Forest Policy and Economics 72 (2016) 18–26

Contents lists available at ScienceDirect

Forest Policy and Economics

journal homepage: www.elsevier.com/locate/forpol

Global climate change impacts on forests and markets☆

Brent Sohngen [a,*], Xiaohui Tian [b]

[a] AED Economics, Ohio State University, 2120 Fyffe Rd, Columbus, OH 43210, USA
[b] Renmin University, Beijing, China

ARTICLE INFO

Article history:
Received 8 November 2015
Received in revised form 21 April 2016
Accepted 5 May 2016
Available online 9 July 2016

Keywords:
Climate change
Dynamic optimization
Dieback
Disturbance
Ecosystems

ABSTRACT

This paper examines how foresters have adapted to important supply and demand driven shocks in the last century that affected timber prices and forest investments. Many of the adaptations that foresters made to changing economic conditions will be the same types of adaptations that society will need foresters to make in the future in order to adapt to climate change. These include changing rotation ages to adapt to shifting disturbance conditions, increasing intensification of management in response to dwindling old growth stocks, movement of species across regions to find better growing conditions, among other things. The paper presents results of an integrated assessment of climate change impacts in forestry and shows how projected future changes for the next century are well within the historical context.

© 2016 Elsevier B.V. All rights reserved.

1. Introduction

Forested ecosystems are likely to undergo substantial change in structure and composition in the future as climate change unfolds, according to the Intergovernmental Panel on Climate Change (IPCC, 2014). These changes include increases in carbon dioxide in the atmosphere due to industrial carbon emissions that will potentially fertilize forest growth. Global temperatures are expected to increase, with the largest increases occurring in northern boreal zones, opening up new areas to forests. While forests in some regions may benefit from climate change, other areas will experience increases in drought-induced mortality and potentially greater forest fire activity. Climate change will cause some species to end up in regions that are inhospitable to regeneration.

Given the potential impacts that climate change could have on forested ecosystems, foresters will need to utilize a range of tools to adapt. These tools include shifting rotations to respond to forest fires or changes in forest growth, adjusting species to maximize growth potential in new climate, changing management intensity to suppress competition or increase growth of selected species, increasing fire-fighting capability, planting forests in previously un-forested areas, etc. Fortunately, most of these tools have already been deployed in forestry by innovative foresters and landowners. Over the last century, foresters worked to accommodate enormous changes in wealth, preferences, and land use that occurred, and forestry appears to have made the transition from a non-renewable old growth resource to a renewable resource.

This paper explores the link between adaptations that have been undertaken in the past, for economic reasons, with adaptations that foresters likely will have to take in the future in response to climate change. One of the most important questions faced by the forest sector is when and how to start adapting to climate change. We answer this in this paper by providing evidence illustrating that to a large degree foresters have already been adapting to enormous changes in the forestry sector. Many of these changes have been driven by economic forces – old growth depletion, rising income, new technologies, and changing preferences, to name a few – but others may have been driven by climate change that started affecting forests in the last century. Using historical data, mostly from the United States, but some from other locations around the world, we illustrate how numerous adaptations in the forestry sector over the last century, which increased management, have helped produce the enormous stock of forests that we have available today.

To show this, the paper focuses on the role prices have played in transmitting information to foresters through markets. The paper begins with a simple Faustmann model that illustrates how the historical path of prices in the United States can be rationalized as an economic process of old growth depletion and movement toward sustainable forestry. Rising prices over the early part of the last century gave rise to a host of forest management responses, including investments in planting forests, investments in forest fire-fighting, movement of tree species around the world, and increased management intensity and rising timber yields. There is also evidence that forests have already been influenced by climate change as atmospheric carbon dioxide concentrations increased 30% over the last century, global temperatures rose, and precipitation patterns shifted (IPCC, 2013).

☆ This article is part of a special section entitled “New Frontiers of Forest Economics: Forest Economics beyond the Perfectly Competitive Commodity Markets”, published in the journal Forest Policy and Economics 72, 2016.

* Corresponding author.
E-mail address: Sohngen.1@osu.edu (B. Sohngen).

http://dx.doi.org/10.1016/j.forpol.2016.06.011
1389-9341/© 2016 Elsevier B.V. All rights reserved.

This paper then looks forward and presents results of a modeling exercise that considers the effects of future potential climate change on global forested ecosystems and economic systems (see Tian et al., 2016). The analysis considers high levels of potential future warming (over 9 W/m^2), as well as two policy scenarios that assume climate mitigation and lower warming potential. Several key results from the integrated impact analysis are examined more carefully, including prices, outputs, land area, and growing stock volumes. The results suggest that while climate change could have fairly large impacts on harvesting and prices in markets, mostly because climate change causes a net increase in annual growth by up to 30% on average globally in the future, the effects on forest stocks are fairly modest. When considering the US in particular, growing stock volume increases in the US in the future without climate change. It still is projected to increase with climate change, but to a lower level.

The next section introduces a simple Faustmann model that illustrates timber price dynamics. The model is linked to historical prices in the US, old growth depletion, and the transition to renewable forests. Additional data is presented to illustrate how foresters adapted to old growth depletion with forest fire exclusion, planting new forests, and increasing timber management. Foresters also shifted species to different locations to optimize growth. The results of the integrated assessment analysis of climate change impacts are then presented, followed by the conclusion.

2. Historical adaptation in forestry

One interesting story of the last century in timber markets is that, after a long period of increasing prices in the US, timber price growth slowed toward the end of the century (Fig. 1). From 1910 to the 1950s, US sawtimber prices rose 3.6% to 4.5% per year. In the US, price growth rates diverged in the 1950s, with price growth averaging 1.6% per year in the Southern US and nearly 6% per year in the Pacific Northwest. Price growth slowed across the board from the 1970s to 2010, rising <0.5% per year in the Southern US and falling 0.1% per year on average in the Pacific Northwest. The Great Recession undoubtedly explains some of the recent slowdown in price growth in the US, but the data also suggests that the stabilization in timber prices started in the 1970s.

Why did timber price growth slow in the 1970s? To understand this,it is useful to start with the basic Faustmann model of bare land value:

$$W = \frac{P(t)V(t)e^{-rt} - C}{(1 - e^{-rt})} \quad (1)$$

In Eq. (1), W represents the value of bare land planted to trees, where P(t)is the price of timber, V(t)is the volume of timber at time t, r is the discount rate, C is the cost of replanting. The optimal harvesting time, is determined by taking the derivative of W with respect to "t" and setting it equal to 0. After rearranging terms, one obtains

$$\frac{\dot{P}}{P} + \frac{\dot{V}}{V} = r + \frac{R}{PV} \quad (2)$$

In Eq. (2), R = rW, which is the annual land rental value for timberland. The first term in Eq. (2), $\dot{P}/P$, is the rate of growth of prices. The second term, $\dot{V}/V$, is the rate of growth of forests.

Consider the case of old growth extraction. When forests are composed mostly of old growth, $\dot{V}$ will be small, and V will be large, implying that $\dot{V}/V$ is small, and likely negligible. In order for Eq. (2) to hold in the case of old growth, with positive interest rates of say 4–5%, price growth must be positive, $\dot{P}/P$>0, and likely in the range of 4–5%. It could be

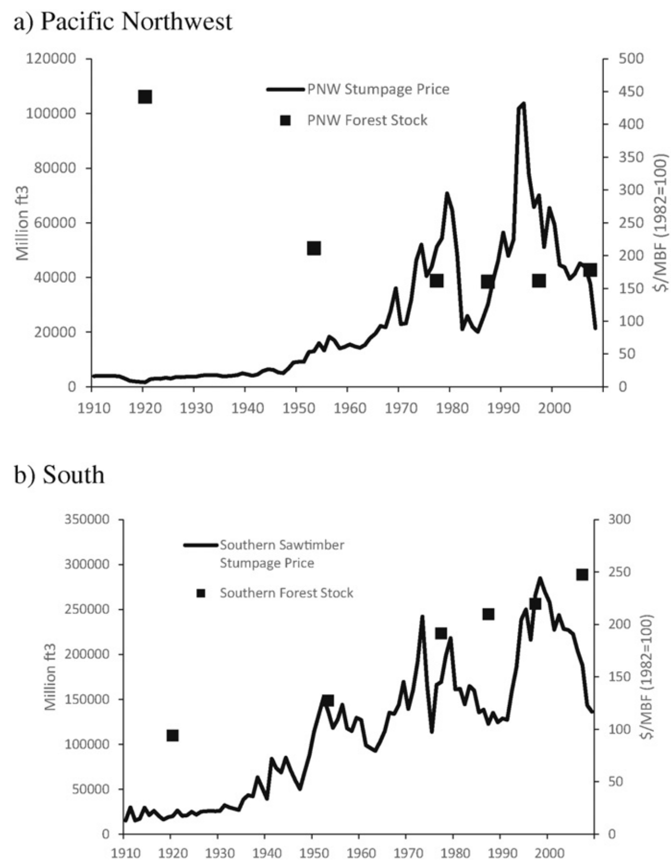

Fig. 1. Historical US Timber prices and forest stocks in the Pacific Northwest and the Southern US (1920 timber volume data from US Forest Service, 1920; later timber volume data from Oswalt et al., 2014; Price data from Haynes, 2008; Sohngen and Haynes, 1994).

larger if rents are positive, but in the early part of last century, rents in many forested areas were not likely very high.

Looking to the Pacific Northwest, forests were primarily old growth, with stocks estimated to be around 220–250 billion ft^3 in the 1600s. By the early 1900s, forests in the Pacific Northwest were still mostly old growth, with stocks estimated to be around 180 billion ft^3 (Kellogg, 1909; US Forest Service, 1920). These stocks were largely depleted in the first half of the last century (Fig. 1a). By the second half of the last century, forest stocks in the Pacific Northwest stabilized, with growth generally offsetting harvests. Timber prices in the Pacific Northwest experienced sustained growth during the period of depletion, lasting from 1900 to the 1960s. Subsequently, forest stocks stabilized in aggregate, and price growth slowed. Prices spiked in the 1970s, due to high energy prices, and again in the 1990s due to high demand and a policy induced supply shock (see Sohngen and Haynes, 1994), but there has been no sustained timber price growth in the Pacific Northwest in real terms, since the 1970s.

In the Southern US prices rose in the first half of the 20th century at a similar rate as in the Pacific Northwest (Fig. 1b). Forests in the South had long been depleted by the late 1800s and early 1900s. Inventories, which were estimated to be around 220 billion ft^3 of timber in the 1600s (Kellogg, 1909), were less than half as large by the early 1900s. Evidence suggests that forest inventories have regrown throughout the 20th century, while land area in forests has remained about the same (Oswalt et al., 2014). Total inventories today in the Southern US appear to be as large as they were in pre-settlement times, with perhaps 30% less land in forests.

Eq. (2) accommodates this outcome in the South. Timber output in the South peaked at about 16 billion board feet per year (or 3.5 billion ft^3 per year) in 1909, and then declined through the early part of the 20th

Download English Version:

https://daneshyari.com/en/article/6459876

Download Persian Version:

https://daneshyari.com/article/6459876

Daneshyari.com