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Forest condition change, tenure reform, and government-funded eco-environmental programs in Northeast China☆

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ABSTRACT

Northeast China has one of the largest forested areas in China, which provides an important production base for timber and forestry by-products and is significant for maintenance of regional ecological security. This study examined the effects of forest tenure reform and government eco-environmental protection programs on forest condition change using two measures—forest area and stocking volume. Generalized spatial panel autoregressive models were developed using data on 72 forest farms in Northeast China in 2005 and 2009. The results showed that forest condition change in the region was driven by socio-economic characteristics, geographical conditions, and forest land management policy. In particular, the forest tenure reform and government eco-environmental protection program were found to affect forest condition change. There were also strong spatial effects between neighboring forest farms, suggesting that the forest management policy of one forest farm was correlated with that of neighboring farms. When formulating and implementing forest policy, decision-makers should therefore take account of spatial effects.

1. Introduction

As a renewable resource, forest provides basic livelihood materials, such as wood and fuel, for humans. As an environmental and ecological resource, it supplies various types of ecological service for humans, such as soil and water conservation and carbon sequestration. Understanding the relationship between forest condition change and its determinants, especially the driving factors of policy relevance, is essential in developing long-term strategies to sustain the resources fundamental to sustainable human development. The objectives of this study are to improve understanding of the determinants and variations in forest land cover change at forest-farm level in Northeast China and to examine the effects of government investment and forest tenure reform. Specifically, the study measures forest condition by using not only forest area but also stocking volume, an approach which has not been widely used previously in this region and can thus yield potentially more efficient and consistent estimates.

Forest area change has been widely used as one representative of forest condition change in past decades. Forest area change has been detected using remote sensing to track patterns of dynamic changes in forest area, such as converting other land uses to forest and vice versa, and the speed and magnitude of change (Weng, 2002; Turner et al., 2007; Liu et al., 2010; Hansen and Loveland, 2012; Fu et al., 2014). However, remote sensing is not able to identify the driving factors behind the change. Statistical methods, such as principal component analysis and cluster analysis, have been used to identify the determinants of forest area changes (Lambin and Strahler, 1994; Munteanu et al., 2014). Such methods tend to be good at detecting the relevant factors in forest area change, but weak at capturing the dynamic change pattern. Econometric models have been also used to explain driving factors for forest area change (Niquidet, 2008; Deng et al., 2011; Zhao et al., 2011; Yin et al., 2016; Shi et al., 2017).

Stocking volume should be considered, in addition to forest area, when measuring forest condition change. The term forest condition is used to describe not only the change in forest area, but also forest stocking volume and even the health status of the forest (Yin, 2016). Stocking volume can significantly affect forest condition through impacting forest biodiversity and carbon dynamics, but less weight is given to it in the policy arena (Gibson et al., 2011). Jiang et al. (2013) measured timber harvest and timber production when analyzing the impact of policy on the development of forestry, while Furukawa et al. (2015) measured forest harvest index, defined as the expected gross forest cover loss, reflecting the demand for wood products. Therefore, analyzing forest condition change by taking both forest area and stocking volume into account might be a good starting point to evaluate the determinants of forest condition change and the impact of

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government investment and forest tenure reform.

Forest area and stocking volume in rural areas in China have been expanding, largely due to continuing government investment and institutional reform (Xu and Berck, 2013; Yin et al., 2016). A broad range of literature has examined the influence of forest tenure reform policy and government forest eco-environment protection programs in driving forest condition change, forest harvest production, and even forest farm production (Yin and Newman, 1997; Jiang et al., 2013; Yin, 2016; Yin et al., 2016; Shi et al., 2017). However, to the best of our knowledge, the literature has tended to ignore the spatial characteristics of natural resources (Li et al., 2013). According to Anselin (2001), ignoring spatial correlations in data may lead to inefficient or biased estimations. Therefore, we opted to use a spatial econometrics model (Anselin and Griffith, 1988) for analyzing the change in forest condition and its determinants, as we expected this to provide the most consistent and efficient results. Empirically, the generalized spatial panel autoregressive two-stage least squares (GS2SLSAR) model is applied by incorporating own forest-farm and neighboring forest-farm effects (Gebremariam et al., 2010; Gebremariam et al., 2011).

There is still an alarmingly high rate of deforestation in the world (FAO, 2014), although actions have been taken to try to slow down its rate in the past decade. According to the 8th National Forest Inventory covering the period 2009–2013, the national forest area in China at that time was 208 million hectares, with a forest cover rate of 21.63% (SFA, 2013). Northeast China is an important production base for timber and other forest products. It is also a water conservation area for important rivers (e.g., the Ussuri, Amur, and Sungari rivers) and is significant for maintenance of regional ecological security. Forest land in Northeast China has shown an increase over the past 10 years (FAO, 2014). However, the age structure of its forest trees tends to be monotonous and juvenile, and the forest resources suitable for exploitation and the income of state-owned forest bureaus have gradually decreased (Jiang et al., 2013; Yao et al., 2014). We used both forest area (size) and stocking volume in analyzing the determinants of forest condition change in Northeast China, with the focus on government investment and forest tenure reform.

The remainder of this paper is structured as follows. Section 2 reviews changes in forest land property rights and eco-environmental protection programs implemented in Northeast China. Section 3 describes theoretical framework and empirical model. Section 4 presents the data and econometric model. The results of the spatial econometric analysis are presented and discussed in Section 5. Section 6 summarizes the findings of the study and makes recommendations for future reforms.

2. Review of forest tenure change

Northeast China comprises Liaoning province, Jilin province, Heilongjiang province, and four leagues (administrative prefectures) in the eastern Inner Mongolia Autonomous Region (Fig. 1). The institutional framework of forest land property rights in Northeast China has undergone fundamental changes in the past century, from wilderness to invasion and occupation by foreign countries, to reversion to China, and then forest management under a system of mixed state control and market function.

Prior to 1949: Northeast China was the birthplace of the Qing Dynasty (1644–1911), when most of the people there were of the Man minority. Although the Man people had lived in Northeast China for centuries, much of the natural environment in that part of China was a wilderness during the Qing Dynasty. There were only rare human activities or human disturbances in the region's forests until it was invaded and governed by Russia and Japan from 1896 to 1945 (Yu et al., 2011).

1949–1978. After 1949, when the People's Republic of China was founded, the state introduced profound land reforms, and forest land property rights were taken over by the government. China's state-owned forest areas started to be developed in the early 1950s, when all forest resources were managed and owned by state forest bureaus and by state-owned forest enterprises. Thousands of small mills were built to process timber and manufacture related by-products. The late 1950s and 1960s were marked by people's communes, when timber logging and wood processing were the primary tasks to meet the demands for national economic development, which resulted in rampant forest degradation and highly inefficient afforestation campaigns (Zhang et al., 2000; Wang et al., 2004; Yu et al., 2011; He and Weng, 2012).

Post 1978. There was no formal forestry legislation in China until 1979, when the first Forest Law was passed and subsequently officially promulgated in 1985. The first annual timber harvesting quotas were set following the Forest Law in 1986. With the successful introduction of the Household Responsibility System (HRS) in China, the household as the basic unit of production and decision-making was re-established in the early 1980s. The HRS model was copied from cropland to forest land in much of the southern forest region in China, where forest land was mostly collectively owned, such as in Fujian and Jiangxi provinces. Although forest land was not contracted to forest farms in Northeast China, modern forest management and economic incentives were introduced, such as an open price for timber and market-based transactions, as well as systems for stumpage fees and managerial responsibility. Forest land ownership still rested with the state government, but the rights to use forest land were devolved to state forest bureau managers or mill managers. Although there were annual harvesting quotas, excessive logging and little reforestation led to a series of problems, characterized as a ‘double crisis’, i.e., a shortage of timber resources and a financial crisis in state-owned forest enterprises (Yin, 1998; Jiang et al., 2013; Yao et al., 2014).

Since 1998. The year 1998 was a turning point in the development of China's forests, as at that time environmental protection programs were initiated in order to address environmental problems and to improve ecological security (Brukas and Weber, 2009). Forest policies concerning the sustainable development of forestry were initiated, such as increasing government investment in forest rehabilitation, establishment of a compensation system for forest ecological benefits, and reform of the collective forest ownership system in some provinces and regions (FAO, 2009). Of the six national eco-environmental protection programs introduced in Northeast China, the Natural Forest Protection Program (the NFPP) is considered the most important for the state-owned forest enterprises regarding the amount of financial support and affected area. The NFPP was introduced in 1998 and since then it has significantly reduced the previously excessive logging (Yin et al., 2010; Xu et al., 2006a; Xu et al., 2006b; Yin, 1998; SFA, 2010; Xu and Berck, 2013; Jiang et al., 2013). By the end of 2008, the total amount of investment in the 72 forest farms sampled for the present study was 316,740 thousand RMB Yuan, with the NFPP providing the largest funding amount.

Present. There have been no significant state-level institutional changes in the forestry sector since the Forest Law was revised in 1998. However, new forms of forest resource management have emerged, such as multi-mill corporations, joint shareholding firms, contractual management, and management rights leases. These forms of resource management have aimed to clarify the interests of owners, sublease renters, and managers. The previously observed sharp decline in the quantity and quality of natural forests has now been reversed. According to estimates of the 6th National Forest Inventory (1999–2003), the level of forest harvesting in Northeast China at that time was about 2.2 times its annual productivity (SFA, 2005).

3. Methodology and model specification

3.1. Theoretical framework

The inclusion of spatial effects in forest resource modeling is typically motivated by both theoretical and data-related considerations.