AN EMPIRICAL MODEL FOR ESTIMATING THE TRADE BENEFITS AND ENVIRONMENTAL COSTS OF REMOVING A LUMBER EXPORT BAN A CASE STUDY OF THE PHILIPPINES

Harold W. Wisdom

Abstract.—A theoretical and empirical model is developed for estimating the net social benefit (cost) of removing the Philippines lumber export ban. The benefit from removing the ban is the earnings from the sale of the lumber to external markets where it is more highly valued. The cost of removing the ban is the additional environmental damage attributable to the additional harvest for export. It cannot be determined in advance whether removal of the ban will yield a net gain or loss to the Philippine economy. The optimal environmental policy instrument to protect the environment is neither a complete ban nor completely free trade; but rather, it is a production tax.

INTRODUCTION

Log and lumber export bans have become popular as ways to reduce deforestation, timber theft, and to promote further manufacture in developing countries. The protection of the environment is now considered an essential component of government policy in many if not most developing countries. As governments gain more experience with export bans, however, it is becoming clear at least to some that trade bans are not the optimal environmental policy. At the same time, the impact of international trade on the environment remains a divisive issue. As Primo Braga (1992) points out, many environmentalists harbor a virulent anti-trade bias; trade, as the "handmaiden of growth" is an inevitable "suspect" from an environmental perspective. Primo Braga goes on to explain,

... the attitude of most ecologists toward international trade is dominated by the perception of its role as a major carrier of the seeds of systemic disturbance to frontier ecosystems ...; and the support for trade regulation either as a device to halt environmental degradation ... runs strong.... Most ecologists accept the use of trade restrictions in the pursuit of these objectives as a matter of fact.... The proposition that "rain forests are worth more standing than converted into timber or hamburgers: is not only increasingly popular in industrialized countries, but it is often interpreted as a clear indictment of international trade.

The combination of underpriced public timber and a strong international market for logs encouraged rapid increases in Philippine log exports, beginning in the mid-1950's and peaking in 1970 (Figure 1). In response to the rapid deforestation of its forests, the Government of the Philippines adopted a strong interventionist forest policy, including a sharp curtailment in the number of Timber Lease Agreements (TLAs) and allowable annual cut (AAC) for many of the TLAs. Timber production declined precipitously after 1968 (Figure 2). The reduction in the AAC and the log export ban, coupled with a strong export market for lumber, forced up domestic lumber prices, and threatened the survival of the domestic furniture industry.

The furniture industry pressured the government to ban lumber exports. Environmentalists, dismayed with the failure of efforts to reduce the destruction of old growth forests and widespread log theft began to call for a lumber export ban in addition to the log export ban. Public indignation over illegal logging has reached a fever pitch in the Philippines, with drastic solutions proposed. Indeed, the entire issue has become so emotionally charged that one suspects that much of the forestry program is driven by public hysteria rather than by sound principles of sustainable forestry. But that is another story.

The lumber export ban is a major concern to the Philippine forest products industry, since it restricts the market opportunities of lumber producers for the higher grades of lumber (e.g., S4S grade). Interestingly, veneer exports are not banned, even though veneer and lumber occupy the same stage of manufacturing. If the rationale for the lumber export ban is to promote more domestic value added from wood products manufacture, it is not clear why veneer exports are not also banned. The answer that the furniture and handicraft industries use mainly lumber is not convincing, because modernization of these industries would entail a substantial shift to the use of veneer and plywood in furniture manufacture. Thus, the price of plywood and veneer is likely

1Professor of Forest Economics and Policy, Department of Forestry, College of Forestry and Wildlife Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA. 24061-0324.
to be a more critical factor in the modernization of the Philippine furniture industry than the price of lumber. Finally, lumber products exports are permitted, but "lumber products" are not well defined. It is not clear how much further manufacturing is required to qualify as a lumber product (e.g., would running a groove down one side qualify the board as a "lumber product"?).

On the positive side, the lumber export ban likely reduces environmental damage from logging by reducing production and probably encourages at least some additional value added production in the Philippines. Just how important these changes are is an empirical matter.

WELFARE EFFECTS OF REMOVING THE LUMBER EXPORT BAN

This paper focuses on the trade-off between environmental protection and benefits of lumber exports. The work presented here is part of a larger study assessing the effects of selected policy actions taken by the Philippine government as a part of its Natural Resource Management Program (NRMP).1 The model I am developing will be used by other analysts to assess the impacts of other policy actions as well.

I start by accepting the proposition that logging the Philippine forests generates negative environmental externalities. For various reasons (myopic behavior of TLA holders, inadequate property rights, misguided government policies), TLA holders do not take into account the external environmental costs of their operations. The question I pose is whether lifting the Philippine lumber export will bring about a level of environmental degradation whose cost is greater than the welfare benefits from exporting the lumber. As far as I can ascertain, the Department of Environmental and Natural Resources has simply assumed that the environmental costs of the additional timber harvested for export will always be greater than the trade benefits. In the last two or three years, however, that assumption has been challenged. Even if it turns out to be desirable to restrict lumber exports, the question remains whether a complete ban is the optimal policy instrument.

Basic Assumptions

I assume that logging imposes negative environmental externalities on others through its effect on the natural environment. That is, there is a marginal divergence between the private and social costs of logging in the form of downstream producer costs.2 I assume that either property rights are inadequate and/or high transactions costs prevent the full internalization of the externality (Anderson 1992). I make several additional strong assumptions.

(1) Philippine lumber exports are a small part of the total world market. Therefore, the increase in world supply of lumber caused by a removal of the export ban will not affect the world price for lumber.

(2) The exported lumber is identical to other tropical lumber in the world market.

(3) The prices of substitutes for exported lumber, other than competing foreign lumber, and the prices of complementary products are not affected by the added lumber exports.

(4) The export demand for lumber is not affected by any change in real income that might arise from the exports.

(5) No domestic lumber producer is able to affect the price he/she receives for his/her lumber. That is, each is a "price taker" having to accept the market price for his product.

(6) The exchange rate is fixed.

(7) The economy is in a steady state. Markets adjust smoothly to the repeal of the export restriction, with no frictional unemployment of workers or capital.

Environmental Costs Without Trade

The marginal private benefits from consuming and the marginal private costs of producing lumber in the Philippines are represented by the D and S curves, respectively, in Figure 3.3 The production of lumber (but not consumption) generates negative environmental externalities, so that the marginal social costs of Philippine lumber production, represented by S\text{\textprime}, lies above S, by the amount of the externality. (The costs of lumber production—private and social—include all costs from tree-felling to stacking the lumber in the yard). The price axis represents the price of lumber relative to all other prices in the Philippine economy. All other prices are assumed to remain constant throughout the analysis.

Given the above assumptions, OQ is the equilibrium level of lumber production and consumption with the lumber export ban in effect, yielding a net social welfare equal to the difference between areas abc and acd. The triangle cde is the deadweight environmental cost of lumber production, brought about by negative environmental externalities not reflected in gains elsewhere in the economy.
Benefits and Costs of Removing the Lumber Export Ban

We now look at the effect on Philippines welfare if the lumber export ban is removed. Suppose the world price, $P_1$, of lumber is above the domestic price (Figure 4). If the ban is removed, Philippine lumber producers will take advantage of the higher world price and begin exporting lumber. The increase in production for export will drive up the domestic lumber price until it reaches world price, $P_1$. At $P_1$, there is no incentive to increase exports further and the lumber market is in equilibrium. At this higher price, domestic consumers reduce their consumption, moving down their demand curve to $C_d$, domestic production is $Q_d$, and $C_dQ_d$ is exported. Part of the export, $QQ_e$, comes from increased production, and part, $C_dQ_d$, comes from reduced domestic consumption.

The changes in price, production, and consumption generate welfare effects. With lumber exports, the change in social welfare would be $cfn-ctnh$, which may be positive or negative. The ambiguity arises because the benefit from lumber exports, area $cfn$, in the absence of the externalities associated with the extra lumber production, is more or less offset by the uncharged cost of environmental degradation generated by producing the additional lumber exported (area $ctnh$).

Clearly, the smaller the divergence between the social and private costs of timber harvesting, the greater will be the potential for lumber export to make a positive contribution to the Philippine economy, despite the negative externalities it generates. On the other hand, if the wedge is broad, even small increases in lumber exports generates unacceptable environmental costs. The latter scenario appears to be the assumption behind the environmentalists’ opposition to lumber and log exports.

It also is apparent that even if the wedge is broad under current harvesting practices, it may be possible to reduce the divergence through improvements in logging and forest management practices. Opponents of timber harvesting overlook the fact that the divergence between private and social costs is as much a function of the quality of logging and forest management practice as it is of anything else. It is a mistake to conclude that just because current logging practices may generate substantial environmental cost, all harvesting must necessarily generate large environmental costs, and thus export bans are always desirable. It may be that a better solution is to adopt harvesting and management practices less environmentally damaging.

EMPIRICAL ESTIMATION OF WELFARE EFFECTS

I estimate the net welfare effects of removing the lumber export ban in three steps. First, I estimate the benefit from trade, area $cfn$ in Figure 4. Next, I estimate the environmental cost of removing the ban, area $ctnh$. The difference between area $cfn$ and $ctnh$ is the net benefit of removing the lumber export ban. Finally, I determine the present value of all future net benefits by discounting the infinite series of annual net benefits at the appropriate discount rate. (In practice, areas $cfn$ and $ctnh$ will be estimated using different procedures. Area $cfn$ will be estimated using an econometric model of the Philippine lumber industry developed for that purpose. Area $ctnh$ will be determined by a special study of the environmental impact of logging in the Philippines, conducted by the NRMP Policy Analysis Team. An additional complication not discussed here is the possibility that the time streams of trade benefits and environmental costs will differ. This will complicate the analysis, without changing the basic procedure. I explain how to adjust the model for unequal time streams in an earlier paper (Wisdom 1992).

Estimating Trade Benefit

In order to estimate the benefit of removing the export ban, we need to know the changes in price and quantity purchased that would be induced by lifting the ban. If this information were available directly, it would not be necessary to know anything about the domestic demand or supply curves. Unfortunately, these changes in prices and quantity cannot be observed directly, because they require knowing the price and quantity in the counterfactual state where the ban is removed, but all other factors that affect the priced quantity remain unchanged (i.e., the with-and-without situation). In particular, it is not sufficient to merely compare prices and quantities before and after the export ban removal, because a number of other factors that affect domestic (and export) prices and consumption, such as TLA’s, income, the prices of substitutes and complements in world markets, and supply conditions (allowable cut), and forest charges, will have changed in the interim.

Estimation of the social benefit of removing the lumber export ban is accomplished in two steps. First, the annual social benefit is estimated, using demand and supply price elasticities obtained from an econometric model of the Philippine lumber industry developed for this purpose. Second, the present value of all future benefits is estimated.

I begin with the derivation of the formula for estimating the net social trade benefits from a removal of the lumber export ban, areas $cfn$ and $ctnh$, designated as $B_1$ and $B_2$, respectively, in Figure 5. Mathematically:

$$B_1 = area\ cfn - V_{aQ_d}P = V_{aQ_d}P$$

(1)

Remember that $aQ_d$, the change in quantity consumed domestically, is negative.
Generally, data are more readily available for the value of total consumption of lumber (PQ) than for either the price or quantity, and predictions of the change in price caused by the removal of the ban (ΔP) are often more accurate than predictions of actual prices and quantities (Roussolland and Suomela 1985). Finally, for assessment purposes, we need to tie change to actual observed consumption, not that estimated by an econometric model.

Thus, we want to manipulate equation (1) to convert it to these quantities. From the elasticity formula,

\[ QC_e = \delta Q_d = Q \cdot E_d \left( \frac{\Delta P}{P} \right) \]  

(2)

substituting (2) into (1), and multiplying by P,

\[ B_1 = \frac{1}{2} \left( Q \cdot E_d \left( \frac{\Delta P}{P} \right) \right) \frac{\Delta P}{P} \cdot P \]

(3)

Rearranging terms,

\[ B_1 = \frac{1}{2} E_d \left( \frac{\Delta P}{P} \right)^2 \cdot PQ \]

(4)

or,

\[ B_1 = \frac{1}{2} E_d \rho^2 V \]

(5)

where

- Q = the quantity of domestic lumber consumption
- P = the domestic price of lumber
- E\textsubscript{d} = the price elasticity of domestic lumber demand
- V = the dollar value of domestic lumber consumption (PQ)
- \rho = the percentage change in domestic lumber price (\Delta P/P)

The same procedure will yield

\[ B_2 = \text{area cnh} = \frac{1}{2} \text{cnho} = \frac{1}{2} E_s \rho^2 V \]

(6)

where

- E\textsubscript{s} = the price elasticity of domestic lumber supply
- V = the dollar value of domestic lumber production

All other variables are as defined previously.

The total trade benefit from removing the lumber export ban is

\[ TB = B_1 + B_2 = \frac{1}{2}(E_d \rho^2 V + E_s \rho^2 V) \]

(7)

In other words, the sum of B\textsubscript{1} and B\textsubscript{2} measures the total social benefit from trade to Philippine residents of a removal of the lumber export ban.

Before we can estimate the trade benefits from the removal of the lumber export ban, area B\textsubscript{1} and area B\textsubscript{2}, we need an estimate of the parameters E\textsubscript{d} and E\textsubscript{s}. The values of P, and V can be obtained from published statistics. An econometric model of Philippine lumber domestic demand and supply will be developed to provide estimates of the lumber demand and supply elasticities, E\textsubscript{d} and E\textsubscript{s}. The structure of this model is explained elsewhere (Wisdom 1992).

Measuring Environmental Costs

The environmental cost from removing the ban is the area cndi. In theory we could estimate the value of this area using the same approach used to estimate welfare gain from trade. In practice, this approach is inconvenient because of the unusual shape of the area. A more practical approach is to estimate the negative externality environmental costs from logging, with and without the lumber export ban, and subtract the former from the latter to get the net change in environmental cost due to the removal of the lumber export ban. The Department of Environmental and Natural Resources (DENR) is conducting an environmental assessment of logging in the Philippines, and it is anticipated that this study will provide me with the necessary cost data to estimate the environmental cost of removing the export ban. It is assumed that environmental cost is related to the volume of harvest, but not to changes in prices of the product, complements or substitutes. Thus, the before-and-after pitfall will not be a problem in this case.

PRESENT VALUE OF ANNUAL NET BENEFITS

The trade benefits estimated using the benefit formula and the environmental costs are annual flows; that is, these benefits are accruing every year, in perpetuity. Therefore, I will need to estimate the present discounted value of these perpetual annual series of benefits and costs.

The present value of an unchanging perpetual annual series of benefits is:

\[ PVNB = \frac{NB_1}{(1+i)} + \frac{NB_2}{(1+i)^2} + ... \]

\[ + \frac{NB_j}{(1+i)^j} + ... + \frac{NB_n}{(1+i)^n} \]

(8)
where NB is the total trade benefit (areas $B_1 + B_2$), minus the additional environmental cost attributable to removal of the export ban, area $cdih$, in year $i$. That is $NB = \text{annual trade benefit} - \text{annual environmental cost}$. Since, for present purposes, I assume constant annual values for both trade benefit and environmental cost, the perpetual annual series can be reduced to $PVNB = \frac{NB}{i}$, by applying the perpetual geometric series rule. I have described elsewhere (Wisdom 1992) the procedure for estimating the present value of net benefits when domestic demand or environmental cost grows over time, but it is unlikely that this refinement will be used, because of data limitations.

The present value of the perpetual annual stream of welfare gains is found using an appropriate real social discount rate (all values are in real terms, so that inflation can be ignored). Deciding upon the appropriate real annual discount rate is always difficult, calling for a great deal of judgement and faith. This situation is exacerbated in the Philippines by the instability of financial markets during the last decade or so, and the current IMF/World Bank program to restructure the Philippines financial sector. These two factors can be judged upper and lower interest rates, and test the sensitivity of the results to changes in the rate. (For the practical purpose of the assessment, the choice of a discount rate is not as critical as it may seem, since the sign on the annual net benefit will largely answer the question of whether removal of the ban is desirable or not).

**FRICTIONAL UNEMPLOYMENT OF LABOR AND CAPITAL**

Theoretically, we should subtract the costs of moving resources out of the export-competing industry (e.g., furniture and housing) from the gains realized from eliminating the export ban, to get the net social benefit of the elimination of the ban. The social cost of resource reallocation from trade liberalization (i.e., frictional unemployment) is the value added lost by labor while searching for new jobs. In a high unemployment economy such as the Philippines, one cannot assume that alternative productive employment will be secured immediately. To estimate this dislocation cost, we have to estimate the decrease of output of the export-competing industry attributable to the ban, the marginal labor output coefficient, and the time it takes released labor to find a new job. This loss should be added to the consumer surplus loss. I shall not attempt to make this estimate because of data limitations. Instead, we merely note that our estimate of total benefit ignores the cost of labor adjustment, and thus our estimate overstates net benefit.

**THE OPTIMAL ENVIRONMENTAL POLICY INSTRUMENT**

Even if the analysis shows that the lumber export ban should be lifted (e.g., trade benefits exceed environmental costs), it doesn’t follow that the free-market level of lumber production should be permitted. The presence of external environmental costs means that the optimal level of output determined by private benefits and costs is too high, and produces environmental costs not covered by benefits received. The government should seek to restrict domestic production to the point where the social marginal cost curve is equal to the world price, or point $g$ in Figure 4. What is the best policy instrument to achieve this goal?

**Production Tax**

I first consider the optimal environmental policy with the lumber export ban. The optimal environmental policy is an environmental tax equal to the vertical distance between the private and social supply curves at the point at which the marginal social cost of lumber production equals the marginal social benefit. In the autarchy case, the optimal tax would be a tax of $r$ per unit of lumber produced, which would induce output of $Q_s$ rather than $Q$, yielding a welfare benefit represented by area $cde$, the difference between the social cost and social benefit of those $Q_s$ units of lumber (Figure 6).

In the free trade case (Figure 7), the optimal production tax would be $g$. Production would decline from $Q_s$ to $Q_s'$, improving welfare by area $ghi$. The gain from removing the export ban in the presence of the environmental tax is represented by area $efg$. If the production tax was not in place before removal of the lumber export ban, the gain from removing the ban would be even greater, by $cde$.

If the administrative cost of an environmental tax is prohibitive, the government may elect to impose an export tax. delos Angeles, et. al. (1989) and Laarman and Montecillo (1990), discuss the use of an export tax as an alternative to the export ban. It can be shown, however, that an export tax is less efficient than an environmental tax. This can be seen in Figure 8. An export tax of $g$ would lower the price producers receive and hence domestic consumers pay by $P_1P_1'$, thereby reducing lumber export from $CQ_s$ to $C'Q_s'$. This would ensure the marginal social cost of production is lowered to its marginal benefit (the international price, $OP_2$), thereby bringing about the same welfare gain on the production side as an environmental tax of the same rate($g$), namely, area $ghi$. But the export tax distorts consumption, because at the lower price, $P_1'$, consumers are encouraged to purchase an extra $C'C'$ units of lumber. The area $C$ is the deadweight welfare cost of the additional domestic lumber consumption at the lower price.
Thus, an export tax reduces environmental degradation as much as an environmental tax of the same rate, but at a higher economic cost. Indeed, if $ijk$ is greater than $ghi$, this second-best policy instrument is worse than no intervention, despite the reduction in environmental degradation brought about by reducing production to $OQ'$.

ENDNOTES

1 Briefly, NRMP calls for nine policy actions, designed to put the Philippines forests on a sustainable management basis. I am assessing two of these policy actions: (1) the deregulation of the Philippines forest products industry, including removal of trade restraints; and (2) the privatization of government-owned or controlled forest enterprises.

2 Other externalities, such as loss of biodiversity, and the cost of reforestation could be added to the social cost function to make it even more general, with little difficulty.

3 While $D$ is properly defined as a compensated demand curve, for measurement purposes I will assume that lumber enjoys a zero income effect and that, as a consequence, the ordinary demand curve corresponds to the compensated curve.

4 There are negative environmental externalities associated with sawmilling as well; however, only externality costs associated with harvesting are dealt with in this study. Externalities associated with sawmilling are largely independent of the decision whether or not to remove the lumber export ban. With the ban, log imports substantially replaced domestic logs in domestic mills, and any environmental costs attributable solely to the sawmilling stage of processing continue as before.

5 The derivation of the formulas for net social trade benefits follows Szenberg, et al., 1977; Marke and Tarr, 1980; Tarr and Markre, 1984; and Roussland and Soumela, 1985.

6 If the time stream of annual trade benefits and annual environmental costs behave differently, it will be necessary to estimate the present value of the two streams separately and then subtract the present value of the cost from the present value of the benefit to get net present value. Also, if environmental costs decline over time, it may be necessary to assume a finite rather than infinite time period for discounting.

7 I adopt Krutilla's argument that the optimal environmental policy is a production tax on all extracted timber (Krutilla 1991).

LITERATURE CITED


Figure 1: Philippine saw log and lumber exports: 1962-1990

Figure 2: Philippine timber lease agreements and annual allowable cut: 1970-1990
Net social welfare = Area abc - Area acd

Figure 3. Environmental cost of lumber production, with export ban

Trade benefit = Area cfh
Envir. cost = Area cdih

Figure 4. Benefits and costs of removing the lumber export ban
Figure 5. Estimating trade benefits

Net Social Benefit = cde

Figure 6. Effect of a production tax, with lumber export tax
**Net social benefit = Area ghi**

*Figure 7. Effect of a production tax, with lumber exports*

**Net social benefit = Area ghi - Area fkj**

*Figure 8. Effect of an export tax*