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Trade-mediated biotechnology transfer and its effective absorption: an application to the U.S. forestry sector

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Abstract

In this paper, we analyze the consequences of biotechnology innovations in the United States forest sector (logging) by modeling technology transfer embodied in trade flows and its absorption. A seven-region, seven-traded-commodity version of a dynamic computable general equilibrium model is used to achieve this task. A 0.63% Hicks-neutral biotechnological progress in the source region (U.S.) has differential impacts on the productivity of the log-using sectors in the domestic as well as in the recipient regions. Since recipient regions' ability to utilize biotechnology innovations depends on their absorptive capacity (AC) and structural similarity (SS), we construct the AC and SS indices based on multiplicity of factors such as human capital endowments, skill content and social appropriateness of the new innovations. The model results show that biotechnological innovations in the U.S. forest sector result in a significant increase in timber production. Following the productivity improvements and its embodied spillover, wood products and pulp and paper sectors in the U.S. register higher productivity growth. The role of AC and SS in capturing technical change is shown to be evident. In the face of growing regulations on timber production from public forests, increasing productivity through biotechnology may be the most effective way to meet the consumer demand for forest products.

Keywords: Total factor productivity; Dynamic computable general equilibrium; Capture parameter; Forestry biotechnology

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1. Forestry biotechnology: technological and economic aspects

Historically, the U.S. enjoyed significant comparative advantage in industrial wood production based on its vast acreage of old growth forests. As much of these forests have either already been harvested or converted to other land uses, the U.S. can no longer solely rely on its natural forests for industrial timber production. In addition, forest preservation sentiments are growing in the face of rising demand for forest products. For example, a house bill, H.R. 1494 entitled "National Forest Protection and Restoration Act," was introduced into the U.S. Congress in 2001. This bill proposes an elimination of commercial logging from all national forests of the U.S. The essence of this bill is to protect the environment, preserve biodiversity, to avert indirect costs to the recreation and tourism industry, fishing industry, and to stoppage of flooding damage in the process of supplying consumer goods. If passed, this policy is expected to reduce U.S. timber supply by approximately 5%. On the other hand, consumption of forest products in the U.S. is expected to increase by 69% over the next 50 years [1]. The application of productivity-enhancing activities through genetic improvements and tissue culture is thought to be a viable option to address the above paradoxical situation. The advent of biotechnological innovations and its potential impact on sustained productivity growth in forestry is well documented [2–5].

In the literature, two principal sources are identified for increased forest sector productivity—firstly, technical change in logging and second, technical innovations focusing on intensive forest management and plantations for commercial wood production [3–5]. The latter source has been dominant with over 33% of global industrial wood production coming from plantation forests [4]. Intensively managed tree plantations achieve much higher productivity, particularly with the application of biotechnology for tree improvement, biopesticides for forest management and propagation, and conservation and restoration [6,7]. Biotechnology is used to achieve desired tree traits such as tolerance for herbicide, insects and faster tree growth. In terms of potential gains in wood production, these innovations contribute to significant cost savings [8].

The acquisition and effective assimilation of transferred technologies are essential for the development of forest product industries. This has been discussed in the context of agroforestry extension efforts for the adoption and diffusion of technology [9,10]. Whiteman et al. [11] identified important social factors such as land tenure security, local participation in the implementation of agroforestry ventures and attitudes towards acceptance of novel techniques. Based on Rogers' [12] theory of "diffusion of innovations," Whiteman et al. [13] emphasized that an efficient technology transfer process involves development of indigenous knowledge systems and "the ability to understand and apply complex technical knowledge." Thus, extension programs based on social factors and educational attainment play important role in promoting absorptive capacity (AC) to "adopt" the new technique. Effective adoption of new forestry technologies depends, inter alia, on the process of invention, its transmission, "local adoption" and social acceptance [4,14].