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Marketing Research
Report No. 1149

Evaluation of the Effectiveness of Market Responses to Timber Scarcity Problems

The Forest Service, in collaboration with State forestry agencies, forestry schools, forest industries, and other forestry interests, has prepared a comprehensive analysis of the timber situation in the 12 Southern States—Forest Resource Report 24, "The South's Fourth Forest: Alternatives for the Future." This handbook is one of several supplements to that document.

"The South's Fourth Forest" is available for purchase from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161, in both paperbound and microfiche.

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Evaluation of the Effectiveness of Market Responses to Timber Scarcity Problems

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Introduction

The effectiveness of free markets in increasing quantities of timber supplies has been a forestry issue for centuries. Doubts about market effectiveness have prompted establishment of many public and private programs designed to improve forest management and timber utilization. However, the comparative merits of market mechanisms versus public programs have not been thoroughly analyzed. In this paper we will examine existing literature on the market responsiveness of timber and agricultural resource supplies to price changes and discuss the implications of this research for public and private policies and programs.

In the United States, foresters and policymakers have implemented various means to increase timber supplies. Efforts to prevent destructive forest cutting practices and improve forest management and utilization began in the late 1800's and are still supported by forestry leaders. Forest Service analyses of the timber demand situation have consistently shown that timber demand will exceed supplies at current prices—indicating that real price increases must occur to achieve market equilibrium (USDA Forest Service 1958, 1965, 1973, 1981). Studies reveal that sawtimber prices have increased at real rates of about 1 to 2 percent per year for decades, indicating economic scarcity. However, pulpwood prices have remained relatively constant over time (Zaremba 1958, Barnett and Morse 1963, Manthy 1978a, Skog and Risbrudt 1982, USDA Forest Service 1982).

Based on the premise that real price increases for wood are undesirable, a number of public programs have been developed to augment timber supplies. However, the economic justification for public intervention in the market has usually not been explicitly considered. In addition, the responsiveness of market mechanisms for increasing timber supplies, which may be adequate, has seldom been explored. Some critics, most notably Clawson (1978), dispute claims that timber supplies are inadequate and suggest that modifying or eliminating some public programs may be appropriate. Indeed, given the current budget austerity at the Federal level, even the American Forestry Association, a staunch supporter of public forestry programs, has begun to reassess its position on the role of government in forestry (Sampson 1985).

Increased debate about public and private mechanisms for eliciting socially desirable levels of wood fiber supplies is likely. To provide a better basis for policy discussions, we initiated the research described here to review the economic theory underlying free markets and to collect information on the market responsiveness of various natural resources and the effects of public policies on supply.

Can privately owned forest lands provide the socially desirable level of forest resources in a free market economy? In an atomistic free-market system, forest landowners should provide the appropriate products needed by society by responding to price signals the market generates. As Adam Smith (1776) wrote, individuals should help better society according to the principle of the "invisible hand":

> But it is only for the sake of profit that any man employs his capital in the support of industry; and he will always, therefore, endeavor to employ it in the support of industry of which the produce is likely to be of the greatest value, or to exchange for the greatest quantity of either money or other goods . . . . He is in this, as in many other cases, led by an invisible hand to promote an end which is no part of his intention. Nor is it always the worse for society that it was no part of it. By pursuing his own interest he frequently promotes that of the society more effectually than when he really intends to promote it.

This principle has been a foundation for neoclassical economic theory. Free markets with voluntary exchange between willing buyers and sellers should automatically produce the optimum level of goods for most resources, including agricultural or forest resources. However, it is obvious that in agriculture as in forestry, totally free markets are the exception rather than the rule. Forestry and agriculture producers benefit from many government programs designed to improve their production of food or wood fiber. In addition, farm producers benefit from a wide variety of commodity price-support programs and planted acreage limitations that subsidize production.

This paper will examine some of the economic rationales for interference in private markets.

The free-enterprise private-market system for allocating resources works well when the underlying assumptions are met. This system underlies most neoclassical economic theory, where prices in free markets are determined by the interaction of supply of and demand for goods and services. Early political economists generally valued goods based on their usefulness, either to individuals or to society as a whole. But this view was not adequate to explain why goods such as water, which is very useful, has a low market price, or diamonds, which have very little use, enjoy high market prices. The neoclassicists, led by Alfred Marshall, developed a theory of value based not only on practical usefulness but also on psychological value and the costs of production. Neoclassical theory

states that value is determined by the equilibrium of supply (marginal production costs) and demand (marginal utility). In a market economy, prices are determined by the intersection of these two functions. Neoclassical economics provides the tenets of faith in competitive markets and price allocation of goods for most current free-market economists.

Assumptions

The efficiency of free markets rests on several assumptions. First, property rights must be defined so that market participants cannot impose costs on nonconsenting parties. Second, voluntary response to market price signals requires that productive activity and personal reward be closely linked. Third, both buyers and sellers must be reasonably well informed. Otherwise, they may unwittingly consent to arrangements they will later regret. Last, competition among buyers and sellers must exist (Gwartney and Stroup 1982).

Kneese (1977) discussed these assumptions in detail. Generally, they are all based on the value judgment that the personal wants of individuals in society should guide the use of society's resources. A similar premise underlies Anglo–American political theory, so the value basis, at least, should hold. First, Kneese writes that all markets must be competitive. No particular firm or individual can affect any market price significantly by decreasing or increasing the supply of goods and services offered. Thus all participants in the market exchange process must be small units. This is commonly referred to as atomistic competition.

The second assumption of efficient markets discussed by Kneese is perfect information: all participants in the market must be fully informed as to the quantitative and qualitative characteristics of goods and services and the terms of exchange. This is, of course, only approximately true in any market.

Kneese classes the need for clearly defined property rights and linkage of personal activity and reward into one class. He writes that all valuable assets must be individually owned and managed without violating the competition assumption. This, plus competitive market exchange, implies that all costs of production and consumption are borne by the producer and consumer.

If these conditions hold, society's best method to allocate scarce resources would be to limit the role of government to deciding questions of income distribution, providing the rules of property and exchange, and

letting exchange of privately owned assets in markets take care of the rest.

Randall (1981) describes this free-market, laissez-faire system as a pure enterprise economy. As such, ownership rights are exclusive, enforceable, and transferable. The parties to an exchange or trade determine value. Exclusive rights "facilitate trade by assuring individuals that they can use what they own, that they cannot use what they do not own, and that they can obtain desired things that they do not own only by giving up less desired things that they own." Competition among buyers and sellers leads to relative prices that remain stable until there is some change in market conditions. The use of money as a medium of exchange converts relative into monetary prices.

Prices serve as the incentive for production of goods and services, ration consumption, and signal changes in scarcity and demand. Interest rates serve as the price of capital, tending to stabilize the economy and resource use over time. The price mechanism allows individuals to pursue their self-interest, via innumerable decentralized decisions, and achieve the common good. Given the prior assumptions, modern economists have proven mathematically that the price system generates completely efficient organization of the private-enterprise economy (Randall 1981).

Failure

Under the preceding assumptions, a laissez-faire, free-market economy should maximize the social welfare, at least as far as most economists are concerned. However, markets often fail to meet the assumptions to a greater or lesser degree, and equity may be a concern as well. If market failure is severe, even economists allow that public intervention may be required. Equity—the distribution of income, costs, or benefits among different people—may also be perceived as inappropriate in the market allocation of resources (Wolf 1979).

Based on their assumptions for efficient markets, Gwartney and Stroup (1982) divide market failure into four classes: externalities; public goods; conflicts between buyers and sellers after an exchange, stemming from poor information or misrepresentation; and monopoly. Musgrave and Musgrave (1984) and Pejovich (1984) add some additional limitations to neoclassical theory. First, it assumes that one specific set of exclusive private property rights governs the use of *all* resources. Second, transaction costs must equal zero. Both of these assumptions are rather dubious—a fact that could account for the limited success of neoclassical

theory to arrive at practically correct explanations of real-world situations. In fact, the price mechanism is costly both in terms of establishing and enforcing exclusive property rights and providing adequate information (Randall 1981).

Phelps (1965) and Hirshleifer (1984) note one additional reason that markets may fail—disequilibrium. Prices serve to bring the separate optimizing decisions of individuals and firms into balance. Since market conditions in the world are ever changing, chances are that prices will always be some distance from and scarcely ever at their equilibrium values. Phelps suggests this is similar to the case of "decreasing costs," in which private firms, if they set price equal to marginal cost of production (as they should in an ideal economy), cannot break even despite enough consumer demand to justify production.

Each of these potential market failures and the equity effects will be discussed in this report. Market failure or distributional problems are often viewed as prima facie evidence for government (public) intervention. Indeed, such problems have implicitly been the basis for most current agricultural and forestry programs. Historically, public policymakers and the relevant interest groups probably did not couch their demands, analyses, or decisions in terms of economic theory but did act according to its principles. In forestry, all the commonly cited types of market failure are relevant.

Externalities—Externalities are costs or benefits that are not reflected in market prices. They occur when the activities of one person affect the welfare of other persons who have no direct means of control over those activities, whether it be in production, consumption, or exchange (Hirshleifer 1984). Externalities may occur among individuals and firms at a given point in time or over long periods of time (Griffin and Stoll 1984). Pecuniary externalities may affect others only through movement in market prices. However, direct externalities are usually considered most important; they occur when one decisionmaker's actions have an immediate effect on the production or consumption activities available to others (Hirshleifer 1984).

Pollution is the classic example of a negative externality. Polluted air or water are resources that are not counted in the cost of production for the firm; society bears the cost. Governmental intervention in the market may force firms to internalize such costs, either through taxes, regulations, redefining property rights, or other means. External benefits may also occur when producers fail to capture all the value of a product via

market exchange. This seems to promise a bonus but in practice does not. Producers will make less of the good than would be socially desirable (Lindblom 1977).

Externalities occur because private property rights are not exclusive. Coase (1960) theorized that regardless of the specific initial assignment of property rights, in market equilibrium the final outcome will be efficient—provided that the initial legal assignment is well defined and that transactions involving exchange are costless. However, the negotiations required may be impractical. Parties who bear external costs often cannot bargain effectively with polluters. Transactions costs (e.g., legal fees) are too high, so they do not gain by pursuing recompense.

Ownership externalities occur when owners fail to capture the entire benefit of the good they produce. Technical externalities occur if resources are indivisible or technology exhibits smooth or increasing returns to scale in the relevant range of output (Bator 1958).

In natural resources, market externalities over time are crucial. Since the independent decisions that generate prices are made by individuals, whose lifespans are brief, there is no assurance that prices provide adequate guides for decisions with long-lived consequences (Randall 1981). Neoclassical economist Arthur Pigou (1877–1959) acknowledged that money as a measure of satisfaction was generally acceptable, except in the case of consuming resources or reserving them for the distant future. He believed that the time preference of individuals would generally be short, leading them to consume more resources (particularly nature's exhaustible resources) than would be consistent with the general interest and welfare. Thus, the social time preference of society would be longer than that of individuals. Based on this premise, Pigou argued that there was a general presumption in favor of the state taking action to conserve natural resources (Alston 1983).

These concerns with intertemporal allocation reflect differences in private (high) and social (low) discount rates. Landowners discount future income considerably; society does not. However, even low discount rates may not lead private owners to practice soil conservation. Society generally recognizes an obligation to leave future generations with a relatively intact resource base. Therefore, preserving the productive capability of the land becomes an objective for society if not for a private owner. If operating land is unprofitable, individual incentives may lead to destructive practices. Public intervention may then be the only method to protect social interest (Brubaker 1983).

In forestry, nonmarket costs and benefits are common, both among current forest landowners and between present and future generations. Soil erosion, loss of site productivity, and pollution may occur in forestry. Discussing the similar situation in agriculture, Griffin and Stoll (1984) write:

> First, the discount rate of the individual farmer is argued to be greater than the social discount rate, and the farmer's time horizon is argued to be less than the social time horizon. The result of each of these situations is the same: society places a greater present value on the future benefits of today's soil conservation efforts than the farmer does. Therefore, society's desire for soil conservation exceeds that of individual farmers. . . . This element of the soil erosion problem constitutes a market failure because there is an interdependence between future generations and today's farmers that is inadequately handled by the market (an intertemporal externality).
>
> Second, soil resources lost by the farmer must appear elsewhere. In sufficient quantities these resources can be regarded as pollutants, and since water is the primary transport media for these resources, it is water that is potentially polluted. This situation represents a rather obvious externality.

These two negative externalities—the short-sightedness of private forest landowners and pollution—triggered the demands for many of the current public forestry programs. The large areas burned by wildfires at the turn of the century were another large, harmful market effect leading to public programs.

Forest resources are generally a long-term investment. Timber rotations usually exceed 20 years, even in the South, and are at least 50 or more years in the West. Expecting private forest landowners to make investments from which they will never see returns is optimistic, no matter how financially or socially desirable such investments may be. In addition, many private forest landowners lack the capital or ability to borrow for needed regeneration.

Water and air pollution from forest land-management activities occur often. Nonpoint source pollution of water occurs frequently after site preparation. Chemical applications also can result in external costs, as can prescribed burns. Forest landowners are also subject to problems with positive externalities. By performing prescribed burns for timber

management, they are also likely to increase wildlife habitat. But they are unlikely to receive the full value of this production.

Overall, large positive and negative externalities in forest resources have led to many forms of public intervention. Even Compton (1919), a staunch advocate of free markets in forestry, admitted that such intervention might be necessary, as did many foresters who felt that timber resources were wasted during the 19th century. Externality problems led to many intervention proposals in the late 1800's, most notably setting aside the national forests and enacting State and Federal fish and game laws.

Public Goods

> Public goods are those goods that, once produced, are available for anyone to use, whether or not they contributed to their production. Individuals may become "free riders," benefiting from goods that others have provided. Because the benefits associated with public goods are not necessarily paid for by all who enjoy them, market behavior generally underproduces such goods (Stroup and Baden 1983).

Public goods are a type of externality in that costs and benefits of production are not reflected in the marketplace. In fact, in most instances owners receive no benefit from production of a commodity because exclusion is not possible. The cost of consumption and benefits of production are minimal. Thus consumption will be excessive and supply minimized if markets alone are relied on for production. National defense, highways, parks, and wilderness may be considered public goods (Leman and Nelson 1981, Lindblom 1977). Hardin (1968) depicted the problems of public goods as the "tragedy of the commons." Common pool land is overgrazed because economic incentives lead people to consume the range quickly before other herdsmen use the resource. He concluded that freedom and lack of property rights in the commons bring ruin to all.

Public goods are generally common-pool or collective in nature—they are consumed jointly by many individuals, and exclusive use of the product by owners is difficult or infeasible. These may be contrasted with private goods or toll goods, where exclusion is possible. Savas (1982) writes that without exclusion, market prices will be nil, resources overexploited, and supply spent. Common-pool goods (e.g., fish and wildlife) will be consumed, even squandered, to the point of exhaustion, as long as the cost of collecting, harvesting, extracting, appropriating, or otherwise taking direct possession of the free goods does not exceed the value of the

goods to the consumer. He adds that market mechanisms fail to assure a continued supply of common-pool goods. Instead, other forms of collective or cooperative action are required. Completely collective goods, such as clean air and water, are simply not provided by the marketplace. Individuals have economic incentives to use such goods without paying a fair share of the effort to supply them.

The Coase (1960) theorem suggests that a proper definition of property rights would allow for market solutions to be as efficient as anything that could be achieved by government intervention. However, problems of public goods arose because property rights approaches were costly and difficult to implement (Leman 1984).

Savas (1982), in a book on limiting the role of government, concedes that supply of collective goods requires public intervention, such as taxes or government programs. He notes that social pressures may be adequate to ensure that individuals in small groups (or homogenous societies, like Japan's) contribute their fair share to produce collective goods, but in larger, more heterogenous groups, legally sanctioned coercion is necessary.

Like all classification schema, the distinction between public and private goods can be fuzzy. Private firms do supply public goods, such as television and radio broadcasts. Government agencies, while supplying public goods like national defense, also produce a vast range of private goods (Hirshleifer 1984). These include electric power (Tennessee Valley Authority), public schools, mail delivery, and, of course, timber and other forest resources.

Several forest products are collective or common-pool goods. Fish in streams or lakes and wildlife in the woods are goods that private forest landowners help produce but others may consume. Some exclusion, at least from one's own property, is possible. But fish, and particularly game, are often not confined by the boundaries of one tract. Thus owners have little incentive to produce them, i.e., improve their habitat. Clean air and water can either be produced or soiled by forest landowners. Economic incentives lead them to externalize their costs—shift them to society—and not produce clean air and water. This again has led to public intervention to ensure production of socially optimal levels of these outputs from forests.

Based on the economic assumption that productive activity and personal reward should be closely linked for efficient market performance, timber production may be considered a collective good. Waiting for years or

even decades to receive investment rewards is not a close linkage. Thus, markets may not entice as much timber production as is desirable. Or at the least, they may not lead to production of enough desirable species of appropriate age classes. Instead, default forest management will occur, yielding only noncommercial fiber.

Imperfect Knowledge—Perfect knowledge is one of the more heroic assumptions of neoclassical theory. Achieving an optimum allocation of goods and services may be impossible when persons are ignorant of their own preferences or of the quality of goods and services they buy. No consumer is competent in all purchases. The problem of inadequate knowledge exists in all forms of organization; decisionmakers are never wholly competent in any form of politicoeconomic organization (Lindblom 1977). For any individual or organization, information is costly (Randall 1981). The benefits of obtaining perfect, or even adequate, information must be weighed against its opportunity costs. Acquiring and analyzing information requires money. Excessive time analyzing data penalizes slow-footed market participants.

Knowledge deficiencies may prompt public intervention to ensure that consumers are not at a disadvantage in business transactions. Laissez-faire tacitly assumes that caveat emptor is an acceptable policy. Current mores in the United States do not. At the turn of the century, muckrakers exposed unscrupulous business practices by producers, and this led directly to government regulation of many business activities.

In forestry, the problem of imperfect knowledge lies more in production than in consumption. Timber or wildlife producers are apt to be largely unaware of the value of the goods they are producing. First, not realizing that returns to forestry investments can be quite attractive, they may fail to grow timber. Second, some producers (nonindustrial private landowners) are likely to know very little about the quantities or the prices of the timber they grow. In fact, many probably don't even now what a board foot is, let alone how many they have "standing on the stump," or what the going per-unit price of "stumpage" is. On the other hand, timber buyers make purchases regularly and are usually either foresters or loggers who can estimate stumpage (standing timber) volumes and values with reasonable accuracy.

Public technical assistance and education programs are provided to nonindustrial private forest landowners to help correct disparities in knowledge and information and help ensure that all firms compete under the same rules in free-market transactions. First, the programs may help

owners realize that growing timber can be profitable. Second, they may help owners better estimate volumes and values so they receive fair prices when selling timber. Cubbage et al. (1985) and Jackson (1983 unpubl.) found that forest landowners received significantly greater stumpage prices when they were assisted by a forester than when making sales on their own.

Corporate forest landowners may also underproduce timber because of imperfect knowledge of financial returns compared with investments in plant and equipment or because of high discount rates. Long-term timber investments often must compete with short-term equipment investments that appear to have greater rates of return, or are at least more pressing. In addition, timberland may be looked upon as a profit center that must contribute its share to accounting-based measures of corporate returns. Thus forest-products companies may liquidate inventories prematurely to satisfy corporate profit goals, or even to maximize the net present value as dictated by harvest scheduling models.

Imperfect Competition—The price mechanism works best when buyers and sellers are so small they they cannot affect prices, a situation commonly referred to as atomistic or perfect competition. However, modern production processes are generally rather large, and firms have obvious opportunities to influence prices (Randall 1981). In fact, most economists today refer to the United States economy as one of monopolistic competition, as described by Schumpeter (1949). Under monopolistic competition, producers may influence product prices because of product differentiation. They are not faced with a given market price (a horizontal demand curve equal to their average or marginal revenue curve). Instead each firm has a downward sloping demand curve, indicating that they can influence the quantities consumed by changing prices.

Monopolistic competition may also cause market failures. Opportunities may exist for collusion between buyers or sellers in influencing prices. These fears led to the Sherman Antitrust Act of 1890 and the Clayton Antitrust Act of 1917. These laws prohibit collusion or restraint of trade among sellers in setting prices in order to guarantee competition. Violations of the Sherman Act are considered criminal in nature and are prosecuted by the Federal Government. The Clayton Act allows civil suits for consumers to sue producers who collude to set prices. Many forest-products firms have been prosecuted under both acts for price-fixing of folding cartons, plywood, and other products.

The government may intervene in the market in order to prevent monopoly—the most often cited form of imperfect markets. The Sherman Act was also designed to prevent monopoly. The Act tries to prevent excessive market concentration in any industrial sector. Large corporate mergers must be approved by the Federal Government. The spinoff of Louisiana–Pacific from Georgia–Pacific was required based on the Act. Some mergers have required assets to be divested in order to prevent excessive concentration in certain market segments.

Public and private timber sellers face a related problem of imperfect competition, termed oligopsony. Some markets, particularly hardwood and southern pine sawtimber, are fairly competitive. Competition near large pulp mills is considerably less (Zaremba 1963). In any given market area, there are thousands of private forest landowners (producers) but probably only a few to a dozen buyers. The relative scarcity of buyers certainly reduces competition and could lead to collusion (Mead 1966). A recent court case in Alaska convicted two forest-products firms of bidding collusion on national forest timber sales. Again, with collusion in bidding, private owners could receive less for stumpage, perceive growing timber as undesirable, and invest elsewhere. Socially desirable timber supplies would be underproduced. Technical assistance foresters also help landowners improve competition by recommending that they obtain several bids rather than taking the first offer.

Equity

Even if markets are imperfect, they will allocate resources. Many economists contend that even imperfect markets are better than less-perfect politics. However, the price mechanism is indifferent to equity—who gains and who pays in market allocations. Markets may lead to wide price fluctuations, with devastating impacts on the income of producers. Changes in technology may reduce the value of obsolete plant and equipment or displace workers who have no other marketable skills. Randall (1981) writes that

> Income is the reward for labor, skill, education, and training, and also for the use of capital and resources owned. For the very rich, the greater portion of income comes from the latter sources. While capital and resources must be rewarded, to attract them to productive uses, the high incomes of their owners do not always seem fair and just to those who do not own much of value.

Equality and equitable distribution of wealth have historically been important American political values. The question remains how far one should go in sacrificing efficiency (the pure free-market criterion) in order to achieve equality (Hirshleifer 1984). Excessive government efforts to guarantee equal results can effectively destroy incentives to innovate, change, and grow. Modern economists, such as Hirshleifer, concede the limits of Smith's "invisible hand" in allocating resources. But they have little faith that government intervention will improve matters.

Faced with the same facts, others tend to support the role of government. Leman (1984) writes that

> Equity is not only an inescapable question in theory; it also has long been *a*, perhaps *the*, central concern in politics. As Jacob Viner (1960) has pointed out, the 19th century doctrine of laissez-faire fell into disfavor precisely because of concern about inequities in the resulting distribution of wealth and income. Jonathan Hughes (1977) points out that it was at the turn of the century, during the period of the American economy's greatest growth, that the most ideas emerged on extending nonmarket control over economic life.

In the case of land resources, Brubaker (1983) asserts that equity is the main issue presented by public intervention. All social actions create gainers and losers, but constitutional questions regarding ownership compound concern with land. Should owners bear costs not asked of other citizens? Who should reap the gains of intervention if land values increase? Pay if they decrease? Traditional economic efficiency criteria have not been nearly as influential in such decisions as have legal doctrines or political processes.

Concerns about the distribution of income have also prompted establishment of public forestry programs. Nonindustrial private forest landowners may need public assistance because they are less able to afford forestry expertise than large timber companies. Flick (1985) describes the equity aspects of capitalism in forestry in an article on the wood dealer system in Mississippi:

> The two great merits of capitalism are the impersonal character of the constraints it places on people and its unrivaled flexibility [Scitovsky 1980]. Individuals are free to enter, exit, buy, sell, produce, and adapt as they see fit. There is little mercy, however, for those landowners, dealers, or producers who make

mistakes. In the aggregate, the system is flexible in that it can move rapidly from nonadapters to innovators, always keeping its center of gravity near the most efficient and productive.

Its great faults tend to be its fragmentation, and consequent lack of provision for the future, and its unsatisfying distributive consequences. Dealers played almost no role in developing modern mechanical logging equipment and they have in fact been slow to adopt it once developed. A logging system costing five hundred thousand dollars or more and requiring skilled operators is simply too expensive for a small business with fluctuating wood orders, unless the system's value has been proved.

The least satisfying distributive aspect of the wood supply system is that it does not enable the uneducated rural labor force to improve its situation. The pressure of competition forces each player to seek his maximum advantage. The least advantaged players, usually landowners, producers, and laborers, are traditionally ill-equipped to negotiate profitable contracts.

Public forestry investments are also significant because they usually occur in poor regions and counties. While some forest landowners may be affluent, the local economies of timber-based regions usually are not. Community stability, income for poor people, maintenance of an infrastructure for forest contractors, and the multiplier effect have all been cited as reasons to support forestry programs.

Development of forest resources on a continual basis avoids the deleterious boom or bust effects on local economies. Increased investment and supplies may also increase development of both primary (management practice contracting services, harvesting) and secondary (manufacturing plants) forest industries. Increases in these areas would, in turn, generate benefits in terms of employment, earnings, value added, and multiplier effects (Hickman and Siegel 1985, unpubl.). Income maintenance for forest landowners, the common raison d'etre for government involvement in agriculture, is less important in forestry but still a concern.

Responsiveness and Scarcity

The responsiveness of markets to problems of scarcity is related to efficiency and equity. This section will briefly review the economic theory regarding market responsiveness and its equity implications.

Economic Theory—Economic theory dictates that in free-enterprise, private-market economies, the equilibrium prices for products will be determined by the intersection of the producer's supply curve and the consumer's demand curve. The responsiveness of markets to price signals is usually measured by price elasticities. Elasticities are unitless measures of the percentage change in one (dependent) variable with respect to a percentage change in another (independent) variable. Thus, in a market equilibrium model (fig. 1), price elasticities may measure either the responsiveness of consumers to changes in product prices (price elasticity of demand) or the responsiveness of producers to similar changes (price elasticity of supply). The price elasticity of supply would be measured as:

$$E_s = \frac{\%\Delta Q_s}{\%\Delta P} = \frac{\frac{\Delta Q_s}{Q_s}}{\frac{\Delta P}{P}} = \frac{\Delta Q_s}{Q_s} \cdot \frac{P}{\Delta P} = \frac{\Delta Q_s}{\Delta P} \cdot \frac{P}{Q_s} = \frac{d(Q_s)}{dP} \cdot \frac{P}{Q_s}$$

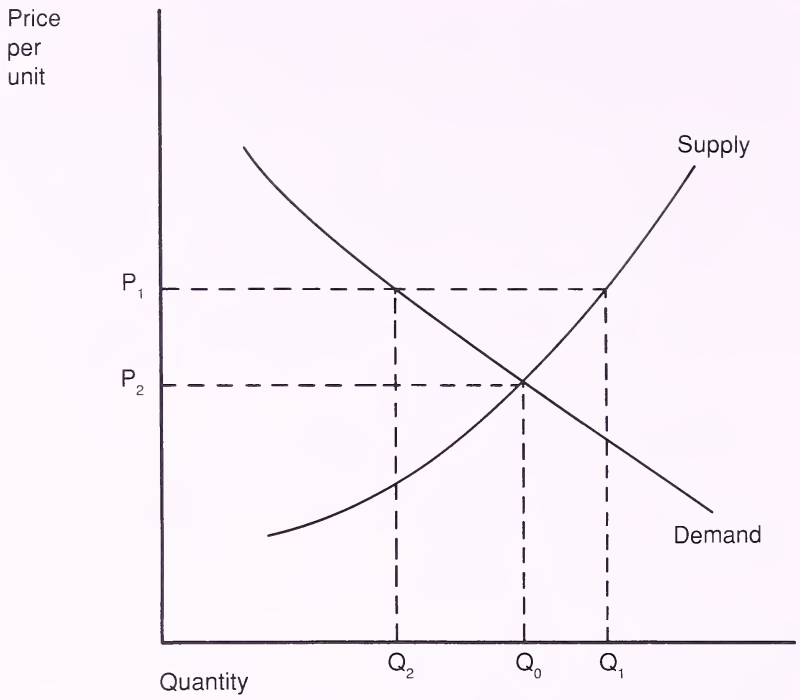
where: Δ = change
P = product price
Q_s = quantity supplied.

Similarly, the elasticity of demand would be measured by the percentage change in quantity demanded due to a change in price.

Elasticities can measure the market responsiveness of either producers or consumers. In the case of timber, policymakers have been most commonly concerned with the responsiveness of producers in supplying more timber as prices rise. In particular, prices that increase at a rate greater than the inflation rate suggest that the economically available amount of timber is decreasing, regardless of the actual amount of wood growing. The price elasticity of supply is the principal method for evaluating supply responses. Demand elasticities may also be relevant in evaluating market responses. For all elasticity measures, the following classifications of responsiveness are used:

Elasticity	*Responsiveness*
$\|E\| > 1$	Elastic
$\|E\| = 1$	Unitary elasticity
$\|E\| < 1$	Inelastic

Elastic supply implies that the proportional change in output produced would be greater than the proportional change in price. Unitary elasticity implies equal proportional changes. Inelastic supply means that propor-



$$\text{Price Elasticity of Supply} = E_S = \frac{\Delta Q_S}{\Delta P} \cdot \frac{P}{Q_S} = \frac{Q_1 - Q_0}{P_1 - P_0} \cdot \frac{P_0}{Q_0}$$

$$\text{Price Elasticity of Demand} = E_D = \frac{\Delta Q_D}{\Delta P} \cdot \frac{P}{Q_D} = \frac{Q_2 - Q_0}{P_1 - P_0} \cdot \frac{P_0}{Q_0}$$

Figure 1—Supply and demand elasticities in an equilibrium market model.

tional changes in output are less than proportional changes in prices. Elastic supply curves tend to be flatter, indicating that the quantity response is greater than the price change. Inelastic supply curves are steep, indicating that quantities change little with price changes. Horizontal supply curves are perfectly elastic. In perfect competition, individual firms face a perfectly elastic supply curve; they cannot change the price received by varying output levels. Vertical supply curves are perfectly inelastic; the quantity produced remains constant at all price levels.

In practice, supply curves usually have varying elasticities depending on the point on the curve that is being measured. Small quantities of output and low prices are more likely to be more elastic than large quantities or high prices. Most studies measure elasticity of supply at sample period means and draw conclusions regarding potential changes from the average conditions.

Supply elasticities may also vary depending on whether they are based on short-run or long-run supply curves. Short-run elasticities are generally less than long-run, as one would expect. In the short run, company resources and supply curves are fixed, so supply responses are necessarily limited. In the long run, resources may be shifted among productive sectors and firms, allowing greater responsiveness.

Elasticity of demand may also be important in determining the effectiveness of free markets. Demand elasticities are similar to those for supply. When quantity demanded changes little with price, demand curves are referred to as inelastic (unresponsive). If quantity demanded changes greatly with price, the demand curve is elastic. For most products, demand is defined as the amount of the product that consumers are willing to buy at a given price at a given time. But demand exists for many resources solely because they are inputs in the manufacture of other consumer products; this is referred to as derived demand. The desire for most forest products consists of derived demand, including stumpage (into lumber), lumber (into homes), and pulp (into paper, boxes, etc.). Generally, the derived demand for inputs into production will be less elastic than that for the final products.

The interaction of supply and demand determines market prices (fig. 2). Inelastic demand is apt to cause prices to increase greatly if supplies decrease (the supply curve shifts back). Similarly, inelastic supply is likely to cause large price increases if demand increases (the demand curve shifts out). Even though markets will equilibrate supply and demand if prices exist, not everyone may be satisfied with market outcomes.

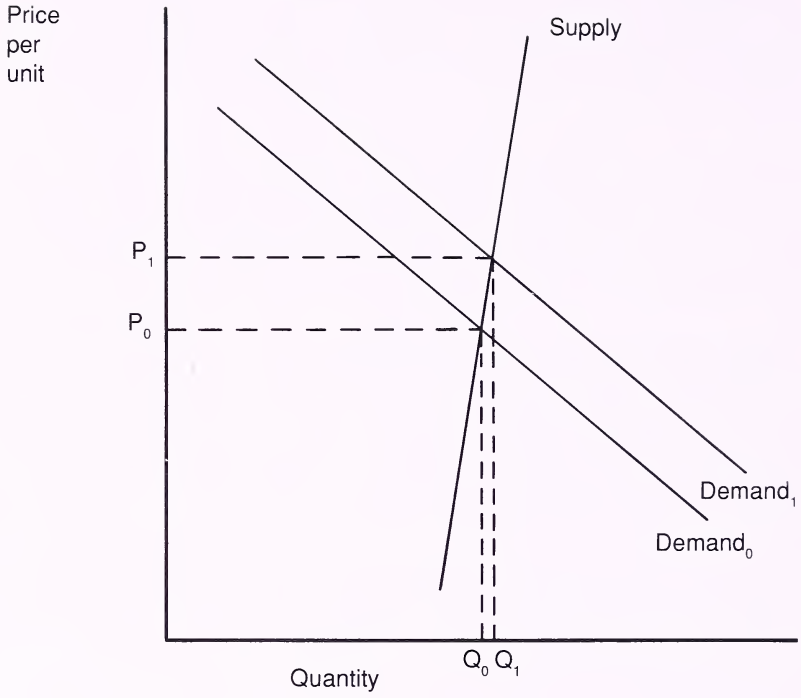


Figure 2—Effects of inelastic timber supply in the free market model.

Agricultural Studies—Many studies of agricultural supply responsiveness have been made. The market situation in agriculture differs from that of forestry in that most government programs are designed to maintain minimum price support levels or constrain supply (contradictory goals). In forestry, markets alone have determined the prices landowners receive for stumpage, and the public role has been one of developing programs to augment supplies. These are at least internally consistent goals. However, the models used to measure supply elasticity in agriculture may provide insights useful in forestry.

Most agricultural supply response estimates are based on the Nerlove (1958) model. A summary of the methods and results of these supply response estimates is helpful in understanding Federal agricultural subsidy programs. The Nerlove model and subsequent modifications are reviewed extensively by Askari and Cummings (1976, 1977). In conjunction with the analysis of the methods and modifications of the Nerlove model, the applications to specific crop groups are examined at great lengths by the same investigators.

A list of agricultural supply elasticities and their source of estimation is given in table 1. The reported elasticities vary widely, from inelastic to somewhat elastic. Long-run elasticities are usually greater than the corresponding short-run values. This difference may be attributed to the definition of the "long run" as being an interval sufficient to allow for changes in production decisions. The supply elasticities in table 1 have played an important role in the formulation of farm policy. Using, in part, estimates of supply response, legislators develop agricultural policies that, in turn, influence production decisions.

Forestry Stumpage Markets—Unlike agriculture, relatively few studies of supply (or demand) responsiveness have been made in forestry. Most of the econometric models developed have estimated demand and supply in the lumber markets, and few have included stumpage markets. Even published stumpage supply elasticities estimate only the quantity of wood supplied to manufacturing firms at varying prices and times. They do not actually measure the standing supply of timber (inventory) and its response to price, so they can serve only as a proxy for the relationship between stumpage prices and investments in growing timber (planting or timber-stand improvement). Indeed, in the short run, it is conceivable that stumpage price elasticities could remain high while existing inventories were actually being liquidated. The first econometric studies that specifically developed or discussed equations that included stumpage markets were published in 1974. Two research publications (Adams 1974,

Table 1—Empirical supply elasticities for selected agricultural products (from Askari and Cummings 1976)

Crop	Period (years)	Author	Elasticities of supply	
			Short-Run	Long-run
United States				
Wheat	1909–1932	Nerlove	+0.47 to 0.93	—
Barley	1909–1932	Brandow	+1.32	—
Maize	1909–1932	Nerlove	+0.09 to 1.02	—
Lima beans	(1)	Nerlove & Addison	+0.10	+1.70
Snapbeans	(1)	"	+0.15	∞
Peas	(1)	"	+0.31	+4.40
Cabbage	(1)	"	+0.36	+1.20
Carrots	(1)	"	+0.14	+1.00
Cucumbers	(1)	"	+0.29	+2.20
Lettuce	(1)	"	+0.03	+0.16
Kale	(1)	"	+0.20	+0.23
Spinach	(1)	"	+0.20	+4.70
Celery	(1)	"	+0.14	+0.95
Peppers	(1)	"	+0.07	+0.26
Cauliflower	(1)	"	+0.14	+1.10
Beets	(1)	"	+0.13	+1.00
Tomatoes	(1)	"	+0.16	+0.90
Onions	(1)	"	+0.34	+1.00
Soybeans	1946–1966	Houck & Subotnick	+0.84	—
Cotton	1883–1914	De Canio	+0.13 to 0.34	+0.23 to 0.85
Cotton (S.E.)	1905–1932	Brennan	+0.33	—
Cotton (Delta)	1905–1932	"	+0.31	—
Cotton (S.W.)	1905–1932	"	+0.37	—
Cotton	1909–1932	"	+0.20 to 0.67	—
Eggs	1927–1957	Jones	+0.42	+1.35
Milk	1948–1965	Witherell	+0.14 to 0.15	+0.32 to 0.35
Pork	1924–1937	Dean & Heady	−0.46	—
Foreign				
Sisal (Tanzania)	1945–1967	Gwyer	+0.42 to 0.50	+0.24 to 0.42
Tea (India)	1921–1961	Rajagopalan	−0.02 to 0.06	+0.09 to 0.16
Cocoa				
(Cameroons)	1947–1963	Behrman	+0.68	+1.81
(Brazil)	1947–1963	"	+0.53	+0.95

Table 1—Empirical supply elasticities for selected agricultural products (from Askari and Cummings 1976)—*Continued*

Crop	Period (years)	Author	Elasticities of supply	
			Short-Run	Long-run
Rubber				
Malaysia				
(small holders)	1948–1961	Chan	−0.12 to 0.34	—
(estates)	1948–1961	"	0	—
Indonesia				
(small holders)	1949–1964	Behrman	−0.02 to 0.33	+0.03
(estates)	1949–1964	"	0 to 0.05	+0.40

[1]Nerlove and Addison periods began between 1919 and 1929, and all end in 1955.

Robinson 1974) and one literature review (Duerr 1974) examined supply and demand elasticities.

Adams—Adams (1974) developed a quarterly econometric model of forest-products markets in the Douglas-fir region to simulate the response of prices and output to various national forest timber-supply policies. The stumpage sector in the model consisted of sales from the Forest Service, the Bureau of Land Management (BLM), the private sector (integrated forest industry and nonintegrated), and the "other" government sector. The model also included log and secondary-products sectors. Twenty-nine equations and identities were developed for the market model, and model parameters were estimated using a modified form of two-stage least-squares regression.

In the Forest Service and Bureau of Land Management demand relationships, bid prices (a proxy for demand) depended on various combinations of lumber or pulpwood prices, volume sold in the current or prior periods, overbid on sales, or uncut volumes. The Forest Service elasticity of bid price with respect to volume sold (evaluated at sample means) was low (−0.107), indicating that a change in volume offered had little effect on bid price. The BLM elasticity of bid price with respect to volume sold was even less (−0.07).

In using the model to examine national forest policies, Adams found that as the Forest Service offered different volumes of timber for harvest, most price shifts were confined to the stumpage sector with successively smaller price changes at the log and secondary-products levels. As Forest Service cut increased, private timber harvest fell by nearly 60 percent of the increase, so that total regional harvest was only slightly changed over

the sample period. Adams states that "In the usual equilibrium supply–demand framework, the reduction in private harvest would depend heavily on the price elasticity of private stumpage supply. In the present model, this elasticity is effectively zero, with private harvest being most strongly influenced by the rate of secondary product output and the level of log inventories."

Robinson—Robinson (1974) developed an eight-equation econometric model of the markets for Douglas-fir and southern pine stumpage. Robinson writes that factor market theory suggests that the demand for Douglas-fir and southern pine lumber arises in the main from the contributions they make to various forms of building activity. Thus, their demand is derived from the aggregated production functions of individual sawmillers. The supply of lumber is derived from the aggregated production functions of individual sawmillers. Similarly, derived demand for stumpage would be determined by sawmillers' production functions and supply by timberland owners.

For the time period examined, Robinson determined that the demand for southern pine lumber was infinitely elastic. Thus to satisfactorily represent the southern pine sector, only two equations are needed: one for supply of lumber and one for stumpage. Robinson describes his final model as follows:

> The resulting theoretical model consists of eight interdependent relations, one for each of the eight endogenous variables. Six of these relations describe the behavior of the softwood lumber market. The other two relations are definitional. The eight endogenous variables appearing in the model are (1) the quantity of Douglas-fir lumber consumed per dwelling unit, (2) the quantity of Douglas-fir lumber produced domestically, (3) the quantity of Douglas-fir lumber imported, (4) the price of Douglas-fir lumber, (5) the price of Douglas-fir stumpage, (6) the price of southern pine lumber, (7) the price of southern pine stumpage, and (8) the total quantity of Douglas-fir lumber demanded.

Based on the model, Robinson found a price elasticity of demand of -0.14 for Douglas-fir stumpage and -0.52 for southern pine stumpage. The more inelastic Douglas-fir demand implied that producers were less able to adjust their production decisions than southern pine producers in response to changes in the price of stumpage. By considering both quantity and price as endogenous variables, Robinson estimated the short-run price elasticity of southern pine stumpage supply to be 0.32; that of Douglas-fir was 0.11.

He notes that the supply of stumpage usually depends on landowner objectives, which are in large measure insensitive to the price of stumpage. He concludes that

> The impact which accelerated forest management will have on stumpage prices depends upon the price elasticities of demand and supply for Douglas-fir stumpage and upon the actions other landowners take in response to shifts in the stumpage supply from National Forests. The model estimates of the short-run price elasticities of Douglas-fir stumpage demand and supply were both highly inelastic. Hence, if demand remained stable, substantial increases in the stumpage supply from National Forests will tend to force stumpage prices down sharply and reduce the amount cut from private lands, as suggested by Mead (1959). This would in turn increase the supply of Douglas-fir lumber and thereby tend to dampen the impact that the anticipated increase in demand would have on the prices of Douglas-fir lumber.

Duerr—Duerr (1974) also discusses timber supply and prospects, including the effects of price elasticities. He notes that the notion of impending timber scarcity is not unreasonable. From about 1790 to the present, timber has had a consistent long-run upward trend of about 2 percent annually (Hair and Ulrich 1972). The long trend of timber prices includes periods (usually after wars) in which the real stumpage price has risen at a rate of 5 to 10 percent or more, interspersed by calm periods as long as 30 years when the yearly rise averaged less than one-half percent. Essentially, prices rise, reach a plateau, and rise again. The rapid rise in prices reflects a short-term supply crisis: demand outstrips short-term supply, so prices increase to equilibrate the two. Demand pulls cause price increases because short-term plant capacity cannot expand rapidly. However, long-term prices in lumber and stumpage do not decline to former levels. Rather, they stabilize at or slightly below the price peaks.

Duerr continues to describe a theory of timber characteristics that helps explain the supply behavior of this commodity. First, timber is the producing product and the resulting product (wood) as well. To use wood, one must demolish the tree completely, not merely harvest its fruit. Thus, standing timber is essentially a stock (fixed amount) supply during most of its production stage, and keeping it on hand entails very large fixed capital carrying costs. The incentive to carry such capital does not stem from the product price level (though it may come from expectations of change). If prices change, the opportunity cost of carrying capital changes in equal proportion, and no rational supply response is possible.

Thus, the stock supply of timber, which is the dominant form of supply, has essentially no price elasticity (Duerr 1960). Rather, the quantity of timber supplied (investments in timber) is responsive primarily to the firm's guiding rate of return for the long run, not short-run prices. Therefore, Duerr concludes that the short-run supply of timber is inelastic to price. Supply may be more responsive to price in the long run, but trees take a long time to reach marketability. Prices in the future must also be discounted when making investment decisions, so the guiding rate of return again becomes the crucial supply variable.

Duerr cites a study (USDA Forest Service, Division of Forest Economics Research 1963) of the long-run supply of west coast Douglas-fir that found price elasticities of 0.07 to 0.12—approaching absolute inelasticity. Elasticities to the guiding rate of return ranged from −0.7 to 1.1, about 10 times as great as the price elasticities in absolute terms. Duerr also mentions an unpublished Canadian study that found price elasticities of long-run supply that were essentially zero at all guiding rates of return down to about 6 percent. The largest price elasticities ran from 0.02 to 0.12. Based on these studies, he concludes that perhaps the best means for increasing supply would be to "subsidize" the rate of return that guides forest management, not to raise timber values via subsidies. Lastly, he states that

> . . . society can beam price signals at forest owners until everyone concerned is blue in the face, and little will happen except an exchange of money from one set of pockets to another.
>
> That is to say, all our vast consumer efforts over the decades to buy, bid, and wheedle more wood out of our timber factories by offering to pay higher and higher prices for wood and its products have served merely to keep the processing industries afloat and to leave the timber situation about as it would have been anyhow.

Duerr also notes that returns on timber investments are generally not spectacular, with some exceptions in the South and the Pacific Northwest. This, coupled with our European heritage of conserving scarce forest resources, has led to substantial government involvement in supply of forest resources, ranging from outright public ownership to tax incentives to technical assistance.

Adams and Haynes—In 1980, Adams and Haynes published a monograph on the Softwood Timber Assessment Market Model (TAMM). TAMM is

an econometric "spatial model of North American softwood lumber, plywood, and stumpage markets designed to provide long-range projections of price, consumption, and production trends. Six geographic demand regions and nine supply regions (including Canada) are included in the model."

Aggregate derived stumpage demands were estimated in equations having the form below:

$$d_{jt} = k_{jt}^{L} S_{jt}^{L} + k_{jt}^{P} S_{jt}^{P} + k_{jt}(P_{jt}) + MP_{jt} + F_{jt} + LE_{jt}$$

where

d_{jt} = total stumpage demand (million cubic feet, roundwood equivalent), region j, period t;
k_{jt}^{L}, k_{jt}^{P} = product recovery factors for lumber and plywood (cubic feet, log scale/unit product output);
S_{jt}^{L}, S_{jt}^{P} = lumber and plywood output;
$k_{jt}(P_{jt})$ = roundwood requirement for regional pulp output, P_{jt};
MP_{jt}, F_{jt}, LE_{jt} = miscellaneous products, fuelwood, and log exports output (in million cubic feet, roundwood equivalent).

The variables considered for stumpage demand consist of the products for which stumpage is used. Exports, fuelwood, and miscellaneous products are also relevant. Product recovery factors, which vary by region and type of product, are also significant determinants of derived stumpage demand.

Traditional supply and demand relationships cannot explain harvest levels (stumpage supply) on national forests. Harvest levels are based on legislated public policy, not market equilibrium. For the TAMM model, public timber supply equations were determined by (1) identifying future levels of allowable cut; (2) determining historical relations between cut, stumpage price, and inventory; and (3) estimating actual harvest by inserting "base stumpage price" projections in the preceding supply relations. Simulations for the full model used the following methods to determine final harvest levels on national forests:

(a) If stumpage price in period $t - 1$ was greater than in $t - 2$, cut in period t rises along the initial estimated path in (3).

(b) If stumpage price is stable or declining, cut in t is set equal to cut in $t - 1$.

(c) Once cut departs from (always below) the path in (3),

(i) if prices rise from $t - 2$ to $t - 1$, cut increases at the same rate as in (3) but from the actual level in $t - 1$,

(ii) if prices fall, cut declines at the same rate as in (3) from the actual level in $t - 1$,

(iii) if prices are constant, cut is constant.

Adams and Haynes write that private stumpage supply should react to timber prices according to traditional economic theory, providing bases for development of long-term equilibrium models. Rational landowners would select the management regime—and hence future harvest levels—that would maximize the present net worth of stumpage returns. Owners must decide how much timber to grow (or sell) in the short run and how much inventory to accumulate for the long run. Taking this into account, TAMM includes two parts for private supply: "a short-term relation which explains the response of cut to current prices and inventory levels, and a long-term investment process which adjusts the level of management intensity and thereby growth, future inventory, and ultimately cut operating through the short-term relations. The short-term model rests on two simple assumptions, that, other things being equal: (1) private stumpage owners will vary their cut directly with stumpage price; and (2) that private cut will be greater if a greater stock is available from which to draw and less if the stock is reduced. Two alternative functional forms were used to represent supply:

$$s^o_{jt} = z_0 + z_1 P_{jt} + z_2 i^o_{jt} - 1 \tag{18}$$

$$s^o_{jt}/i^o_{jt-1} = z_0 + z_1 P_{jt} \tag{19}$$

where

s^o_{jt} is cut of owner o in region j, time t,
P_{jt} is regional stumpage price in time t, and
i^o_{jt-1} is the start of period inventory.

In (18) z_1 and z_2 are expected to be positive in sign. In (19) z_0 and z_1 should be positive. Both functions yield elasticities of cut with respect to price which are positive and increase as price increases, and elasticities of cut with respect to inventory which are positive and nondecreasing with increases in inventory."

Supply equations estimated by Adams and Haynes are reproduced in table 2, classed by regions (Pacific Northwest, West, Southeast, Northeast) and by private owner class (forest industry or other private). The cut or cut/inventory ratio served as the dependent variable in the equations and price and inventory as independent variables. The calculated price elasticities for forest industry (FI) and other private (OP) are shown in table 3. Several modifications were made by the authors in the initial equations, as explained in the footnotes at the bottom of table 2.

Table 2—Coefficient estimates for forest industry (FI) and other private (OP) stumpage supply equations (from Adams and Haynes 1980)

Region and owner	Dependent variable[1]	Coefficient estimates (t-statistics)			R^2	DW	Method
		Intercept	Price	Inventory			
Pacific Northwest–West (PNWW)							
FI	C/I	0.033566	0.00033467	—	0.75	1.31	2SLS
		(20.8)	(8.49)				
OP	C	−16.6492	0.47360	0.028220	—	—	([2])
Pacific Northwest–East (PNWE)							
FI	C	−60.591	0.79644	0.037292	0.50	1.71	2SLS
		(−1.09)	(4.69)	(2.57)			
OP	C	−11.2606	0.56260	0.012170	—	—	([2])
Pacific Southwest (PSW)							
FI	C/I	0.027820	0.0038150	—	—	—	([3])
OP	C	−32.2491	1.4142	0.02039	—	—	([4])
Rocky Mountain (RM)							
All private	C/I	0.010499	0.000058193	—	0.16	1.09	2SLS
		(29.5)	(2.16)				
South Central (SC)							
FI	C	20.804	5.7905	0.018760	—	—	([5])
OP	C	3.827	7.9112	0.036792	0.77	0.30	2SLS[6]
			(3.36)	(7.67)			
Southeastern (SE)							
FI	C	11.724	3.4564	0.021243	0.88	1.52	2SLS
		(0.46)	(9.35)	(5.60)			
OP	C	14.178	7.9112	0.036792	0.77	0.30	2SLS[6]
			(3.36)	(7.67)			

Table 2—Coefficient estimates for forest industry (FI) and other private (OP) stumpage supply equations (from Adams and Haynes 1980)—*Continued*

Region and owner	Dependent variable[1]	Coefficient estimates (t-statistics)			R^2	DW	Method
		Intercept	Price	Inventory			
North Central (NC)							
FI	C	−7.0397	1.5595	0.005524	0.95	1.80	2SLS[7]
			(4.00)	(5.10)			
OP	C	−24.261	4.0551	0.0066718	—	—	([2])
Northeastern (NE)							
FI	C	31.7183	1.5595	0.005524	0.95	1.80	2SLS[7]
			(4.00)	(5.10)			
OP	C	94.239	4.0551	0.0066718	—	—	([8])

[1] C = cut, C/I = cut–inventory ratio.

[2] Fit with price and inventory terms constrained. Elasticity estimates derived from C/I form were unusable due to negative intercepts.

[3] Fit with price term constrained. Elasticity estimate derived from PNWW-FI.

[4] Fit with price term constrained. Elasticity estimate derived from simple average of PNWW-OP and PNWE-OP.

[5] Fit with price term constrained. Elasticity estimate derived from SE-FI.

[6] Estimates from combined SC-OP, SE-OP equation with intercept dummy.

[7] Estimates from combined NC-FI, NE-FI equation with intercept dummy.

[8] Fit with price and inventory terms constrained using combined NC-OP, NE-OP date and intercept dummy. Elasticity estimates derived from combined SC-OP, SE-OP relation.

Note: R^2 is coefficient of determination unadjusted for degrees of freedom. DW is Durbin–Watson statistic.

Supply functions for nonindustrial private forest owners could be calculated in only the two southern regions. Adams and Haynes explain:

> The positive results in the South probably derive from the heavy dependence of wood and pulp products producers on stumpage from nonindustrial lands and the existence of active markets for nonindustrial timber. In all other regions, however, cut, price, and inventory are poorly or even negatively correlated. In the western regions, for example, it is not uncommon to observe nonindustrial cut declining in historical data while stumpage prices and inventory rise. Unlike their southern counterparts, western products producers have had substantial integrated timber holdings and large harvests available from public lands as substitute timber sources. Markets for nonindustrial

Table 3—Elasticity estimates for forest industry (FI) and other private (OP) stumpage supply, computed at sample period means (from Adams and Haynes 1980)

Region	Owner	Price	Inventory
PNWW	FI	0.26	1.00
	OP	0.06	1.00
PNWE	FI	0.16	1.46
	OP	0.18	1.00
PSW	FI	0.26	1.00
	OP	0.12	1.00
RM	All private	0.06	1.00
SC	FI	0.47	0.41
	OP	0.39	0.66
SE	FI	0.47	0.49
	OP	0.30	0.72
NC	FI	0.99	0.20
	OP	0.31	0.35
NE	FI	0.32	0.37
	OP	0.99	0.28

stumpage have not been well developed. Continuation of these conditions, however, seems unlikely in the future.

The calculated price and inventory elasticities of supply are usually inelastic. Inventory elasticities for the west coast were generally unitary, implying that an increase in inventories would increase cut proportionally. Eastern regions all had inventory elasticities of less than 1, reflecting that inventory increases would cause less than proportional increases in harvest. Cut on other private ownerships in the South was most responsive; cut in northern regions was least responsive.

Price elasticities were all inelastic, and all but two were less than 0.50. Elasticities for other private lands in the West were extremely low, averaging about 0.105. Forest industry response in the West was slightly greater, at an average of 0.18, but still very inelastic. In the East, forest industry averaged a price elasticity of supply of 0.47 in the South and

0.66 in the North. Price elasticity in the "other private owners" category averaged 0.345 in the South and 0.66 in the North. These results confirm that private suppliers do not respond well to price signals, but the supply curves were not as inelastic as suggested by other studies. In addition, these are short-run stumpage supply relations that ignore any linkages between the level of management intensity and timber harvest. Management intensity levels have increased from largely custodial fire protection early in the century to intensive forest management on many lands today. Timber volumes have increased as well, albeit not as much as demand. In a policy simulation of intensified forest management on private lands, large inventory increases and supply shifts to the South were found to be possible based on economic returns to the owners (Brooks 1985).

Implications

Inelastic supply has significant policy implications. First, increased prices will generate only small additional supplies. Similarly, even small shifts in the demand curve will have large price effects. In forestry, these characteristics have translated into two problems. First, real timber prices have increased consistently for decades, even centuries, indicating that price signals do not seem to be increasing supplies (USDA Forest Service 1982, Manthy 1978a). Studies performed after World War II have indicated that supplies respond poorly to price. Responsiveness before the war was probably even more dismal because real prices were considerably less.

Second, as demand increases or decreases with cyclical economic patterns (the demand curve shifts out or back), prices change drastically. A study by Davis (1985) of Georgia stumpage sales found changes in annual sawtimber prices ranging from +71 percent to −44 percent. Milliken and Cubbage (1985) found similar volatility in an analysis of Southwide national forest timber sales, with sawtimber prices ranging from +44 to −23 percent. Pulpwood prices were less volatile but by no means stable.

In brief, supply (and demand) inelasticity makes timber selling and buying a boom-or-bust proposition. Forest landowners and forest-products firms generally agree that such volatility is undesirable. Widely varying returns make planning for forestry investments difficult and probably exacerbate the lack of supply responsiveness. The volatility affects landowner's expectations negatively, causing them to perceive timber investments as risky and less desirable than they actually are. Real price increases indicate scarcity, but they also tend to make timber an attractive long-run investment. However, large price fluctuations may depress

investment below personally and socially optimal levels. They may also attach excessive risk premiums to timber discount rates, which would again adversely affect such long-term investments.

Scarcity

Rising real prices are one indicator of scarcity, and imports are another. Though we possess a large supply of standing timber, the United States is the world's leading importer of timber products. In 1979, we imported 3.7 billion cubic feet of wood. We exported 2.1 billion cubic feet, a substantial increase from 1950 exports of only 0.1 billion cubic feet. We are a net importer of lumber and pulp products and a net exporter of other wood products (primarily logs). The United States has usually been a net importer based on value of wood products as well, with a $2.3 billion deficit in 1979 (USDA Forest Service 1982). Further real price increases for U.S. timber would continue to reduce our comparative advantage in timber production and exacerbate the already negative balance of payments.

Real price increases and net imports indicate economic scarcity of desirable wood supplies. For decades, forest survey data have indicated increased timber supplies for both softwoods and hardwoods. Hardwood growth continues to outpace supply by a large margin. In some areas, however, southern pine supplies are dwindling for the first time in decades. If this trend continues, we can expect significant real price increases for stumpage, lumber, and perhaps pulp and paper.

The USDA Forest Service (1982) discusses some of the social, economic, and environmental effects of rising timber prices. From an economic point of view, the greatest cost of rising relative prices will be borne by consumers, particularly home buyers. Effects for forest landowners with timber would be desirable: they would receive greater stumpage prices. Effects on the industry would be less beneficial. Greater costs would force out of business less efficient firms or firms remote from low-priced supplies. Reduced production would, of course, lead to less local employment and could lead to loss of competitive advantages and an increasing balance-of-trade deficit with other countries. Substitution of nonrenewable for renewable resources could also have a negative impact on the environment through increased mining and its side effects. Energy costs might also increase with the substitution of some extractive industries for forest industries.

In the abstract world of neoclassical economics, individuals will voluntarily exchange goods and services in the marketplace, prices will equilibrate supply and demand, and social welfare will axiomatically be maximized. Markets will be characterized by atomistic competition with many producers and consumers, perfect knowledge by both groups, complete and exclusive property rights (no unpriced values or externalities), and no transaction costs. Equity would not be a concern since the market would reward individual consumers and producers according to their talents and efforts, and the altruism of the wealthy would provide food, shelter, and clothing for the less fortunate.

In the real world, this fantasy degenerates, and perhaps even more in the forestry sector than in other manufacturing or service sectors. In fact, criticizing the application of neoclassical economic theory in forestry seems to be attacking a straw man. But nevertheless, critics of government programs charge that they are even less efficient than imperfect markets. They propose dismantling public programs and allowing free markets to allocate (Dowdle 1984, Hanke 1984, Stroup and Baden 1983, Vardaman 1970, Walker 1983). Indeed, they raise many issues that could increase efficiency of public programs and should be adopted. Their ideology seems to overlook all market flaws, however, and they often seem overly optimistic that corporate bureaucracies are more efficient than government bureaucracies (Leman 1984). Given that there is public involvement in forestry, this section will review the types of broad public programs.

Laissez-Faire

Simply allowing free markets to allocate resources is one means of implementing forest policy. This laissez-faire approach implicitly assumes that markets are best for allocating resources, or at least that they are superior to other alternatives. Modern-day advocates for laissez-faire stipulate that property rights—rights of use and exclusion—must be clearly defined for effective market allocation (Stroup and Baden 1983). For the first century after the signing of the Constitution, the United States loosely observed laissez-faire, transferring farm and forest lands to private individuals, who then used them as they deemed best. In addition, a large amount of forest land in the Lake States and the South was owned by the Federal Government but actually held as a common-pool good. Most timber was cut on these public lands around the end of the 19th and beginning of the 20th century.

Government Ownership

The free-market policies followed in the 1800's led to massive harvesting of America's virgin timber. In the case of farms, timber was seen primarily as an impediment to the plow and used, cleared, or burned if possible. In the South and the Lake States, most areas of virgin timber were cut and left as timber companies began to move to the West. However, by the mid- to late 1800's, perceptions of unlimited supplies of timber began to change. Fears of imminent timber shortages and the widespread forest devastation allowed by laissez-faire led to radical proposals for setting aside Federal forest reserves. The Creative Act of 1891, which was passed by Congress after being attached as a rider (Section 24) to the general land laws bill in conference committee, first authorized the President to set aside forest reserves from the public domain (Dana and Fairfax 1980). This precedent-setting policy implemented a new direction for Federal forest policy—the purposeful public ownership and operation of forest land.

After passage of the bill, Presidents Harrison and Cleveland set aside 38.8 million acres of public lands in the West. By the time Theodore Roosevelt became President, about 40 million acres had been reserved. In the next 7 years, Roosevelt reserved about another 90 million acres before signing legislation that rescinded presidental authority to do so. But this did not end the era of public ownership. Massive forest fires and floods prompted acute concern about forest land management in the East as well as the West and led to passage of the Weeks Act of 1914. The Weeks Act authorized government purchase of private forest land for national forests in the East for watershed protection purposes, along the headwaters of navigable streams (i.e., in the mountains). The Clarke–McNary Act of 1924 amended the Weeks law to allow purchase of forest lands for timber production purposes in the remaining land area in the East. Purchases were never extensive, but about 25 million more acres of land were acquired, in scattered tracts throughout the States east of the Mississippi. Weeks law purchase authority still exists, but few funds have been available in recent years.

Forest Regulation

Problems that led to establishment of the national forests also created calls for public regulation of private forest land. Gifford Pinchot, cohort of Theodore Roosevelt, founder of the Society of American Foresters, and first Chief of the Forest Service, championed a drive to enact Federal regulation of all private forest landowners. In 1919, the Committee

for the Application of Forestry (chaired by Pinchot) and the Society of American Foresters both called for Federal regulation of timber cutting on private lands. With characteristic zeal, Pinchot (1919) stated that the need for governmental control of private timberlands was self-evident:

> The field is cleared for action and the lines are plainly drawn. He who is not for forestry is against it. The choice lies between the conscience of the lumberman and the public good.

Legislation providing for Federal regulation was introduced into Congress based on the recommendation of the committee. However, opponents of Federal control introduced similar legislation calling for State forest-practice laws with Federal assistance. Pinchot opposed the State-oriented bill, forcing a stalemate. Eventually, the efforts initiated in the 1920's led to passage of the Clarke–McNary Act of 1924. Rather than regulation, Clarke–McNary stressed Federal–State cooperation in education, fire control, and seedling production—the precursor of many such cooperative efforts in forest resources.

The regulation issue at the national level faded temporarily during the late 1920's and early 1930's. However, national drives for regulation began anew in the late 1930's. While legislative efforts were unsuccessful at the national level, about 15 States enacted seed-tree or State forest-practice laws that regulated private forest landowners to some extent. Many were strictly exhortative in nature, relying only on voluntary compliance. The three west coast laws were relatively strict, however, even by modern standards. In general, these laws required that harvest sites be regenerated adequately with desirable forest species in order to ensure productivity for future generations. Many of these forest-practice laws were revised and strengthened considerably in the 1970's, primarily to prevent negative externalities (pollution) from harming air or water resources.

Public Assistance

The Clarke–McNary Act initiated the approach to implementing public policy for forest resources that has remained most important to this day: public guidance and assistance to private forest landowners. Rather than free markets, Federal ownership, or public regulation, many policymakers agreed that public guidance, education, and subsidies to private landowners would most effectively promote optimal production of forest resources in the face of imperfect markets. Based on this premise, a

plethora of State and Federal programs has been initiated. The remainder of this paper will discuss these programs in detail.

Agricultural Assistance Programs

In the period from 1933 to 1955, five types of Federal agricultural assistance programs were created. According to Frischknecht (1953), the first category of assistance programs concerns direct payments to farmers, which began with the Agricultural Adjustment Act of 1933. Plummeting prices of the mid-1930's were due in part to surplus production; therefore, this legislation was designed to reduce planted acreages through direct-payment subsidies. This Act was superseded by the Soil Conservation Act of 1936. It extended the previous program to include all agricultural commodities. Soil-conservation payments were made for both reductions in acreages planted and for implementation of soil-building cultivation practices. The Agricultural Adjustment Act of 1938 continued the policies of the SCS Act of 1936. Subsequent legislation limited the amount any producer could receive under these programs to $10,000. Additionally, each of these Acts included some provision for parity payments on basic commodities.

Frischknecht lists commodities purchase programs as the second category of Federal agricultural subsidies. The earliest purchases were made under provisions listed in the Agricultural Adjustment Act of 1933 with the Commodity Credit Corporation (CCC) functioning as the purchasing agent. The commodities purchased were distributed to the general public through the Federal Emergency Relief Administration. Through the late 1930's and early 1940's the CCC gradually expanded its role as a purchasing agent to include nonbasic commodities such as tobacco. The Steagall Amendment of 1941 extended the life of the CCC to 1943 and authorized price supports at 90 percent of parity for 14 agricultural commodities until 1948.

The third category of Federal assistance programs are those involving the use of the CCC to provide price-supporting commodity loans to farmers. Under this program the farmer is given the option of repaying his loan plus interest at any time. If market price was less than the amount of the loan at the maturity date, the farmer could give his crop to the CCC as reimbursement for the loan. This program was extended in 1938 to provide price support for farmers who retired land under other programs but were still victims of surpluses resulting from improved technology and intensified management. The Steagall Amendment of 1941 broadened the range of commodities covered by this program.

A fourth method of Federal assistance, purchase-agreement programs, was very similar to the commodities loan programs. Under this program, the Commodity Credit Corporation contracted to purchase commodities in any quantity the producer elected to deliver. The producer was not obligated to sell his or her products to the CCC but was guaranteed a market for the crop. This type of program was not used until 1948, though it was authorized by the Steagall Amendment of 1941.

A fifth method of agricultural assistance categorized by Frischknecht includes market quota programs. As suggested by their name, market quotas limit the amount of a commodity that can be sold in a given year. This type of program originated in the early 1930's as an emergency support program for nonbasic commodities such as tobacco and cotton. The Agricultural Adjustment Act of 1938 extended marketing quota programs to many basic commodities, including corn, wheat, and rice. In the early 1940's marketing quotas were used in conjunction with acreage allotments in an attempt to prevent surplus production.

Problems in forestry have differed from those in agriculture. Agriculture programs are designed to maintain minimum price levels in the face of excess supply, which is indicated by declining real prices for agricultural products. Resource scarcity has been the principal concern in forestry. It has been indicated by increasing real timber prices for decades.

In general, prices for other wood-fiber resources have not increased or decreased at real rates. However, based on timber scarcity and regional supply and demand imbalances, public programs to augment timber supplies have been the focus for the last century. Compared to the results from a half century of costly agricultural attempts to limit production and guarantee farm income, forestry appears to be in an enviable position. Fears of inadequate supplies dominate discussions and program directions, and market processes generally set price levels and determine landowner incomes. Additionally, program funding levels have been quite modest compared to those of agricultural support programs.

The preceding discussion outlines the rationale for public intervention in free-market economies. The remainder of this report will review the public programs that have been or could be developed to assist private forest landowners.

Skok and Gregersen (1975) divide public approaches to motivate American nonindustrial timber production into two broad classes (table 4). The

Table 4—Principal public incentive programs for private forestry in the United States (adapted from Skok and Gregersen 1975)

Category	*Comments*
Taxation (exemption, remission, or deferred payment of taxes)	
1. Capital gains treatment for timber	1. Of greatest importance to industrial ownerships—complex procedures reduce interest of many small private forest landowners.
2. Reforestation investment credits in 1980	2. Initiated by the Packwood Amendment.
3. Yield taxes	3. Declining in acceptance.
4. Modified property tax laws (current use valuation, modified assessment rate)	4. Now adopted by almost every State in Nation.
5. Tax exemptions and rebate laws	5. Limited effectiveness and applications.
Financial assistance (subsidies for production through cost-sharing, provision of material, etc.)	
1. Agricultural Conservation Program (ACP)	1. General agricultural conservation program that includes timber and wildlife components.
2. Forestry Incentives Program (FIP)	2. Forest timber-production program with cost-sharing for planting and management practices.
3. State incentives programs	3. Publicly and/or privately funded programs with cost-sharing for mostly timber and some wildlife production and management practices.
4. Soil Bank Program	4. Conservation program from 1956 to 1960 that converted erosive farmland to permanent grass or tree cover, with annual payments to participating owners.

Table 4—Principal public incentive programs for private forestry in the United States (adapted from Skok and Gregersen 1975)—*Continued*

Category	*Comments*
5. FHA loans	5. Low-interest, long-term loans; very limited availability for forestry.
6. Low-cost seedlings	6. Grown by State nurseries with some Federal financial support.
Technical assistance (on-the-ground advice, extension programs)	
1. State technical assistance programs (and SCS soil conservationists)	1. Provide on-the-ground advice to forest landowners, with some Federal funding and support from State and Private Forestry, USDA Forest Service.
2. State extension programs	2. Provide educational programs, field demonstrations; disseminate research results.
Indirect (government research, training, marketing information etc.)	
1. State fish and wildlife agencies	1. Administer game management laws, provide wildlife habitat and management advice, support from U.S. Fish and Wildlife Service.
2. USDA Forest Service, State, and university applied research programs	2. Research on basic and applied forestry resources topics of value to private owners.
3. Public cooperative forest-protection programs such as Clarke–McNary Act, Forest Pest Control Act	3. Necessary since fire, insects, and disease spread across ownership boundaries and present large risks.
4. Production and marketing cooperatives	4. Limited use and success to date.
5. State income-tax checkoff systems	5. Provide State taxpayers opportunity to designate portion of tax refund for nongame wildlife management.

direct incentive approach provides identifiable monetary benefits to forest landowners who perform certain forest practices. Indirect approaches provide forest landowners with programs such as forest research or fire protection that are subsidized with government funds.

Skok and Gregersen also note that although most of these programs are based on the premise of divergent social and market values, efficiency is

still important. At the very least, public programs should be socially desirable, with the social benefits exceeding the social costs. The following review of programs will examine the history and efficiency of each and then express our conclusions regarding their relative effectiveness.

Taxation

Tax benefits received by forest landowners include the exemption, remission, or deferred payment of taxes. Tax policy has been an important concern in forestry for over a century, and was even identified as needing study in the 1924 Clarke–McNary Act. Capital gains treatment of timber, investment credits, yield taxes, and modified property tax laws are the principal tax treatments that affect timber production. The tax exemptions and rebate laws tried by some States have been of rather limited effectiveness (Skok and Gregersen 1975).

Income Taxes

Capital Gains—In 1943, Congress passed legislation over President Roosevelt's veto that allowed timber-growing income to be treated as capital gains for tax purposes. Prior to that time, only individuals who were not in the business of growing timber and who made infrequent sales could claim capital gains. The 1943 legislation, which went into effect in 1944, extended this treatment to individuals and corporations engaged in the business of growing timber. Based on this legislation, for both corporate and personal income taxes, revenue from timber sales was taxed as capital gains under Section 631 of the Internal Revenue Service (IRS) Code. Thus, only 40 percent of the net income received from selling timber—after deducting unamortized growing expenses and timber sale costs—was taxed at the individual's marginal tax rate. Corporations were taxed at the alternate 28 percent rate on capital gains income if it is less than the ordinary rate. Forest landowners took advantage of capital gains treatment when filing their personal income tax forms for the year in which payment was received. This treatment usually also applies to State personal income taxes (Siegel 1978).

The rationale for capital gains treatment of timber is based on the fact that timber is a long-term investment. As such, it should receive the same tax benefits as other long-term investments such as stocks. Additionally, the treatment of income as capital gains allows both corporate and noncorporate owners who invest in timber growing to be treated equally. It was also passed with the specific intent of encouraging reforestation of timber by preventing an excessive tax that would occur if the

tax were levied on an annual income basis. Capital gains treatment of the income gives societal support to overcome the short-sightedness of private owners, reducing any intertemporal externalities (Dennis 1985). In addition, it helps offset any nominal increases in value that are caused only by inflation of assets held for long time periods. The extension to corporate ownership, however, was unusual. Other industrial sectors did not receive capital gains tax treatment of income from the sales of any other product.

Despite the 40-year history of capital gains treatment of timber profits, very few empirical studies have been performed that measure the actual effects of the policy. Indeed, for nonindustrial private forest owners, it is difficult even to estimate the number of people using capital gains, let alone its effects on timber supplies. The capital gains provisions are complex, so forest industry has probably taken more advantage of the laws than have nonindustrial private owners (Skok and Gregersen 1975). The forest-products industry has been a vocal supporter of capital gains since its passage. Legislators have continually threatened to modify or eliminate capital gains provisions for timber (including in the Reagan administration), along with all other forms of capital gains treatment. Several Congressmen have also been vocal critics of capital gains treatment for the industry, calling it the least defensible tax subsidy on the books. The U.S. Treasury has estimated that capital gains treatment costs at least $0.5 billion per year, with most gains accruing to forest-products companies.

In a theoretical study of capital gains taxation of timber, Dennis (1985) concluded that capital gains was preferable to ordinary income taxation according to efficiency and equity criteria. Social welfare implications and impact on timber supply also favored such treatment.

In one empirical study on the effects of corporate income taxation in the forest industry, Singleton (1983) found that the investment tax credit had the most significant stimulative impact on investment expenditures, creating a bias to short-lived assets. Capital gains tax provisions also had some stimulative effect on investment expenditures, favoring the appreciating asset case. He found that the 1979 corporate tax rate decrease had little measurable effect in stimulating investment. Capital gains did reduce the effective tax rate of timber income. Singleton concluded, however, that "timber is not taxed at excessive rates relative to other assets, nor would it be in the absence of capital gains provisions. In addition, taxing accrued timber income would not result in industry effective tax rates exceeding statutorily prescribed levels."

The tax reform act of 1986 eliminated Federal preferential capital gains tax treatment for income from all assets, including timber. Thus, one would expect less investment in timber growing because of its loss of favorable income tax status compared to other assets. Some people believe that capital gains treatment of timber income may be reinstated in 1988 or later.

Reforestation Investment Credits—In 1980 the reforestation tax incentive provision, or the Packwood Amendment, was enacted to allow forest landowners to receive credits on their income taxes for timberland investments. The amendment was attached as a rider to the Recreational Boating and Facilities Improvement Safety Act of 1980, as Title III. Under the amendment, private landowners may receive both Federal tax credits and deductions on their income tax for planting trees. The legislation allows a 10-percent investment credit plus an amortized deduction for annual reforestation expenses up to $10,000 per year. With site-preparation and planting costs ranging between $100 and $200 per acre, this means that only 50 to 100 acres would qualify per year. Thus the investment credit cannot exceed $1,000 annually. The amortized deduction requires that 1/14 of the investment be deducted in the first year, 1/7 in the second through seventh years, and 1/14 in the eighth year.

The Tax Equity and Fiscal Responsibility Act of 1982 (TEFRA) altered the IRS rules for all such credits and deductions, including reforestation. If landowners elect to take the full 10-percent investment tax credit, they can claim only 95 percent of the previously allowed deductions in the 8 years. Alternately, they may choose to claim only an 8-percent investment tax credit in the initial year but receive the full deductions over 8 tax years. As long as landowners have taxes due that exceed the amount of 10-percent credit, it is usually advantageous to elect the credit and have slightly reduced deductions. Unlike capital gains, reforestation tax incentives were retained in the 1986 tax reform legislation.

Few evaluations of the effectiveness of the new reforestation tax incentives law have been made. Dennis (1983) found that it had very favorable impacts on investments by nonindustrial private forest landowners. For landowners in the 40-percent tax bracket, average loblolly pine investment rates of return increased from 6.9 to 8.4 percent. Douglas-fir investments increased from 7.3 to 8.2 percent.

Property Taxes—Property taxes have always been an important issue in forest policy in the United States. In fact, the effects of property taxes were the first forest policies that received legislative attention. Property

taxes are levied at the State or local level, so naturally, such tax legislation has been enacted by the State, not Federal, Governments. Most State tax policies were designed to encourage reforestation and conservation of forests. Meeks (1982) concluded that tax legislation is the most extensive method used by the States to encourage management of nonindustrial private forests.

Hickman (1982) summarized the current status of forest property tax laws in the United States. First, he described the types of special forest property tax laws:

> Special forest tax laws can be grouped into three classes: (1) exemptions and rebates, (2) yield taxes, and (3) modified property taxes. Statutes in the last group are themselves of three types—deferred payment laws, modified rate laws, and modified assessment laws. A fourth class of special forest tax—the severance tax—will not be considered because it is not a substitute for the general property tax, but is imposed in addition to it.
>
> *Exemption laws* provide for removal of forest land and/or timber from the property tax rolls, either permanently or for some specified number of years. A timber exemption may apply to all standing timber, planted stands, immature stands, trees of a particular species, or trees retained for specific purposes, such as reforestation or windbreaks.
>
> *Rebate laws* provide that landowners who engage in some approved activity, such as tree planting, may subsequently apply for abatement (i.e., refund) of a portion of the taxes levied on the value of their land, timber, or both. The rebates generally continue for only a limited period of time, and may be given as a direct cash payment or a reduction from the total amount of taxes owed.
>
> *Yield tax laws* provide for a conceptual separation of land and timber values. Land values normally remain subject to the annual property tax, although sometimes in modified form. Timber values go untaxed until the time of harvest. At this juncture a gross income tax, equal to some percentage of the stumpage value of the products cut, is imposed.
>
> *Deferred payment laws* provide that annual taxes on forest land and timber are to be determined as for other classes of

property, but that some portion of each year's tax is to be postponed until the time of timber harvest.

Modified rate laws provide that forest land and timber are to be assessed like other forms of property, but that a different tax rate, lower than otherwise applicable, is to be used in computing the tax.

Finally, *modified assessment laws* provide that forest properties are to be valued differently from other forms of property. If fair market value in highest and best use is retained as the basic valuation standard, forest assessments may be frozen or calculated using a reduced assessment ratio. Alternatively, fair market value may be abandoned in favor of another valuation standard such as current use value.

Exemption laws were the earliest form of tax relief enacted, beginning in the Great Plains (Nebraska, 1861) and spreading to the Northeast (1872–78). During the 1940's, 15 States had such legislation. Now, only 10 States have these laws, partially because of their limited effectiveness (Williams 1961), and equity criteria which suggest that all property owners should pay a fair share. Only two States enacted rebate laws (Pennsylvania in 1887 and New Hampshire in 1903). Beginning in 1910, exemptions and rebates began to be supplemented by yield tax laws. Yield taxes were designed to ensure local revenues yet defer the taxes until the time that forest properties produced income. Modified property tax laws are now the most common form of special property taxes for forest and agricultural lands. Details of each of these laws on a State-by-State basis are reported in Hickman (1982); only a brief summary is contained here.

Exemptions and Rebates—In 1982, 11 States offered a total of 10 exemption laws and 1 rebate law. About two-thirds are mandatory and one-third are optional. Exemption tax treatment varies from complete exemptions for all standing timber (Alabama, North Carolina, Tennessee) to exemption of planted timber or young growth, to exemptions for up to 15 to 30 years.

Yield Taxes—Counties and municipalities in most States levy annual ad valorem taxes on both forest land and standing timber in order to obtain revenue for local schools and services. In many States, young growth timber is taxed at rates less than mature timber. Two reasons make this a disincentive to long-term investments in timber growing. First, annual taxing of a timber crop that generates yields only at harvest favors short

rotations in order to pay the ad valorem taxes. These rotations may be less than optimal. Second, taxing mature growth at rates greater than young growth favors timber liquidation. Owners would clearly prefer to cut timber soon after it is classed as mature, despite biological and perhaps economic advantages in holding timber until it reaches larger size classes.

Hickman's survey found that 10 States had yield tax laws and 4 had "severance" taxes that were actually yield taxes. These laws tax forest land on an annual basis and forest timber only at the time of harvest. Accordingly, when timber is sold, forest landowners must notify the local tax assessors and pay taxes on the value of the sale. This arrangement should not penalize landowners for holding timber as it matures. Timber owners in aggregate pay as much yield tax as they would pay general ad valorem tax. However, tax incidence varies among individual owners. Yield taxes favor those who do not cut timber (i.e., those who hold forest land for amenity values) and those who have a small ratio of cut to mature timber inventory. For any owner operating on a sustained yield basis, it would make no difference which form of tax applied (Vaux 1983).

Vaux concludes that California intervention in the field of forest taxation provided a significant shield for forest owners against the epidemic of tax reversions that hit the private forest economy between 1925 and 1935. A 1926 California constitutional amendment exempted all young or planted timber from taxation until it reached maturity. Mature timber was taxed on an annual basis, but Vaux still believes that even the temporary (40 years or more) protection against annual taxation on young growth was helpful. He wrote that aggregate reversions in California between 1911 and 1933 amounted to only 2.1 percent of the area involved in the Northern Sierra Nevada. In contrast, up to 20 percent of the forest area in northern Minnesota and 13.5 percent of forested land in timbered counties of Washington and Oregon had reverted to the States (Fairchild and Associates 1955).

Modified Property Taxes—Ad valorem taxes have traditionally been assessed and taxed on the basis of the highest and best use for a piece of property. This policy tends to force lands into their most valuable uses in order to pay their tax burden. Taxing farm or forest land on the basis of subdivision values will force conversion, no matter what the landowner's desires may be. Because productive agricultural and forest lands are scarce, the wisdom of forced conversion to urban uses has been questioned.

In response, most State legislatures have recently enacted use-value taxation or preferential property-tax assessment-rate laws that allow nonindustrial agricultural and forest landowners to receive reduced property-tax rates. Under these laws, qualifying landowners must agree to keep their land in agricultural or forest uses. Each must file with the local tax assessor to receive preferential treatment. If they meet State and local requirements, their land is taxed at its current use or at a reduced rate. Most of these laws have restrictions and penalties for landowners who withdraw from the programs or make conversions without prior notice. Restrictions sometimes apply for up to 10 years. Otherwise, the programs could merely serve as a tax dodge, with no penalties for switching lands into high-value uses.

Hickman (1982) also surveyed use-value (modified assessment) and modified rate laws in the United States. At that time, 38 States had a total of 43 modified assessment and 5 modified rate statutes. Since then, Georgia has also established a modified rate law. Nearly one-third of the existing laws are mandatory; two-thirds are optional. States with optional laws impose a variety of eligibility constraints (Hickman 1982):

> The most common, employed in 29 statutes, is based on tract size. The second most common, used in 10 statutes, pertains to the minimum number of years a property must have been in forest use before the owner can seek classification. Other constraints, in order of decreasing frequency of use, are based on: (1) income from past timber sales, (2) the existence of an approved timber management plan, (3) the question of whether or not an area has been "zoned" as forest land, (4) the level of stocking, and (5) the length of property ownership.

Financial Assistance

Nonindustrial private forest landowners may also receive a variety of direct financial incentives, again primarily for timber-growing purposes. These range from Federal and State cost-sharing programs to loans to low-cost seedlings.

Agricultural Conservation Program—As its name implies, the Agricultural Conservation Program (ACP) is a general farm program designed to promote resource-conserving practices on farms. ACP began during the Depression as part of the Soil Conservation and Domestic Allotment Act of 1936 and has been maintained in various forms to the present. ACP is designed to encourage farm conservation practices, including tree plant-

ing, timber stand improvement, and wildlife habitat improvement. Landowners performing these or other conservation practices may receive partial reimbursements called cost-share payments through the county office of the Agricultural Stabilization and Conservation Service. ACP was designed to be primarily a conservation program, and as such differs from the timber-production orientation of most direct forestry programs.

Manthy (1970) performed an evaluation of the tree planting and timber-stand improvement components of the ACP program in conjunction with the provision of Cooperative Forest Management (CFM) assistance to forest landowners. He found that the cost-share payments made returns to private landowners generally quite attractive. Manthy calculated the returns to public investments in CFM and ACP programs compared to the value of stumpage available in harvest. Private investment returns were computed as returns to the landowner, assuming no opportunity costs for land. Total investment costs were the sum of public and private costs compared with the value of future yields. He found that on good and medium sites, internal rates of return for planting usually exceeded 6 percent (classes I and II) for public and total investment stances and were greater than 10 percent for private investors. Cleaning and liberation returns ranged from 4 to 7 percent for public investors and 7 to 10 percent for private investors on site classes I and II. Thinning of cove hardwoods and northern hardwoods on site I and II lands offered the greatest public and private returns (9 to 10 percent) but had negative returns on low site-class lands.

As expected, the financial desirability of alternative practices varied with the productivity of the forest site. Thus, Manthy suggested that program efficiency would be increased by concentrating on practices and sites that yield high returns. Low returns were generated from timber-stand improvement of less than 10 acres or planting two or more species on 6 acres or less. Planting softwoods, particularly larch and spruce, in areas with primarily hardwood markets was also not recommended as a desirable practice.

Skok and Gregersen (1975) reported on a study of the REAP (ACP) program in 1972 in Minnesota that also generally had acceptable program benefit–cost ratios. But the study found that 70 percent of the participants would have planted the same amount of land with less REAP funding. Once planted, ACP lands have remained in timber production, with only 5 percent being found to change to other uses (Kurtz et al. 1980).

Forestry funding and acreage treated under the ACP program was rather limited. Table 5 summarizes ACP program accomplishments from 1977

Table 5—Funding of forestry practices through the Agricultural Conservation Program, 1960–83 (from Skok and Gregersen 1975 and USDA Agricultural Stabilization and Conservation Service, Agricultural Conservation Program fiscal year statistical summaries)

	Reforestation			Timber-stand improvement		
Year	Dollars (millions)	Pct. of total ACP funds	Acres (thousands)	Dollars (millions)	Pct. of total ACP funds	Acres (thousands)
1960	3.9	2.0	339	2.0	1.0	256
1961	3.9	1.9	319	2.2	1.0	256
1963	3.0	1.6	203	1.7	0.9	183
1964	2.8	1.4	187	1.6	0.8	158
1966	2.7	1.4	181	1.6	0.8	210
1967	2.8	1.4	174	1.9	0.9	220
1968	2.5	1.4	148	1.5	0.8	169
1969	2.3	1.4	129	1.4	0.8	154
1970	2.4	1.4	[1]	1.4	0.8	[1]
1971	3.0	2.0	[1]	1.8	1.2	[1]
1972	6.8	3.6	[1]	2.5	1.4	[1]
1973	2.3	1.1	[1]	1.0	0.5	[1]
1974	1.5	1.9	[1]	1.1	1.5	[1]
1975	1.5	1.1	[1]	1.1	0.8	[1]
1976	0.7	0.6	[1]	0.5	0.4	[1]
1977	1.9	0.8	33	0.9	0.6	43
1978	1.4	0.7	32	0.9	0.5	43
1979	2.1	0.9	47	1.2	0.5	66
1980	2.6	1.5	49	1.5	0.9	62
1981	3.3	1.8	53	1.7	0.9	75
1982	3.4	2.2	55	1.4	0.9	55
1983	3.8	2.2	66	1.2	0.7	38

[1] Data could not be obtained.

through 1983. Until the 1980's, less than $3 million per year was spent on planting trees and shrubs, or about 1 to 2 percent of the annual ACP funds. ACP timber-stand improvement funds decreased steadily from $2.0 million in 1960 to about $1.5 million in the seventies and eighties. With constant nominal dollar appropriations, acreage treated for both practices declined significantly from the 1960's. Concern that future wood supply would be inadequate spurred interest in separate forestry programs.

Forestry Incentives Program—ACP funds for tree planting and timber-stand improvement dwindled in the 1960's because of increasing competition for the available funds and the reluctance of ASCS county boards oriented to farm management to approve forestry practices. Faced with needs for a better funding base, forestry interest groups successfully lobbied Congress for a separate cost-share program for forestry practices. In 1973, Congress enacted the Forestry Incentives Program (FIP) attached as a rider (Title X) to the Agriculture and Consumer Protection Act of 1973 (Dana and Fairfax 1980).

Program Components—FIP authorizes cost-share payments for reforestation and timber-stand improvement, site preparation for natural regeneration, and firebreak construction. ASCS is charged with program administration, and the Forest Service is responsible for forestry technical assistance. State forestry agencies provide the assistance via cooperative agreements with the Forest Service. State service foresters must approve the plans before practices can be performed, and the county ASCS committee must decide which of the many applicants will receive funding. Service foresters must also approve performance of the practice before payment is made.

The Federal cost-share rate is commonly 50 percent in the South and ranges up to 65 percent. It is determined by the State ASCS committee. Cost-share funds under FIP are allocated to counties by State ASCS committees, in consultation with each State forester. In allocating funds, the committees follow the criteria the U.S. Department of Agriculture uses to allocate funds to States. These include acreage of commercial forest land and number of nonindustrial private forest landowners; potential productivity of this forest land; and need for reforestation, timber-stand improvement, and other practices. Consideration is also given to availability of vendor services for tree planting, site preparation and timber-stand improvement work; use of cost-sharing funds for forestry in the past; existence of forest landowner associations; and high-priority factors in local areas such as an adverse growth–drain ratio (Forest Farmer 1985).

Nonindustrial private forest landowners may receive FIP cost-share funds. Individuals, groups, associations, or corporations whose stocks are not publicly traded are eligible. However, they cannot be primarily engaged in the business of manufacturing forest products or providing public utility services. Tract sizes must be 10 acres or more to qualify. After an early evaluation of the program, minimum treatment size was established and the maximum forest land ownership size was raised from

500 to 1,000 acres. Exceptions for ownerships of up to 5,000 acres may be granted by the Secretary of Agriculture. Land must also be classed as commercial timberland—able to grow 50 cubic feet of wood per acre per year. No landowner may receive more than $10,000 in total cost-share funds during 1 program year (Risbrudt and Ellefson 1983).

Though the FIP program was authorized to spend $25 million per year, annual appropriations have ranged from $10 million to $15 million (Risbrudt and Ellefson 1983). About 75 percent of the program funds are spent in the South. Currently, over 200,000 acres are treated each year under FIP (table 6). This is substantially more than current ACP treatment levels but somewhat less than ACP in the early 1960's.

Program Efficiency—Several studies have examined the efficiency of FIP. In an evaluation of the initial 1974 program, Mills (1976) and Mills and Cain (1978, 1979) analyzed private landowner and program returns. Most investments had satisfactory returns, with an average financial return of 10.2 percent, but a few problem areas were identified. Many of the small treated tracts were unlikely to yield satisfactory returns. Additionally, returns from timber-stand improvement in oak–hickory stand types were generally dismal. Based on these findings, minimum treatment size and recommended site-quality requirements were adopted in subsequent years.

Table 6—FIP accomplishments and funding, 1974–84 (from Risbrudt 1985)

Year	Acres treated			Funding	
	Total	Reforestation	Timber-stand improvement	Cost-shares paid	Cost-shares allocated
	(thousands)			*(millions of dollars)*	
1974	293	168	125	9.1	10.0
1975–76[1]	275	108	168	8.1	30.75
1977	307	153	155	10.3	13.5
1978	323	169	154	12.0	13.5
1979	329	212	117	14.5	13.5
1980	342	219	123	16.8	13.5
1981	314	211	103	17.8	11.25
1982	240	155	74	12.2	11.25
1983	205	143	58	10.2	11.25
1984	187	145	36	8.9	11.25

[1] Includes the short 1975 year when funds were received late, the full FY 1976, and the transition quarter when the beginning of the FY was changed from July to October.

A national update of Mills' study found that program efficiency had improved (Risbrudt and Ellefson 1983, Risbrudt et al. 1983a). Average treatment size increased considerably from the initial years, and practices on lower site-quality lands had been curtailed. The update also found favorable program returns, and the authors concluded that the 1979 program would eventually result in an additional 1.3 billion cubic feet of timber over the first rotation compared to that generated by current management intensities. Of this additional volume, 93 percent is in softwoods. Investments made by the Federal Government and landowners were found to return about 8.6 percent above inflation. Also, the present value of Federal tax dollars generated by the program would exceed program costs. Another study has found that 94 percent of the acreage established in trees under FIP was retained after the first 5 years (Risbrudt et al. 1983b). In a recent econometric study, Brooks (1985) found that financial incentive programs can increase plantings and softwood timber supplies, thus decreasing prices.

Capital Substitution—In sum, it seems that the FIP program has been efficient—its social (and private) benefits exceed its social costs. But is it necessary? Might landowners plant trees or perform timber-stand improvement without public assistance? Does FIP increase timber supplies and harvests—its ultimate goal as a production incentives program? Several recent studies have addressed these questions.

Essentially, the question of whether landowners would plant without FIP is one of capital substitution of public funds for private funds. Two econometric studies with contradictory findings were performed in the early 1980's on capital substitution. De Steiguer (1983, 1984) used a single model to test if public funds had substituted for private dollars for tree planting for selected Southern States. His analysis found that FIP contributed only incremental funds beyond those that would be invested by private landowners. Cohen (1983) used a variety of models, all of which led her to conclude that considerable capital substitution had occurred. On the average, she estimated that public funds had supplanted about 40 to 50 percent of capital that would have been spent by private landowners, with a range from 20 to 100 percent depending on the model formulation.

In a study examining the supply issue, Wallace and Silver (1983) could find no statistically significant evidence that FIP had increased or decreased timber supplies in the southeast Georgia forest survey unit, despite large public FIP expenditures in the region. This suggests capital substitution. However, they noted that it would be difficult to measure

volume increases after only 7 to 8 years of the program (and tree growth). Another interpretation of the study might suggest that FIP did not prompt shorter rotations and reductions in growing stock.

Some consulting and State foresters feel that FIP is counterproductive because owners may delay or fail to perform tree planting in hopes of getting government cost-share funds. Since funds are inadequate for all requests, the harvest sites instead grow brush for several years and become more of a problem than if landowners initiated their own planting. One other study by Boyd (1983, 1984) did find that FIP was apt to increase the likelihood that owners would plant trees but did not increase the likelihood of timber harvest.

Overall, it seems possible that FIP may cause some capital substitution. Some advocates claim that this is merely because the program has never been funded to desirable levels. But the likelihood for funding increases seems dim, so program justifications should not rely on those prospects.

State Incentive Programs—As of 1985, six States had enacted public State incentive programs, and two have established privately funded programs that are funded by a variety of means. Of these eight, California and Illinois are the only States not in the South. Forest Farmer (1985) and O'Laughlin et al. (1983) summarize the programs in the South, and Vaux (1983) describes the California program. A few analyses of program effectiveness have been published.

The 1970 Virginia plan, or Reforestation of Timberlands Program, is designed to bring nonforest or hardwood forest land into pine production (Flick and Horton 1981). It is administered by the Virginia Division of Forestry. Funding comes from a severance tax on harvested pine timber (50¢ per thousand board feet in 1985) and matching funds from the State's general fund. County foresters make regeneration prescriptions, and landowners must sign reforestation agreements with the Division of Forestry. Lands with adequate pine or poplar seed trees are not eligible. In 1985, incentive payments of 50 percent of total costs or up to $60 per acre could be paid on a maximum of 500 acres per year. The enabling legislation also increased the minimum number of pine seed trees required per acre from four to eight, which also helped encourage reforestation (Hall and Starr 1985 unpubl.).

Flick and Horton (1981) note that the exclusion of funding for lands already forested with pine is important because it helps guarantee that the planted acres subsidized are indeed additions to the stock of productive

pine lands. Their economic analysis revealed that the first 6 years of the program cost about $6.3 million and promised to return a present value of benefits of about $29 million, yielding a benefit–cost ratio of about 3.5:1 using a 10-percent discount rate. Approximately 20 percent of all acres planted in Virginia from 1972 to 1977 were sponsored through the Reforestation of Timberlands Program, which will surely have a significant impact on future timber supplies.

The Mississippi Forest Resource Development Act, which went into effect in 1974, provides cost-share payments to landowners who establish or improve a stand of forest trees and for timber and game management. The law is limited to nonindustrial private forest landowners, and requires a forestry-commission-approved forest-management prescription or plan. Funds are derived from a severance tax on timber harvests. Cost-share rates cannot exceed 50 percent. No ownership size limits exist, but landowners cannot receive more than $3,000 per year or $9,000 for a 3-year allotment.

The North Carolina Forest Development Program was enacted in 1977 to provide cost-share assistance to private woodland owners. Program funds come from State appropriations and a tax on primary forest products. Private individuals, groups, associations, and corporations are eligible, regardless of ownership size. Approved practices include site preparation, silvicultural clearcut, tree planting or seeding, and timber-stand improvement. Cost sharing is performed at 40 percent of prevailing rates that are set each year. Management plans from each State's division of forestry are required. Funds are available for only 100 acres per landowner per year.

South Carolina's Forest Renewal Program received initial funding in July 1982. Most private landowners not engaged in the wood-products industries are eligible. Taxes on manufactured wood products provide 80 percent of the program funding and State appropriations, the remainder. Landowners must submit plans for approval to the South Carolina Forestry Commission to receive cost-share funds of up to 50 percent. Lands qualifying for FIP may not receive payment. Allowable practices include tree planting, timber-stand improvements, site preparation, and natural regeneration. Ownership size is not limited, but treated area cannot exceed 100 acres.

Florida's private forest industry underwrites the Florida Reforestation Incentives Program with contributions of pine seedlings. The program began in the 1981–82 planting season in selected north Florida counties.

Contributions are channeled through the Florida Forestry Association and administered by the Division of Forestry. Landowners must have at least 10 acres of commercial forest land and plant at least 5 acres in pine. During the first 3 years, the program helped 446 landowners plant 17,693 acres at an average program cost of $11.30 per acre.

The Texas Reforestation Foundation is privately funded by voluntary contributions from forest industry. Funds are paid to nonindustrial private forest landowners on a matching basis and are administered by the Texas Forestry Association. The Texas Forest Service provides technical assistance and administers establishment of forestry practices. The program stresses planting of pine trees, but site preparation may qualify if recommended by a forester. Timber-stand improvement practices of seedling release, precommercial thinning, or prescribed burning may also qualify. Management plans prepared by foresters are required for consideration. No predetermined payment levels or acreage limits exist (O'Laughlin et al. 1983).

The California Forest Improvement Act of 1978, which took effect July 1, 1980, initiated a program of grants-in-aid to small nonindustrial forest owners. The Act may subsidize up to 90 percent of the cost of reforestation, stand improvement, wildlife habitat improvement, or other measures required to bring depleted forest areas into full production. It is funded by receipts from timber sales on State-owned forests that previously went into the general fund. Appropriations of $4.5 million were made in the 1981–82 fiscal year (Vaux 1983).

In 1983, Illinois enacted an incentives program that helps landowners in reforestation and timber-stand improvement. Minnesota also has had a 50-percent cost share for a seven-county area administered by the Soil and Water Conservation District (Meeks 1982). Several other States had also developed or considered minor types of cost-share programs in 1985 and 1986.

Soil Bank Program—The Conservation Reserve Program, better known as the soil bank program, helped farmers convert erosive marginal crop land to permanent grass or tree cover from 1956 to 1960 by paying for planting costs and making annual cash payments of up to $12 per acre per year to participating landowners for up to 10 years. In the South, about 1.9 million acres were planted with trees during the program, 700,000 acres in Georgia alone (Williston 1980). Returns to landowners under the program have been excellent, clearly justifying the conversion from annual crops to timber. The program was enacted for conservation

purposes, but it also helped make a significant contribution to timber supplies in the South. In addition, most lands planted with trees remained out of agricultural crop production, even after cash payments to farmers were discontinued. Alig et al. (1980) found that most soil bank plantations in the South remained in trees (86 percent), though some did need followup treatments. With some stands approaching 25 years of age in 1976, over 37 million cords of wood were standing on the plantations, and 11 million more had already been harvested.

A modern Conservation Reserve Program was enacted as part of the 1985 Farm Bill—The Food Security Act, P.L. 99-198—on December 23, 1985. Subtitle D of the Act authorizes the Secretary of Agriculture to carry out the program by retiring highly erodible land from crop production in order to help conserve and improve the soil and water resources of owners' or operators' farms or ranches. The program is authorized for the crop years 1986 through 1990, and for a cumulative retirement acreage of not less than 40, nor more than 45, million acres in the United States. At least one-eighth of this acreage (5 million acres) is supposed to be planted to trees.

The Secretary of Agriculture is authorized to pay landowners or operators for (1) establishing the conservation practices and (2) maintaining the practice. Establishment costs are to be shared at 50 percent by the government and 50 percent by the owner/operator, which in most cases is based on a flat rate for that particular practice. Annual rental payments to owners/operators are to be made for 10 years under the conservation contracts to maintain the designated cover. The amount of the annual payment will be determined through a competitive bidding process wherein all bids are placed in a pool and the lowest bids are accepted first.

The total amount of rental payments per person may not exceed a value of $50,000 in any fiscal year. Currently, cost-share payments are to be made in cash. Annual rental payments totaling $100 or more will be with "in-kind" commodity certificates. Rental payments totaling less than $100 will be made in cash or commodity certificates, at the producer's option. Subtitle F of the Food Security Act also allows participants in the Conservation Reserve who plant softwood timber to reamortize distressed farm loans and defer payment until the timber crop produces revenue, or 45 years, whichever comes first.

An economic analysis of tree planting under the old soil bank program in South Carolina found that the real social internal rate of return for the

project was 6.3 percent (Marsinko and Nodine 1981). The analysts considered this to be a satisfactory return, particularly compared with other investments made during the 1950's. Current program payment rates for enrolled forest lands have averaged more than $40 per acre per year. These payment rates would translate into excellent returns for individuals (Werblow and Cubbage 1985).

Other Direct Payments—In addition to the preceding programs, landowners may receive direct financial support in the form of FHA or other subsidized loans. In addition, the cost of seedlings purchased from State nurseries for timber or wildlife plantings is also subsidized with State and Federal funds. One component of the Clarke–McNary Act of 1924 authorized Federal and State cooperation in the production of forest-tree seedlings. The legislation was intended to promote reforestation by making tree seedlings available to landowners at costs below those that would be available through "market" processes.

The pioneering Federal–State efforts involved partial Federal funding and expertise coupled with State funds and State personnel who actually developed and maintained tree nurseries. The efforts have led to the production of billions of seedlings, allowing the economical reforestation of millions of acres. Forest-tree seedlings are still produced by State nurseries at considerably less than commercial nursery market costs. In addition, many States also have produced and packaged species in small quantities that are desirable for wildlife plantings.

Technical Assistance

The Federal and State Governments also provide a number of technical assistance programs designed to improve the conservation, management, and production of forest resources. These include direct on-the-ground technical advice for landowners, extension programs, and education for loggers and timber processors. Private consulting foresters also provide technical assistance to nonindustrial private forest landowners, as do management assistance programs instituted by forest industry.

Cooperative Forestry Assistance—Federal efforts to provide forestry assistance to private landowners were initiated by Pinchot when he was Chief of the Forest Service and continued on a modest basis for three decades (Robbins 1985). Cooperative efforts between the Federal Government and the States have officially provided technical, on-the-ground forestry assistance to forest landowners since 1937. The Cooperative Farm Forestry Act of 1937 (Norris–Doxey Act) first established a program of Federal

funding for technical assistance to farm woodland owners, which was actually provided by State-employed foresters. The legislation authorized an annual Federal appropriation of $2.5 million. The first appropriation actually received was for $300,000 in fiscal year 1940 (Dana and Fairfax 1980). The 1950 Cooperative Forest Management Act superseded the 1937 law and broadened the clientele served to include nonfarm private forest landowners, harvesters, and primary processors (Skok and Gregersen 1975). This was the first comprehensive program to provide substantial technical assistance to nonindustrial private landowners. Under the programs, Federal funds allocated to the States must be matched by State funds.

Program Components—In 1978, the Cooperative Forestry Assistance Act consolidated all previous cooperative legislation, authorizing the Secretary of Agriculture to provide financial and technical assistance to each State forester to produce seeds and seedlings; perform non-Federal forest planning; protect and improve watersheds; and provide technical and financial forestry assistance to private forest landowners, vendors, operators, wood processors, and public agencies. As such, the authority for management assistance under the Cooperative Forest Management program was superseded by the 1978 law, which is referred to as Private Forestry Assistance in some States and as Rural Forestry Assistance in Georgia.

The programs provide direct, on-the-ground technical assistance to help private landowners manage their forests for multiple outputs. Funds provided by Federal and State Governments support State service foresters who perform the field work. Currently every State in the Nation has private forestry assistance programs. However, large budget cuts have been made in several State forestry budgets and Federal appropriations for the State and Private Forestry in the USDA Forest Service are declining (Borden 1982, Heinrichs 1983). Extension and service foresters also help disseminate current timber prices that are published in Timber Mart South to private landowners. Some States have now instituted a fee system for forest-management assistance.

Program Efficiency—Several recent studies have examined the effectiveness of the provision of technical assistance. Boyd (1983, 1984) used regression to estimate the effects of various types of forestry assistance on timber production. In general, Boyd found that incentive programs did encourage investments in growing timber, though somewhat less than one might expect from a profit-maximization criterion alone. He found that FIP did not contribute to timber harvest. He computed that provision of

technical assistance was more likely to increase regeneration than subsidy programs were (7.3 percent probability versus 5.5 percent) and that technical assistance was significant in increasing the probability of harvest (7.1 percent). Royer and Kaiser (1985) found that the use of foresters was commonly associated with southern pine regneration by nonindustrial private forest owners.

A survey in Georgia identified the characteristics of nonindustrial private forest landowners who contributed to investment in forestry (Mullaney and Robinson 1980). Investors usually owned more than 100 acres of land, had greater than average incomes, and often were repeat users of forestry subsidy programs. The study concluded that subsidy programs would be ineffective in encouraging further investment by currently uninterested owners, despite their high use by current investors. Mullaney and Robinson felt that technical assistance stressing low-cost management should be provided to encourage production by lower income forest owners if full subsidies were not used.

Hickman and Gehlhausen (1981) performed a survey in east Texas that examined the interest of forest landowners in different assistance programs. They found that provision of management assistance for multiple use and requiring performance bonds from loggers were preferred program features. Urban residents with above-average education and income levels expressed the most interest in forestry programs.

In a study in the Georgia Piedmont, Cubbage evaluated the effects of the provision of technical forestry assistance to assisted and nonassisted groups of landowners who made timber harvests (Cubbage 1983b, Cubbage et al. 1985). He found that harvests between the assisted and nonassisted landowners differed significantly. Landowners assisted by State foresters generally had less pine timber removed (1,135 vs. 1,485 cubic feet per acre), had more softwood volume left after harvest (810 vs. 226 cubic feet per acre), and had more pine seedlings (1,602 vs. 803 per acre) after natural-stand harvests. A pine-plantation sample was too small for differences to be detected, but the two groups seemed similar. Personal characteristics did not differ greatly between assisted and nonassisted landowner classes.

Harvest returns also differed significantly. Owners assisted by State service foresters received an average price of $108 per thousand board feet of timber, while those making their own sales averaged only $66 per thousand board feet. A small amount of this difference could be explained by differing product distributions, but even in the most conserva-

tive case, assisted landowners received stumpage prices 58 percent greater than landowners making their sales without assistance. Greater returns for current sales and greater residual volumes also led to a greater total net present value per acre on lands whose owners received assistance ($1,563), compared to the nonassisted group ($940), at a real discount rate of 4 percent.

Greater returns to landowners receiving assistance created large private, social, and program benefit–cost ratios. In fact, returns for sawtimber marking and harvesting assistance alone were enough to justify total cooperative forestry assistance program costs in most comparisons. Tax dollars that could be attributed to harvesting assistance exceeded costs for timber marking but not entire program costs. Returns to the Federal treasury were greater than those to the State, and the Federal share of program cost is less; so paybacks were greatest for the Federal contribution.

In Montana, Jackson (1983 unpubl.) performed an economic evaluation of the private forestry assistance program by examining records of landowners who made timber harvests in the State. From his sample, Jackson found that more timber would be grown on lands whose owners had received State assistance than those that had not, and that landowners would receive substantially greater present values. Accordingly, assisted lands would generate more State income taxes in the future. Seven owners receiving technical assistance and seven not receiving assistance were used in current stumpage price comparisons. Using regression analyses to predict timber prices based on the empirical data, receiving technical assistance was a significant independent variable as an interaction term with haul distance. Holding other variables at their mean values, Jackson estimated that on the average, forestry assistance added $4,205 to the price received by each landowner.

Jackson discussed several implications of his study. First, nonassisted landowners tended to make high-grading selective cuts, leading to lower present values of future harvest yields. Based on the economic results, the private forestry assistance program could be expanded to provide positive economic returns. Also, using a price-prediction equation, Jackson found that economical sales could have volume as small as 35,000 board feet, translating into an area of 5 to 10 acres. He noted that small landowners might even be a logical group to receive private forestry assistance.

Overall, these studies of the provision of State technical assistance seem to indicate that it is both effective (has measurable impacts) and efficient (has acceptable social benefit–cost ratios). Expansion of the analyses to include nontimber outputs would also be useful. Jackson (1985 unpubl.) is currently finishing such a study in Montana. His preliminary conclusions indicate no detectable difference in use of best management practices on forester-assisted and nonassisted ownerships, although the study did confirm the advantages of assistance in making timber sales and in encouraging good timber management practices.

The State foresters and State and Private Forestry also cooperate in providing advice to loggers and sawmillers regarding harvesting, sawmilling, lumber drying, secondary processing, wood energy, and market and industrial development—called the Forest Product Utilization programs. Harvesting and marketing programs are available to landowners. In an evaluation of the Sawmill Improvement Program, Risbrudt and Kaiser (1982) found excellent returns to sawmillers and social returns to the program. The Forest Service and some States also offer urban forestry programs, which were authorized federally in 1972. The program emphasizes combating insect and disease outbreaks and utilizing wood that would otherwise be lost from pests and land clearing.

Soil Conservation Service employees also provide limited on-the-ground technical assistance to forest landowners when making SCS farm plans. In heavily forested counties and States, county conservationists provide considerable advice on multiple-use management and farm (forest) conservation practices. They often coordinate their farm plans with recommendations from State foresters or extension service personnel.

Private Forestry Assistance—In addition to public programs, technical forestry assistance is also now offered by many private consultants and forest-products firms. Consulting forestry services available to private landowners have increased greatly in the last 20 years. Currently, it is estimated that there are over 1,900 consulting foresters in the United States. Georgia has the largest concentration, with over 100 known consultants (Field and Holt 1984 unpubl.). In addition, many forest industries have begun formal management assistance or landowner assistance programs in areas around their mill. They also lease a large amount of forest land in the South.

A number of surveys have been performed to estimate the extent of private forestry assistance to nonindustrial private forest landowners. Studies were begun at the Southern Forest Experiment Station (Pleasonton 1968, 1969; Siegel 1973; Siegel and Guttenberg 1968) and have been con-

tinued by others until the present. Leasing programs began in the 1940's and 1950's. In these programs, industry leases land from private, nonindustrial owners and generally manages it as if it were their own. The acreage under lease in the South seemed to peak at about 6.7 million acres (Siegel 1973) in 1970. Current surveys indicate that this figure has declined to about 4.66 million acres in 1982 (Meyer 1984, Meyer and Klemperer 1984). Average tract size under lease was 2,078 acres.

Industrial forest-management assistance programs also provide private forest landowners with forest regeneration, timber-stand improvement, and harvesting assistance, in addition to leasing programs. Land-management practices may be performed at cost for private landowners. Programs generally require that treated tracts be of a minimum size and within a maximum distance from the mill, and some require first refusal rights—the right to meet or exceed any other firm's bid—when participating landowners sell timber (Cleaves and O'Laughlin 1983, Cubbage and Skinner 1985). Land enrolled in formal industrial management-assistance programs has increased steadily. In 1984, Meyer and Klemperer found that total enrollment included 4,214,000 acres in the South, with the largest programs being in the west gulf. Average tract size was 484 acres.

Regional and national surveys have found a steadily increasing number of private forestry consultants through the 1970's and 1980's (Field and Holt 1984; Harou et al. 1981; Kronrad and Albers 1984a, 1984b; Martin 1977; Myers and Goforth 1980; Pleasonton 1968, 1969). Forestry consultants provide services similar to those of State foresters for a fee. In addition, consultants can provide detailed assistance in timber marking, land surveying, timber and land sales negotiations, and many other forestry practices that are considered inappropriate for State foresters. Good estimates of the total area in the United States receiving consulting forestry assistance do not exist. Field and Holt (1984) performed a national survey of consulting services but had only a 12-percent response rate. Thus, total assistance levels could not be estimated. Hodges and Cubbage (1986) found that for Georgia in 1983, 3,900 landowners received management-plan assistance from consultants for forest land covering a total of 779,400 acres. In 1983, consultants in the State also marked 279,400 board feet of timber and 485,600 cords of pulpwood and helped in the artificial or natural regeneration of 61,400 acres of nonindustrial private forest land (Hodges 1985, Cubbage and Hodges 1985).

If private forestry assistance is now available at reasonable costs, is technical assistance necessary? Hodges and Cubbage also estimated the total

levels of assistance in Georgia in 1983 in order to examine this issue. They found that the total level of accomplishments and average tract size varied significantly among the management assistance, consulting, and State forestry programs (table 7). Consultants marked more timber than industry and State programs and generally provided more services and detailed management plans compared to State foresters. Industry programs assisted considerably fewer owners but had very large average tract sizes associated with each ownership managed (636 acres). Average tract size managed by State foresters was 131 acres; for consultants it was 376 acres. Georgia State foresters assisted the most landowners, but the brunt of the assists consisted of brief plans that did not require intensive site examinations. The State also helped in marking less than 1 percent of the timber harvested in the State, compared with about 8 or 9 percent marked by consultants.

Overall, it seems that each type of technical assistance fulfilled separate needs. Industry programs concentrated on owners of large forests, consultants focused on medium-size ownerships, and State foresters on the smaller ownerships. The State, with its yearly limit of 5 person-days of assistance per owner per year, probably referred most large requests to private programs. However, the State does seem to be fulfilling a necessary goal of providing assistance to smaller owners who might not be able to afford consultants or qualify for industrial programs.

Extension Programs—The Smith–Lever Act of 1914 pioneered Federal–State legislative cooperation. The Act provided for cooperative agricultural extension work between the U.S. Department of Agriculture and the State Land-Grant colleges. The Act is funded by the Federal Government, individual States, and local communities, with total contributions of about $1 billion in 1985. Recently, the Federal Government has funded about 37 percent of the programs, local governments 7 to 11 percent, and the States the balance.

Extension includes a substantial forestry component in most States. Separate congressional authority for forestry extension services was granted under the Renewable Resources Extension Act of 1978, but to date very little additional money has been appropriated. Annual forest-management and utilization extension funds have usually amounted to about $4 million, and natural resources as a whole to about $15 million.

State extension foresters provide information and education for private landowners, loggers, and forest-products firms, primarily by holding workshops, meetings, tours, and forestry demonstrations and by publishing forestry bulletins. They also work closely with county extension

Table 7—Public and private forestry assistance provided by sector in Georgia, 1983 (Cubbage and Hodges 1985)

Practice	Assisting sector		
	Consultants	Industry	State
Management assistance			
Landowners assisted	4,934	710	5,656
Acres managed	1,858,932	1,217,000	741,659
Management plans			
Brief (number)	2,647	338	4,587
(acres)	240,999	38,500	427,330
Detailed (number)	1,245	91	116
(acres)	538,442	232,378	21,042
Average size (acres)	376	636	131
Timber harvests			
Pine			
Pulpwood (cords)	375,252	98,078	23,141
% of State harvest[1]	7.3%	1.9%	0.5%
Sawtimber (MBF)	244,573	4,000	19,420
% of State harvest	10.5%	0.2%	0.8%
Acres	107,805	6,260	6,762
% of State harvest	14.1%	0.8%	0.8%
Hardwood			
Pulpwood (cords)	110,358	18,537	374
% of State harvest	17.3%	2.9%	0.1%
Sawtimber (MBF)	34,870	—	1,250
% of State harvest	6.0%	0.0%	0.3%
Acres	27,219	—	546
% of State harvest	3.5%	0.0%	0.1%
Reforestation (acres)			
Site preparation	37,586	40,484	34,617
Regeneration			
Acres planted	29,413	37,596	43,835
Acres seeded	9,898	1,400	2,642
Natural regeneration	22,078	—	6,509
Total	61,389	38,996	52,986

[1] 1981 Georgia State harvest levels as reported by Sheffield and Knight (1984):

Softwood
Pulpwood 459,513,000 cubic feet/90 cubic feet per cord = 5,105,700 cords
Sawtimber 2,324,771 thousand board feet (sawlogs, veneer logs, poles)
Hardwood
Pulpwood 50,928,000 cubic feet/80 cubic feet per cord = 636,600 cords
Sawtimber 456,134 thousand board feet (sawlogs, veneer logs)
Harvest area: About 767,000 acres annually for all types.

agents in conducting local forestry education programs. In addition to public education, extension personnel have taken a leading role in disseminating research findings to public and private foresters, as well as informing researchers of the concerns of forestry professionals and the public.

The State and Private Forestry branch of the Forest Service serves an extension and administrative role at the Federal level. It helps administer Federal funds given to the States for cooperative forestry programs. Additionally, it provides technical expertise to the States in fire, pest-management, and forest-management programs. In particular, State and Private personnel assist in and coordinate State forest resource planning and provide much-needed advice in managing forest land for nontimber uses. In the 1980's, annual funding for State and Private Forestry dwindled from almost $100 million to about $60 million, and the Office of Management and Budget has repeatedly proposed reducing State and Private Forestry or eliminating it entirely.

Few evaluations of forestry extension or State and Private Forestry per se have been performed. Agricultural economists have performed detailed analyses of the combined returns to investment in agricultural research and extension and found that they have large payoffs (e.g., Huffman 1978, Norton and Davis 1981, Orden and Buccola 1980). Krygier's 1980 study concluded that people receiving assistance through extension woodlands programs believed the programs had provided them with income benefits, improved forest-management practices, increased timber supply, facilitated use of other government and State forestry programs, and increased timber harvest.

Indirect Assistance

Publicly Funded Research—The Forest Service and Land-Grant universities perform much of the research in the forestry sector. This is an indirect subsidy to nonindustrial and industrial forest landowners and wood processors. The 1928 McSweeney–McNary Act established forest experiment stations under the authority of the Secretary of Agriculture. The experiment stations are to conduct studies to determine (1) methods of reforestation, and of growing, managing, and utilizing timber, forage, and other forest products; (2) methods of maintaining quality water flow from forested areas; and (3) methods of protecting forests from fire, insects, and diseases. The McIntire–Stennis Act of 1962 authorized the Secretary of Agriculture to cooperate with State colleges and universities for the

purposes of carrying out forest research, including the training of research workers.

The Forest Service and forestry schools now perform a wide variety of research in such areas as forest management, forest products, recreation, wilderness, and wildlife. State agencies also perform some applied forest research, primarily for nonindustrial private forests. The U.S. forest inventory programs and publications are also funded as part of the Forest Service research program. The Forest Service and most State agencies collect and publish general production and trade statistics as well as supply and demand analyses of the forestry sector. In fact, collection and dissemination of research information has become a central role of public forestry programs.

The annual budget for the Forest Service experiment stations exceeds $100 million, and total spending for research and teaching at the approximately 60 forestry schools in the United States probably equals that amount. McIntire–Stennis appropriations have been about $15 million per year during the early 1980's. Studies to evaluate the effectiveness of forestry research have just begun, but early indications suggest that research investments have quite attractive social benefit–cost ratios (Hyde 1983; Lundgren 1981 unpubl., 1982).

The results of research programs are generally disseminated by the Forest Service, extension, and forestry organizations. Though no analyses have been performed, academic researchers could certainly be expected to find large benefit–cost ratios for educating professional foresters.

Forest Protection Programs—Public forest protection programs for private lands have widely been considered necessary because fires, insects, and disease spread without regard to ownership boundaries. In addition, these threats present large risks in terms of both economic and esthetic values, and often personal safety as well. The principal purpose of the landmark Clarke–McNary Act was to initiate Federal and State cooperative efforts to control forest fires. At the time of its passage, few States had active forest-fire prevention or suppression programs. The Act provided Federal funding which was to complement States that developed their own funding and programs.

When Clarke–McNary was enacted, wildfires were the most serious problem preventing establishment of new forests on cut-over lands. Most States soon passed enabling legislation for their programs, and fire protection improved dramatically. Although few studies have formally evalu-

ated the effects of fire protection, it has without a doubt been the most effective forestry program. Much regeneration of idle lands in the South was made possible by fire-protection programs. Fire may help prepare sites for pine regeneration, but wildfires often destroyed young regeneration when protection was lacking.

Like they have with cooperative forest-management programs, the States have assumed the burden of funding and provide the personnel for fighting fires on nonindustrial private forest lands and, in some cases, industry lands. Federal funds are now used primarily to defray some program costs, help train and equip local fire departments for forest-protection measures, and coordinate fire agency efforts between the Forest Service and the States.

The Forest Pest Management Act of 1947 instituted similar cooperative efforts and funding for pest control and diseases, regardless of ownership. It authorized surveys to detect infestations and authorized federally performed or funded measures against incipient, potential, or emergency outbreaks. Large regional pest-management control and research programs have been sponsored under the aegis of this and other acts.

Like other forestry programs, evaluation of forest-fire and pest-control programs has just recently begun in earnest (e.g., Bellinger 1983, USDA Forest Service 1983). More results will no doubt be published shortly.

Production and Marketing Cooperatives—In order to assist private forest owners in managing and marketing timber, some landowner cooperatives have been attempted. These are intended to overcome diseconomies of size that owners of small tracts incur (Cubbage 1983a). Cooperatives also should be able to help owners bargain better when making timber sales to large forest-products firms. However, the long timeframes involved in growing timber and the rather short average tenure of most forest landowners have prevented success. Forest owners make sales only periodically and tend to be very independent, especially in the South. McComb (1978) documents a few limited co-ops that have been successful in the South. These have employed only one part-time or full-time forester and relied heavily on the other public assistance programs.

A variety of alternatives may be used to implement public policy for forest resources. In the broadest sense, laissez-faire, government ownership, public regulation, or public incentives and education may produce socially desirable results. The appropriate mix of these programs at any given time depends on the goals of society and the current institutional structure. Successful policies must be designed to achieve an objective or solve a perceived problem; however, they cannot do this based on economic or political science theory alone. Policymakers must also consider all other relevant policies that affect forest resources. Examining a program in isolation may lead to overlooking its side effects on other programs.

Public Policies

While agricultural literature and agricultural economics theory have provided much of the tools for forest economics, significant differences in agricultural and forestry programs do exist. Public agricultural policies have been designed to dampen production, maintain price supports (provide minimum income levels for farmers), and conserve soil resources. Public forestry policies have focused on increasing timber supplies via tax benefits, technical assistance, or subsidy programs. These policies do have equity effects, but encouraging increased timber production has been their principal goal. Indeed, even the national forests were set aside in part to avert a threatened timber famine, as well as to prevent floods and conserve soil resources. Other than the obvious effect of massive public ownership and harvest levels, public forest policy has not purposefully tried to guarantee or limit market prices for private owners as has agricultural policy. Production of timber has been most important; markets have been allowed to set prices for the quantity of wood sold and purchased.

Conservation of forest and soil resources has been an important component of public policy. Griffin and Stoll (1984) discuss the public interests in soil conservation, many of which apply to forestry, and how they might justify government involvement in the production decisions of the agricultural sector. Economists posit that market failures or distributional problems must exist to justify public intervention (Wolf 1979). Alternately, some persons argue that markets may be unable to satisfy some higher order social goal such as health, personal liberty, or national security.

Market failures include such things as externalities, public goods, imperfect knowledge, and imperfect competition (Griffin and Stoll 1984). These

market failures have served as bases for public programs to assist nonindustrial private forest landowners. The forestry and social benefit–cost literature is rife with support for the concept that desirable social discount rates may be less than private rates, although in one study, Berck (1979) found the private rate to be a surprisingly low 5 percent in real terms. Resource conservation was the motivating factor behind most of the initial forestry legislation in the early 1900's, and remains crucial today.

Social concerns about provision of adequate housing at affordable costs—and thus, raw material (timber) supplies—have also been of continual importance in the United States. As Duerr (1974) wrote, periodic rapid rises in lumber and timber prices are inevitably followed by a national concern, congressional investigations, and new public policies. This does differ from agriculture, which is continually concerned with falling prices and oversupply.

Market Responsiveness

Measures of market responsiveness have been made in agriculture for decades, as Nerlove's seminal 1958 book explains. Though a few pioneering forestry models were developed in the 1950's and 1960's, widespread, sophisticated market models were not developed until the mid-seventies. Agricultural supply models generally stem from the Nerlove formulation, with production (supply on a volume or area basis) being a function of price and previous (lagged) prices that form the basis for future price expectations. Lumber market models in forestry have commonly relied on similar formulations. Stumpage supply (inventory) models in forestry have successfully used the lagged-expectations approach less often, perhaps because timber suppliers are less apt to respond to prospective prices that are far in the future, prohibiting successful quantification.

Price elasticities of supply for different agricultural crops and in different countries vary widely. Short-run elasticities of supply for most vegetable crops are relatively small (less than 0.40), but often approach or exceed 1.0 in the long run (Nerlove and Addison 1958). Grain crops seem to have larger short-run elasticities. Little data have been published on long-term supply elasticities for grain crops. Overall, agricultural commodities seem slightly, but not drastically, more responsive than timber.

Forestry studies indicate that price elasticities for timber supply calculated from data for the 1960's to 1970's were generally small—0.4 or less.

Elasticities for private producers in the West were much less, usually below 0.15, indicating an almost completely inelastic supply curve. Prices generated somewhat greater, but by no means spectacular, supply responses in the South. Overall, the contention that markets alone are inadequate to induce increased supplies seems reasonable. Short-run responsiveness is very inelastic, which helps contribute to the volatility in the stumpage (and lumber) price markets. Most studies also indicate that demand through the seventies was inelastic, which would exacerbate market volatility.

Lastly, while supply price elasticities were small, they were at least significant in recent decades. They were probably almost nonexistent in the first half of the century, when prices were exceedingly low in nominal and real terms. Low prices then, and now for some species, were doubtless a disincentive to private investment in timber supply. Perhaps future research efforts could provide more information on the relevant supply and demand price elasticities, particularly for longer time series. The linkages between prices, stumpage supplied, and investments in forest management (inventories) are also unknown. Better research efforts here would also be helpful.

Skok and Gregersen (1975) discuss four assumptions that underlie public expenditures for private forestry. Three of these apply equally well as goals for any public involvement. First, public programs assume more wood should be produced than is currently and that wood prices should not rise as rapidly as in the past. Second, nonindustrial private forests should produce more forest outputs than they do, and can do so at costs less than the benefits. Third, divergent public (social) and private costs and benefits justify social involvement. Fourth, spending funds to assist private forests is more efficient than spending funds on public forests.

Each of these assumptions mixes values and economic efficiency. Free-market economists might question the wisdom of wood for wood's sake and of preventing rising real prices. It is likely that these economists do not care if private (or public) forests can economically grow more wood. They believe that eventually markets will equilibrate available supply and demand by substituting other resources for scarce, expensive wood. However, the public and the forestry profession have generally accepted the values implicit in the goals of ensuring adequate timber supplies and preventing rising real prices. Duerr (1981) suggests that all we need to support public programs is the belief that wood has value and will prove useful in the future. In practice, such beliefs are important in public policy, but not sufficient.

The second question of nonindustrial forests producing more outputs at profitable benefit–cost ratios is also important. Such forests have often been considered underproductive compared to industrial forestry or even public ownerships. Clawson (1979) refutes this belief and discusses economic opportunities nonindustrial lands do have for increased production. In any case, the relevant policy question is whether nonindustrial private forests can profitably produce greater outputs than they currently do, not whether they are under- or overproductive.

Divergent private and public costs suggest market failures such as public goods (unpriced values), or externalities (intertemporal or present-day). Such problems seem likely in forestry, and public assistance programs or regulation are responses that have been used. In fact, establishment of the national forests was based largely on the perception that timber cutters were senselessly destroying timber that future generations would need.

The last assumption, that of investments in nonindustrial private forestry being more efficient than those in industrial or public forests, is debatable but academic. If the first two assumptions hold, the only realistic political alternative for increasing wood output is guidance and assistance to private forest landowners. National forest timber supplies are constrained by sustained-yield, multiple-use legislation that prohibits large incremental additions to supply. More extensive public support for industrial forestry is unlikely. If additional timber (or other forest) resources are to be forthcoming, nonindustrial private forests must be the source.

What, then, is the role of forest policy? While analysis may not dictate decisions, efficiency is important. The wealth of program evaluations being performed can inform policymakers regarding the benefits and costs of alternative programs and the efficiency of existing programs within the current institutional framework (Randall 1981, Alston 1983). By identifying the best means of implementing public policy, the public can achieve the greatest returns for the dollars spent (Skok and Gregersen 1975). Market benefits and economic criteria alone may not be determining in political decisions, but in the current times of budget austerity, demonstration of satisfactory returns and elimination of waste are important.

Comparative Policies

The discussion thus far has focused on the rationale for and the types of public programs available for increasing the output from nonindustrial private forests. The role and objectives of these private landowners have

not been examined here, but their views are obviously important. Royer (1979) reviewed the wealth of forest landowner studies that have been performed over the last 50 years. He concluded that landowner characteristics and attitudes have been thoroughly summarized, but some very basic questions remain unanswered. In particular, the relationship between landowner behavior and increased timber supplies and the influence of markets and public programs are still unclear. Foster (1982) estimated the public benefits from increased stumpage supply in the South and concluded that the rate of return from pine regeneration programs is likely to be large. McKillop (1975) generally concluded that forestry incentive programs were socially beneficial.

A recent study performed by Royer (1985) reviews several recent landowner studies that better link markets, behavior, and public programs. Each used regression models to explain landowner behavior. Binkley (1981) studied New Hampshire nonindustrial private forest owners. He found that stumpage prices strongly influenced the probability of harvest; owners of large holdings were more apt to harvest than owners of small holdings; and the probability of timber harvest had an insignificant negative correlation with income. Farmers were nearly twice as responsive to harvest prices as nonfarmers.

In North Carolina, Boyd (1983, 1984) found that harvest decisions were significantly, positively correlated with timber prices, size of forest holding, use of professional forestry assistance, and farm ownership. For planting and management practices, he found that education, professional forestry assistance, ownership size, and knowledge of cost-share programs influenced landowner decisions. Sawtimber prices had weak positive correlations (alpha = 0.20), and farmers and absentee owners had weak negative correlations (alpha = 0.20) with undertaking forestland improvements.

The models of de Steiguer (1983, 1984) and Cohen (1983, 1984) examined reforestation expenditures by nonindustrial private forest owners and the influence of income, stumpage price, and interest rates, as well as government cost-share programs. As mentioned, de Steiguer found that government cost sharing did not affect private funds invested; neither did stumpage prices nor income. However, personal income had a significant positive effect on investment, and the available alternative rates of return on financial investments (e.g., T-bills) had a significant negative effect on investment. Cohen's models, on the other hand, found that government cost-sharing programs decreased levels of private investment. Depending on her formulation, income, stumpage price, and lumber production had

significant positive effects on reforestation. The effect of interest rates varied from positive to negative, depending on the formulation.

After reviewing the preceding studies, Royer (1985) described the preliminary results of a logit regression model he developed using data from an earlier survey of nonindustrial private forest landowners in the South (Fecso et al. 1982). He examined the reforestation decision made by nonindustrial private owners as a function of tract ownership characteristics, personal characteristics, market variables, and public policy variables. Sixteen independent variables were used in the analysis, divided into four groups. Owner variables included tract size, part of farm, and the predominant local land use (urban, agricultural, mixed agriculture/forested, and forested). Personal characteristics included income, age, education, farming as a primary occupation, absentee ownership, and plans to sell harvested land. Indices of stumpage prices for sawtimber and pulpwood, an index of reforestation costs, and advice by industry or consulting foresters constituted the market factors analyzed. Financial (FIP) and technical (PFA) assistance were the relevant policy variables.

A hierarchical statistical analysis of the data indicated that ownership variables alone would correctly predict reforestation decisions only 17 percent of the time. Personal characteristics interacted with ownership variables, adding nothing to the model's explanation of reforestation probability. Economic (market) variables increased the model's probability of accurately predicting reforestation by 13 percent. Public policy variables—the provision of FIP or public technical assistance—were most influential, explaining 60 percent of these landowners' reforestation decisions.

Royer then developed single-equation models that eliminated the effects of multicollinearity (interrelatedness) among many of the independent variables. This allowed interpretation of the effects of individual variables within each category. Partial derivatives and elasticities were calculated for each independent variable. Derivatives represented the "probability of reforestation corresponding to a one-unit increase in the independent variable evaluated at the means. The elasticity, which can be computed only for continuous variables, reflects the percent change in the probability of reforestation corresponding to a percent change in the independent variable."

Royer's results indicated that the asset positions (income or forest ownership size) of landowners had a strong positive influence on the probability of reforestation. Pulpwood (but not sawtimber) prices had a posi-

tive but only modestly significant effect on reforestation decisions. Coefficients for technical assistance from both private and public foresters were positive and significant, as was the effect of public cost-sharing. Of the significant variables, increases in reforestation probability, as indicated by the partial derivative, were greatest for the provision of public forestry assistance (about 66 percent greater), followed by FIP expenditures (+50 percent per dollar spent) and provision of private forestry assistance (+44 percent). Other statistically significant factors were much less influential: size (+0.04 percent per acre), income (+0.05 percent per $100), farmer status (−0.14 percent), and age (−0.6 percent per year). Plans to sell the land had a negative effect on the probability of reforestation (−21 percent), and pulpwood prices a slight positive effect (+1.3 percent).

Brooks (1985) recently completed a study of the effects of public policies on long-term timber supply in the South. He used the national Timber Assessment Market Model (Adams and Haynes 1980) to determine that low levels of pine regeneration in the South will cause softwood stumpage prices to rise faster than expected by the year 2000. Examining the effects of cost-share programs by using changes in producer and consumer surplus, Brooks found that public benefits of the programs far exceed program costs. In addition, despite reasonable returns for investments in southern pine plantations, few owners replant. However, he found that financial incentive programs can have the desired effect of increasing plantings and softwood timber supplies and decreasing future prices.

Overall, these recent studies provide considerably more information on the roles of owner characteristics, markets, and public policy. Virtually all the studies and evaluations have shown that public policy is crucial in the decisions made by nonindustrial private forest landowners. Markets may equilibrate supply and demand, but they are not particularly effective at eliciting increased supplies, even when significant real price increases occur. Most studies found that price was only moderately significant, at best, in increasing the probability of forestry investments. Ownership characteristics, the most-studied, least-fruitful avenue of research for decades, appear to make only a modest contribution to forestry investment decisions. All public programs seem to be important in encouraging nonindustrial private forest landowners to make forestry investments.

All the published evaluations have found technical assistance to be effective and to provide excellent private and social returns. It has helped inform unknowledgeable landowners, encouraged reforestation and harvest, and promoted other investments in forestry. State and Federal cost-sharing assistance has also encouraged reforestation. Some studies indicate that some capital substitution may occur, but others do not. Either way, it seems that the probability of reforestation by nonindustrial private owners—a proxy for investments—increases with all public programs.

Additionally, public and private assistance programs seem crucial in encouraging prudent forest management by private forest landowners. In the United States, trees of some species will grow with or without assistance to landowners. But many recent studies have shown that assistance is crucial in fostering good land-management practices and the growth of desirable species. Thus, it seems likely that a mix of public and private programs will continue to be an effective approach to increasing timber supplies from tracts owned in the private, nonindustrial sector.

Conclusions

Studies of the responsiveness of stumpage markets generally indicate that price elasticities of supply and demand are quite unresponsive. Thus, economic theory dictates that shifts in the demand or supply curves will have substantial impacts on product prices. Additionally, it suggests that if significant declines in resource supplies (inventories) do occur, large real price increases are likely. These results are not particularly astounding, nor are they apt to change the attitudes of persons who either strongly oppose or favor public intervention in timber markets.

The degree of public policy involvement deemed desirable in timber production probably depends on one's beliefs about the severity of the supply problem. Economic theory and empirical forestry studies indicate that inelastic timber supplies are likely to create volatile markets and probably contribute to rising real prices, particularly if significant declines occur in the resource inventory.

As Manthy (1978b) concluded years ago, if rising real prices and price volatility are not considered pernicious, there is no problem. If they are, there is. Who is receiving the benefit of rising prices and who is paying the costs may influence one's viewpoint. Rising prices may reduce the comparative advantage of forest products, thus causing the loss of firms, jobs, and value added from the forestry sector. On the other hand, forest landowners are apt to reap greater profits from growing timber if prices rise in real terms. In any case, empirical studies have shown that market prices do not induce much incremental timber supply. It will continue to be up to public policymakers to decide if public programs are necessary to improve market outcomes, and if so, the nature and extent of those programs.

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