Chapter 12

Public Timber Supply under Multiple-Use Management

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In many parts of the world, substantial shares of timber inventories are managed by government agencies. The objective of this chapter is to examine the potential influence of public timber production on market structure as well as on prices, harvest quantities, and economic welfare. National forest management in the United States is used as a tractable case study, but findings provide general insights into the potential market effects of interactions between public and private producers in timber markets.

The United States has held a substantial portion of its forested lands in public ownership for more than 100 years. Currently the vast majority of public forests are managed by two different agencies, the USDA Forest Service and the Bureau of Land Management, with the largest share held by the Forest Service. The national forests (originally Forest Reserves) were controversial at their inception, and their management remains controversial today. While contemporary conflict has focused on various aspects of management and planning, the essence of the debate is discord regarding the ultimate ends for which public forests should be managed. In this regard, today's debates over public forests are little different from debates at the turn of the 20th century between Gifford Pinchot, the first chief of the Forest Service, and John Muir, the founder of the U.S. wilderness movement (Frome 1962). The issues are less about how these forests are managed and more about whether they should be managed at all.

Many of the debates regarding national forest management have revolved around economic issues, especially the harvesting of timber. The management of public forests in a market economy raises a number of interesting economic questions. Producing timber from public lands defines

Sills and Abt (eds.), Forests in a Market Economy, 203-220.

an unusual situation where the government takes part in a private market (Wear 1989a). How might activities of a public producer, with a potentially large share of production, shape the market? How might abrupt changes in timber production caused by policy shifts allow for windfalls or impose costs on other market players? The provision of nonmarket benefits, including public goods, is another important aspect of public land management. How are values formed regarding national forests and their sometimes unique benefits? National forests are highly concentrated in parts of the United States, where they represent dominant landowners especially in rural regions. What impacts do national forests have on the structure of these rural economies? Because they are spatially concentrated, public lands can also act as a vehicle for transferring wealth to or from these small areas (Wear and Hyde 1992). What are the distributional implications of national forest management?

In this chapter, we focus on the first set of questions-that is, on how the activities of a large public timber producer might influence the structure of timber markets and how these impacts might be addressed within a forest planning approach. We explore a theoretical structure of timber markets with a dominant public player, address the impacts that changes in timber management regimes might have on timber markets and the distribution of economic activity, and discuss how market effects could be incorporated within national forest planning.

1. WHY PUBLIC FORESTS?

An investigation of the role of national forests in private timber markets requires some clarity on the general rationale behind government participation in markets. Producing timber can be viewed as an intervention in the market, in some ways little different from more traditional means of market intervention—e.g., taxation or subsidy. There are three traditional reasons for government intervention in a market: stabilization, efficiency, and equity (Atkinson and Stiglitz 1980, Boyd and Hyde 1989). All three have been invoked to justify national forest management.

The initial motivation for national forests focused on stability. During the frontier epic of timber harvesting in the United States, forest regeneration and management was absent as the product was mined from successive regions of the country. The forestry movement of the day sought mechanisms to guard against eventual timber famine. Careful husbandry of forests by the federal government was seen as a logical instrument for stabilizing future timber markets.

The efficiency rationale can be seen in Forest Service concerns for nonmarket benefits, and these also date from the inception of the agency. Dueling with timber stability as justification for national forests were concerns regarding the protection of watersheds, in particular protection against flooding that could result from deforestation. This is classic market failure, where markets fail to endogenize offsite costs (floods) while procuring market goods (timber). The number of nonmarket services formally addressed by national forest management—e.g., recreation, aesthetics, and wildlife habitat-has expanded, but they all are conceptually similar to the flooding case in that they address services derived from *in situ* forests. Recent concerns regarding the role of public lands in well-functioning ecosystems shifts the debate somewhat in that management now addresses the role of national forests in broader dynamic landscapes that are shaped by both private and public land management. Still, this is an efficiency rationale.

Distributional motivations have also played a role in the management of national forests. Concerns for the stability of forest-dependent communities date to the Great Depression, when the general notion of redistribution via government intervention was more widely accepted. The community-stability rationale for public forest management suggests that careful federal management of forests can insulate communities in the hinterlands from wide swings in lumber markets-in this sense it can also be viewed as a stability rationale-and implies a redistribution of income to these areas from the economy at large-an equity rationale. Community stability persisted as an important rationale for public forest management until the 1990s, especially as it was tied into broader government initiatives to encourage rural development (see generally Schallou and Alston 1987).

The breadth of expectations and objectives for national forest management has expanded considerably since the turn of the 20th century as the public interest in public lands has expanded both in terms of the range of goods and services and the spatial scale of the interested publics. The scope of national forest planning has increased dramatically in response.

Understanding the breadth and complexity of motivations for public forestry is important, because it helps illuminate the controversy surrounding public and increasingly private forestry and illustrates the difficulties of isolating the role of timber production from the broader scheme of public forest management. Knowing the evolution of rationales also allows for insights into the long-run flexibility of public forestry institutions. Changes in motivation and management reflect the evolution of institutions over time in response to changing public perspectives and preferences as well as changing resource scarcities.

2. NATIONAL FOREST PLANNING

Translating the rationale of public forest management into operations and forest management activities is a complex undertaking. The technologies of planning have evolved considerably on several fronts. As objectives have become more complex, so have regulations that govern the planning of national forests. Here we look back on a planning system that has been in place for 20 years. At the time of this writing, the regulations that prescribe planning procedures are being revised.

The planning of national forests is possibly the most complex application of natural resource economics to date. Several factors which contribute to its difficulty are significant: (1) forests are used by society to a variety of ends, and many uses are incompatible with others; (2) because most of the national forest system is concentrated in rural western states, public planning decisions can have strong effects on local economies; (3) resource tradeoffs must be evaluated with imperfect information on the values of many resources; (4) the actual resource tradeoffs are unclear because the production responses of forests to management are uncertain; and (5) the complexity of the problem creates an enormous number of plausible management alternatives. The national forest planning process has been an attempt to structure this complex and sometimes ambiguous resource management problem in a way that leads to well-informed decisions.

The primary tool for forest planning analysis has been an optimization model used to bring together data to describe a national forest, the production relationships which describe how the forest will develop and respond to different management activities, the values of different resource outputs, and the costs of management. The model is solved using an optimization approach that defines an economically efficient management plan for the forest subject to a set of policy and management constraints. This reduces the decision space by eliminating from consideration the many suboptimal management plans that could achieve the same level of outputs. Of course, the degree to which a solution actually reflects an optimal plan depends on the construction of the model, especially the constraints.

Cost/benefit analysis of this type addresses the relative efficiency of forest management alternatives and attempts to define that management plan which gives rise to the highest net discounted benefits. In addition, forest planning clearly addresses distributive or equity questions as well. These distributive issues, often encapsulated as a community stability policy, are largely concerned with a redistribution of resource wealth from the public at large to the rural areas, which are dependent on public forests for input to their wood products industries. These concerns for local production levels and their derivative employment and income are often used to justify departures from the efficient solutions defined by cost/benefit analysis. Impact analysis utilizes an input-output model (IMPLAN) that describes the historical impacts of forest outputs on local economies and projects the economic impacts of various production alternatives.

3. THE MARKET VIEW IMPLIED BY NATIONAL FOREST PLANNING

Forest planning addresses production decisions at a national forest level using two economic analyses: a cost/benefit analysis and an impact analysis. While each national forest plans separately without explicit consideration of its market interactions, a market view is implied by the structure of these analyses. The cost/benefit analysis views each national forest as a typical producer in natural resource markets. That is, each forest is assumed to not be able to influence total production in these markets, and, therefore, its production decisions have no bearing on resource prices or on input quantities. The impact or distributional analysis using IMPLAN, on the other hand, assumes considerable market power for individual national forests'. When each forest compares the derivative jobs for its alternative production levels, the implication is that the forest is omnipotent in resource markets, defining its production as an increment to total production and employment levels within the local area. The extent of the market power actually held by most national forests likely falls somewhere between these two extremes.

Alternative market structures for use in forest planning have been discussed to a limited degree. The discussion has centered on whether a downward-sloping demand curve should be applied in management models instead of the horizontal demand curves that have been used (e.g., Chappelle 1977, Walker 1971). There are theoretical as well as computational implications of this approach. Using a downward-sloping demand curve would imply that each national forest would control total production in its market area. If this were the case, the approach would be appropriate, but only with some important modifications. Simply replacing the horizontal demand curve with a downward-sloping curve and solving the linear planning model would lead to a monopoly solution with reduced production and higher prices relative to a competitive solution. This solution would increase public timber revenues at the expense of timber consumers, thereby redistributing wealth from the local area to the federal government. In order to account for total consumer and producer benefits, and to simulate the fair market solution, the objective function would need to be redefined as the maximum of the sum of producer and consumer welfare (Samuelson 1952).

This provides a useful approach for places where the public sector is the sole or strongly dominant timber producer.

In most cases, however, the actual structure of the market problem lies between the extremes of a powerless and an omnipotent resource supplier. Because the agency does not ordinarily control the entire resource base in a region, it cannot completely control production and therefore total price. What's more, harvest levels are not set by administrative edict. Rather, sale quantities are set by plans, and harvest rights are sold at auction. The actual quantity sold is very much influenced by market conditions (Adams et al. 1991).

Where the government does control a large share of the resource base, its actions have some potentially strong influence on the production and investment decisions of private producers so that total production may be influenced indirectly. If this is the case, then an examination of direct effects alone is inadequate. Because changes in public production may lead to changes in private production, the total influence of forest planning decisions may not be captured in individual forest plans.

The role of the Forest Service in certain timber markets has been extraordinary. It is unique because only in the case of forestry has the federal government taken such a large and active role as a resource producer in an otherwise private market. The national forests contain the largest share of the nation's softwood sawtimber (51% in 1997; Smith et al. 2001), and the share is much higher in western regions (e.g., 74% in the Rocky Mountain region). Because of this dominance and because of a multiple-use agenda that allows the agency to manage timber at a financial loss, the Forest Service cannot be considered a typical timber producer. Indeed, in many cases it can be argued that planning decisions largely shape markets for timber. Therefore, production plans and actions should hold at least some influence over timber production from private and other public producers and consequently determine market prices for timber.[2]

4. THE MECHANICS OF REGIONAL TIMBER MARKETS

A discussion of the role of the Forest Service in timber markets is best built as a departure from the perfectly competitive case. A market is the place where producers and consumers interact and production levels and prices are established. In the case of timber, the outcome is timber harvest quantities and timber prices. Putting aside the public role in these markets for the moment, consider first the actions of private timber producers and consumers that would define timber supply and demand, respectively, in a perfectly competitive market.

For the purpose of this discussion, consider timber demand at the regional level as derived from the national market for wood products (see also chapter 9). For a small production region, the demand for delivered logs is dependent on prices for products, such as lumber and plywood, determined in national and perhaps international markets, and on local manufacturing costs. The value of the logs in production is the value of the lumber and other outputs produced minus all the relevant production costs. Logs are consumed by wood products manufacturers who adjust their demands for logs and other inputs such as labor and machines, based on the prices of products, logs, and these other inputs. A similar demand relationship holds for labor as well as any other input; employment in local wood products industries is therefore dependent not only on national product prices but also on local wages and timber prices.

The demand for standing timber or stumpage is derived through the next step in production, logging and hauling. The value of stumpage to a logging firm is defined by the prevailing price of delivered logs and the costs of transporting standing trees to the mill yard (logging plus hauling costs). Timber consumers adjust their demands for timber and other inputs based on these prices and costs.

The supply of timber from forest owners is derived in a somewhat different way. The dominant question facing owners of merchantable timber is whether to harvest today or to hold onto standing timber (chapter 8). This decision is based on owner preferences, market expectations, and the costs of bringing timber to market. The forest owner must decide whether revenues exceed costs and then whether the returns to harvesting today are better than the future opportunities for timber revenues. This conceptual model of supply is complicated beyond the usual analysis of commodity supply because a typical producer cannot be defined (see chapter 8). This is because the complement of forests is not homogenous but varies in terms of site productivity, operability, and accessibility. The result-and this is important for this analysis-is a segmented supply relationship: as prices rise, discrete bundles of timber may enter the market.

This relationship defines how profit-seeking forest owners would respond to any set of timber prices. For illustration, consider that forests, especially in an area like the Rocky Mountains, are composed of stands of trees of various qualities and accessibility. These attributes define the costs of bringing each type of stand to market, which include the cost of accessing the timber and preparing a sale. Assuming for the moment that future prices or opportunity costs are constant across these timber stands, the timber supply response function is defined as the quantity of timber placed on the market for any given price of timber. An example is shown in figure 12.1. At some minimum price (pi) forest owners will produce timber from a certain quality/accessibility class (al). Production begins when the market price is equal to p_1, which is the opportunity costs plus the cost of bringing timber of class al to the market. As price increases (to p_2, p_3, and so on), more costly timber classes are brought to market.

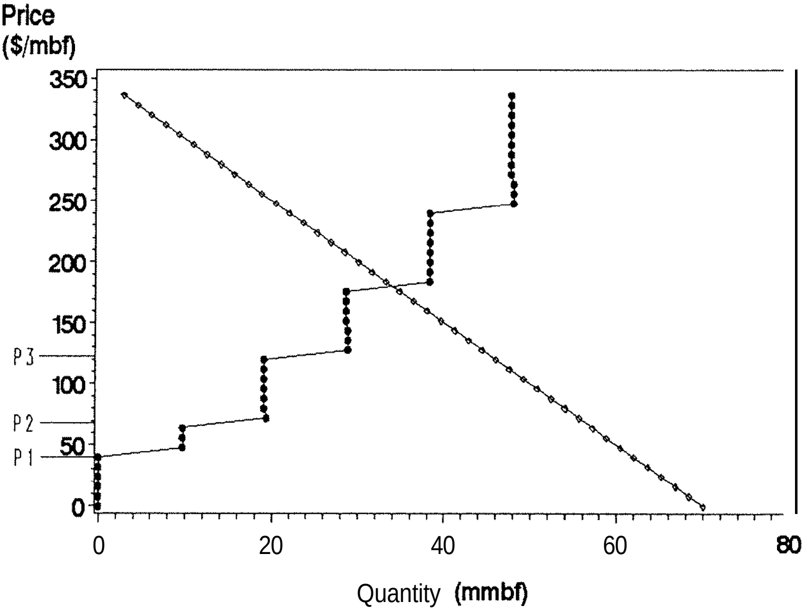

Figure 12.1. A hypothetical timber market described by a supply curve (stair-stepped) and demand curve (linear)

If we apply the demand curve in figure 12.1, then the market is completely defined. The quantity of timber produced is defined where the demand price for timber-the value of the derived products minus the costs of logging, hauling, and manufacturing--is just equal to the supply price—the opportunity costs of harvesting plus the marketing costs. Our key assumption is that the market is perfectly competitive, so that all producers and consumers seek to maximize their profits and utility, respectively, from timber production and that no producer or consumer is large enough to influence the market. If such a case holds and externalities do not exist, then social welfare is well served by this solution. That is, the net discounted benefits arising from timber production are at a maximum.

5. THE FOREST SERVICE ROLE IN TIMBER MARKETS

Extending this analysis to distinguish between private and public production requires adjusting some of the basic assumptions. The Forest Service is not bound to profit-maximizing behavior because of important externalities involved in the production of timber and because of other objectives guiding public land management, such as the distributive goals discussed earlier. At an operational level, federal forestry agencies are not funded by timber receipts, so do not face efficiency incentives. Because of differences in motives and the large share of timber stocks controlled by the agency in some regions, production decisions on the national forests can change the shape of a supply response function. This, in turn, will feed back to the production decisions of other producers. In this section, we explore these feedbacks-that is, the potential interactions between private and public producers in a market for timber.

When the assumption of a profit motive for a major timber producer is dropped, the behavioral basis for the supply response curve shown in figure 12.1 is lost. That is, because the agency makes decisions based on nonmarket as well as market concerns, the amount of timber brought to market is no longer based strictly on marketing and opportunity costs. For example, the Forest Service may decide to depart from efficient production levels to address distributive goals. This redefines the shape of the timber supply response function because some timber is brought to market at a price that does not completely cover marketing and opportunity costs. Therefore, and quite regardless of motive, the agency may alter the aggregate supply response in a region.

In a sense, this is analogous to a Stackelberg model of oligopsony (Shapiro 1989), where a dominant producer leads the market and all other producers-who comprise what is referred to as the competitive fringe—react to the dominant producer's plans. The departure from the Stackelberg model is that, in this case, the leader (public lands) is not driven by profit maximization but is, in effect, a profit-indifferent leader. This does not necessarily imply that the public producers are inefficient, but that their objectives are not characterized by a strict financial optimization. As a result, their behavior appears less than optimal from the perspective of a timber profit function. The next section examines the potential implications of this type of market structure.

5.1 Simulating Timber Supply

Our analysis uses an engineering approach to simulate long-run timber supply relationships for hypothetical private and public timber owners within a region (e.g., Hyde 1980). Assume that timber grows according to the following logistic biological production function (Swallow et al. 1990):

$$f(T) = \frac{K}{1 + e^{(\alpha + \theta T)}} \qquad 12.1$$

where $f(T)$ defines volume as a function of stand age, T; K defines a carrying capacity of 15.055 mbf/acre; and the coefficients are defined as α=6.1824 and θ=-0.0801.

If we assume that this production function applies to both private and public landowners, that both ownerships apply a discount rate of 4%, and that both maximize the net present value of timber production, then the standard Faustmann solution for the rotation age (see chapter 4) occurs where the present net value of the infinite series of rotations is at a maximum

$$V = \max_T \left[(p - c_1) f(T) e^{-rT} - c_2\right]\left(1 - e^{-rT}\right)^{-1} \qquad 12.2$$

wherep is stumpage price, c_1 is a harvesting cost, c_2 is a forest regeneration cost, and r is the discount rate. Long-run supply is derived by solving 12.2 for a range of price scenarios. The contribution of a stand to timber supply is defined by multiplying volume at age T ($f[T]$) by the area of the stand and dividing by T (i.e., this is the average annual contribution of the forest type to supply). This method implies that the forest has reached a long-run equilibrium where the forest has a uniform age distribution between zero and age T. While this simplification limits insights into short-run dynamics, the equilibrium engineering approach provides a useful mechanism for evaluating long-run implications of various management approaches (chapter 8).

With only one stand type, however, the resulting timber supply curve is trivial because the solution to the Faustmann problem is invariant to changes in long-run price levels. To generate a realistic supply curve, we need to account for a distribution of stand types consistent with what we observe in nature. For this analysis, we generate a hypothetical forest with six stand types and hold the biological production function constant across these types. We recognize differences in stand types by varying the cost terms ($c1$ and $c2$) by type so that forest type 1 is the least costly and forest type 6 is the most costly to harvest. This is consistent, for example, with a forest in a mountainous landscape where costs can vary substantially between sites. Area and cost factors for the hypothetical forest are displayed in table 12.1.

Table 12.1. Distribution of area (acres) and costs ($/acre) for six land classes and two owners

Variable	Owner	LC 1	LC 2	LC 3	LC 4	LC 5	LC6
Area	Private	100.	100.	100.	100.	100.	100.
Area	Public	100.	100.	100.	100.	100.	100.
cost (c2)	Private	$10.	$20.	$35.	$50.	$70.	$100.
cost (c2)	Public	$5.	$10.	$18.	$25.	$35.	$50.
cost (cl)	Private	$10.	$10.	$20.	$30.	$40.	$50.
cost (cl)	Public	$10.	$10.	$10.	$10.	$10.	$10.

LC= Land class

We next apply these long-run models to explore the implications of various public management strategies for the aggregate supply from a region. As shown in table 12.1, we assume that the public and private sectors have an identical distribution of forest types. This is consistent with the checkerboard ownership pattern observed in the western United States where alternating sections of land are arbitrarily assigned to the two different owner groups. It is very different from ownership patterns in other parts of the country where the public sector occupies the lands nobody wanted, thereby skewing the distribution toward low-quality land (see Shands and Healy 1977). However, assuming equal land-quality distributions serves our purpose here by allowing us to focus exclusively on the impacts of differences in management approaches.

We examine three scenarios for public timber management while treating private timber management as if it were driven strictly by timber profit maximization. (1) As a benchmark, we start by examining the case where public lands are managed identically to private lands and with the costs listed for private lands-labelled the market scenario. (2) The subsidized scenario applies the Faustmann criterion to public lands but allows the costs to be subsidized as outlined in table 12.1. (3) The CMAI scenario forces timber harvest to occur at the age of maximum timber volume production (the culmination of mean annual increment or CMAI) as long as the net present value (equation 12.2) is positive. The third scenario also uses the subsidized costs for timber management shown in table 12.1. Use of the subsidized cost figures is consistent with observed management and with using timber harvesting to accomplish other ecosystem goals, thereby incurring both joint benefits and joint costs (a rationale for so-called below-cost timber sales). The CMAI rule has long been applied to national forest management.

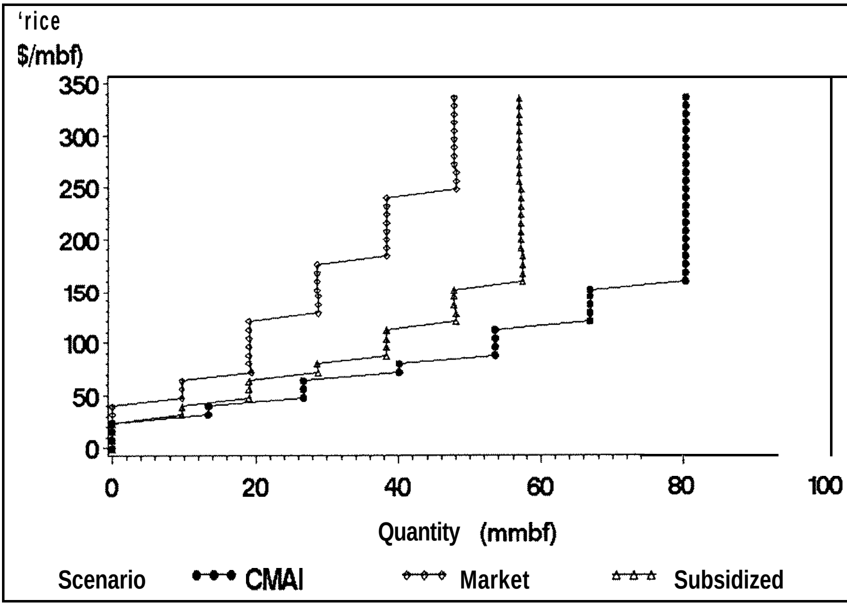

Figure 12.2. Supply curves estimated for three public forest scenarios: (1) profit maximization (market), (2) profit maximization with some costs subsidized (subsidized), and (3) profit maximization constrained by a culmination of mean annual increment rule (CMAI)

Public intervention of the two varieties listed above yield flatter supply curves (figure 12.2), as anticipated from the theoretical development. The benchmark market scenario is the steepest of the supply curves. Maximum annual production of 48 mmbf is reached at a price of about $270/mbf. Subsidized timber production on the public lands results in a flatter supply curve with more timber produced throughout the price range. Maximum annual production of 57 mmbf is reached at a price of about $160/mbf. The CMAI scenario is flatter yet, with maximum annual production of 80 mmbf reached at $160/mbf. As modelled here, public intervention has the general effect of rotating total supply outward.

5.2 Market-Level Implications

To fully develop the market implications of public intervention, we specified a demand function and conducted simulations of market clearing behavior with the three specifications of supply, compared to the case of no public supply. To smooth out the mechanistic definition of supply described above, we tit OLS regression equations for the supply schedules shown in figure 12.2. Supply equations were given the general form:

$$p = aQ + bQ^2 \qquad 12.3$$

and are specified for private and public owners. The demand equation has the form:

$$p = c + dQ \qquad 12.4$$

Coefficients are shown in table 12.2. Simulations are used to address how these interventions could influence (1) total timber harvests and the price of timber in the region, (2) private production and private producer surplus, (3) consumer surplus, and (4) stability. The first three issues can be addressed using a deterministic solution to the markets defined by equations 12.3 and 12.4. To examine effects on stability, we specified a stochastic demand equation by defining distributions for the parameters c and d. We solve for market clearing price and quantities by finding where producer plus consumer surplus is maximized (chapter 8).

Table 12.2. Estimated coefficients for supply and demand equations (equations 12.3 and 12.4)

Equations	Parameters	
	a	*b*
Supply - market	4.23	*0.039*
Supply - subsidy	0.133	*0.072*
Supply - CMAI	*0.044*	*0.037*
	c	*d*
Demand equation	*400*	*-3*

The simulation model was implemented using a FORTRAN program. Draws from a pseudo-random number generator were used to specify the demand equation. A simple search algorithm was used to define the optimal solution for each iteration. Producer and consumer surpluses are calculated for each scenario and supply and demand equations (12.3 and 12.4). The simulations were repeated 1000 times for each scenario and results summarized using means and coefficients of variation for all variables listed above. Simulation results are summarized in table 12.3.

Table 12.3. Harvest quantities and coefficients of variation resulting from Monte Carlo market simulations for four scenarios where public timber is managed: (1) None: without any harvests from public inventories, (2) Market: to maximize timber profit, (3) Subsidy: to maximize net present value but with costs subsidized as shown in table 12.1, and (4) CMAI: to maximize volume but only if subsidized net present value is positive

Variables	Scenarios			
	Quantities			
	None	Market	Subsidy	CMAI
Price ($/mbf)	162.98	120.1	97.27	SO.64
Quantity (mmbf)	30.45	46.8	55.18	61.87
Q-private (mmbf)	30.45	23.2	19.24	16.28
Q-public (mmbf)	0	23.6	35.9	45.59
Consumer surplus ($1000s)	1300.16	2951.4	4080.6	5069.98
Private producer surplus ($1000s)	2715.31	1574.3	1106.7	804.34
	Coefficients of variation			
	None	Market	Subsidy	CMAI
Quantity (mmbf)	0.16	0.23	0.23	0.26
Q-private (mmbf)	0.16	0.23	0.32	0.38
Q-public (mmbf)	—	0.23	0.18	0.21
Consumer surplus ($1000s)	0.27	0.22	0.20	0.20
Private producer surplus ($1000s)	0.37	0.52	0.70	0.82

5.2.1 Price and Quantity Effects

Simulation results show that both the subsidy and the CMAI scenarios lead to reduced prices and increased total harvest levels. For the CMAI scenario, price falls by about 25% while harvest quantity expands by about the same percentage. Proportional response is also found for the subsidy scenario with price decreasing and quantity increasing by about 12%.

5.2.2 Private Production

Compared to the case where public timber is managed for profit, the subsidy and CMAI scenarios result in reductions in timber production from private lands. Private output is reduced by 10% and 21% under subsidy and CMAI scenarios, respectively. However, the impact on private producer surplus is nearly double, with a reduction of about 20% for the subsidy scenario and about 38% for the CMAI scenario. This reflects the simultaneous reduction in output from private forests and in output prices.

5.2.3 Consumer Surplus

Consumers of timber are unambiguously better off with the interventions modelled here-that is, without regard to other forest goods and services that may be substitutes for public timber production. Consumer surplus is 25% higher for the subsidy scenario and 57% higher for the CMAI scenario.

5.2.4 Stability

We evaluate the impact of intervention on stability by examining the coefficients of variation for the variables described above. For timber prices, the coefficient of variation increases under the intervention scenarios (as much as 40% for the CMAI scenario). The effect on quantity is much less emphatic-there is little impact on the coefficient of variation for total harvest. However, the coefficient of variation is increased for private production with the intervention scenarios (+24% for subsidy and +40% for CMAI). Likewise, the coefficient of variation for the producer surplus for private landowners increases by similar percentages. The variability of the consumer surplus measure decreases but only slightly.

Public intervention in timber markets therefore harms private timber producers-private output and timber prices are reduced. As a result, producer surplus for the private timber-producing sector falls substantially. This has the unambiguous result of discouraging timber harvest and investment in timber management on private lands. What's more, the intervention increases the variability in private returns. For private owners, intervention leads to a less stable market.

However, total harvests do increase with the subsidy, as expected, and the variability of total harvest does not increase with level. Consumers of timber benefit from increased output and reduced prices but face increased price uncertainty as a result. To the extent that timber production is correlated with labor used in manufacture of wood products, the increased harvests would have a positive impact on employment in this sector, without increased variability, though this impact would be tempered somewhat by the degree of substitutability between labor and timber in the wood products sector (see Wear 1989b and chapter 9).

6. CONCLUSIONS

Simulations developed here provide useful insights into the direction of certain impacts but little in the way of the actual magnitude of these impacts. Therefore the findings presented here should be viewed as working hypotheses regarding the long-run implications of public intervention in timber markets.

The simulation experiments presented here suggest that public timber harvests can have direct as well as indirect impacts on the operation of timber markets. The interventions described here cause output to expand and prices to fall consistent with economic intuition. There are two types of indirect impacts. One is the decrease in private production and the substantial reduction in rent accruing to private timber owners. While investment was not directly modelled here, this result suggests that public harvesting reduces the incentive to invest on private lands. Additionally, the flattened total supply curve results in prices that are relatively more volatile (measured in terms of the coefficient of variation). This suggests that a harvest policy at least partly justified by a stability rationale may in fact expand and smooth harvests but at the cost of making prices more variable.

Depending on the share of public ownership and the extent of public participation, these findings suggest that market feedbacks should be considered in forest planning. Recent developments in forest planning have focused on public forests as components of broader landscapes and ecosystems rather than as isolated systems. The same logic can be extended to the economic perspective regarding public forest management. The analysis presented here suggests that where the public sector is a dominant producer, public forest management should also be evaluated in a broader market context.

Findings also highlight a need to coordinate forest policies that address private and public forest management. Public harvest policy may counteract policies and programs intended to encourage management on private forests.

The market model defined here was simplified to focus on the interactions among producers and abstracted from the very important inter-temporal aspects of forest plans and timber supply. Extending the time horizon of the market analysis would add considerable complexity but would not change the overall result; private timber production decisions are influenced by public decisions. Accordingly, the total production of timber in a region and the price of timber will be influenced by public production decisions, not only directly through the availability of public timber but also indirectly through the effects of these decisions on regional timber prices and therefore private production levels. The extent of these influences is proportional to the share of timber held by the public sector and the condition of public and private inventories.

In the United States, timber harvest from public land has dropped precipitously over the past decade, resulting in a redistribution of welfare between consumers and private producers (see Murray and Wear 1998). This illustrates another mechanism through which public management-in this case the sudden reduction of public harvests-may influence private decisions and timber markets as a whole.

These issues have increasing currency in many parts of the world, especially where countries have undergone transitions to market economies. In such places, governments face questions regarding how to organize forest ownership and how to market public timber resources in a new market economy. The salient findings are that feedbacks between public and private sectors can have compounding impacts on timber markets and that these interactions can distort markets and social benefits.

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[1] IMPLAN does not assume market power-i.e., prices are fixed-but the tacit assumption behind the analysis of employment impacts of individual timber sale programs is that increased national forest production will influence total market output and therefore total employment in the wood products sector.

[2] Shares of timber production had approached shares of inventory in some western states until the early 1990s. Since then, timber production has fallen precipitously (see Murray and Wear 1998).