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Effects of land urbanization and land finance on carbon emissions: A panel data analysis for Chinese provinces

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ABSTRACT

The rapid urbanization in China comes with several economic, social, and environmental issues, most of which are related to land use. This study contributes to research on the land–growth–environment nexus by investigating the effect of land urbanization and land finance on carbon emissions in China from 2004 to 2013 using the Stochastic Impacts by Regression on Population, Affluence, and Technology (STIRPAT) model. Results show that land finance and land urbanization significantly affect carbon emissions. The rate of land urbanization contributes to the reduction of carbon emissions; however, it has less impact compared with other determinants. The effect of land finance and land urbanization on carbon emissions indicates that a local government's willingness to lease land for revenue aggravates carbon emissions. Economic growth and industrial structure also influence carbon emissions. Furthermore, the land requisition system and rural land conversion market should be enhanced through the guidance provided by the 13th Five-Year Plan (2016–2020) to promote the diversification of land transfer, fully consider regional differences, and establish a distinct policy focus that can contribute to emission reduction and land use.

1. Introduction

With rapid urbanization, leasing land to raise extra budgetary revenue has been a common fiscal phenomenon among local governments in many developing countries (Fang, 2013). Local governments in China hold a market monopoly at the first-level land market. They can acquire agricultural land at a low price and then sell it at a high price. The enormous amount of revenue can be further used on new land expropriation or combined with financial funds for city construction. For local governments, the process not only generates a significant increase in the extra budgetary revenue but also contributes to investment in infrastructure, attracts foreign investment, and promotes regional economic growth (Zhang, 2000). This revenue-generating approach of a local government is often referred to as "land finance" (Wu et al., 2015). Since the 1990s, land finance has become increasingly important and continues to accelerate China's urbanization and economic growth. According to Cao et al. (2008), land finance has existed for many years, indicating that local governments lead in the process of "land acquisition—urban sprawl—land revenue—urban construction—land acquisition again." (Pan et al., 2015).

Over the years, land has served as one of the main sources of income for local governments in China (Tao et al., 2010). According to the Ministry of Finance's data, China's total land premium reached 3.37 trillion yuan in 2015, which accounts for 40.6% of local fiscal revenue. This fiscal effect is derived from the various fees, taxes, and other revenues involved in land transfer (Ministry of Finance, 2016). Local governments compete for manufacturing investments, resulting in strong incentives to lease out most of their land. Meanwhile, such a practice leads to sharp urban expansion, as the urban built-up area increased from 23,943 km^2 to 673,123 km^2 from 2004 to 2013. Further, as land finance (reliance on land revenue) increased from 20% to 46% during the research period, carbon emissions in China also increased by 6.7% annually during the same period. Higher carbon emissions were notable in provinces like Shandong and Hebei, where land finance accounts for over 50% of local revenue and the average emission growth rate is over 10% annually. We are concerned with the causes of this phenomenon. Therefore, the present study investigated the possible relationship between carbon emissions and land finance (Svirejeva-Hopkins and

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Schellnhuber, 2008; Bai et al., 2011; Wu and Yang, 2012; Ou et al., 2013; Liu et al., 2016a).

Development is interdependent with urbanization. As a country modernizes its cities expand, and people move from the countryside to the cities (Lian and Lejano, 2014). This process is accompanied by an important change, that is, the conversion of large areas of cultivated land into urban land: a process known as land urbanization. Efficient land use not only contributes to urban development but also has positive effects on rural land conservation, especially in China, which faces an intense human–land relationship (Du et al., 2016). Zhou et al. (2006) negatively viewed the massive magnitude of urban development and stated that the dualization system of urban and rural land as well as incomplete population urbanization leads to inefficient land use. According to Liu et al. (2012), "the quantity of land urbanization" refers to urban sprawl, while "the rate of land urbanization" refers to the speed of expansion. In the present study, we focus on urban land used to raise a local government's revenue during expansion, namely, urban construction land. Thus, following the study of Lin et al. (2015), the land urbanization rate in this study refers to the expansion speed of land construction.

Land use and cover change (LUCC) caused by land (landscape) urbanization and construction can lead to an increase in carbon dioxide (CO_2) emissions (Edmonds et al., 2003; Searchinger et al., 2008; Wise et al., 2015). Meanwhile, LUCC is considered the key factor affecting terrestrial carbon stocks, especially in urbanized areas (Tao et al., 2015). One of the New Normal(referred to as "Xin Changtai" in Chinese) proposed that natural law should be adopted, the most stringent conservation and intensive land-use system should be adhered to, and the land-use patterns should be changed to promote urban restructuring and development. For urban construction land, emphasis should be given to "strictly control increments and revitalize the stock of construction land, optimizing the land use structure and improving land use efficiency" (Liu et al., 2014). Additional requirements highlight border control on the urban growth boundary and advancing urbanization through sustainable land use. Moreover, the 13th Five Year Plan in 2015 proposed that "green, cycle and low-carbon development" is an important concept in the New-Type Urbanization Plan. The construction of an ecological civilization and low-carbon development should serve as the core content and the key point in the promotion of urbanization. Considerable attention has been paid to gain insight into the effects of land use on CO_2 emissions. However, to the best of our knowledge, the effects of land finance and land urbanization have not been investigated. Further, given that China is a vast country with significant regional differences, patterns of urbanization development vary according to region. Therefore, studying the effects from the national and regional levels is necessary.

This study contributes to the literature by investigating the effect of land urbanization and land finance on CO_2 emissions in China through national and regional analyses. As a country faced with an intense human–land relationship and high levels of environmental pressure, the Chinese government should pay attention to urban land use and its possible effects (Y. Li et al., 2015; B. Li et al., 2015). How does a local government's willingness to lease land for revenue relate to carbon emissions? How does land urbanization respond to the sustainable development of urban areas? Are the determinants of carbon emissions in China geographically different? What are the policy implications to effectively improve urban land use and thereby contribute to the environment? Using panel data covering 30 provinces in China from 2004 to 2013, we will employ the Stochastic Impacts by Regression on Population, Affluence and Technology (STIRPAT) model and spatial econometric models to investigate the effect of land urbanization and land finance on CO_2 emissions, while considering regional differences in China.

2. Research base: carbon emissions, urban land use, and land finance

Previous research on the subject is concerned with determinants of carbon emissions. Among these determinants, urbanization rate results in higher energy consumption and carbon emissions (Wang et al., 2014a,b). Significant attention has long been paid to the relation between carbon emissions and urbanization (Wang et al., 2015, 2016). Xu and Lin (2015) adopted non-parametric additive regression models and found that urbanization and CO_2 emissions in the eastern region of China follow an inverted U-shaped pattern. Shahbaz et al. (2016) adopted STIRPAT and found that economic growth is a major determinant of carbon emissions in Malaysia. Arvin et al. (2015) adopted a panel vector autoregressive model and confirmed that urbanization rate significantly contributes to higher CO_2 emissions in G20 countries.

One of the notable features of urbanization is land-use change, which brings about significant environmental impacts. Over the years, extensive research has focused on land urbanization and its relationship with socioeconomic indicators. These indicators include LUCC (Parker et al., 2003; Mundia and Aniya, 2005), health (Kiirya and Mandere, 2012), arable land (Baessler and Klotz, 2006), and fiscal decentralization (He et al., 2016). Furthermore, several studies have suggested that population growth and economic development drive land urbanization (Li, 2015). The dynamic evaluation of land urbanization focused on the concept and its coordinated development with population urbanization and economic urbanization. Some analyses, on the other hand, presented provincial-, regional-, and city-level studies that focused on measuring the speed, quantity, and change of land-use structures (Li, 2012; Zhen et al., 2010; Zhao and Chai, 2015; Zhu, 2015). In recent years, scholars started focusing on the environmental effects of land urbanization (Long et al., 2016). For instance, Xu and Zhang (2016) verified the bidirectional causal relationship between the quality of land urbanization and carbon emissions in China.

Rapid land-centered development in China has also been apparent in recent years. Revenues from selling land are essential to starting urbanization and attracting investment into the city. In the promotion of modernization and land urbanization in China, land finance effectively increases local revenue and significantly contributes to the development and modernization of urban construction: land finance (1) speeds up economic development and the construction of new urban areas, promotes and attracts capital accumulation, and even contributes to the development of modern and tertiary industries; (2) accelerates urbanization and promotes the benefits of urban agglomeration; and (3) promotes urban infrastructure, transportation facilities, and other "hard environments" (Pan et al., 2016; Zhang and Wu, 2016).

Existing studies have focused on the institutional foundation and social influence of land finance (Heikkila, 2007; Y. Li et al., 2015; B. Li et al., 2015; Fu, 2015). Land finance usually represents a positive opportunity for local development and economic growth in China (Jia and Liu, 2012). Moreover, Wu et al. (2015) suggested that the two primary reasons for land finance are fiscal decentralization and the competition among city governments. Chen and Hu (2015) found that land finance contributes negatively to the number of urban public green spaces. Moreover, land finance strategy stimulates real estate markets, which pushes housing prices up even further (Fang and Zi, 2012; Pan et al., 2015). Wang and Ye (2015) found that land finance is significantly influenced by external fiscal circumstances, the career concerns of local leaders, and other political factors.