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博 士 学 位 论 文

中国建筑业绿色低碳化发展研究

Studies on China’s Green and Low-carbon Construction

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摘 要

全球气候变暖促使绿色低碳化转型成为建筑业可持续发展的必经之路。国内外对绿色低碳建筑业的研究主要围绕建设过程中的的碳排放量测算与影响机制来进行研究，以及技术路径、管理策略等问题展开，对绿色低碳建筑业的量化评价和政策措施等问题还缺乏全面的系统性研究。从最新的国家“一带一路”发展战略对建筑业的要求、以及建筑业本身的可持续性发展前景来看，这些方面的研究价值巨大。针对已有文献的不足与缺陷，本文从能源消费产生的二氧化碳排放角度入手，就中国建筑业绿色低碳化发展实现路径进行了深层次量化研究与讨论。主要的研究内容包括：

（1）在考虑建筑业施工技术的约束与投入要素间相互作用的前提下，构建建筑业绿色低碳绩效评价指标体系，对中国省际和区域建筑业绿色低碳绩效进行定量研究和比较；

（2）就建筑业能源消费所产生的碳排放进行因素分解，从宏观视角（如能源消费结构、能源使用效率等）探索驱动中国建筑业碳减排变化的主要因素和各自的影响力，为区分主要矛盾和次要矛盾，有的放矢研究建筑业绿色低碳化发展实现路径、制定建筑业节能减排低碳发展激励措施提供政策依据；

（3）在上述两部分研究基础上，从三个角度探讨中国建筑业绿色低碳化发展的实现路径：

一是从优化要素结构视角，探讨建筑业能源与其他投入要素、以及能源品种间的替代可能性，并且基于要素间的交叉价格弹性，以碳税为例，估计实施节能减排政策对中国建筑业的影响；

二是从提高能源效率的技术进步视角，不仅测算了中国建筑业能源效率上的技术进步率，同时还基于超越对数生产函数和非对称能源价格研究了技术进步对建筑业能源需求产生的反弹效应，为对建筑业绿色低碳技术改进上的政策措施有效性提供更加准确的认识和理解，也为制定建筑业绿色低碳发展长期有效的政策措施提供参考；

三是从省际最优碳排放配额分配视角，通过参数化的方向距离函数测算了各个地区

建筑业二氧化碳边际减排成本，并基于此构建各省建筑业的边际减排成本曲线，进而以全国减排总成本最小化为目标，测算在实现全国建筑业碳强度指标约束下各地区建筑业二氧化碳排放最优配额。

（4）最后，基于全文研究结果，结合宏观背景，提出实现中国建筑业绿色低碳发展的政策建议和保障措施，包括市场化机制、经济激励机制、财税机制等。

关键词：低碳经济；绿色施工；能源政策

Abstract

As climate change issues continue to be attached increasingly significant, green and low-carbon construction becomes necessary for the whole building sector as well as the sustainable development of human beings. Buildings are designed to be more energy efficient and carbon emissions for their operation decreases in recent years. Thus, energy conservation and emission reduction for the building construction is getting of greater importance. Construction is a leading industry in China’s economy, which is also conductive to mitigate climate change. Although an increasing number of researches and applications on green and low-carbon construction have made many achievements, they are still limited to qualitative analyses on influencing factors, technological progress, policies, management strategies and so on. Considering the latest green and low-carbon construction requirement in Chinese “One belt one way” development strategy as well as the sustainable development of construction industry itself, it is imperative to quantitatively study the implementations for China’s green and low-carbon construction.

Given the limitations of existing literature, this paper fills the research gap by quantitatively investigating the implementation of green low-carbon construction in China from the perspective of energy consumption, through the following work:

First, considering the constraints of construction technique and the substitution across input factors, this paper constructs an complicated indicator for evaluating green low-carbon performance of building construction in China.

Second, the energy-related CO2 emissions in building construction have been decomposed into several contributions, and the purpose of the decomposition is to quantify the relative contributions of interested factors, such as energy structure, energy efficiency, etc. And then, the main driving forces of CO2 emissions in building construction can be identified. It is thus conductive for

implementing green low-carbon construction and helpful for making policy on energy conservation and CO2 mitigation.

Third, based on the results of above two parts, this paper studies the implementation of China's green low-carbon construction from three perspectives:

(1) Optimizing factor inputs. This paper assess the substitutability of energy with other factor inputs, such as capital and labor, and the inter-fuel substitution. Based on the results of inter-factor and inter-fuel substitution and using the carbon tax as a case, I evaluate the impact of energy saving and emission reduction policies on building construction.

(2) Technological advancement. This paper not only measures the energy efficiency improvement in China's building construction, but incorporates the rebound effects as well. In estimating the rebound effect, the trans-log production function are employed and the asymmetric effect of energy price changes are considered. The results have important values for understanding the effect of technological progress on energy conservation and CO2 mitigation, and could provide policy implications for promoting the technological advancement.

(3) Optimal carbon emission quotas. This paper measures shadow prices of carbon dioxide emission for China’s construction industry by adopting a parameterized directional distance function, so as to construct marginal carbon abatement cost curve for each province in China. Based on the curves, the optimal CO2 emission quota allocation among provinces and regions for China’s construction industry is obtained with a minimum total abatement cost.

Finally, based on the theoretical and empirical results of this paper, several suggestions and policy implications for implementing the new path of China's green low-carbon construction in China are provided, including market reform, economic incentives as well as financial and tax mechanisms.

Keywords: Low-carbon economy; Green construction; Energy policy

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