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Economic Models of Forest Management, Multiple Use and Sustainability

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Abstract

The purpose of this paper is to review economic models useful in sustainable forest management and to elaborate on the institutional framework in which the economics of sustainable timber production, multiple-use forest management, and environmental protection operate. Basic economic models used in forestry are described and their applicability within the post-UNCED system of international policy networks is discussed. As these international networks are used in the formulation of public policy at the national and local level, inferences about the applicability and usefulness of economic models in forestry are more difficult, for the complexity tends to obscure and even confound causal relationships, making prediction of outcomes, if not analysis, more difficult.

Key Words: Land management models, sustainable wood production, multifunctional forest management, property rights, cross-sector forest policy networks

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1. Economic Models in Forestry

1.1 Ecosystem Management and the Economic Stewardship Paradigm

Over the past century, the practice of sustainable forest management has become increasingly complex. Early models of forest management were simply aimed at sustaining the supply of timber by equating harvest with growth. Later models were more broadly directed to accommodate an array of other forest values that society deemed important to perpetuate: water quality, wildlife habitat, recreational values and more. Models were further developed to include critical habitat for threatened or endangered species, and the capacity for sequestering atmospheric carbon to mitigate global climate change. Forest management has also been made more complex by an increasingly sophisticated understanding of the ecological functioning of forests, and the effects of management interventions in these ecosystems. A major challenge for forestry is to produce an ever more increasing diversity of products and services from the forest, all the while reflecting a knowledge and understanding of the natural limitations on doing so in ways that can be sustained in perpetuity.

The term "ecosystem management" entered the forestry lexicon in the early 1990s to convey this far more complex set of factors that now must be considered in forest management planning and decision making (Johnson et al. 1999). Traditional silviculture, sometimes called "applied forest ecology," focuses on maintaining site productivity at the stand level so the maximum volume (or value) of timber can be produced in successive harvests over the long term (Smith et al. 1996). Ecosystem management is an evolutionary extension of this concept, focusing on maintaining ecological productivity and forest conditions conducive to providing the broader array of goods and services--including, but not limited to, timber and other market commodities--over the long term.

MacCleery and Le Master (1999) stress the changed objectives of management under ecosystem management, writing: "The focus on multiple use-sustained yield has tended to be on resource outputs or 'flows,' whereas ecosystem management places relatively more emphasis on ecosystem 'states' and 'conditions.'" In other words, the focus management has changed from the outputs of the forest "factory" to the condition of the forest "factory" itself.

The problem of operationally managing for the difficult-to-measure goal of ecosystem condition is a serious problem (Sedjo 1996). It is widely recognized that one cannot manage what one cannot measure. But how do we assess the success of ecosystem management if meaningful measurement is not possible? Kirkland (1987) has argued that in the absence of meaningful measures, the achievement of the best balance becomes
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a matter of judgment. However, whose judgment should be used to determine what set of forest attributes provide the ideal condition and by whom is this ideal condition to be determined? Science cannot choose objectives. Science can only assist people in managing for those objectives once they have been determined (Botkin 2000).

Almost since Faustmann (1849) first published his model for determining optimal rotation length on the basis of "financial maturity," some foresters and forest owners rejected it because the model focuses on the value of near-term production and fails to account for asset value. In many forest enterprises, both public and private, where ownership of the land is expected to continue indefinitely into the future, a key objective is to increase and concentrate the asset value of the land and timber. Current harvest levels are set to capture mortality before it occurs as well as to take advantage of favorable markets.

What the neoclassical economic paradigm would regard as an unacceptably low return on equity (relative to the cost of capital) should be viewed in a larger context. In Europe, where centuries-old forest enterprises have endured through multiple wars, currency devaluations, and other events that have put most forms of investment at great risk, forests have served as a stable, reliable, tangible asset. In other parts of the world, the recent advent of timber investment management organizations (or "TIMOs") has been stimulated by investors seeking a stable, appreciating asset that, because its value tends to fluctuate in the opposite direction from most forms of equity investment, reduces the level of risk associated with their overall investment portfolio (Binkley, Raper and Washburn 1996).

The developing field of ecological economics offers an important insight into the relationship between a flow of income and the value of the underlying capital asset, such as a natural system, and whether the latter is accumulating, remaining the same, or being depleted. An Ecological Economic Stewardship Paradigm, has been developed, which features at least six points (Farber and Bradley 1999).

- Nature systems are viewed as natural capital, which, combined with economic and social capital, generate welfare.
- Sustaining a flow of income (welfare) requires maintenance of the source of income, which is wealth (capital).
- Measures of economic health require the subtraction from traditional economic income the amount necessary to replace any net degradation in the quantity and quality of natural capital.
- Any concept of value applied in assessing economic welfare should include the extent to which the properties of ecosystems, including humans, are preserved and enhanced.
- Humans are presumed adaptable to changing economic circumstances.
- Property rights, laws and institutions must provide incentives for achieving sustainability norms.
Sustaining a flow of income requires maintenance of its source: capital, and natural systems are natural capital. Maintaining a sustainable economy requires careful assessment of natural capital. Useful attempts have been made to improve existing national income accounting so the flows of economic products from the natural capital supporting these flows can be connected (Constanza et al. 1997). Repetto et al. (1989) demonstrated that data are adequate even in many developing countries for estimating adjustments for the depletion of some important forms of natural capital and that the adjustments could be large relative to conventional gross measures of national product and investment. The adjusted net measures suggest that a substantial portion of many countries' economic growth is simply the unsustainable "cashing in" of their natural wealth or capital. More recent research has examined the application of this concept at the local level (Prugh et al. 2000) and explored the concept in the context of forests in particular (Hartwick 1993).

1.2 A Multiple Period Modeling Approach

The nature of forestry, with its uneven growth rates and rather long periods of production, makes many forestry problems difficult to handle outside of the context of a multiple-period model. Modeling factors to be considered are treatment of time, optimal rotations of forest stands, regulated forest yield, and strategies for reducing risk and avoiding uncertainty.

Treatment of Time: As with many other economic models, time is important in forestry models. Given a society with a positive discount rate, which reflects the opportunity costs of resources, the time streams of costs, revenues, income, and so forth must be adjusted with the discount rate to reflect those opportunity costs. Furthermore, discounting is critical to an assessment of the economic viability of an investment. Investment costs usually occur early in the life of a project while returns tend to occur later. The simple comparison, for example, of undiscounted costs and revenues cannot give a proper comparison of the social or financial returns since, without a discount rate, opportunity costs are not properly accounted for.

Optimal Rotation: Of issues that have captured the attention of economists in forestry, none has drawn more attention than the question of the optimal length of harvest rotations. For much of its history, forest economics has devoted considerable energy to the analysis of the appropriate harvest rotation period, assuming an initial bare ground starting point. This focus undoubtedly reflects the influence of European forestry, where many early American foresters received their training. Europe, unlike America, had not inherited large areas of mature forest. Hence, the overhang of large old-growth stocks and their draw-down was not a serious consideration in Europe. Rather, the question was that of how long a new forest should be allowed to grow and the appropriate length of the harvest rotation cycle.

In much of agriculture the answer is simple; harvest occurs when the crop is mature. Forestry is not so easy. When is a tree mature? Trees can grow for a century or more. Biologists have argued that forests should be grown for maximum sustainable yield. A biological harvesting rule argues that harvest should occur when the growth reaches the “culmination of mean annual increment.” That is, harvest should occur when the average
annual increment of volume growth begins to decline. This rule maximizes forest volume from a steady state harvesting regime, but it ignores financial considerations, including a positive discount rate, and thus is not the rule that would be followed where forests are viewed as an asset that generates income from the value of the harvested timber. The answer of the biologists to the rotation problem, which ignores both value and marginal considerations, is inherently unsatisfactory to economists.

When is it appropriate to harvest? It was the rotation issue that Faustmann, the father of forest economists, first addressed in his famous 1848 article. Starting from bare ground, he correctly determined the marginal conditions necessary to maximize the value of the income stream generated by the forest asset. Taking into consideration the discount rate, which is the opportunity cost of capital, Faustmann showed that, with a positive interest rate, the income maximizing financial rotation is determined by the incremental growth rather than the average growth. For a fixed timber market price, when the biological rate of timber volume growth declined to the level of the interest rate, a financial optimum was achieved. Before this point is reached, the value of the incremental increases of the biological growth of timber exceeded the opportunity cost of the timber capital as reflected in the interest rate. After this point, the value of incremental increase of the timber was less than the opportunity cost of the timber. This basic message was repeated and refined more than once, including, Bentley and Teeguarden's (1965) paper on financial maturity and the 1976 article of Nobel Laureate Paul Samuelson.

**The Regulated Forest and Sustained-Yield Forestry:** Foresters have been enamored with the concept of a regulated forest, i.e., a forest that has an identical representation of each of the relevant age classes. For example, 100 hectares of a 100-year old forest harvest rotation would allow for 100 one-hectare plots for each of the 100 age classes. Such a configuration would allow for the harvesting and regeneration of 1 hectare (the oldest) of forest each year indefinitely. Assuming equally productive sites throughout, each year’s harvest would be identical and would represent the sustainable yield of the entire 100 hectares. Felling at this level would equate growth to harvest.

Considerable effort has been spent on issues involving converting a non-regulated forest to a regulated one. For example, Lyon (1981) examined the question of the optimal transition from an old-growth forest to a steady-state regulated forest. Drawing extensively from the famous Hotelling model (1933) for nonrenewable resources and applying a modification to allow for resources renewability, Lyon examined the optimal draw-down of an existing forest. He showed that forest regeneration would depress the rate of price increase to less than the actual real rate of interest as the new growth moderated the price increases. Lyon and Sedjo (1983) refined and expanded the approach to develop an optimal control model to examine the simultaneous draw-down of a mature forest even as newly planted forests were being established. The model was used to simulate the time path of timber prices and quantities from the old-growth forest to a steady-state forest and was the basis for timber supply models developed subsequently.

**Financial Analysis:** Financial analysis relates to the assessment of an organization’s financial profitability in undertaking certain economic activities. Financial analysis, as opposed to economic analysis, relates to the purely financial, i.e., market generated costs and returns to the investing entity, typically those associated with a particular investment.
activity. As such, non-market values and other returns not captured by the investing entity are not considered, except perhaps as non-monetary “public good will.” While financial analysis in forestry typically relates to the costs and revenues associated with industrial wood production, it could be broadened if, for example, the firm could generate additional revenues (and perhaps costs) by selling hunting rights.

Strategies for Reducing Risk and Avoiding Uncertainty: A number of important papers have examined how different potential risk factors affect the value of timber and how, given these risks, the length of the optimal rotation for the single commodity output, wood, may be adjusted. Reed (1984), for example, shows how the risk of a disturbance, such as fire, may affect the optimal rotation of a forest. Lofgren (1985) examines the rotation question in the context of anticipated technological change, while Johansson and Lofgren (1985) begin to examine the effects of uncertainty on management and rotation. Newman, Gilbert, and Hyde (1985) examined timber harvests in the context of fluctuating or evolving prices, an issue that is further developed by Brazee and Mendelsohn (1988). Koskela (1989) examines the effects of taxation and timber supply under price uncertainty.

1.3 Valuation of Non-timber Outputs and Multiple-use Management

Although history has long recognized a variety of values emanating from the forest, it is only recently that society has come to ask that these values, the values of the natural environments (Krutilla 1967), be incorporated in society’s broad social calculus. One reason may be that, in earlier periods, the marginal values of environmental services were seen to be very modest.

Economics as a separate discipline began by initially focusing on a single value of the forest resource, timber. Gradually, however, multiple-use forestry evolved as it became apparent that non-timber values were important as well. The problem was how the non-market values might be measured. Early research suggested that the “travel cost” approach might be used to obtain a proxy of the market value of recreation. Other approaches have been developed, such as contingent valuation, which relies on survey information, and hedonic pricing, where valuation is related to certain desired attributes. It should be noted that such approaches are still rather controversial in the economics profession.

In many respects forests are the quintessential natural resource. In addition to the production of the wood resource, forests are capable of producing a host of other outputs, both market and non-market. These other outputs, which are typically produced jointly, may include forest foods, recreation, scenic values, and so forth. Multiple-use forestry recognizes explicitly the value of these other resources and systematically includes them in the analysis, usually qualitatively but also quantitatively, in economic assessments. Additionally, new types of forest outputs are beginning to be recognized as part of the management for multiple-uses. For example, environmental outputs of the forest, such as biodiversity and the carbon reservoir functions forests provide (which is associated with the global warming issue) are now frequently considered.

Multiple-use management recognizes that in many cases, both market and non-market outputs and values should be considered. Gregory (1955) recognized much of this in his
seminal paper on multiple-use forestry. Hartman (1976) has shown that if standing timber in itself has value, as with recreation or wildlife habitat, the optimal rotation period would be extended. Subsequently, a major model, FORPLAN, developed by Johnson and Scheurman (1977), addressed multiple-output questions and was used extensively by the U.S. Forest Service to assess multiple-use management options and their implications. The usual approach of this model is to estimate feasible annual timber harvest levels under varying non-timber objective constraint conditions, including wildlife, recreation, water and so forth.

Bowes and Krutilla (1989) formalized much of the economics of multiple-use forestry and developed a number of case studies. Their approach recognized the interrelation of multiple outputs and that there was sometimes joint production, that is, when the production of one output also involves the incidental production of others. For example, timber growth improves both water quality and also improves habitat for some types of wildlife. However, conflicts or competition in production also may exist. They suggested that forests be viewed as a forest factory capable of producing a host of desired outputs. They also suggested a theoretical means for selecting the economically optimal mix of outputs. However, such an approach requires estimates of both underlying production functions and output values. Finally, Swallow, Parks, and Wear (1990) demonstrated some of the complexities inherent in multiple-use management when non-convexities exist in production. Such a situation might be common if some of the joint output values peaked early and others much later in a timber rotation cycle.

1.4 Benefit-Cost Models

Benefit-cost analysis is an approach commonly used in the assessment of public projects where the costs and benefits occur at different points in time. In some respects it is a broadening of financial analysis in that estimates of non-market values, such as, ecological and recreational values, are often converted into monetary values for purposes of the analysis. Such an approach can readily be applied to public forestry, where market and non-market values are to be considered. This approach systematically compares the broader definition of costs and benefits. Since benefits and costs may occur at different points in time, typically investment costs occur early and benefits occur later, the discount rate or time cost of capital must be included in the analysis. (See “Treatment of Time” above)

1.5 Optimization Models

Optimization models are common in forestry. In economics, social welfare is usually optimized. In most cases this is equivalent to maximizing the sum of consumers and producers’ surplus in a competitive market economy in the absence of externalities, or when appropriate prices are given to traditionally non-market outputs. In forestry, optimization is often associated with the question of the inter-temporal optimization of the timber harvest, as discussed in the “optimal rotation” above. But optimization models can also be applied to assess the optimal inputs of various silvicultural practices.

A fundamental concern in the field of timber resources has been the question of the long-term availability of timber. Two questions are very important and have been addressed
with optimization models. First, what is the economically optimal rate of old-growth liquidation? Second, what was the optimal rate of management input to be applied to newly established or growing forests, including resources directed to forest regeneration, either naturally or through artificial means? In response to forest sector concerns, forest economists began to systematically consider the economic issues related to forest draw-down, forest management, and the establishment of new forests. Practicing forest economists were asking questions about the appropriate economic rate of draw-down of existing natural forest, particularly in the old-growth region of the Pacific Northwest and a number of “timber-harvesting” models were developed to provide guidance for harvesting levels, e.g., Walker (1971).

An early supply-and-demand modeling approach that traced out an endogenous optimized inter-temporal timber price was that of Berck (1979). He also used the approach to investigate whether private and public entities were harvesting the forest at optimal rates. He concluded, contrary to the conventional wisdom that criticized the private sector for excessive logging rates, that private harvests were perhaps somewhat less rapid than the optimal private financial rate of harvest.

An important but seldom cited paper is that of Vaux (1973), in which he developed an economic view of timber production as a function of economically applied silvicultural inputs, as well as of time. He noted that increases in market prices provide economic justification for more intensive forest management, thereby increasing the timber volume and its value at harvest. Hyde (1980) addressed various management aspects of the planted forest as they related to the economic application of silvicultural inputs. Using a Faustmann approach to determine optimum harvest rotation lengths, and introducing economically optimal management practices in response to prices and productivity gains, Hyde developed an economic model optimizing the marginal cost (supply) of timber from planted forests in the Douglas-fir region.

Hyde (1981) also examined the question of productivity as it relates to silvicultural investments and found that below a certain point; virtually no level of investment is economically justifiable. In some forest areas, the level of investment required to harvest the existing timber and undertake the minimum treatments necessary to restore forest cover to the site, suggest that the optimal choice is to not harvest existing timber at all. In federal forests in the U.S., timber harvesting on such sites by the private sector was subsidized by investments of public funds. In many instances in the past, the silvicultural investments were not made following timber harvesting, leading decades later to extensive areas of federal forests characterized by low timber quality and high susceptibility to wildfire, infestations of insects and disease epidemics (Hirt 1994).

Sedjo and Lyon (1990) developed a fully integrated optimization model that optimized the draw-down of the existing stock of mature timber, the optimum application of management, and the optimal expansion of planted forests in their global timber supply model (TSM). Subsequently this model has been expanded and updated to more fully reflect the real-world parameters (Sohngen, Mendelsohn, and Sedjo 1999) and to examine questions of the impacts of climate change on global timber markets (Sohngen, Mendelsohn, and Sedjo 2002).
There are numerous other applications of optimization in forestry at less than the total forest level. For example, Hoen and Solberg (1994) examined detailed elements of various silvicultural practices with respect to optimizing their returns from additional carbon sequestration. In their 1995 paper, Van Kooten, Binkley, and Delcourt asked how valuing carbon stored in the forest might influence the optimum harvest rotation. They showed that providing carbon sequestered in the forests with a positive price will lengthen the traditional timber rotation, in the limit to infinity.

1.6 Simulation Models

Models common in forestry include harvest simulation models used to examine long-term timber supply issues but outside the context of economic optimization. The question of long-term timber supply became an important policy issue and generated a number of economically sophisticated timber projection models, most using a supply-and-demand type of approach. An early effort was the Timber Assessment Market Model (TAMM), a simulation model. Using empirical parameters, developed by Adams and Haynes (1980), the model is still used by the Forest Service to examine timber supply and demand questions for the US. Kallio, Dykstra, and Binkley’s edited volume (1987) discussed the development of the Global Forest Sector model. This simulation model, which is conceptually patterned after the TAMM, was used to examine global timber issues.

2. Institutional Framework Regulating Multifunctional Management

2.1 General Considerations

The foregoing economic models were not developed and are not applied without simplifying assumptions that are better recognized and understood than ignored. In most cases, these assumptions collectively provide an institutional framework that can be characterized collectively as a market economy and a democratic political system. A democratic political system is one in which power is ultimately vested in the people and exercised by them directly or indirectly through a system of representation, usually involving periodically held free elections. A market economy is one in which “decisions about the allocation of resources and production are made on the basis of prices generated by voluntary exchanges between producers, consumers, workers, and owners of factors of production” (MIT Dictionary of Modern Economics 1992).

A model of a simple market system is usually presented in economic textbooks as a circular flow with households on one side and business firms on the other (Haveman and Knopf, 1981). Firms supply consumer goods and services for which they receive revenue and households supply factors of production for which they receive wages, interest, rent, and profits. The exchange of consumer goods and services is done in markets, as is the exchange of factors of production. To distinguish among markets by type, goods and services are exchanged in product markets, while factors of production are exchanged in factor markets. Exchange in markets is facilitated by the use of prices as control mechanisms and money as a medium of exchange.
Households are assumed to maximize the satisfaction of their wants through consumption. Firms are assumed to maximize profits. Hence, self-interest is the driving force in both sectors. Similarly private property is common to both sectors. Households own houses, automobiles, land, and financial securities, among other things. They also own their own labor services that they can sell or withhold from factor markets as they want. Firms also own property, including plants, equipment, and inventories, and they can manage them as they wish in their efforts to maximize profits.

Firms operate within industries. An industry is all the sellers of close substitute products, for example, soft drinks, fruit juices and bottled water. Many firms are assumed in each industry, and none of them can influence the price of the products they sell. In other words, they are “price takers,” taking the prevailing price in the market as the price for their product. No barriers of any kind exist to either the entry of firms into the industry or their exit. In addition, population growth and technology are fixed, and government does not exist.

Without qualification, the foregoing assumptions and characteristics are artificial. Yet this simple circular flow model allows important, if not powerful, insights to the functioning of an economy. Furthermore, its assumptions and conditions can be eliminated one-by-one and the resulting constructs can be used to predict consequences with surprising effectiveness. The point is the presence of the institutional framework of a market economy, which the circular flow model describes in its ideal or extreme form, as well as democratic political system, is more or less assumed in the application of the models discussed in the previous section. Their effective application outside of the presence of this framework is questionable at least. What follows is a discussion of several features of the framework.

2.2 Secure Property Rights and Tenure Systems

Definitions of property rights are reasonably consistent and generally accepted. In the Supreme Court decision in *Ruckelshaus v. Monsanto Co.* (1984), property rights were defined as “the group of rights inhering in the citizen’s relation to the physical thing, as the right to possess, use, and dispose of it.” Barzel (1989) uses a similar definition: “Property rights of individuals over assets consist of the rights, or the powers, to consume, obtain income from, and alienate these assets.” Key to understanding both definitions is that property rights do not define the relationship between individuals and scarce assets. They define instead the relationships among individuals and scarce assets, including the respective property owners (Pejovich 1997). For example, a property owner has the right to use his asset including the concomitant right to exclude others from its use. No one else can use it unless he or she permits.

The foregoing suggests more precision than actually exists over time, which is not the case. Creation of property rights is a continuing process in large part because of the cost of delineation. Barzel (1989) observes: “The delineation of property rights is subject to individuals’ optimization; delineation consumes resources, and perfect delineation is prohibitively costly. Property rights, then, are never perfectly defined.” Nevertheless, property rights are basic to the functioning of markets, and one of the most important functions of government is to protect them. For without property rights, no incentive
exists for individuals to invest in property ownership. No assurance exists they will reap its rewards. If property rights were abolished, what incentive is there, for example, for a farmer to plant a crop if his neighbors reap it and take it for their own use? He has gained nothing. Indeed, he has incurred substantial loss in terms of cost of the materials he used and his labor.

Land tenure rights are directly related to property rights where the asset involved is land. Land tenure is “the manner in which and the period for which rights in land are held” (Harris 1953). Fee simple ownership, long-term leases, and concessions are examples of land tenures. Secure land tenure rights are essential for long-term investments in land management such as in forestry. Such investments will not be forthcoming without them. Several dimensions attend land tenure. Lukert and Haley (1994) delineated eight, elaborated upon later by Le Master and Owubah (2000): 1) comprehensiveness, 2) duration, 3) transferability, 4) right to economic benefits, 5) exclusiveness, 6) use and size restrictions, 7) operational stipulations and controls, and 8) security.

**Comprehensiveness** is the number of rights a tenure holder has according to the tenure arrangement. For example, while some forest tenure arrangements allow tenure holders access to both surface and sub-surface resources, some allow use of only one or the other. Generally, the more comprehensive forest tenure rights are, the more willing are tenure holders to make investments in forest management.

**Duration** is defined as the period during which a tenure holder can exercise his or her rights. Longer tenure duration tends to positively affect investment behavior and innovation. **Transferability** refers to the freedom of property owners to sell or otherwise exchange their rights. Transferability is a measure of the robustness of the tenure arrangement and has a positive effect on investment. **Right to economic benefits** is virtually self explanatory: the right of a tenure holder to the economic benefits associated with his or her asset. **Exclusiveness** addresses the extent to which a tenure holder can prevent others from infringing on his or her rights. When a tenure holder can prevent all others from access to the benefits of his or her property, then the rights are exclusive.

**Use restrictions** affect the right of a tenure holder to put a property to another use. Use restrictions, for example, may prevent the conversion of forest land to agricultural use. **Size restrictions**, on the other hand, are often used to respond to a different challenge. Asset size should promote economic efficiency and investment, and it can be either too small or too large for achieving these objectives.

**Operational stipulations and controls** refer to the requirements that must be met as a condition of holding tenure as well as the control measures that are put in place by government to ensure the tenure conditions are met. An example of the first is a forest tenure may require their holder to harvest according to sustained yield standards or to protect water quality and critical wildlife habitat. An example of the second is that tenure holders are required to prepare and operate according to management plans submitted and approved by a designated government agency.

**Security** relates to the confidence tenure holders have in the exercise of their rights, that the tenure arrangement will be protected and enforced by government. Protecting property rights and land tenures is one of the most important functions of government in a market economy. Secure property rights and land tenures facilitate the functioning of
markets because they ensure property holders reap the economic benefits associated with holding and investing in property.

2.3 Incentives for Forest Landowners

A key premise for both a market economy and a democratic political system is that people are rationale. While it is recognized that not all consumers maximize their satisfaction in their purchases, that not all producers maximize profits, and that, theoretically, moving from individual preferences to a rational majority preference may not be possible under a very reasonable set of conditions, the premise is operationally valid. Studies of public opinion are reinforcing. Page and Shapiro (1992), after analyzing thousands of questions asked in national surveys in the U.S. covering a period of more than 50 years, concluded: “(P)ublic opinion as a collective phenomenon is nonetheless stable (though not immovable), meaningful, and indeed rational in a higher, if somewhat looser sense; it is organized in coherent patterns; it is reasonable, based on the best available information; and it is adaptive to new information or changed circumstances, responding in similar ways to similar stimuli.”

It follows that landowners are rationale and will behave predictably with what they believe is in their self interest, including incentives of various kind that government may offer. Governments frequently offer incentives to landowners when externalities are perceived to exist to modify their behavior. Externalities are descriptive of situations in which goods or services are produced or consumed, and as a result, others incur costs for which they are not reimbursed—like someone downstream from a manufacturing plant that dumps pollutants into a water course—or receive benefits for which they do not pay—like neighboring farmers to a beekeeper whose bees supply pollination services.

Forest landowners often supply external benefits because, for example, of the habitat their forests provide for wildlife. They impose external costs if and when they use harvesting techniques that adversely impact water quality or scenic quality. Governments frequently provide incentives to forest landowners to augment external benefits and disincentives to lessen external costs. In other words, government can intervene in a market to either increase or decrease the production of forest resources. Common public policy instruments or tools are:

- **Insurance or “cushioning” programs** to reduce the risks associated with forest ownership, risks due to such things as fire, insect infestations, disease epidemics, and wind damage;
- **Resource protection programs** designed to control forest fire, insect infestations, and disease epidemics;
- **Land management planning** to encourage integrated forest land management and use and a long-term perspective;
- **Regulation** to direct forestry activities according to rules established by a constituted authority, which sometimes might include an outright prohibition of a certain activity such as clearcutting;
• **Taxation or subsidization** programs which provide disincentives or incentives with regard to certain landowner behavior;

• **Trusts for amenity, conservation, or recreation values** which are designed to delineate and exchange property rights thereby eliminating apparent external costs or benefits.

None of the foregoing tools has been found to be wholly effective as an incentive to landowners. Instead, they seem to be most effective when used in combination.

### 2.4 Rational Land-use Allocation and Stakeholder Consultation

Johann Heinrich von Thünen, a 19th century German landowner, published a book in three parts (1826, 1850, and 1863) that applied the concept of diminishing productivity with respect to land, on which David Ricardo based his theory of rent. Another feature of von Thünen’s book was its treatment of the location of agricultural production vicinity of a city. Commodities requiring to be consumed in fresh condition, and those costly to transport, would be produced nearest the town. In broad rings, other goods were produced at greater and greater distances from the town as their nature and value made them more and more able to bear the time and cost involved in transportation.

Von Thünen’s analysis suggested another approach to land use might provide more desirable results than unfettered market forces. Land-use planning considers all interests while attempting “to integrate land use, transportation, public service, environmental protection, hazard mitigation, public finance, historic preservation, and other related functions into a comprehensive plan that accounts for the connection among these areas” (Kaiser, Godschalk, and Chapin 1995).

Land-use planning establishes basic parameters for land use from existing law and agreement of stakeholders in the planning process. It recognizes an organizing theory of land use beyond market forces is necessary and that its implementation will affect property rights and land values. It also asserts that planning can increase economic rationality and be quite supportive of the market processes.

### 2.5 Use of Participatory Processes for Stakeholder Consultation

Power is ultimately vested in the people in a democratic political system. Every adult has a voice in government. The goals of a democratic society are treating each person as being individually worthwhile and ensuring political power is shared in a morally equal way. These goals cannot be achieved without use of democratic institutions and techniques, those institutions and techniques that are inclusive and egalitarian, as opposed to those exclusive and hierarchical. Systematic use of democratic institutions and techniques insure the existence of a democratic society.

Public participation in decision-making is a democratic institution, and while the term may be of relatively recent origin, the practice has long been applied under different names, for example, the town hall meetings of 18th and 19th Century New England in the U.S. The logic is clear. Involvement by citizens in the decisions that affect them promotes the acceptance and legitimacy of those decisions both for implementing government officials but for the entire political system. Public participation in decision-
making became a feature of U.S. environmental legislation in the late 1960s and 1970s and quickly spread to Europe.

Principle 10 of the 1992 Rio Declaration on Environment and Development reads: “Environmental issues are best handled with participation of all concerned citizens at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided.”

The Aarhus Convention, more formally known as the “Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters” was adopted in 1998 by the United Nations Economic Commission for Europe in the Danish city of Aarhus. Among other things, “it establishes that sustainable development can be achieved through the involvement of all stakeholders.” Public participation in decision-making is now quite formalized in Europe and North America and part of the institutional framework that comprises a market economy and a democratic political system institution.

2.6 Complementary Cross-sector and Multilevel Policy and Law Networks

Effective public policy making—and common sense as well—requires that related public policies and laws and their implementing regulations be complementary. They should not be at odds with each other in their requirements. Schmithüsen (2000) includes consistency as one of four criteria in evaluating the advancement of policy making and legislation, the three others being comprehensiveness, subsidiarity, and applicability. Experience suggests that compatibility is most frequently a problem not with the laws themselves, but with their implementing regulations. A public policy functional failure, including bureaucratic breakdowns, can be the consequence. The same result can occur in excessive procedural requirements.

A recent report of the USDA Forest Service (2002), titled “The Process Predicament: How Statutory, Regulatory, and Administrative Factors Affect National Forest Management,” concluded: “Statutory, regulatory, and administrative requirements impede the efficient, effective management of the National Forest System.” Virtually the same conclusion was reached in similar study by the previous administration. (Thomas Task Force 1995)

The same principle applies to the network of laws in different sectors. Sectors of an economy include agriculture, natural resources, mining, manufacturing, construction; energy, water, education and training, health, and community. Linkages exist across sectors, for example, agriculture, natural resources, energy, and water. A policy of expansion of agricultural production can adversely affect forest management if forest lands are converted to agriculture. Similarly, a policy of oil exploration can take forest land out of production and into energy. Both expansion of agriculture production and oil exploration and production can negatively affect water quality. Hence, the policies of one sector can affect polices of one or more other sectors.
An integrated framework of public policies with coordinated aims, strategies, and instruments is essential in order to overcome complex problems on consistency and to develop more comprehensive solutions that correspond to the overall goal of sustainable development. Taking cross-sector impacts into account and approaching problems in a more integrative manner are key concepts for improving the effectiveness and efficiency of public policies, legislation, and administrative decisions and activities (FAO 2003, Schmithüsen 2003).

An important trigger for the international community to focus on cross-sector impacts and policy linkages was UNCED. In Agenda 21, cross-sector approaches are seen as a prerequisite for the sustainable development of society. The separation of land management issues by various public policies is considered as a reason for lack of development that balances economic advancement, sustainable ecosystem management, and environmental protection. A more comprehensive approach is advocated which integrates economic, social and environmental policy objectives. National governments and the international community have been advised to pay more attention to cross-sector impacts and to develop more consistent public policy frameworks for sustainable development (Agenda 21, Chapter 8, Integrating Environment and Development in Decision-Making).

2.7 Harmony of International Agreements with National Forest Laws and Environmental Legislation

Forests and wood production have gradually become a priority issue in the international policy and political agendas of the 1990s, and a number of legally and non-legally binding international agreements were made (Le Master and Schmithüsen 2003, Schmithüsen 2003). A large number of legally and non-legally binding international agreements with regard to the environment and economic development were also established during the same time period. Their implementation is a challenge because of the multi-levels at which it occurs.

International agreements are negotiated by nation states, which are also the principal agents of implementation through subsequent statutes, administrative rules, and program funding. Even though nation states are signatories, their respective commitments to international agreements vary widely as well as their abilities to carry them out. National policies coming out of international agreements are applied regionally and locally. Individual decision-making is affected, and it is at this level that success is determined by whether the policies are workable, socially acceptable, and economically viable. Ultimately, harmony among international agreements; national statutes, rules, and program funding levels; and regional and local implementation is essential for success.
3. Conclusions

The institutional framework in which economic models are applied in practice is very complex. It includes a market economy, a democratic political system, secure property rights and tenure systems, a rather modest number of public policy instruments providing incentives for landowners, an organizing system of land use beyond market forces, use of participatory processes for stakeholder consultation, integrated and complementary laws and regulations among the sectors of an economy, and harmony between international agreements and national statutes.

FAO (2001) identifies “two major and seemingly contradictory” trends occurring in the world, namely, decentralization and globalization. In the case of decentralization, national forest agencies are being restructured, decentralized, and a reduced in size in terms of both employees and budgets. As a result local communities are being turned to for assistance in protection and management of nationally owned forests. Community involvement is now an important feature of national forest policy and practice.

Globalization refers to the increased use and application of global networks, freer flows of capital, labor, and information among countries, and increased growth of large multinational pulp, paper, and paperboard companies largely through mergers and acquisitions. The private sector now owns or controls significant areas of forests around the world. It is being increasingly held responsible for the environmental aspects of forestry by governments. In the process, corporations have found that significant benefits attend being "a good citizen," leading to a significant number of them to adopt environmentally practices voluntarily rather than having them imposed.

The private sector is being held increasingly accountable for the impacts of forest management on communities. Accountability expectations tend to be even greater when multinational corporations are involved. The implications are great. What responsibilities do corporations have in the communities in which they operate? How should communities be involved? What are appropriate participatory processes for consultation with community members? Who are the legitimate stakeholders?

The institutional framework in which the economic models in forestry operate thus continues to elaborate. The increasing complexity assures that future economic models will themselves become more intricate. As such, they will tend to be more analytical and, quite possibly, less predictive. For the growing complexity of the institutional framework will tend to obscure and even confound causal relationships, making prediction of outcomes difficult.
References


New Zealand Case Study, as presented during a Workshop for Multiple-Use Forest Management at Albury, New South Wales, New Zealand, Nov 1-6.


von Thünen, Johann. 1826, 1850, and 1863. „DerIsolierte Staat in Beziehung auf Landwirtschaft und Nationalokonomie“.

Working Papers International Series Forest Policy and Forest Economics; 
Swiss Federal Institute of Technology (ETH), Zurich, Switzerland
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E-mail: franz.schmithuesen@env.ethz.ch

05/7  Le Master Dennis c. / Sample Alaric V. / Schmithüsen Franz / Sedjo R. A. 
Economic Models of Forest Management, Multiple Use and Sustainability. (22 pages)

05/6  Schmithüsen Franz 
El Papel de la Legislación Forestal y Ambiental en Países de América Latina para la 
Conservación y Gestión de los Recursos Naturales Renovables. Publicado en IUFRO World 
Series 2005, No 16: 5-21, Vienna, IUFRO Secretariat. (22 pages)

05/5  Bouriaud Laura / Schmithüsen Franz 
Allocation of Property Rights on Forests through Ownership Reform and Forest Policies in 
Central and Eastern European Countries. Swiss Forestry Journal 156 (2005) 8: 297-305. (20 
pages)

05/4  Schmithüsen Franz 
Comprender el impacto transversal de las políticas – Aspectos jurídicos y de políticas. Publicado 
en Estudio FAO Montes No 142 (2005): 7-50, Roma FAO. (42 paginas)

05/3  Schmithüsen Franz 
Analyser les impacts des politiques au niveau intersectoriel – Aspects Juridiques et politiques. 
Publié dans Etude FAO Forêt No 142: 5-47; Rome, FAO (2005) (42 pages)

05/2  Lazdinis Marius / Carver Andrew / Schmithüsen Franz / Toenisson Kristjan / Vilkriste 
Lelde: Forest Sector Concerns in the Baltic States – Implications for an Expanded European 
Union. Published in Society and Natural Resources (2005) 18: 839-848. (10 pages) 
Lazdinis Imantas / Lazdinis Marius / Carver Andrew / Schmithüsen Franz / Vilkriste Lelde 
Elite Concerns in Forest Sectors of Estonia, Latvia and Lithuania. Published in Baltic Forestry 
Volume 11 (2005) 1: 97-104. (11 pages)

05/1  Schmithüsen Franz 
Forests, Landscape and Society. Address to the Ceremonial Gathering of the Faculty for Forest 
Science and Natural Environment, June 2005; Aristotle University of Thessaloniki. (15 pages) 

04/8  Giudici Fulvio / Bertogliati Mark / Schmithüsen Franz 
I Patriziati in Ticino – Analisi di alcuni casi con riferimento al ruolo, l’organizzazione e i 
pages)

04/7  Bauer Josephine / Mathleena Kniivilä / Sasse Volker / Schmithüsen Franz 
Common Forest Legislation Issues in European Countries – Reforestation obligations, public 
access and use of non-wood forest products; Summary Report. Forest Legislation in Europe; 
Geneva Timber and Forest Discussion Paper 37, UNECE/FAO. (14 pages)

04/6  Kohler Volker / Schmithüsen Franz 
Comparative Analysis of Forest Laws in 12 Sub-Saharan African Countries. FAO Legislative 
04/5  Schmithüsen Franz

04/4  Schmithüsen Franz

04/3  Oliva Jiri
Rechtliche Bedingungen der ordnungsgemäßen Waldwirtschaft. Fakultät für Forstwirtschaft und Umwelt, Lehrstuhl für Wirtschaftslehre und Steuerung der Forstwirtschaft; Prag, Tschechische Universität für Landwirtschaft. (20 Seiten)

04/2  Brioudes Mathieu
La stratégie forestière européenne face à l’élargissement aux pays d'Europe centrale et orientale en matière de forêts. Rapport basé sur un Mémoire DESS Environnement et développement sylvicoles (2003) Université Montesquieu Bordeaux IV. (40 pages)

04/1  Schmithüsen Franz
Role of Landowners in New Forest Legislation. Published in *Legal Aspects of European Forest Sustainable Development*, 2004; Forestry and Game Management Research Institute, Jiloviste–Strnady / Czech Republic. (16 pages)

03/3  Schmithüsen Franz
Understanding Cross-Sectoral Policy Impacts - Policy and Legal Aspects. Published in *Cross-Sectoral Policy Impacts Between Forestry and Other Sectors*. Forestry Paper 142 (2003); Food and Agriculture Organization of the United Nations, Rome 2003 (48 pages)

03/2  Schmithüsen Franz

03/1  Gallardo Gallardo Enrique
Regulación de los bosques para la conservación de la diversidad biológica - El caso de Chile. Contribución para el Grupo IUFRO 6.13, Derecho Forestal y Legislación Environmental. (10 pages)

02/3  Schmithüsen Franz / Iselin Georg / Herbst Peter
Bibliography - Contributions IUFRO Research Group Forest Law and Environmental Legislation as of September 2002. (35 pages)

02/2  Herrmann Kaspar B.

02/1  Rosset Christian
Participants and Participation in the Management of Natural Resources within Forest Users’ Groups. A Social-Cultural Study in the Middle Hills of two Districts of Nepal. (38 pages)

01/1  Schmithüsen Franz / Wild-Eck Stephan