



New frontiers of forest economics[☆]

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ABSTRACT

This special issue of *Forest Policy and Economics* is based on the papers presented and discussions held at the International Conference on the New Frontiers of Forest Economics, June 26–30, 2012 held at ETH, Zurich, Switzerland. This paper discusses the need of new frontiers of forest economics, provides an overview of the special issue, and presents thoughts about new frontiers. The paper suggests that all knowledge of forest economists is conjectural, and without the competition of contradictorily theories forest economics sinks into intellectual poverty. The progress of forest economics will need a never ending fabrication on new and venturous theories for solving problems and strong attempts to refute, to critically assess and discuss, and to test empirically the new theories. The paper discusses three areas for new frontiers of forest economics – integration of sciences using multidisciplinary and transdisciplinary approaches, incorporation and integration of various streams of economics, and answering the unanswered questions by developing new models and methods.

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1. Introduction

Since the Faustmann revival (Amacher et al., 2009) forest economists worldwide study forest economics with help of the Faustmann-model (Faustmann, 1849), which applies the microeconomic investment theory (e.g. Hirshleifer, 1970; Samuelson, 1983) to the field of forestry. Newman (2002) counts 313 articles, in 2001, based on the Faustmann-model, and we estimate that the number of these articles may be more than 500 by now. However the Faustmann model is only a careful first step to understand the economic aspects of forestry, because all knowledge of economists on forestry is conjectural.

The improvement of our conjectures is the result of competition among theories on their explanatory success but not to build a closed scientific society. Without the competition of contradictorily theories forest economics sinks into intellectual poverty. That means at first, scientific progress needs a never ending fabrication on new and venturous theories for solving problems, and second, scientific progress needs strong attempts to refute, to critically assess and discuss, and to test empirically the new theories (Popper, 2002).

In the past 10 years or so, there have been some efforts in this direction. In 2003, Kant called for extending the boundaries of forest economics. Since then many scholars have made notable contributions in this direction.¹ Some examples of these contributions are the two-tier approach for forest economics suggested by Wang (2004), the need of pluralism in forest economics proposed by Wang and Wilson (2007), applications of the complexity theory to forest economics by Colander

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¹ Prior to 2003 also, there were some efforts to broaden the scope of forest economics. Some examples of those efforts are Clawson (1959), Hartman (1976), Mitra and Wan (1985), Bowes and Krutilla (1989), and Swallow et al. (1990). Nobel Laureate Elinor Ostrom's work also included analysis of forest resources.

(2005), inter-temporal ethics by Khan (2005), post-Keynesian consumer choice theory by Lavoie (2005), behavioral economics by Knetsch (2005) and Kant and Shahi (2013), declining discount rates by Price (2005), social choice theory by Kant and Lee (2004), Mitra (2005), and Asheim and Buchholz (2005), and nonlinearities and multiple equilibria by Rosser (2005), Vincent and Potts (2005), and Chakrabarti et al. (2005). Helles and Vedel (2006) suggested experience economics as an emerging field of forest economics, and Shogren (2007) argued for including behavioral economics into forest economics. In 2011, a special issue of the European Journal of Forest Research on Socio-economics in Forestry followed Kant's (2003) call for extending the boundaries of forest economics (Schlüter and von Detten, 2011).

In 2010, Shashi Kant, Martin Hostettler, and Hans Heinemann organized a sub-plenary session on the new frontiers of forest economics at the XXIII IUFRO World Congress, 2010, Seoul. At this session, papers related to the applications of new-institutional economics (Prof. Elinor Ostrom), behavioral economics (Prof. Urs Fischbacher), public choice theory (Prof. David Laband), and incremental approaches (Prof. Karl-Gustaf Löfgren) to forest economics were presented and discussed. In addition, two scientific sessions were also organized at the IUFRO congress. A volume titled Post-Faustmann Forest Resource Economics, based on these and some other papers, edited by Kant (2013b) has been published.²

After the XXIII IUFRO World Congress, Peter Deegen, Martin Hostettler, Sen Wang, and Shashi Kant constituted a working group on the new frontiers of forest economics (neFFE). The first meeting of the group was held during April 18–20, 2011 at the Faculty of Forestry, University of Toronto. In this meeting, the group decided to launch the activities of the group with an International Conference on the New Frontiers of Forest Economics, June 26–30, 2012, held at ETH, Zurich, Switzerland. The main objectives of the conference were: (i) to bring together leading thinkers in forest economics to explore thought-provoking perspectives on new frontiers of forest economics; (ii) to provide a unique forum to present and discuss cutting-edge thinking papers that will enrich and provide future direction to the discipline of forest economics; and (iii) to provide an opportunity to the participants to discuss the organizational aspects of a research group that will work for the promotion of new frontiers of forest economics.

The key features of the conference were that the number of participants was restricted to 30, only 11 papers (5 invited and 6 chosen through a rigorous selection process) were presented. All papers in full length were submitted before the conference, and all papers had two discussants. The presentation of each paper was allocated 70 min for presentation by author, presentation by two discussants of their reports, and open discussion by all participants. Hence, there was a thorough and lively discussion on each paper. After the conference, the authors were given the reports of the two discussants and editors' suggestions/observations on their papers, and they were asked to revise their papers in view of these observations and the observations of the participants during the discussion.

The papers included in this volume are the revised papers. We are also breaking the tradition, at least in forestry journals, of keeping the reviewers' comments secret. In this issue, we are including the reports of two discussants/reviewers of each paper. The readers should keep this in mind that the discussant reports were prepared on the basis of the first draft of every paper, and discussants were not asked to revise their reports on the basis of the final version of papers. Hence, the discussant reports provide some idea about the evolution of papers. We believe that the combination of the final paper and two

discussants' reports will be more enriched reading rather than the reading of the final paper only.

There is no doubt that the eleven papers included in this volume provide multiple perspectives about the new frontiers of forest economics. However, as stated earlier, every participant contributed towards enriching the idea of new frontiers of forest economics. Many participants, who did not present a paper at the conference, contributed their thoughts towards developing the new frontiers of forest economics. Hence, the remainder of this paper is divided into three sections. The first section provides a brief overview of the eleven papers and their contributions towards new frontiers. The second section does the most difficult task of presenting a synthesis of collective perspectives of the conference about new frontiers. The final section concludes and acknowledges support by various people and organizations.

2. Overview of the papers included in this volume

The special volume starts with a paper by Robert Nelson in which he argues that foresters believe that forest management is a scientific discipline driven by value-neutral experts, but in reality it is driven by new (secular) religious directions of the "gospel of efficiency". Similarly, the recent shift in forest management philosophy from "multiple-use management" to "ecosystem management" is not driven by science, but it is a reflection of new religious direction in American society where the "gospel of efficiency" is losing to a "gospel of naturalness." Some forest economists may be surprised to see this paper in this volume because in their own religion of forest economics which to some appears to be driven by the "gospel of the Faustmann formulation", criticism of their religion is banned and there is no role of open discussion. However, the main idea behind the neFFE is to break down these walls and make the discipline of forest economics inclusive and evidence-based rather than exclusive and assumption-based. In this direction, Nelson makes two outstanding contributions. First, he very clearly demonstrates the need to understand and address the normative, even philosophical and theological, side of forest policy making. Second, he makes a strong case that the so called scientific disciplines, such as forest management, forest economics, and economics, are not driven by objectivity but by the religious views of people who follow the "gospel of efficiency" blindly. In economics, such phenomena are characterized by positive feedbacks and path-dependence, both of which imply certain inefficiencies (Arthur, 1994a, 1994b). Hence, Nelson makes a very strong case for the neFFE not to be driven by any gospel. Martin Hostettler, in his discussion of this paper, offers number of strategies to address religious issues in the discussion of forest policy issues, and confirms Nelson's findings on the basis of discussions on forest reforms in Switzerland. Sen Wang, in his discussion, agrees that the management regimes are subject to societal values, and personal preferences and belief systems must be incorporated in management decision making.

In the second paper, Peter Deegen argues that economics is the science of explaining human interactions, and differences in human interactions are often caused by different institutional structures. Hence, economics, including forest economics, is not detached from institutional structures, and predictions about human interactions are only valid for the given institutional structure. Deegen suggests a framework, using sub-constitutional contracts (markets and politics) and the forms of moral order (external and extended) as two variables, to classify institutional structures, and classifies the Faustmann-model, as a pure model of market exchange in the extended moral order. Ostrom's commons, public choice, and local markets are other parts of forest economics. He suggests that the framework can be used to understand interrelations between different forest economic models as well as to study unanalyzed or less analyzed areas of forest economics. Deegen's framework is an excellent contribution towards the neFFE and offers valuable insights for economic analysis of forestry issues in diverse institutional settings. In a broader sense, it confirms the arguments of Nelson about forest management and forest economics and offers a way to

² This volume includes papers on behavioral economics (Shahi and Kant, 2013), complexity theory (Kijazi and Kant, 2013), agent-based models (Schwab and Maness, 2013), time preference (Atmadja and Sills, 2013; Price, 2013), public choice theory (Laband, 2013; Zhang, 2013), systems approaches (Yin and Zhao, 2013; Lippke et al., 2013), and incremental approaches (Löfgren and Gong, 2013; Kant and Shahi, 2013; Zhang and Majumdar, 2013).

move forward. Sen Wang, in his discussion, agrees with Deegen that Faustmann's method is a sub-set of the space of economic analytics for forestry purposes. Shashi Kant, in his discussion, suggests that Deegen's institutional setting classification system and the Samuelson/Musgrave goods classification system should be treated as complements and not substitutes.

In the third paper, Barkley Rosser argues that interactions between forest ecosystems and economic systems generate nonlinear relations resulting in complex dynamics. In view of these complexities, he suggests moving forest management from the current economic concept of net present value maximization to the concept of the steady-state forest in which some overall structure or pattern of forest is stationary. He identifies three sources of non-linearities: non-linearity in production processes of forests, multiplicity of discount rates, and the backward bending nature of timber supply curves. Rosser's concept of steady state forest is similar to the biological concept of continuous cover forest management and the economic concept of multiple equilibria. Hence, this paper adds a new dimension to the neFFE – the economics of multiple equilibria rather than the economics of a single general equilibrium, a key feature of the “gospel of efficiency”. Peter Deegen, in his discussion, observes that forest economists have a lot of homework to do and the new frontiers are not new subjects but better research methods. As per discussion by Shashi Kant, the main message of this paper is that real critical thinking, from different disciplinary perspectives such as economics (social science) and biology (natural science), should lead to similar conclusions as that of the steady-state forests, and he expects many forest economists to be motivated to conduct research on the complexity of forest ecologic–economic systems.

In the fourth paper, David Laband demonstrates, with the example of the recent poisoning of Auburn University's (Alabama, USA) beloved Toomer's Oaks, that values of esthetic, spiritual, and cultural ecosystem services are not trivial but private markets fail to account properly these values. He argues that some of these ecosystem services might be treated as public or quasi-public goods but public decision-making is plagued by inefficiencies also, and public decision-making related to private land owners is especially prone to inefficient results, resulting in the extreme in the Tragedies of the Political Commons. Martin Hostettler, in his discussion, suggests that these values of ecosystem services influence costs and therefore land market outcomes, specifically in Switzerland, and these responses of forestland market outcomes are similar to the market of art work which incorporates highly subjective values. In addition, Hostettler observes that Laband brings subjectivity into play, and its exclusion by mainstream economics is a failure and needs to be corrected. Peter Deegen, in his discussion, suggests that the analysis of dealing with extraordinary values in society should be based on a positive theory of voting rules, and therefore, constitutional economy becomes important in forestry and could be a new frontier in forest economics. Deegen questions the meaning of efficiency and observes that from a subjective perspective, the result-oriented definition of efficiency is an oxymoron. In brief, Laband's paper brings non-trivial values of ecosystem services, subjectivity, limitations of commodity markets as well as political markets to the forefront, and shows public choice theory as another frontier of forest economics.

In the fifth paper, Sen Wang argues that changing societal values due to increased urbanization, such as increased demand for forest recreation and higher values for ecosystem services, demand for environment-friendly forest management practices, and development of new wood-based products, will influence the next frontier of forest economics. He observes that these developments will require a better understanding of forests in providing multiple streams of benefits simultaneously to different segments of society, and suggests a stratified framework based on Maslow's hierarchy of needs for examining forest economics issues. Higher values of ecosystem services and differences between rural and urban peoples' forest values are common features of this paper and Laband's paper. Ted Howard, in his discussion, observes that Wang has

provided an interesting and useful framework for the application of our analytic techniques, and the framework may work well as a positive model to explain the evolution of our discipline. However, the challenge to forest economists is how to use the framework in normative analysis when there are asymmetries in values and power. Similarly, Walter Sekot, in his discussion, agrees with the contributions of this paper for further progress in the field of forest economics, and suggests that an understanding of the interrelationships between forestry and other forms of land use, dynamics of systems, complexity of human behavior, and a synthesis of different theoretical approaches may lead to more suitable economic models and a higher significance of economic analysis and research.

In the sixth paper, Claire Montgomery explores the relevance of the New Institutional Economics to understand the relationships between governance structures and the characteristics of resource and resource user community using the example of Watershed Councils in the State of Oregon, US. She observes that the outcome of “one-size-fits-all” uniform regulatory standards can be disastrous if those standards prove to be wrong. The top-down approach that dampens the disturbance cycles puts ecosystems at risk of collapse when disturbance does occur. The bottom-up approach, by incorporating variability in resource rules, may be the most promising way to manage natural disturbances. Hence, an understanding of the evolution of institutions to incorporate changes in knowledge, technology, and values may help in accepting an experimental and adaptive approach to institutional design for resource management. In his discussion, Bill Hyde agrees that the assessment of complex ecosystems is an important topic for the discussion of frontiers of forest economics, and there is a strong need for an organized set of insights for decision making within complex forest ecosystems. Similarly, Daowei Zhang, in his discussion, recognizes the importance of understanding the emergence of new institutions in managing complex forest ecosystems and suggests many questions that need to be answered as we move along this line of research.

In the seventh paper, Roderich von Detten and Fenn Faber make a very convincing case for organizational studies to be one new frontier of forest economics. The authors present the results of organizational long-term decision-making, by German state-owned forest companies facing heterogeneous expectations and interests, under uncertainty due to climate change. The authors report that these organizations use previously established solutions (e.g., climate risk maps) to gain legitimacy and demonstrate one's expert status, and use experience-based traditional heuristics for long-term decision-making under uncertainty. The authors draw parallels between their findings and some economists' argument of moving from efficiency to complexity. Claire Montgomery, in her discussion, makes very strong arguments for trans-disciplinary approaches in forestry and for the topic of appropriate institutional arrangements for managing forests become a new frontier of forest economics and forest social science. Min Kyung-taek, in his discussion, supports these organizational findings with examples from South Korea.

In the eighth paper, Runsheng Yin and others introduce a social-ecological systems (SES) framework in the context of payment for ecosystem services in general and ecological restoration in particular. On the basis of China's Cropland Restoration program analysis, using the SES framework, the authors discuss lessons learnt from ecological, socioeconomic, and institutional perspectives to design payment for ecosystem services mechanisms. The authors conclude that a continuous focus on the dynamics of linkages between the governance system and the resource system, in the light of movements, shifts, and contingencies occurring to internal actors and external conditions, is necessary for the success of ecological restoration programs. In essence, this paper again adds to the importance of institutions and organizations in the new frontiers of forest economics. Zuomin Wen, in his discussion, highlights the complexity involved in the study of multiple facets of social-ecological systems and suggests further research. Similarly, Ja-Choon Koo, in his discussion, suggests many topics related to the subject for further research.

In the ninth paper, Toth and others introduce the concept of a voluntary market mechanism (termed ECOSEL) to match willing buyers and sellers of forest ecosystem services. The ECOSEL is a web-based auction platform that allows competition as well as collaboration among buyers to bid on alternative forest management plans offered by landowners. In this paper, the authors, using a case study of production plans for carbon sequestration, forest habitat, and timber production, demonstrate the use of multi-objective programming to generate minimum-cost management alternatives for a real ECOSEL auction. Both discussants of this paper, Gregory Valatin and Nicolas Robert, emphasize the importance of creating markets for ecosystem services and the concept of ECOSEL, and suggest many associated topics/areas for further research.

In the tenth paper, Nicolas Robert and Anne Stenger demonstrate the importance of understanding interactions between ecosystem services in designing payment for ecosystem services (PES) programs because payment for the additional provision of one ecosystem service might affect the production of other ecosystem service produced jointly. The authors observe that in the case of multiple services, payments can either be made independently for each service (stacking) or jointly for all services (bundling). In the case of bundling, the minimum payment should be the total opportunity cost irrespective of interactions between services. In the case of stacking and the presence of diseconomies of scope, the sum of individual opportunity costs for each service will not compensate for the total opportunity cost, and therefore some services might remain undersupplied. On the other hand, in the case of economies of scope, the total stacked amount will be greater than the total opportunity cost. SándorTóth, in his discussion, believes that the study has high value for policy makers, forest managers and students. Xiaoping Zhou, in her discussion, observes that the authors provide a very good framework for analyzing the relationships and trade-offs between different ecosystems services and suggests many challenges that the framework will face in addressing real-life issues and situations.

In the last paper, Sun Joseph Chang argues that the problem of carbon dioxide emissions is not only an environmental problem but is a basic human rights issue, and proposes a solution based on Green Human Rights that entitles every person to equal carbon dioxide emissions. Based on this principle, countries with per capita carbon dioxide emissions above that of the global average must pay for the privilege to pollute while countries below the global average receive compensation. The author also suggests that to determine the net emissions of individual countries, the total emissions of every country should be adjusted for carbon dioxide out-sourcing through international trade and carbon sequestration by forests and forest products. The author argues that the proposed solution would encourage all countries to control or lower their carbon dioxide emissions. Martin Hostettler, in his discussion, observes that the suggestion of Green Human Rights raises some very delicate and complex questions, and terms the suggestion as the most dramatic change ever to be implemented by political entities. Sen Wang, in his discussion, believes that it is a fairly straightforward, easy-to-follow solution to the complex challenge of carbon emissions but identifies a number of hurdles in its acceptance by policy makers.

3. Collective perspectives about new frontiers

One of the common dominant themes of these papers is the unity of social sciences: The first paper focuses on a normative consideration including philosophical and theological aspects while the last paper focuses on human rights and distributional aspects. The importance of interdependence between economics and other social sciences is also emphasized by other papers, specifically those by Peter Deegen, David Laband, and Sen Wang. Moreover the papers by Claire Montgomery and Runsheng Yin et al. emphasize interconnections between social sciences and the ecology as a discipline of natural sciences. The paper by

Barkley Rosser demonstrates the complexity due to interconnections between social systems and ecological systems.

Although these papers focus to only some small points we conclude, that the unity of social sciences, and moreover the unity of sciences could be a new frontier of forest economics. To understand the problems in contemporary forestry the study of history, culture, religion, governance and much more is necessary. Partnerships with policy scientists and sociologists as well as joint work with historians and anthropologists should be more common. Moreover, although forest economists have long collaborations with biologists, for example by studying forest growth and forest succession, to connect the approaches of the different sciences is not so well developed and could be a further new frontier of forest economics or better, of forest science.

The second common dominant theme is that the Faustmann forest economics analysis is only one part of forest economics. To analyze and understand other economic problems related to forests, other streams of economics, such as constitutional economics (Peter Deegen; and David Laband), new institutional economics (Claire Montgomery; and Runsheng Yin et al.), and organizational economics and studies (Roderich von Detten and Fenn Faber) could be incorporated as integral parts of forest economics. Clearly the many various streams of economics are sources of high value by answering un-answered questions in and by finding new scientific question on forestry. Besides the streams of economics discussed above, other streams of economics such as behavioral economics, welfare economics, ecological economics, post-Keynesian economics, and social choice theory need to be integrated in forest economics.

The last common theme is that new methods and models can be developed using the existing framework of forest economics to address the emerging issues, e.g., ecosystem services. Barkley Rosser applies complexity theory and discusses the problems of multiple equilibria. Sandor Toth et al., and Nicolas Robert and Anne Stenger provide examples of new tools to answer emerging questions related to market creation and designing incentive schemes for the provision of ecosystem services.

These three themes were also common and dominant during the discussions of papers as well as discussions about new frontiers at the conference. Hence, one possible way to organize the discussion of new frontiers of forest economics is to use these three themes, but it is not the only way.

An alternative way is to explore new frontiers with regard to two dimensions. First, forest economics may be inspired by developments of general economic theories and methodological progress in related fields of research. The respective challenge is to assess the significance of such innovations in regard to forestry and to design adaptations or modifications where necessary. Second, new problems concerning the relationship between human beings and forests may trigger specific challenges in terms of theoretical understanding, thereby creating new topics for economic analysis and applied research. Hence, intense interaction with practitioners utilizing the results of economic analysis for decision-making as well as transdisciplinarity should be a characteristic for exploring the new frontiers of forest economics. The possible combinations of established or new methods applied to established or new topics will generate a matrix of four categories of new frontiers that will resemble the matrix of strategic management by Ansoff (1957).

Another possible way of exploring new frontiers may be three dimensional. First, as an outcome of the progress in many related disciplines, such as economics, biology, forestry, mathematics, and computer sciences, many new tools may be available, and the use of some of these tools will definitely enrich the forest economics discipline. Second, with time new questions arise, such as global warming mitigation and environmental preservation. These questions are related to forestry but also to other human activities such as agriculture and industry. Forest economists are more than ever part of a scientific

ecosystem involving agricultural, environmental and industrial economists. With the increased interest in non-wood forest products, forestry is now considered by a large number of actors with different objectives. Helping decision makers cope with this product-based or outcome-based diversity is a new role forest economists have to play. Finally, trees and forests have social, cultural and spiritual values which cannot be revealed with traditional economic tools. For these reasons, forest economics changes and observing trends helps find new ideas and increases research relevance and efficiency.

We are sure that there can be other approaches to identify new frontiers of forest economics. But, even the three approaches we have suggested are not totally independent of each other, and all three approaches have many similar common elements. Hence, for the further discussion of new frontiers, we return to the first approach.

3.1. Integration of sciences – multidisciplinary and transdisciplinary approaches in forest economics

Forest economics is the study of interactions between social systems, economic systems, and forest ecosystems, their outcomes, and the short-term and the long-term implications of the outcomes to all three systems. In other words, economic systems, social systems, and ecological systems are not independent but are inter-dependent. Hence, the issues of economic efficiency, social acceptability, and ecological resilience need to be addressed simultaneously and not separately. Economists and forest economists, guided by the “gospel of efficiency”, take a very narrow view of economic efficiency and generally assume that private economic efficiency will deliver social economic efficiency.³ However, that is not a reality as repeatedly demonstrated by economic systems and social systems. Market prices may reflect the true private values of resources to agents participating in the market but they rarely, if ever, reflect true social values due to a number of reasons including production and consumption externalities and numerous non-marketed resources specifically in the context of forest ecosystems. Hence, social economic efficiency cannot be determined by market prices alone. As soon as we become serious about the fundamental difference between private and social economic efficiency, the differences between social economic efficiency, social acceptability, and ecological resilience start disappearing.

The interdependence between these three types of systems can also be understood by focusing on complex processes and cycles of disturbance and renewal that occur at many scales in time and space in forest ecosystems. Historically, we have managed forests and other ecosystems to dampen disturbance cycles to generate a predictable and stable supply of services. We thought and perhaps still believe that these actions of dampening disturbance cycles were/are economically efficient. These may be economically efficient to private firms that benefit from stable supply of timber, but how can such actions/decisions be economically efficient to society if they lead ecosystems to become “brittle” and vulnerable to collapse when disturbance does occur? At the same time, large scale disturbances such as wildfire are often socially unacceptable and rightly so because they may be economically inefficient to society also. Hence, the challenge for forest economists is to inform the design of forest policy so that it finds management decisions that are socially acceptable, ecological resilient, and socially economic efficient—allowing for disturbance at temporal and spatial scales in the interest of social and economic systems.

Forest economics and economics in general are well-suited to finding privately efficient solutions to problems with clearly defined goals

³ There is no doubt that economists have recognized conceptual differences between private and social economic efficiency, but social economic efficiency has not received the same level of attention as that of private economic efficiency. The treatment of social economic efficiency seems similar to the treatment of increasing returns to scale in economics – treating like a pathological species kept in a jar (Arthur, 1994).

and constraints. For example, forest economics can help firm level production decisions where decision makers can choose the best, most efficient solution. However, in the case of many forestry issues, the goals are not agreed upon, and the constraints are unclear or shifting. In these cases, forest economists can help society, by working together with other social and natural scientists, to develop a more complete picture of the issues and the solutions. In brief, forest economists have to move quickly and openly towards multidisciplinary and transdisciplinary approaches to find socially economic efficient solutions to forestry issues.

The question of interdependence of these three systems is also evident in the title of a book by a well-known resource economist **Marion Clawson (1975)** – “Forests for Whom and for What?”. As forest economists, we must recognize that our discipline does not have a monopoly on the approaches employed to find the answers to those questions. New frontiers of forest economics, to be relevant to society, to answer Clawson's questions, must intersect and collaborate with the natural sciences, other social sciences, and the humanities. National research agendas in the natural sciences are often now requiring collaboration with the social sciences, in recognition of the complexity of the problems being examined. As forest economists, we have long collaborations with biological production scientists, providing, for example, perspectives on how society might price timber commodities produced under alternative regimes. Partnerships with policy scientists and sociologists have been less common and joint work with historians and anthropologists has been quite rare. Yet, how can we answer Clawson's questions from an economic perspective if our work is not assisted by those who understand governance, culture, and the timelines of society?

3.2. Incorporation and integration of various streams of economics

There is no doubt that to fully understand and address the issues related to forest management and forest economics, multidisciplinary and transdisciplinary approaches that include different disciplines from social sciences and natural sciences are necessary. However, the overall discipline of economics is also quite rich, and various streams of economics have emerged to address the new and emerging economic issues or to address the limitations of the main-stream economics. Unfortunately, most of these streams have been unable to make deep inroads into forest economics except some scattered efforts that are listed in the introduction of this paper. Hence, incorporating and integrating various streams of economics into forest economics will be the other dimension of new frontiers of forest economics. Some of these streams and their relevance to forest economics are discussed next.

3.2.1. Behavioral economics and sustainable behavior

Multidimensional and realistic human beings rather than purely selfish economic agents were the members of Adam Smith's world (**Ashraf et al., 2005**). However, it took almost 200 years for economists to accept the other side of human-being, and forest economists should take advantage of that. The endogenous and dynamic nature of individual preferences has become evident from behavioral economics and group-based valuation methods. Forest economics may help shed light on, for example, the way in which preferences for particular types of forest landscapes depend upon the prevalence of these different landscapes. Once the endogenous nature of preferences is accepted, the issue of how they could be influenced to induce behaviors that recognize the importance of ensuring the long-term health of forests and the sustained provision of the benefits they provide becomes important. Investigating the potential for behavioral ‘nudges’ may be useful in changing behavior in some cases, and it is an area of considerable current forest policy interest. The idea that changing preferences is a new frontier will no doubt surprise (or even alarm) those who accept the absolute sovereignty of existing individual preferences as the basis for consumer theory, welfare

economics and economic policy. However, akin to public health strategies to reduce smoking and the incidence of associated lung cancer, effectively tackling problems such as global climate change and biodiversity loss may also require directly influencing preferences, rather than simply relying upon traditional regulatory approaches and institution building. Hence, integration of behavioral economics in forest economics may totally change the landscape of forest policies and forest management practices.

3.2.2. Complexity theory and economics of multiple equilibria

The interactions between ecological systems and economic and social systems, as discussed in the papers by Barkley Rosser and Claire Montgomery, lead to complex dynamic systems. In addition, decision making in forest management is expected to incorporate diverse preferences of heterogeneous agents (Kant and Lee, 2004; Kant, 2013a, 2010), and forest managers and economists have to be responsive to dynamics of preferences as discussed by Sen Wang in this issue. The incorporation of these features is beyond the efficiency story of economics and will require economics based on complexity theory, which views change (e.g., progress towards new forest management regime) as an evolutionary process occurring concurrently at multiple levels (Colander, 2005). In complexity theory, policy change affects mutually-dependent variables at different levels, some of which may change gradually while others may change rapidly, and therefore instead of searching for a single optimum, like in the case of efficiency theory, complexity analysts need to look for early indicators of switch points that will fundamentally change the nature of the system (Colander, 2005). In complex systems, there is no single equilibrium but there is a set of basins of attraction, some basins more attractive than others. In a way, behavioral economics and complexity theory go hand-in-hand because behavioral economics provides evidence for endogenous, diverse, and dynamic preferences, and these actual preferences of human beings result in economic systems that can be best examined and understood by complexity theory. Hence, the incorporation of the economic stream focusing on complexity theory and economics of multiple equilibria will provide the tools to analyze actual human behavior as well as to incorporate interactions between different systems and dynamics of the systems.

3.2.3. Constitutional economics

In recent times, collective consumption and path-dependence aspects of forests and other natural lands have gained prominence. Individuals and interest groups increasingly argue that many of the benefits provided by trees command our attention and respect because they are very sizable in the aggregate and affect large numbers of people. Whether the land that trees grow on is publicly-owned or privately-owned, the fact that there are collective consumption aspects of trees implies a substantive re-thinking of the economics of efficient management. Notwithstanding the fact that valuing environmental services has become an active scientific playground in recent years, our struggle to attach values to tree-derived goods and services, such as soil stabilization, water filtration, or landscape views, by itself creates no impediment to efficient management of privately-owned land. The owner implicitly values these goods and services, as reflected in the management decisions he makes. It is especially in consideration of collective consumption that we encounter problems and these problems potentially confound efficient management decision-making on both publicly-owned and privately-owned property.

In a collective consumption context, efficient decision-making does not require specific knowledge of values. However, it does require efficient aggregation of preferences. As James Buchanan and Gordon Tullock (1962) pointed out 50 years ago in their landmark book, *The Calculus of Consent*, the only voting rule that efficiently aggregates preferences is unanimity. But a unanimity voting rule is so prohibitively costly to implement that, in practice, it is not used in large-numbers settings. Instead, less-than-unanimity decision rules,

such as plurality or majority-rule, are employed. Because each person's vote weighs equally in decision-making but intensity of preferences is not distributed equally, social aggregation of preferences through voting may beget extraordinarily inefficient land-use decisions. Because the consequences, both allocative and distributive, of preference aggregation through voting may prove to be utterly profound, it is essential that we understand and appreciate not only the failures and successes of private decision-making but also the failures and successes of public decision-making, and that will require the integration of constitutional and sub-constitutional economics in forest economics.

3.2.4. New institutional economics

Every forest resource management challenge involves different combinations of characteristics of the resource and of resource users. These characteristics affect the cost and feasibility of defining common resource management objectives, negotiating agreements and rules for what management activities are allowed by whom, who owns what, and who has decision authority, resolving conflict, monitoring resource use, enforcing the rules, and evaluating the condition of the resource. Policies that facilitate the development of governance structures that allow for more adaptive and flexible forest resource management may be more likely to lead to globally stable forest ecosystems.

Answers to these questions can be found through the emerging and evolving disciplines that go under the umbrella of "New Institutional Economics." The branch represented by economists such as Elinor Ostrom and Gary Libecap, as extended in the sub-discipline that Jouni Paavola and Adger (2008) calls "Institutional Ecological Economics," may provide a place for forest economists to start examining the advantages and disadvantages of alternative governance structures for managing forest resources. However, this is not a venture for economists alone. No forest policy that involves institutional organization can be effectively implemented except within the norms, relations, and organizations that comprise the social context in which economic transactions occur. The boundaries between the disciplines of economics and sociology become blurred when we turn to the study of institutions. Nonetheless, barriers to communication between those disciplines exist and a dominant theme in the new frontiers of forest economics should be the formation of healthy conduits of communication across those barriers.

In addition, failures of markets to account for the value of ecosystem services and natural capital (which represent a fundamental cause of unsustainable economic growth, including large-scale deforestation and forest degradation) are due partly to the lack of appropriate institutions. In many countries there is considerable interest among policy-makers in research on design of incentives (e.g., payments for ecosystem services) and other mechanisms to address these failures so landowners no longer face incentives to make choice (e.g., deforest or degrade forests) which are far from optimal from a societal perspective. The issues of institutional design have their roots in institutional economics.

3.2.5. Organizational economics and studies

Some scholars also refer the field of institutional economics, which focuses on the study of transactions that occur within the firm, as organizational economics. This is an important aspect of forest economics specifically for organizations involved in forest management as well as manufacturing of forest-based products because internal transactions in these vertically integrated firms have not attracted much attention of forest economists. However, another important aspect of organizational economics is the study of decision making by organizations involved in forest management. These organizations may be public or private and their decision making may not be necessarily guided by the profit maximization. Such organizations not only formulate policies and management plans but also translate those

policies and plans into actions, and resource allocation outcomes are highly subject to organization's decision making. Hence, the study of decision making within different types of organization is as critical as the study of markets for forest economics. As reported by Roderich von Detten and Fenn Faber in their paper, organizations may use organizational legitimacy and experience-based traditional heuristics in their decision making. Hence, the studies of organizational decision-making should include approaches from behavioral sciences and the plurality of decision making models. Forest economists will have to develop this stream in close collaboration with behavioral scientists and other social scientists.

3.2.6. Welfare economics and political economics

A nearly uncharted frontier of forest economics is that of the application of welfare economics to forestry issues. People hold a wide range of values associated with forests and forest resources and, as an increasing proportion of the world's population inhabits urban areas, urban values will come to dominate the answers to Clawson's questions. Forest economists have usually left out addressing the distributional aspects of forest resource uses and, relative to other aspects of economics, there is little published literature. Yet, as urban values dominate, there is great potential for disparities in the distribution of benefits and costs across locational gradients. While we probably cannot contribute much to the debate about whether a change in distribution is or is not equitable, we should certainly try to develop the tools for identifying the magnitude, direction, and spatial dimensions of changes brought by policies, markets, political processes, and shifting social and cultural values. Our efforts in addressing these questions will be enhanced by collaboration with our colleagues in the humanities and social sciences.

3.2.7. Other streams of economics

In addition to these streams, incorporation and integration of ecological economics, post-Keynesian economics, and social choice theory will also be critical to address many issues related to forest economics. Some discussion about the relevance of these streams to forest economics can be found in Kant (2003), Kant and Berry (2005), and Kant (2013b).

3.3. Answering the unanswered questions by developing new models and methods

In this volume, two papers (Toth et al.; and Nicolas Robert and Anne Stenger) provide interesting examples of developing new models to answer emerging questions related to market creation and designing incentive schemes for the provision of ecosystem services. However, these examples may be just two unnoticeable scratches on the surface of the black box full of unanswered questions. Hence, the third frontier of forest economics may be to develop models and methods using conventional market-based tools of forest economics to answer many unanswered questions, and to move to the first two frontiers in cases where conventional tools fail.

In terms of unanswered questions, there are many areas but in recent years the study of ecosystem services has become the most important. The Economics of Ecosystems and Biodiversity (TEEB) report recently called for national accounts to include the value of changes in natural capital stocks and ecosystem flows (www.teebweb.org), and how best to do this is currently being actively considered by forest economists. There are many issues related to the valuation and accounting of ecosystem services that need to be answered; some of those are: (i) developing consistent methods to account for value of changes in natural capital stocks and ecosystem flows for forests, especially where existing evidence is currently weak (e.g., mental health benefits of forests) and double-counting a potential issue (e.g., health, amenity, and recreation benefits); (ii) understanding and accounting for the extent of ecosystem resilience

(e.g., to climate change, and pests and diseases) and any critical thresholds (e.g., related to species extinction); (iii) understanding temporal and spatial variations in ecosystem service flows and in the opportunity costs of increasing woodland cover; (iv) the cost-effectiveness of forestry climate change mitigation and adaptation options compared to other alternatives; and (v) accounting for life cycle, non-permanence and leakage effects.

The list of these unanswered questions may be lengthy and will continue to grow. However, examples of these questions can be found in Hyde (2013) and Zhang and Pearce (2011). Hyde (2013) has identified twelve unanswered issues including use of the Faustmann formula, relationships between the macro-economy and the forest sector, distributive matters, the performance of public forestry agencies, the diversity of industries with respect to their demands on forest resources, collective forest management, and the Kuznet's curve for forestry. Zhang and Pearce (2011) have identified issues related to ecosystem services, forest health, and governance and institutions for sustainable forestry. There are also many issues related to innovation, growth, change, and forestry business as well as political entrepreneurs.

In brief, the main purpose is not to list all unanswered questions but to identify these aspects as one of the streams of the new frontiers. Some scholars may question the validity of including this stream in the new frontiers of forest economics, and they may have a valid point. Hence, it may be necessary to divide this stream into two sub-streams: (i) new methods and models based on the current dominant stream of forest economics and (ii) new methods and models based on the streams of economics discussed in Section 3.2 and multidisciplinary and transdisciplinary approaches. There is no doubt that the second stream will fall into the new frontiers of forest economics while the first stream may be overlapping with the current stream of forest economics and the new frontiers of forest economics.

4. Conclusions

The eleven papers included in this volume and the collective perspectives about new frontiers present some examples for future directions in forest economics. However, we would like to warn the readers that the objective of this volume is not to draw the tight boundaries around the new frontiers of forest economics but, rather, to let them know that the new frontiers of forest economics will be boundless. Keeping that in perspective, we would like to draw some inferences.

First, the need for the new frontiers of forest economics is well established and we have an obligation to contribute towards that need: we would like to prevent a closed scientific society. Second, the neFFE should not be guided by any gospel. Third, the neFFE should be inclusive in every aspect rather than exclusive that means open doors for contradicting views and arguments. Fourth, forest ecosystems are not timber only and therefore forest economics has to be based on the unity of sciences and the interdependence between social sciences and natural sciences. Finally the integration and incorporation of all relevant and useful streams of economics are strong sources to find unanswered answers and new scientific questions.

We would like to invite everybody to fabricate new contradictory theories on the social phenomena in forestry. Also we need strong attempts to refute, to critically discuss, and to test empirically the new theories. Exactly these are the key impetus to the neFFE.

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