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# Long-term effects of eliminating illegal logging on the world forest industries, trade, and inventory

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ABSTRACT

We assessed the impact on the world forest sector of a progressive elimination of illegal logging. The analysis compared predictions from 2007 to 2020, with and without a gradual reduction of illegally logged industrial roundwood from 2007 to 2011. A large part of the curtailment of timber supply due to the stoppage of illegal logging would be compensated by increased legal production incited by higher prices. As a result, without illegal logging the world annual production of industrial roundwood would decrease by no more than 1%, even though it would decrease by up to 8% in developing countries. World prices would rise by 1.5 to 3.5% for industrial roundwood and by 0.5 to 2% for processed products, depending on the assumption on illegal logging rates. World consumer expenditures for wood products and producer revenues would rise by 1 to 2% without illegal logging. World value added in forest industries would remain the same. However, the changes in consumer expenditures would be more than double the changes in producer revenues in countries dependent on illegally logged timber of domestic or foreign origin such as Indonesia and China. Symmetrically, changes in producer revenues would be almost twice the changes in consumer expenditures in countries with little illegal logging and efficient industries, such as Canada, Germany and the United States. Value added in forest industries would decrease most in countries with heavy illegal logging (12% in Indonesia and up to 9% in Brazil), and it would increase most in Germany, Canada (4%), and the United States (2%). Without illegal logging, the world forest inventory would increase slightly, as the increase in developing countries would more than compensate the decrease in developed countries.


## 1. Introduction

Illegally logged timber and its associated international trade is a major problem for environmental, economic, and social reasons. While logging may be a less direct cause of deforestation than land conversion for agriculture (Geist and Lambin, 2002), illegal logging raises concerns about over-exploitation and poor forest management. Because much of illegal harvesting is in tropical forests, it hampers important environmental services (Kinnaird et al., 2003, Bala et al., 2007), such as the habitat of the great apes in Africa (Walsh et al., 2003), and of the orangutan and Sumatran tiger (Jepson et al., 2001, Nellemann et al., 2007).

In terms of economics, the World Bank (2002) estimates that illegal logging reduces government revenues by about $US5 billion a year. Less direct, but much larger is the effect of the unsanctioned harvests of extra wood on global markets, which depresses prices and reduces the incentives for managing forests sustainably. As illegal logging is very profitable to a few in the short run, it often coexists with corruption, undermining the rule of law and good governance (Jepson et al., 2001, McElwee, 2004; Bulkan and Palmer, 2006).

Accordingly, conservation groups, industries, governments, and multinational organizations are promoting policies to combat illegal logging practices and to stop imports of illegal wood products (G8, 1998; United Nations Forum on Forests, 2002; Brack 2006; Sheikh, 2007). Nonetheless, economic, social, and ecological data on the effects of illegal logging are still scarce, especially at international level. Previous studies such as Seneca Creek Associates (2004) focused on effects on the United States, while Turner et al. (2007) were mostly concerned about the implications for New Zealand.

Without denying the environmental importance of illegal logging, the objective of this study was to assess its economic effects on forest industries by predicting how markets would change if illegal logging were gradually eliminated over five years. The predictions are global, and by major country and industry (logging, sawmilling, etc.). In addition to the effects on forest stock, production, consumption, imports, exports, and prices of various products, data were also obtained on producer revenues, consumer expenditures, and on value added to locate gains and losses and to follow them over fifteen years.

The remainder of the paper consists of a brief presentation of the methods, followed by a description of the different effects in major

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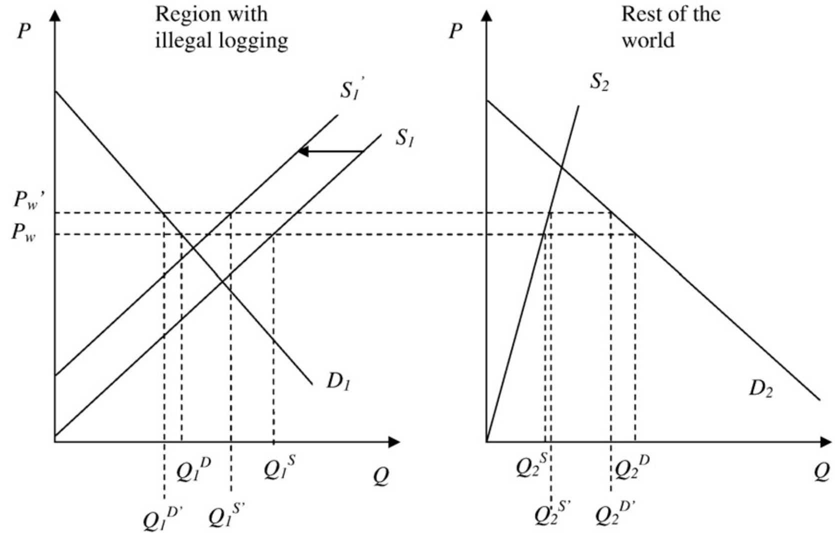


**Fig. 1.** World competitive equilibrium in international wood markets with and without illegal logging.

producing and trading countries, economic groups, and for world regions. It is found that although eliminating illegal logging would have a small relative effect at the global level, the impact would vary considerably by country according to the extent of local illegal logging or the dependency of industry on imported timbers.

## 2. Methods

The international effects of gradually eliminating the supply of illegally logged timber were simulated with the Global Forest Products Model (GFPM) (Buongiorno et al., 2003; Zhu et al., 2006a,b). Initially developed for the United Nations Food and Agriculture Organization (FAO) Global Forest Products Outlook studies, the GFPM is a dynamic spatial equilibrium model which predicts production, imports, exports, and prices of 14 forest products in 180 individual countries.

Among the variables of the GFPM are supplies, imports and exports of industrial roundwood, by country. Demand and supply of each product are represented by econometric functions and by activity analysis. Trade is driven by the economic growth of the countries and by their relative competitive advantage. The equilibrium in each year is found by maximizing the quasi welfare of the world forest sector: the value of the products to consumers, minus their cost of production and transport. Equilibrium prices are the shadow prices of the material balance constraints in each country, such that, for each product and country, demand equals domestic production plus imports minus exports.

The mathematical specification of the GFPM is given in Buongiorno et al. (2003). The most recent improvements, including prediction of changes in forest area and forest stock (Turner et al., 2006a), are described in Zhu et al. (2006a,b).

The theory underlying the experiment carried out with the GFPM for this particular study is sketched in Fig. 1. It symbolizes the demand for and supply of wood in regions where there is illegal logging and in the rest of the world. The figure shows two market equilibria: with illegal logging, and without it. An assumption embodied in Fig. 1 is that illegally logged wood is a perfect substitute for (is identical too) legally logged wood.

With illegal logging, the world price of wood is $P_w$. In reality, and within the GFPM the price in the importing region (here, the rest of the world) is the price in the exporting region (here, the region with illegal logging), plus the transport cost. For simplicity, and without loss of generality, Fig. 1 omits the transport cost. At price $P_w$ the world supply of wood is equal to the world demand, and the net exports, $Q_1^S - Q_1^D$, of the region where there is illegal logging are equal to the net imports, $Q_2^D - Q_2^S$, of the rest of the world.

Elimination of illegal logging is equivalent to a leftward shift of the supply curve $S_1$ to $S_1'$. The magnitude of this leftward shift depends on the illegal logging rate. The new equilibrium occurs at a higher price, $P_w'$. The quantity supplied in the region with illegal logging decreases to $Q_1^{S'}$. This decrease is less than the leftward shift of supply because the price increase induces an increase in legal logging. This compensation follows the Le Chatelier–Samuelson principle (Samuelson, 1947) according to which “if the conditions of a system, initially at equilibrium, are changed, the equilibrium will shift in such a direction as to tend to restore the original conditions” (Pauling, 1964).

The net exports of the region where there was illegal logging decrease even though the domestic consumption also decreases from $Q_1^D$ *to* $Q_1^{D'}$ due to the increase in price. In some conditions, the region could change from net exporter to net importer. The direction and magnitude of the change in the gross revenues of producers, from $P_w \times Q_1^S$ *to* $P_w' \times Q_1^{S'}$ depends on the current rate of illegal logging in the region and on the elasticity of the supply curve. The change in the expenditures of consumers depends also on the elasticity of demand.

In the rest of the world, the halting of illegal logging decreases consumption and increases production due to the increase in price. As a result, the net imports decrease, and the region could even become a net exporter in some instances. In Fig. 1, the producers' gross revenue would increase from $P_w \times Q_2^S$ *to* $P_w' \times Q_2^{S'}$. However, the magnitude and direction of the change in producer revenues, and of the change in consumer expenditures (from $P_w \times Q_2^D$ *to* $P_w' \times Q_2^{D'}$) depends on the elasticities of supply and demand.

The GFPM computations follow the principle of spatial market equilibrium symbolized by Fig. 1. However, the magnitude and even the direction of these effects cannot be predicted as simply. The GFPM depicts not only the world market for industrial roundwood, but also the markets of all of the products (sawnwood, panels, and pulp and paper) that use industrial roundwood as an input. Thus, a decrease in illegal logging can have extensive repercussions on the production, consumption, trade, and prices of other products in many countries.

An example of the GFPM structure, with two countries and three products, is presented in the Appendix. This example illustrates how production in a country is affected by the shift of wood supply in another country due to the elimination of illegal logging. According to equilibrium theory, markets maximize producer and consumer surplus across all countries and products. Thus, changes depend in part on the relative cost and efficiency of wood production and