Evidence suggests that Kautilya (or Chanakya) discussed some economic aspects of forest resources in his famous book Arthashastra (economics) written during the fourth century in India Basu, 2011). It is also believed that the first discussion of economic harvesting in Germany was held in the monasteries of Mauermunster during the 1100s (Amacher, Ollikainen and Koskela, 2009). During the 1700s, Denmark and England played a dominant role in developing basic concepts of forest economic thought (Amacher et al., 2009). Danish Count C.D.F. Reventflow proposed an economic theory of optimal forest rotation as early as 1801 (Helles and Linddal, 1997). Englishman William Marshall, in his writings in 1790 and 1809, suggested the need to include the opportunity cost of growing trees and the cost of occupying the land in the calculation of optimal forest rotation (Scorgie and Kennedy, 2000). Irrespective of these early writings, the origin of current dominant forest economic thought is largely attributed to Martin Faustmann’s paper published in 1849. In the first half of the 1800s, many foresters of Germany, such as Friedrich Pfeil, Gottlieb König and Johan Hundeshagen, published economic aspects of forest management in the first journal of forest science, die Allgemeine Forst- und Jagt Zeitung, which was started in 1824 (Amacher et al., 2009).However, it was the article by Edmund von Gehren on the determination of land value published in the same journal in 1849 that attracted the attention of Martin Faustmann, who published his critique and offered a different approach to calculate land value in the same year. In 1850, Pressler supported Faustmann’s approach with a mathematical formulation (Pressler, 1860). In 1921, Bertin Ohlin, a Swedish economist, also presented a mathematical formulation of optimal forest rotation (Ohlin, 1921). Hence, Faustmann, Pressler and Ohlin are considered the founders of forest economic thought, which remained unnoticed by the English-speaking world for almost a century. The earliest reference to Faustmann’s formulation in English was Gaffney (1957), followed by Bentley and Teeguarden (1965) and Pearse (1967). Faustmann’s paper was translated into English in 1968. Samuelson (1976) gave the credit for current economic thought to Faustmann’s formulation, and since then, Faustmann’s formulation has become the cornerstone of forest economics (Newman, 2002). Irrespective of the origin of current forest economic thought, two aspects – optimal forest rotation and the choice of discount rate – have dominated discussions in forest economics for the past 50 years. The ownership of forests and the trade of forest products are two other aspects that have been discussed heavily. The issue of ownership has multiple aspects. About 75% of global forests are publicly owned, whereas about 14% are privately owned (White and Martin, 2002). In the case of public forests, determining optimal timber prices is a challenging economic issue because of a large single ownership that does not satisfy the conditions of a competitive market. In the case of private forests, the challenge is to design economically optimal tax policies to advance societal goals. Another complexity arises when different forest owners have different forest management objectives. Similarly, forest products have been locally and internationally traded for centuries, and an understanding of trade issues is just as critical as understanding the local economic issues associated with ownership. Although the foundations of forest economic thought laid by German foresters mainly focused on timber resources, the importance of non timber resources in decision making started to emerge in the 1970s. In 1976, Hartman incorporated non timber resources in determining optimal forest economics rotation (Hartman, 1976). Since then, efforts to advance nonmarket evaluation techniques to quantify the value of ecosystem services such as outdoor recreation, biodiversity, clean air and clean water have been intensified. Climate change seems to be the greatest environmental challenge of the twenty-first century. Forest carbon sequestration and storage has been shown to play a critical role in mitigating climate change. For example, Bonan (2008) found that carbon sequestration in forest ecosystems was close Evolving forest resource economic thought to one-third of carbon emissions from the use of fossil fuels and land-use change. Approximately 75% of total terrestrial biomass carbon and more than 40% of soil organic carbon are stored in forest ecosystems ( Jandl et al., 2007). Hence, the economics of climate change must be an integral part of forest management and conservation strategies. The risks and uncertainties associated with markets and natural processes such as climate change, forest fires and biological invasion of species have stimulated many forest economists to incorporate them into the analysis.

The Faustmann formulation assumes that a forest owner operates under the conditions of a ‘private property’ that includes exclusive, perpetual, transferable and unfettered property rights. Forest ecosystems provide a web of goods and services that include private goods, public goods, common-pool goods and club goods; therefore, a simple concept of resource ownership may not be good enough for economic analysis of forest ecosystems (Kant, 2000). In fact, government’s role in regulating and managing forests arises due to the existence of multiple types of goods and associated market failures (Kant, 2003a). Forest ecosystems are specifically susceptible to market failures because they are expected to contribute not only to the private goals of the forest owner, but also to social objectives, including the state of the environment. Most governments play an active role in designing forest property rights arrangements to achieve private as well as social goals. Hence, the economics of forest property rights has become a very important component of current forest economic thought. Finally, there are many economic aspects of forests that cannot be dealt with in the boundaries of the Faustmann framework, and that leads to gaps between theoretical economic models and forestry practices. Kant (2003b, 2013) observed that the economics profession, as a whole, has been re-examining and challenging almost every basis of neoclassical economic thought, in order to reduce the gap between theoretical models and practices. Hence, it is imperative for forest economists to extend the boundaries of forest economics beyond Faustmann’s economic thought. The forest economics profession seems to have taken up this challenge by drawing concepts from other streams of economics, such as new institutional economics and political economy.

Keeping these six themes of forest economics in perspective, we have divided this book into six parts. Each part contains chapters focusing on specific issues related to its theme. There is some continuity, including linkages, among the chapters of each part; however, each chapter stands alone. Given the importance of the fundamental topics that have been the main attraction of forest resource economics for 60 years or more, we start this book with Part 1, focusing on fundamental topics, and close it with Part 6, which focuses on emerging issues and developments.

Part 1: Fundamental topics in forest resource economics

The focus of Part 1 is on four topics – Faustmann’s formulation, rate of discount, ownership and international trade of forest products. In Chapter 2, Deegen and Hostettler note that although the Faustmann model is a useful tool for making an economic decision, the underlying process of market mechanisms, known as catallactics, is also very critical. The authors discuss theoretical concepts and provide an overview of selected contributions of forestry to the inner processes of market functioning. In Chapter 3, Chang discusses the generalized Faustmann formula that allows stumpage prices, stand volumes, annual incomes, regeneration costs and interest rates to vary from timber crop to timber crop. As a result, optimal management and/or optimal rotation would also vary from timber crop to timber crop. Chang notes that this formulation represents a more realistic world relative to Faustmann’s world, in which everything remains static forever.

Price, in Chapter 4, highlights various economic and ethical perspectives associated with different economic justifications for discounting, such as opportunity cost,time preference, diminishing marginal utility, declining discount rate and internal rate of return. Next, three chapters are focused on economic issues associated with ownership. In Chapter 5, Wear presents US forest policy history and forest economics research related to timber supply by ownership groups. He raises many important issues in light of new models of private ownership, such as Timber Investment Management Organizations (TIMO) and Real Estate Investment Trusts (REIT). Leefers and Ghani, in Chapter 6, focus on various timber-pricing mechanisms such as administered charges, negotiated values and market-derived prices – the residual value method and transactions evidence method – used by governments. Ollikainen, in Chapter 7, reviews the results of forest taxation in the Faustmann and Hartman framework, discusses best and second-best forest tax policies, and relates the discussion to modern forest policies promoting ecosystem services such as biodiversity benefits, climate mitigation and nutrient loading. Finally, in Chapter 8, Perez-Garcia and Robbins provide an overview of global forest products trade, discuss economic theory and empirical models of trade and present economic assessments of selected forest products trade policies.

Part 2: Economics of forest ecosystems

Part 2 covers three topics – valuation methods for ecosystem services, economics of specific ecosystems and payment mechanisms for ecosystem services. In Chapter 9, Boyle and Holmes provide an overview of valuation methods and expand on choice experiments. The authors present the latest information on choice experiment methodologies and then discuss their applications to forest ecosystems. The next four chapters are focused on the economics of different forest ecosystems. In Chapter 10, Montgomery and Crandall place old-growth forests within the context of the Faustmann and Hotelling models and discuss old-growth forest values and methods of their measurement. Poudyal and Hodges, in Chapter 11, focus on the economics of open spaces (or green spaces) in urban environments. In particular, they review measures of open spaces, valuation methods (with an emphasis on hedonic price method) and recent studies in open space valuation. Chapter 12 focuses on forest ecosystems that are used to manage game and recreational hunting. Here, Munn and Hussain present the institutional context of these ecosystems in the United States, insights about hunting lease markets of the south-eastern United States and economy-wide implications of wildlife-associated recreation activities. Mercer, Frey and Cubbage, in Chapter 13, focus on the economics of agroforestry systems and review economic principles and approaches to assess agroforestry systems and demonstrate their application through a case study. The focus of the last chapter in Part 2, Chapter 14, is on the status of payment for ecosystem services schemes in developing countries. In particular, Gong, Hegde and Bull discuss schemes for watershed services, biodiversity conservation and forest carbon and present lessons learned and future challenges.

Part 3: Economics of forests, climate change and bioenergy

There are three very important aspects associated with climate change and forests. First, climate change will impact the productivity of forests and thus the forestry sector. Second, forests can be managed to sequester carbon, thereby moderating climate change. Third, carbon emissions can be reduced by using wood as a source of energy and by reducing forest degradation and deforestation. In this part, economic issues associated with the previous three aspects are discussed. Part 3 begins with Chapter 15, in which Sohngen discusses the potential impacts of climate change on forest ecosystems and reviews studies that have analyzed the impact of climate change on the forest sector. In Chapter 16, van Kooten, Johnston and Xu discuss economic issues related to the creation of forest carbon offset credits through forest management strategies and the problems associated with additionality, leakage, duration or impermanence and governance. Buongiorno, Bollandsås, Halvorsen, Gobakken and Hofstad, in Chapter 17, focus on the economics of carbon storage through uneven-aged forest management strategies and present methods to derive a schedule of supply for carbon storage. Lal and Alavalapati, in Chapter 18, discuss economic aspects of forest biomass-based energy, including forest biomass supply, public preferences for woody bioenergy, competition with traditional forest industries, land-use change and greenhouse gas emissions. Part 3 concludes with Chapter 19, in which Angelsen focuses on the economics of REDD+(Reducing Emissions from Deforestation and Forest Degradation) and presents four broad themes: REDD+credits in international carbon markets, REDD+as performance-based aid, national and local payment for ecosystem services and other national policy approaches to curb deforestation.

Part 4: Economics of risk, uncertainty and natural disturbances

Risk and uncertainty associated with natural phenomena, such as climate change, forest fires and biological invasions, and the growth process of forests and markets are important aspects of forest economics. In Chapter 20, Amacher and Brazee review the literature on risk and forest landowner decisions and elaborate on two themes – risk associated with future market parameters and risk associated with established forest stands being subject to natural or catastrophic events before harvest. Burkhardt, Möhring and Gerst, in Chapter 21, present a stochastic model that incorporates risk as a survival function to calculate land value and optimal rotation defined in terms of expectations suitable for a risk-neutral decision maker. In Chapter 22, Khajuria focuses on the applications of real options analysis to forest harvesting and conservation decisions. He discusses the literature that has modeled timber prices as the geometric Brownian motion, mean reversion, mean reversion with jumps and mean reversion with varying long-run marginal cost process. Strange et al., in Chapter 23, focus on economically optimal and biologically sound conservation decisions in an uncertain world and discuss theoretically consistent approaches that combine biodiversity and valuation modeling under uncertainty. Holmes et al., in Chapter 24, focus on the economic analysis of preinvasion and postinvasion management of biological invasions of forests under risk and uncertainty conditions and suggest new microeconomic and aggregate economic studies of damages caused by biological invasions across forest types and ownerships.

Part 5: Economics of forest property rights and certification

Some economic aspects associated with ownership are discussed in Part 1.However, the concept of property rights is so complex and issues are so diverse that it requires a separate part rather than combining it with other topics. In Part 5, four chapters are devoted to property rights issues one chapter provides a broader and general perspective, and the other three provide national perspectives for Brazil, China and the United States. The last chapter deals with the economics of forest certification, which has some property rights implications. Luckert, in Chapter 25, discusses various economic concepts relating to forest tenures, including rules as attenuations and subsidies, forest tenures and economic behavior, economic rent, market and government failures, and then explores the challenges in analyzing economic impacts of forest tenures. The focus of Chapter 26 is on the economics of the evolution of the Brazilian Amazon frontier. In this chapter, Sills discusses the historical drivers of deforestation the Brazilian government policies that increased agricultural rents, new drivers of deforestation and current policy initiatives that seek to change the incentives by increasing tenure security for forest land, imposing penalties for illegal deforestation and creating new opportunities to earn revenue from standing forest. In Chapter 27, Zhang, Shen, Wen, Xie and Wang use changes in the bundle of rights to forests and forestland and the separation of use rights from ownership to examine the evolution of forest property rights in China. Ebers and Newman, in Chapter 28, focus on the economic analysis of conservation easements in the United States. They discuss landowner incentives for instituting conservation easements, methods for easement appraisal and ways to measure easement performance. In Chapter 29, Toppinen, Cubbage and Moore discuss the concepts, advantages and economic aspects of forest certification and corporate social responsibility and elaborate on the challenges of extending these approaches to smaller organizations and developing countries.

Part 6: Emerging issues and developments

The economics profession, as a whole, has been re-examining and challenging almost every basis of neoclassical thought in order to reduce the gap between theoretical models and practices or to increase the theory–evidence ratio. These efforts include the emergence of new streams of economics such as behavioral economics, evolutionary game theory and new institutional economics. Forest economists are also making similar efforts by incorporating these new streams of economics into forestry. The chapters of Part 6 are examples of such efforts. The first chapter in this part,Chapter 30, focuses on new institutional economics (NIE), and Wang, Bogle and van Kooten present an overview of the genesis, scope and main developments of NIE, with emphasis on property rights and contracting, transaction cost economics, moral hazard and information and principal–agent relationships. In Chapter 31, Zhang discusses various theories of political economy and their origin and reviews empirical studies of forestry in various countries. Kumar and Kant, in Chapter 32, provide an overview of game theory and review applications of game theoretic models to forestry issues such as people’s participation in co management of forests, timber markets and interactions among stakeholders in the case of weak property rights. Gundi meda, in Chapter 33, emphasizes the need of expanded forest accounts and reviews two major approaches, namely, income as a return on wealth and income change as an indicator of welfare. Chapter 34 focuses on the applications of computable general equilibrium (CGE) modeling in forest economics. Banerjee and Alavalapati, in this chapter, present the application of a recursive dynamic CGE model to assess the regional economic impacts of Brazil’s forest concessions policy in the Amazon. We close the book with a chapter on twelve unanswered questions in forest economics. In this Chapter 35, Hyde observes that there are many situations in which Faustmann’s formulation is either incomplete or inappropriate. The author identifies unresolved issues within the discipline of forest resource economics at the beginning of the twenty-first century and discusses two concerns – empirical assessment and incremental effects – for policy applications.

Conclusion

This is the first publication of a handbook of forest resource economics. We have tried to cover a wide range of issues associated with the subject, starting with fundamental topics and moving Evolving forest resource economic thought to recent emerging issues and developments. Each chapter provides a synthesis of the state of the topic covered and aims to be a comprehensive, up-to-date, authoritative source on the subject. The current forest resource economic thought is more than 165 years old and is growing in many ways. The growth is largely coming because of an increased understanding of ecosystem services benefits for human welfare. Emerging global issues such as climate change, sustainable development and the green economy have provided further impetus to the growth and diversification of forest resource economics. The emergence of new streams in economics, such as agent-based computation economics, behavioral economics, complexity theory and economics, public choice theory and social choice theory, have also contributed to the growth of forest resource economics. Hence, it is impossible to cover all important topics in this volume, and we regret that.

References

Amacher, G. S., Ollikainen, M. and Koskela, E. (2009). Economics of Forest Resources, MIT Press, Cambridge, MA.

Arthur, W. B. (1994). Increasing Returns and Path Dependence in the Economy,University of Michigan Press,

Ann Arbor, MI. Basu, R. L. (2011). Kautilya’s Arthasastra (300 b.c.): Economic Ideas, Smashwords Edition.

Bentley, W. R. and Teeguarden, D. E. (1965). ‘Financial maturity: A theoretical review’, Forest Science, vol. 11, no. 1, pp. 76–87.

Bonan, G. (2008). ‘Forests and climate change: Forcings, feedbacks, and the climate benefits of forests’, Science, vol. 320, pp. 1444–1449.

Faustmann, M. (1849). ‘Berechnung des Wertes welchen Walboden sowie noch nicht haubare Holzbestände für die Waldwirschaft besitzen’, Allgemeine Forst und Jagd Zeitung, vol. 15, pp. 441–455. Translated by W. Linnard (1968) as ‘Calculation of the value which forest land and immature stands possess

for forestry’ in Martin Faustmann and the Evolution of Discounted Cash Flow, Inst. Pap. No. 42, Commonwealth Forestry Institute, Oxford, UK, pp. 27–55. (Reprinted in Journal of Forest Economics, vol. 1, no. 1, pp. 7–44)

Gaffney, M. M. (1957). Concepts of Financial Maturity of Timber and Other Assets, Agricultural Economics Information Series #62, North Carolina State University, Raleigh, NC.

Hartman, R. (1976). ‘The harvesting decision when a standing forest has a value’, Economic Inquiry, vol. 14, pp. 52–55.

Helles, F. and Linddal, M. (1997). ‘Early Danish contributions to forest economics’, Journal of Forest Economics, vol. 3, no. 1, pp. 87–103.

Jandl, R., Lindner, M., Vesterdal, L., Bauwens, B., Baritz, R., Hagedorn, F., . . . Bryne, K. A. (2007). ‘How strongly can forest management influence soil carbon sequestration?’ Geoderma, vol. 137, pp. 253–268.

Kant, S. (2000). ‘A dynamic approach to forest regimes in developing economies’, Ecological Economics, vol. 32, no. 2, pp. 287–300.

Kant, S. (2003a). ‘Economic theory of emerging forest property rights’, in People and Forests in Harmony, Proceedings of the XII World Forestry Congress, Quebec City, Canada.

Kant, S. (2003b). ‘Extending the boundaries of forest economics’, Journal of Forest Policy and Economics, vol. 5, pp. 39–58.

Kant, S. (Ed.). (2013). Post-Faustmann Forest Resource Economics, Springer, Dordrecht, The Netherlands. Newman, D. H. (2002). ‘Forestry’s golden rule and the development of the optimal forest rotation literature’, Journal of Forest Economics, vol. 8, no. 1, pp. 5–28.

Ohlin, B. (1921). ‘Till frågan om skogarnas omloppstid’, Ekonomisk Tidskrift22. Translated by C. Hudson (1995) as ‘Concerning the question of the rotation period in forestry’, Journal of Forest Economics, vol. 1, no. 1, pp. 89–114.

Pearse, P. H. (1967). ‘The optimum forest rotation’, Forestry Chronicle, vol. 43, pp. 178–195.

Pressler, M. R. (1860). ‘Aus der Holzzuwachlehre (zweiter Artikel)’, Allgemeine Forst und Jagd Zeitung,

vol. 36, pp. 173–191. Translated by W. Löwenstein and J. R. Wirkner (1995) as ‘For the comprehension of net revenue silviculture and the management objectives derived thereof ’, Journal of Forest Economics, vol. 1, no. 1, pp. 45–87.

Shashi Kant and Janaki R. R. Alavalapati and Samuelson, P. A. (1976). ‘Economics of forestry in an evolving society’, Economic Inquiry, vol. 14, pp. 466–492. (Reprinted in Journal of Forest Economics, vol. 1, no. 1, pp. 115–149)

Scorgie, M. and Kennedy, J. (2000). ‘Who discovered the Faustmann condition?’ History of Political Economy, vol. 28, pp. 77–80.

White, A. and Martin, A. (2002). Who Owns the World’s Forests? Forest Tenure and Public Forests in Transition, Forest Trends and Centre for International Environmental Law, Washington, DC. Retrieved from www. forest-trends.org/documents/files/doc\_159.pdf