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# Policy instruments for developing planted forests: Theory and practices in China, the U.S., Brazil, and France

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ABSTRACT

Planted forests are seen as a means to meet increasing demand for timber and environmental services and thus to achieve sustainable forest development. In this paper, we use the Faustmann–Hartman silvicultural investment model to demonstrate how policy instruments influence planted forest development and review such a development in China, the U.S., Brazil, and France. We find that planted forests emerge because of scarcity in timber and environmental services and develop in response to economic and policy and institutional instruments, including secure property rights, stumpage price policy, and efficient forestry governance and administration.



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## Introduction

In 2013, we celebrated the 300th anniversary of the publication of Hans Carl von Carlowitz's Silvicultural Economics (*Sylvicultura Oeconomica oder Anweisung zur wilden Baum-Zucht*; Silvicultural Economics or the Instructions for Wild Tree Cultivation) in 1713. While managing mining on behalf of the Saxon Court in Freiberg, Germany, Carlowitz was responsible for ensuring timber supply for the mining industry. Despite the Court's forest regulations, the impact of timber shortages on Saxony's silver mining and metallurgy industries was devastating around 1700. In his work, Carlowitz formulated the idea for the "sustainable use" of the forest. He saw that only so much wood should be cut as could be regrown through planned reforestation projects. This has become an important guiding principle of modern forestry and sustainability.

Today, we are facing similar challenges that Carlowitz once had 300 years ago, namely, how to ensure adequate supply of forests that provide not only timber, but also various environmental benefits to meet societal demand. Planted forests, which included forest plantations and other forest types originating largely or wholly from tree planting (Evans, 2009), are seen as a means of achieving these goals; just like that reforestation was seen by Carlowitz as means to supply timber in a sustainable fashion. However, most studies on planted forests (e.g. de Steiguer, 1984; Keipi, 1997; Beach et al., 2005; Cubbage et al., 2007, 2010) are done in micro-level and in specific countries. The exceptions are perhaps Sedjo (1980) which is on the comparative economics of planted forests and Enters and Durst (2004) which consists of studies on the role of incentives in planted forest developments in 11 Asia-Pacific countries. Nonetheless, Sedjo (1980) does not discuss the role of policy in planted forest development and Enters and Durst (2004) does not have a theoretical foundation and is not done in a comparative fashion. As such, the results from these two studies are largely country-specific and do not present a unified theme of planted forest development.

In this paper, we attempt to provide a unified theme of planted forest development and to demonstrate its uses at a macro- or country-level through a comparative study of four countries in four continents. In particular, we present the economics of planted forest development, derive the impact of policy instruments, and look into such a development in China, the U.S., Brazil, and France, which collectively account for more than 40% of global planted forests (Carle et al., 2009). We also comment on the type of incentives useful to entice planted forest development in different contexts.

## The economics of planted forest development

The economics of planted forests is about the benefit–cost calculus of tree planting and other silvicultural investments on established forests. Comparing to natural forests, planted forests represent changes in two dimensions: forest area retention/expansion and management intensity. Once a natural forest is harvested, a planted forest could develop on the same site if it could generate the highest return. In this case, forest area is retained even though the natural forest becomes a planted forest. Similarly, planted forests could develop on marginal agricultural lands or idle lands if they generated a higher return than all other land uses, and subsequently forest area expands. As for management intensity, it is change in the optimal level of silvicultural effort applied to one unit area of land. While an increase or decrease in the management intensity does not necessarily lead to any change in the area of planted forests, and vice versa, they often change simultaneously because they are both positively related to land rent, or land expectation value. These changes called shifts in the extensive (if planted forest area changes) and intensive (if intensity changes) margins of planted forests, respectively.

Fig. 1 depicts that the shift in the extensive margin of planted forests associated with the price of standing timber or the stumpage price, assuming that management intensity does not change. Suppose that the supply of timber in a region all comes from planted forests, that lands vary in productivity, and that the supply of timber increase with the stumpage price, as illustrated in the upper portion of Fig. 1. The lower portion of Fig. 1 shows, for possible change in demand and equilibrium price, how many hectares of planted forests are needed for timber production. Obviously, the most productive land will be employed in timber production at low stumpage prices, and the higher the stumpage prices progressively more and more of the less productive land will be drawn into production. Thus, as stumpage price rises from $P_1$ to $P_2$, the annual harvest increases from $Q_1$ to $Q_2$, and the amount of