differ in the presence of externalities, the free market may produce an optimal solution. The Coase Theorem states that if an externality occurs between private parties, then bargaining will produce a socially optimal outcome (Baumol and Oates, 1988). For example, the owner of a reservoir may pay an upstream logging operation to curtail its activity, or conversely, the logging firm may compensate the reservoir for increased siltation. The party that holds the commonly agreed upon right to his activity will determine who bears the cost of the externality. If the reservoir owner has the right to an unsilted river, then the timber company pays. On the other hand, if the timber company has the accepted right to pursue its activity, then it will have to be paid to curtail its operations.

Unfortunately, these rights are often undefined and it is unclear who should compensate whom. Moreover, externalities are often spread over a large number of parties, making it unlikely that private bargaining will resolve the problem. For example, silt-laden water adversely affects dams, urban water intakes, and estuary fisheries. In these circumstances, governments and society must decide who holds the right to certain resources. Are farmers and hydroelectric facilities entitled to silt-free rivers or are timber companies entitled to utilize forest resources? Given these sets of rights, the government can then impose taxes or subsidies on the appropriate parties to equate private and social prices.

Missing markets: Another type of market failure occurs when markets are missing. Many tangible economic goods, such as little-known tree species and non-timber products, have thin or missing markets because their commercial potential is unknown. Despite the fact that tropical forests are exceptionally rich in flora and fauna, relatively few species have been exploited or even identified. For example, just four of Indonesia's 4,000 tree species account for most timber exports (Hurst, 1990). Certainly some of these lesser known species have commercial applications. Indigenous forest people utilize a wide variety of edible, medicinal, and poisonous plants that have been overlooked by modern science (Repetto, 1988). The limited investigations that have been done, however, suggest the applications for agriculture, science, or medicine may be widespread. In Sumatra, for example, two doctors identified over 171 new medicinal plants used by local people in just 10 weeks (Hurst, 1990).

The ecological functions of forests lack markets because they are public goods.[3] Tropical forests contain a great diversity of species, providing habitat for over half of the world's plant and animal species (Albers et al., 1993). They protect watersheds by mitigating wind and soil erosion and by increasing the absorptive capacity of soil through leaf litter (Ives

and Pitt, 1988). Tropical forests enhance the stability of local micro-climates and rainfall and absorb carbon dioxide, the principal greenhouse gas. They are irreplaceable storehouses of genetic material that have widespread uses in the development of pharmaceuticals and new crop varieties (Reid and Miller, 1989). Markets fail to exist for these services because no one can be excluded from their benefits. Creating habitat, providing genetic reserves, and stabilizing rainfall benefits everyone, whether or not they pay for the service. Under these circumstances, it would be rational for everyone to enjoy these environmental amenities for free. Without the ability to cover costs, private individuals will not engage in the investments needed to provide these services. Markets will thus be missing.

There are numerous other benefits of forests that lie outside the market mechanism as well. Some of these benefits are derived from using the forest. For example, forests have a recreation value since they facilitate hiking, fishing, bird-watching, camping, and many other activities. Forests have an option value when people today are willing to pay for preserving a forest today in order to use it in the future.[4] Forests also have values that accrue whether or not the forest is actually used or visited. For example, tropical forests have an existence value which stems from the satisfaction that people derive from knowing they exist. Existence value is not limited to those who live near the forest. Many people in temperate climates derive satisfaction from having tropical rainforests in the world, even though they will never personally visit one. The large membership of organizations which preserve tracts of remote wilderness land or fight for endangered species in faraway places attest to the importance of existence value (Pearce and Turner, 1990).

Without a market, the private price of a good is determined only by individual harvest costs. The private price assigned to many forest goods, such as genetic diversity, habitat provision, or climatic control, is likely to be zero since they are intangible or public goods. Because price regulates the rate of resource use and the profitability of conservation, unpriced goods and services are wasted in pursuit of a few commercially valuable forest commodities. As a result, only a fraction of the potential value of each hectare of forest is currently being captured (Repetto, 1988).

There are several different methods to determine the social value of environmental goods that lack a market price.[5] One approach uses the market prices for related goods or substitutes. For example, the recreation value of a park can be estimated by examining how much people pay to visit the park (travel-cost approach). The cost of losing minor forest products and biodiversity due to logging can be estimated by calculating the change in the value of all forest products before and after logging (change-in-productivity approach). A study of tropical rainforests, for example, found the value of non-timber products lost during logging exceeds the value of timber by two or three times (Dixon and Sherman, 1990).

Another approach to valuing intangible forest benefits is based on survey techniques. The existence value of a forest, for example, can be determined by asking people directly how much they would be willing to pay to preserve a forest or how much they would need to be compensated for the loss of the forest (contingent valuation approach). Instead of measuring forest benefits directly, other approaches focus on the costs that would be imposed if forests were converted from their natural state to an alternative use. The value of watershed protection,

for example, can be estimated by the cost of providing erosion control and irrigation to downstream farms (replacement cost appproach). The value of maintaining biodiversity can be justified by comparing the foregone value of an alternative project (opportunity cost approach). In Thailand, for example, analysts found that the hydroelectric energy generated by the proposed Nam Choan Dam was not enough to justify destroying a wildlife sanctuary, so its proposed construction was cancelled (Dixon and Sherman, 1990). While none of these methods is without criticism, they all can provide information on the social value of unmarketed environmental goods when carefully applied.

Uncertainty, Irreversibility, and Quasi-Option Value: Incomplete information and uncertainty about the costs and benefits of forest resources impedes the market's ability to allocate forest resources efficiently. One type of uncertainty, mentioned above, is over the potential uses of both known and unknown forest species. The rich variety of genetic material found in tropical forests is largely uncatalogued and its value unknown. Inadequate information also clouds our understanding of the biological dynamics and interactions of species within the forest. For example, the minimum population thresholds necessary for the regeneration of most species have not yet been determined, and the extent to which tropical forests can recycle contaminated air and water is largely unknown. Uncertainty also exists over the nature of future human needs and the extent to which future advances in technology can create substitutes for forest resources. Thus, both the future supply of and demand for forest resources is uncertain (Dixon and Sherman, 1990).

In spite of such uncertainties, many current types of forest use cause irreversible changes in the nature and value of tropical forests. Logging, for example, often disrupts the hydrological and nutrient cycling processes to the extent that the original forest cover cannot be reestablished (Wilson, 1988). In Southeast Asia a tenacious weed called imperata grass has overtaken many clear-cut forest areas, rendering the land economically useless (Hurst, 1990). Even when forests can be superficially restored to their original state, the changes in species composition and biological diversity are often great (Dixon and Sherman, 1990). When an irreversible development has been undertaken, future alternatives are limited.

The value of delaying an irreversible change is called quasi-option value (Dixon and Sherman, 1990; Albers, 1993). Quasi-option value stems from the expected value of information that can be gained by postponing an irreversible decision. For example, the costs of clearing a forest depend on the value of the wide variety of species it contains. Often the scientific and commercial values of these species are not currently known but are discovered over time. The quasi-option value of delaying forest clearing, then, includes the currently unknown value of many forest species into the decision.

The quasi-option value of preserving tropical forests in their natural state is likely to be high (Pearce and Turner, 1990). Quasi-option value is high when uncertainty over future costs or benefits is great. As noted above, few forest species are currently utilized but previous discoveries indicate that their value is likely to be great. Quasi-option value is often high when uncertainty is likely to be resolved in the near future. Much scientific research is currently underway on the importance of tropical forests for biodiversity and global climate control (Albers et al., 1993).

Calculating the quasi-option value of a tropical forest is quite complex. In traditional cost/benefit analysis, uncertainty is eliminated by using the expected values of uncertain costs or benefits. Recent research, however, that this traditional approach will lead to too little forest preservation (Albers et al., 1993).[6] To compensate, planners should instead develop more reversible, low-impact forest uses. For example, better timber harvesting methods would allow forest regeneration. Planting cash-crops such as black pepper within a natural forest can increase its economic value with little adverse impact on the forest ecosystem.

2.2 Social and Private Discount Rates

Conserving and replanting tropical forests is an investment, deferring today's consumption of forest products until the future. Economists assume that people are impatient, valuing current income more than future income. A dollar next week is worth less than one today. Therefore, the worth of future dollars must be converted to present terms to determine whether an investment is worth the wait. The rate at which future dollars are converted is called the discount rate (Dasgupta and Heal, 1979; Pearce and Turner, 1990).[7] Formally, income next period is converted to present value by dividing the net return by one plus the discount rate. A stream of benefits is thus discounted by the formula where B is the benefit or return, C is the cost incurred, r is the discount rate, and t stands for time.

$$\frac{(B_1 - C_1)}{(1 + r)^1} + \frac{(B_2 - C_2)}{(1 + r)^2} \ldots + \ldots \frac{(B_T - C_T)}{(1 + r)^T} = \sum_{T}^{1} \frac{(B_t - C_t)}{(1 + r)^t}$$

Greater impatience (a high rate of time preference) causes investors to use higher discount rates, making both future costs and benefits seem less significant.[8] High discount rates bias against long-term forest conservation because benefits in the immediate future may be modest while those in the distant years are heavily discounted.[9]

In the presence of well-functioning capital markets, the rate of interest is the appropriate private discount rate since it is the opportunity cost of money. There are several reasons why the private rate overstates the true social discount rate (Pearce, Barbier, and Markandya, 1990). Because individuals inevitably have a shorter time horizon than society as a whole, they have less concern for the future and are likely to discount future benefits at a higher rate. Some individuals in society are so poor that their immediate welfare takes precedence over future considerations. As a result, private actors overexploit forest resources, undertake too little conservation and reforestation, and implement projects with unacceptable future costs.

In sum, forest managers cannot assume that markets will allocate resources efficiently. External costs and benefits are not taken into account by private users. Missing markets fail to price undiscovered forest products and ecological services and ignore the option value of future forest use. Divergences arise between the private and social rates of discount. Together these factors cause the private costs of forest exploitation to fall short of the social costs, and forests are overexploited (Panayotou, 1993).

Market failures, however, are not the only reason for inefficient forest allocation. Government policy can also adversely distort social and private prices. Often the two are interlinked.

2.3 Government Policy

Government policy can mitigate market failures and improve efficiency through a wide variety of subsidies, regulations, public projects, institutional reforms, and macroeconomic policies. These same policies can also aggravate inefficiency, however, if they are not carefully designed and executed. Sometimes degradation is the unintended result of government action, either because the policies were designed to meet other needs or because they incorrectly valued costs and benefits. Except in cases where inefficiency is tolerated in the pursuit of different goals, such as national security or income redistribution, society as a whole benefits from correcting these policies. From public projects to macroeconomic prescriptions, government actions often contribute to wasteful forest depletion.

Institutional Policies: A fundamental condition for the existence of markets is that all goods have clearly defined, excludable, tradable, and enforceable property rights. Defining and enforcing such rights is one of least disputed roles of government. Forest land can be distributed to individuals in the form of private property or to groups in the form of common property.[10] Because property rights give forest owners a legal claim to future benefits, those who own forest land have an incentive to conserve and invest in their asset.

In Southeast Asia, governments legally own most remaining forest lands (Gillis and Repetto, 1988). Although the nationalization of forests was intended to strengthen the state's control over forest use, it has instead burdened governments with enforcement responsibilities beyond their financial and administrative abilities. As a result, forests are open to both migrants in search of agricultural land and small-scale loggers (Western, 1988). In Thailand, for example, small farmers in the northeast cleared three quarters of the state-owned forest between 1973 and 1982 to expand cassava production (Hurst, 1990).

Conditions of open access encourage users to overexploit forest resources for two reasons. First, lack of a permanent claim erodes incentives for farmers and loggers to conserve either the forests or clear-cut land (Hardin, 1968; Bromley and Chapagain, 1984; McGranahan, 1991). Forest squatters typically practice an unsustainable form of shifting cultivation, thoroughly exhausting the land before moving to another patch of forest (Hurst, 1990). Old plots are left unsuitable for forest growth. Incentives to invest in such land are low. A 1988 study in Thailand found that the capital-land ratio in securely owned land was up to 250 percent higher than that in squatters' land (Feder et al., 1988). Secondly, because access is open, there is no explicit cost to appropriating forest land. Private costs of forest exploitation are consequently lower than social costs, and forests are depleted more rapidly than is socially desirable (Repetto, 1988; Panayotou, 1993).

Project Level Policies: Large-scale investment projects often have dire consequences for tropical forests. In some cases, forest destruction has been due to inaccurate estimates of project costs and benefits. Unless market prices are adjusted upward to reflect social prices, projects

chosen by cost-benefit analysis will allocate recommend projects that should not be implemented. For example, cattle ranching projects have grossly overestimated the suitability of tropical forest soil for ranching and underestimated the value of forest it replaced. Although this project looks profitable on paper, in practice it has destroyed vast tracts of forest and operates at an economic loss in practice. Private owners continue to invest, however, because of government tax breaks and subsidies which more than compensate for their losses (Gillis and Repetto, 1988).

In other cases, investment projects have failed to account for the social responses they generate. Roads built to encourage market development in remote areas attract unintended migrants who clear forest land for agriculture. In Thailand, a new highway through the northeastern forest spawned 318 villages, prompting the clearance of over a million hectares of forest (Panayotou, 1993). Resettlement programs designed to move participants from densely populated areas to less inhabitated regions attract spontaneous migrants as well as planned participants. In Indonesia, the generous social services provided by a resettlement project in the rainforests of Kalimantan attracted many spontaneous migrants, causing far more forest destruction than initially projected (Hurst, 1990). While population growth and lack of property rights may be the ultimate cause of forest destruction in these examples, project planners need to consider the likely social consequences of introducing new infrastructure in forest areas.

Forest Sector Policies: While forest sector policies could rectify the difference between private and social prices, they instead often exacerbate the divergence. Governments undervalue forest resources by setting the tax levied on timber extraction below its social value (Hurst, 1990).[11] Since forests belong to society, this tax should capture the full economic rent associated with foregone future consumption of the timber.[12] Most governments in Southeast Asia have not captured the full value of these economic rents. For example, the Philippines captures only 16.5 percent of potential rents on average, while Indonesia captures only 38 percent (Repetto and Gillis, 1988). As a result, rents accrue to timber companies and create artificially high profits, attracting more logging firms and spurring widespread, rapid deforestation (Repetto, 1988).

Although forests can be harvested sustainably, the current structure of timber concessions encourages wasteful exploitation. While governments often set a minimum size on trees that can be cut, these standards are rarely enforced. In Indonesia, for example, 96 percent of the logs outside one mill were smaller than the legal minimum (Hurst, 1990). Timber royalties prompt loggers to harvest only the most valuable trees with no concern for the condition of the trees left behind. As a result, Repetto and Gillis (1988) estimate that only 25 to 50 percent of the potential yield of a forest is recovered during logging, forcing timber companies to cut larger areas for a given amount of timber. Moreover, they report that nearly 75 percent of uncut trees are left damaged, diminishing both the regeneration capacity and value of the remaining forest. The duration of concession terms discourages conservation. Concessions are typically shorter than the thirty-five year growth cycle of commercially valuable hardwoods, giving loggers no financial interest in replanting or maintaining forest productivity (Repetto, 1988).

Forest-based industrialization is often another example of misguided forest sector policy. Designed to generate rural employment opportunities and foreign exchange earnings, local wood-processing industries have instead drained both forest resources and government coffers (Repetto

and Gillis, 1988). Processing mills generate more demand for raw lumber than tree farms can supply, so timber is taken from natural forests. As long as governments promote investments in local processing, they will be adverse to lowering logging rates no matter what the economic or ecological justification. Many Southeast Asian mills are inefficient by world standards, requiring excessive timber inputs for their products (Repetto, 1988). At one Indonesian mill, as many as 50 percent of felled logs arrive too damaged to be used and are left in a pile to rot (Hurst, 1990). Furthermore, tax concessions are needed to attract investment in local processing, which is inherently unprofitable due to foreign tariffs and poor infrastructure (Repetto, 1988). As a result, natural forests are being cut to satisfy an inefficient and unprofitable industry.

In light of the many economic and ecological values of forests, both replanting and restoration policies are lacking. In the Philippines, for example, only one tree is replanted for every 21 felled (Hurst, 1990). In Thailand, it would take over 200 years at current replanting rates to restore forests to levels seen earlier in this century (Hurst, 1990). The reasons for this failure are well known. The reforestation mandates in timber concessions are rarely enforced. Our limited understanding of the biological dynamics of tropical forests hinders efforts to restore degraded areas. Reforestation has sometimes been confused with establishing tree plantations (Panayotou, 1993). Although tree plantations play an important role in reducing pressure on natural forests, they lack the biodiversity, habitat, material cycling, and ecological functions of natural forests. In sum, current forest policies fail to provide the basic incentives and mandates necessary for private actors to invest in reforestation.

Non-forest Sector Policies: Policies directed at other sectors of the economy may also influence forest use. For example, agricultural programs which stimulate investment in competing land uses, such as the promotion of valuable cash and tree crops, increases demand for agricultural land. Input subsidies and public irrigation projects distort relative prices in favor of agricultural goods and bias against timber and other forest products. Where forest property rights are not well-defined, such policies prompt farmers to clear forest land for agriculture. In peninsular Malaysia, for example, over 10 percent of all natural forests have been cleared in response to the generous tax credits and input subsidies on plantation crops like rubber and palm oil (Repetto and Gillis, 1988). While these policies may generate income, their adverse impact on forests must be considered.

Industrial policies influence forest use as well, although the extent and direction of their impact is unclear. In many developing countries, the terms of trade for agricultural products has fallen in recent years due to import tariffs, foreign investment, energy subsidies, and tax incentives for industry (Panayotou, 1993). While lower terms of trade for agriculture may benefit forest conservation, since it lessens demand for additional agricultural land, it could also have the opposite effect. Lower farm incomes intensify the need to supplement rural earnings by expanding crop production or harvesting open-access resources like forests and fishing grounds. Industrial policy may also impact forest resources through employment. The pursuit of capital-intensive growth may enlarge the pool of unemployed labor, prompting potential workers to migrate to forests in search of agricultural land (Poffenberger, 1990). Because there has been little research to date on the impact of industrial policy on forest use, the magnitude

of the responses described here are uncertain. However, it is important to realize that industrial policies which promote growth do not automatically reduce pressures on forest resources.

Macroeconomic Policies: Macroeconomic policies have the least obvious, although potentially most damaging, impact on forests (Repetto, 1988; Panayotou, 1993).[13] By altering the private prices of capital and labor and by determining the exchange rate, macroeconomic policies influence resource use. This impact is rarely acknowledged, however, because macroeconomic policies are designed primarily to stimulate economic growth and balance government revenue flows. Although other objectives may ultimately outweigh environmental considerations, the effect of monetary, fiscal, and trade policy on forest management must be specified in greater detail than is currently available in the literature. Macroeconomic policy often has an ambiguous effect on resource use, due to the complex interactions it engenders between all prices in the economy. This should not, however, be a rationale for failing to develop a more environmentally responsible economic policy.

Monetary policy is a critical macroeconomic tool used to achieve many goals, such as controlling inflation and stimulating economic growth. Because the interest rate determines the private discount rate, monetary policy alters the returns on forest investments. A higher interest rate makes projects with future benefits, such as reforestation, less attractive and projects with future costs, such as careless timber cutting, more attractive. High interest rates, however, also discourage capital-intensive investments, such as logging in remote mountain areas (Panayotou, 1993). Whether, on balance, high interest rates benefit forest conservation is an empirical matter which has yet to be addressed.

Fiscal policy affects individual behavior by altering private prices with taxes and subsidies. Because fiscal policy is typically designed to raise government revenue rather than manipulate individual behavior, its affect on resource use has largely been ignored. As noted above, governments intervene in forest management through a series of extraction fees, tax credits, investment subsidies, and depreciation allowances. Although these policies are designed to stimulate employment and raise national income, they have also caused timber harvesting rates to exceed those which would have been commercially profitable (Repetto, 1988). An alternative set of fiscal policies might alter the relative prices of inputs and outputs to favor forest conservation. Output taxes on timber products, for example, would slow cutting while tax credits for forest restoration would increase both the area and quality of natural forests.

Trade policies affect forest use because many forest products are traded on world markets (Panayotou, 1993). When goods are traded internationally, exchange rates determine private prices in local currency. An overvalued exchange rate or an export tax lowers the private price of tradable goods, such as timber, relative to nontradable goods. While a lower relative price dampens the level of forest exports, it also discourages investments in conservation and more ecologically sensitive harvest technology. An undervalued exchange rate, in contrast, encourages timber exports. Malaysia's consistently undervalued exchange rate, for example, contributed to widespread logging and the conversion of forest land to exportable tree crops (Repetto, 1988). An undervalued exchange rate also increases the price of imported fuel or equipment, however, and could slow rapid deforestation. Like other areas of macroeconomic policy, the impact of trade policy on forest utilization has not been firmly established.

Population Policies: Population growth is commonly blamed for forest degradation (Erlich and Erlich, 1991; United Nations Population Fund, 1991). Larger populations not only consume more timber and firewood, but most importantly, they require vast tracts of cropland (Brown, Sierra, and Southgate, 1991; Myers, 1991). The extent to which population growth and cropland expansion are responsible for deforestation, however, is under dispute. The United Nations Population Fund (1988) estimates that roughly 90 percent of deforestation worldwide is due to small farmers, and that 79 percent of the increase in farmland is due to population growth. Cruz and Gibbs (1990), in contrast, note that farmers follow loggers into the forests, using logging roads to reach remote areas and planting land that has already been partially cleared.

Indeed, population growth alone cannot explain current levels of deforestation. The absence of any empirical correspondence between deforestation and population growth rates across countries is striking (Barraclough and Ghimire, 1990). Deforestation depends more on the institutional and market failures that determine how people impact forests (Cruz and Gibbs, 1990; McNicoll, 1990; Jodha, 1985; Southgate, 1990; Ehui, Hertel, and Preckel, 1990). Skewed land distribution and unemployment drive the landless to the forest in search of farmland. Unenforced state claims permit them to farm there. Growing populations damage forests because institutional, social, and political factors prevent them from earning a living by other means.

3. NON-EFFICIENCY GOALS

Achieving economic efficiency is not the only objective of forest management. Consider, for example, that under some circumstances it may be economically efficient to fully exhaust a particular forest or species, even though it can be managed to provide a sustainable yield (Clark, 1973; Dasgupta and Heal, 1979; Pearce and Turner, 1990). If the forest grows at a rate less than the private discount rate (and harvest costs are negligible), then it will be privately optimal to cut the entire forest. The forest owner would be better off consuming the resource today and investing his money at the market rate of interest. If private prices and discount rates reflect their true social values, then extinction would also be socially efficient.

Intuitively, it is difficult to accept that destroying a forest is prudent, even if it is economically efficient. Consequently, many policymakers and environmental advocates argue that efficiency considerations alone are insufficient in designing resource policy. Other goals, such as sustainability or intergenerational equity are equally important. Moreover, these other goals are often easier to implement. They tend to reduce to simple rules governing environmental standards, avoiding the difficulty of correctly valuing intangible benefits and costs.

3.1 Sustainability

While there remains considerable disagreement over the meaning of the term "sustainability," it generally refers to a pattern of development and growth that can be maintained indefinitely.[14] Implicit in this notion is the recognition that natural resources - including air, water, land, energy sources, and waste assimilation - are essential in supporting human life. At present, manmade technology cannot substitute for clean air or fresh water. This definition also recognizes that these resources together form a complex and interacting biological system. For example, water supply affects fisheries and the forest affects water supply and soil quality. Species within each subsystem interact as well. The number of predators limit the number of prey and the growth of one plant species may crowd out another.

Sustainability and economic efficiency are two distinct objectives. Pearce and Turner (1990) eloquently explain the difference by noting that traditional resource economics, from which efficiency conditions are derived, views the economy as a linear system. Natural resources supply inputs to the production process, which in turn creates consumption goods. Efficiency requires that resources are allocated to produce the maximum possible output over time.

Sustainability, in contrast, is derived from a circular model of the economy which makes explicit the role of the environment (Pearce and Turner, 1990). The environment not only supplies inputs to production but also receives waste from consumption. Carbon dioxide is released into the atmosphere, sewage is dumped into rivers and oceans, and solid waste is deposited in landfills. Because the environment is a biological system, resources taken from it and waste put into it affect the quality and functioning of the entire system.[15] The economy

is thus a closed, circular system with physical limits on the level of production, and hence utility, that can be achieved.[16]

In practice, the sustainability criterion requires that resource allocation is both economically efficient and ecologically neutral, in the sense that resource stocks are held constant at their optimal level (Peace, Barbier, and Markandya, 1990; Tisdell, 1988; Pezzey, 1992).[17] The appropriate definition and measure of resource stocks, however, is subject to controversy. Does the rule apply to the total resource stock or to each type of resource individually? Should physical quantities or economic values be used to measure resource stocks? Moreover, finding the optimal level of environmental stocks presumes that we can model all ecological interactions correctly. Using the concept of sustainability requires resolving these issues, a matter that may lie outside the domain of economics.

Pearce and Turner (1990) offer one resolution and argue that the current value of all natural resources should at least be conserved at their present levels, which are already suboptimal in many cases (Pearce, Barbier, and Markandya, 1990). They measure resources according to economic value rather than physical quantities, positing that as technological efficiency increases, smaller resource stocks will be needed to maintain a given standard of living. They use total instead of individual resource stocks to allow exhaustible resources, such as oil and minerals, to be used as long as renewable resources are increased. While this interpretation of sustainability is both flexible and easily implemented, there are many other definitions available (Pezzey, 1992). The choice lies outside the realm of economics.

3.2 Intergenerational Equity

The goal of sustainability is derived from the notion that maintaining an ecological balance is vital to the survival of the human species. While fairness to future generations may be one reason that policymakers want to achieve sustainability, it may also be a distinct objective. The argument for intergenerational equity is based on Rawls' theory of justice. If all past, current, and future members of a society were brought together to allocate resources over time without knowing which generation would be their own, they would choose an equal resource allocation across time (Rawls, 1972). By such logic, intergenerational equity requires that the natural capital stock is maintained at its present level (Pearce, Barbier, and Markandya, 1990).

To obtain equity between generations, future options must be preserved. Economic models that include the welfare of the next generation in the current decision fail to ensure intergenerational equity because they assume that future generations have the same preferences, needs, and opportunities as the current one. Given the rapid rate of technical change and fragility of natural ecoysystems, this assumption is dubious. Intergenerational equity requires that the present generation leaves future generations with the greatest scope for choosing what they want (Pearce and Turner, 1990). By preserving the present resource stock, future generations are left with at least the same options the current generation enjoyed. Hence, both sustainability and intergenerational equity require that we preserve the current value of our natural capital stock.

4. REFORMING CURRENT POLICY

Forest management in most countries is failing to attain either efficiency or non-efficiency objectives. Maximizing social welfare means that there may often be trade-offs between conservation, development, political, and social equity goals. As suggested above, sustainability goals may require preserving more resources than efficiency objectives would require (Pearce, Barbier, and Markandya, 1990).[18] Land cannot grow both complex forests and food crops.

Many policies attain none of these goals, however, leaving much room for improvement. Removing certain policy distortions and correcting market failures can improve both economic efficiency and conservation (Gillis and Repetto, 1988; Panayotou, 1993). For example, ending government subsidies to timber processing mills will increase national revenues while slowing deforestation.

Policy changes are never free from distributional consequences. Groups currently benefitting from government subsidies, such as lumber mills, have a vested interest in the status quo. Political will and national consensus will be necessary to enact change. The net gains from improving efficiency, however, outweigh these individual losses. Policy reforms that serve both economic and ecological interests merit particular attention.

4.1 Remove Policy Distortions

The role of policy is not to directly manage or control forests, but rather to create an environment that fosters private efficiency and conservation.[19] Assigning and enforcing property rights is crucial. While governments have overestimated their own capacity for forest management, they have underestimated the value of local management (Gillis and Repetto, 1988). As a starting point, forest land should be classified as private, communal, or state controlled, depending on the externalities associated with its use (Panayotou, 1993). Property rights could then be assigned based on this classification. Watersheds, for example, generate many external benefits and should remain under state control for preservation. Second-growth forests on flat terrain generate few external effects and could be parcelled out to individuals.

Forest policy in most Southeast Asian countries is also in need of reform. While many governments have implemented bans on either logging or log exports, these policies have failed to curtail wasteful forest destruction (Hurst, 1990; Anderson, 1989). In Thailand, for example, aerial surveys showed that deforestation rates increased by 50 percent after the government banned all commercial logging (Panayotou, 1993; Lohmann, 1989). The reasons for this failure are not hard to understand. Because these bans are directed at the legal sale rather than cutting of timber, black markets have emerged. Both concessionaires and small farmers have responded to high informal prices by increased cutting. Logging bans have also failed to curtail agricultural expansion (Panayotou, 1993).

In a more market-oriented approach, costs of timber concessions should be increased, perhaps by forcing concessionaires to bid for timber extraction licenses. This fee, subject to a minimum set by the state, should be based on the volume of marketable instead of extracted

timber. Concessions should last at least seventy years to allow for two full regeneration cycles of the forest. Tax credits and depreciation allowances for timber processing should be ended (Repetto, 1988). Regulations on the size and number of trees harvested per hectare of forest should be enforced. These policy changes will increase government revenue, diminish the extent of logging, curtail destructive harvest methods, and encourage reforestation.

Tree plantations are an important part of any program to conserve natural forests because they create an alternative source of supply for growing wood product demand. In Southeast Asia, the rapid expansion of softwood plantations on deforested land has supplied much of the paper industries demand, saving valuable hardwoods and natural forests (Hurst, 1990). Single-species plantations are less desirable, since they are prone to pest infestations, fail to create animal habitats, and lack biological interactions that improve soil and water (Lohmann, 1990; Barrow, 1990). Multi-cropped plantations, however, can be ecologically sustainable and financially profitable. However, even multi-cropped plantations are not substitutes for natural forests because they lack the biodiversity, habitat, material cycling, and ecological functions of natural forests.

Cost-benefit analysis must be based on the full social value of forests: economic, social, and environmental benefits must be considered, whether they are quantitative or qualitative (Bowes and Krutilla, 1989). Controversies over the value the unmarketed goods and services a forest provides abound (Pearce and Turner, 1990). Nonetheless, the rationality of both public projects and non-forestry and macroeconomic policies will be improved by this reform. Because non-forest policies are typically pursued to attain other goals, trade-offs may be unavoidable. Improving cost-benefit analysis to include full social values would at least permit the impact of these policies on forest depletion to be acknowledged.

4.2 Correct Market Failures

After policies with unnecessary environmental costs and perverse incentives have been reformed, government can address market failures. To start, private and social prices need to be aligned. External costs and benefits generated by forest exploitation cause social prices to exceed private ones. Missing markets allow many forest products and services to be consumed for free. Government taxes and subsidies can be used raise private prices to levels reflecting their true social level. For example, reforestation projects which benefit downstream irrigation projects and reservoirs need tax benefits or investment subsidies to reflect external benefits. Logging royalties should be high enough to compensate the for ecological services and non-timber products that are lost. Carefully tailored government policy can thus alter private prices to promote efficiency.

Because no one can be excluded from their benefits, a second task for government policy is to supply the public goods that markets cannot provide. Many forest services, such as biodiversity, genetic diversity, option value, and existence value, are classic public goods. Governments should therefore establish a system of natural reserves to ensure the availability of these goods (Panayotou, 1993).

In order to succeed, the reserves must address both conservation and rural livelihood issues (Ghimire, 1991). They must be carefully demarcated, patrolled, and managed. Buffer zones can be established between preserved areas and human settlements to prevent encroachment. Local communities can profit from the buffer zones, perhaps by harvesting nontimber products or by developing tourism. Although expensive, each of these steps is necessary. In Thailand, for example, encroachment and poaching are rampant in national parks where planners excluded local people from traditional hunting, fishing, and wood collection areas without providing alternatives (Ghimire, 1991).

4.3 International Aid

All nations have an interest in contributing to the costs of tropical forest preservation. Tropical forest benefit the entire world community by absorbing carbon dioxide, providing genetic reserves, and preserving biodiversity. Furthermore, the optimal forest size depends crucially on one's perspective. For example, a completely forested province may find it optimal to pursue an intensive logging strategy. If this province contains the last forest stand in the nation, however, the rest of the populace is unlikely to concur. Similarly, the rainforests of Indonesia, Zaire, and Brazil may surpass national needs but be essential to the world community.

International aid could provide both financial and scientific support. As noted above, our ignorance and uncertainty over the biological dynamics and economic potential of tropical forests is one of the greatest obstacles to efficient forest use. As Gillis and Repetto (1988) point out, development spending on the forest sector is meager relative to agriculture. While many developing nations have built substantial agricultural research programs, few have created effective research capacities in forest ecology or management. International aid can remedy this research deficiency, as well as helping to create and maintain forest preserves.

5. SUMMARY

While forest resources could contribute greatly to national development objectives, they are currently being depleted at a socially undesirable rate. The sources of this inefficiency are quite clear. Markets fail to value many forest products and services, such as non-timber products, watershed protection, climate stabilization, biodiversity, genetic reserves, and tourism and recreation. The cost of destroying these goods is consequently ignored by both private users and investment projects. In addition, government policies undervalue forest resources, subsidizing logging concessions, encouraging inefficient processing industries, and failing to promote forest restoration. Lack of effective property rights and control over the remaining forest has left them vulnerable to exploitation by all.

There are also goals other than efficiency that shape forest policy. Sustainability and intergenerational equity are valid objectives for resource management, neither of which is served by wasting forest resources. Selling forests for a fraction of their worth, investing in unprofitable projects, and depriving government treasuries of needed revenue has lead to rapid depletion of tropical forests. Such strategies hinder long-term self-sufficiency, cheat future generations, and are ecologically unsustainable. By correcting the market and policy failures that undermine both efficiency and non-efficiency goals, governments can harness the full potential of tropical forests to meet development needs. Only at this point can they face the difficult trade-offs between economic development and forest conservation.

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ENDNOTES

1. Determining the social value for goods without markets is quite difficult. See Bower et. al. (1983), Dixon and Hufschmidt (1986), or Pearce and Turner (1990) for valuation methodologies.

2. See Baumol and Oates (1988) for a discussion of environmental externalities.

3. Technically, a public good is defined as one which is non-excludable and non-rival (Fisher, 1981). Non-excludability means that no one can be excluded from consuming the good, and non-rivalry means that consumption by one person does not diminish the availability for others.

4. Option value differs from quasi-option value, a concept discussed below. The two are often confused in the non-technical literature. Option value arises from keeping options for future use open. It is determined by how much people are willing to pay to preserve the option to use the forest in the future (Pearce and Turner, 1990). Quasi-option value, in contrast, does not depend on the use of a forest. Instead, it arises from the expected value of information that would be gained by delaying an irreversible development (Dixon and Sherman, 1990). It is calculated as the difference in social welfare from making an irreversible decision with and without future information.

5. The literature on valuing environmental benefits is vast. For more detail, see Dixon and Sherman (1990), Baumol and Oates (1988), or Dixon and Hufschmidt (1986).

6. Albers et al. (1993) also provide a framework for calculating quasi-option value. Using data from Thailand, they find the quasi-option value of a national forest to be significant and to alter the optimal forest resource allocaiton. Their approach, however, requires data on the value of preserving the forest, the productivity and sustainability of agriculture on tropical soils, and timber production values. They also define uncertainty by specifying two possible states of the world and the probability of each occurring.

7. See Pearce, Barbier, and Markandya (1990) for a review of the arguments for and against using discount rates in environmental projects.

8. Albers (1993) shows, however, that modelling the ecological constraints on land uses reduces the sensitivity of the optimal land allocation to discount rates.

9. Clark (1973) shows that the extinction of a species is an efficient private outcome if the regeneration rate of the species is less than the discount rate. High discount rates, then, are more likely to result in extinctions and resource exhaustion.

10. Note that common property is not the same as open-access property (Runge, 1981). Common property is owned and can be effectively managed by a group, whereas open-access areas lack property rights altogether.

11. See Repetto and Gillis (1988) and Repetto (1988b) for a complete review of the adverse incentives created by timber concessions.

12. The economic rent for timber is called the stumpage value of a tree, estimated by subtracting the harvest, transportation, and processing costs from the market value of all the products made from the tree.

13. The impact of structural adjustment programs on the environment is discussed in Panayotou (1993) and Reed (1992).

14. See Pezzey (1992) and Tisdell (1988) for a review of several economic interpretations of the sustainability criterion. Redclift (1987) explores the contradictions of sustainable development. Common and Perrings (1992), Batie (undated manuscript), and Archibugi and Nijkamp (1990) contrast the ecological and economic meaning of sustainability. Pearce and Turner (1990) and Pearce, Barbier, and Markandya (1990) give operational definitions.

15. The First and Second Laws of Thermodynamics also require that the system is closed (Pearce and Turner, 1990). The First Law states that energy and matter cannot be created or destroyed, which implies that resource inputs and waste are part of a single system. The Second Law states that materials and energy get used entropically, or are dissipated within the system. This law implies that we cannot perfectly recycle resources. Hence, production processes use natural resources, some of which are changed irreversibly and some which flow back into the environment in the form of waste.

16. It is commonly assumed that there are upper limits on the amount of waste the environment can absorb and lower limits on the level of resources needed to sustain human life. Pearce and Turner (1990) argue that because of irreversibility and uncertainty, these limits should be placed conservatively. In addition, Barbier (1990) shows that waste is an increasing function of consumption.

17. Formally, the sustainability condition can be derived from intertemporal utility maximization subject to a constraint set which includes the internal dynamics of the ecosystem and some type of non-negativity condition on either the change in the total resource stock or the biological resilience of the system.

18. Pearce and Turner (1990) discuss the conflicts and complementarities between development and conservation goals.

19. See Baumol and Oates (1988) for a comprehensive discussion of both regulatory control or free market solutions to improving the environment.