



Can environmental innovation facilitate carbon emissions reduction? Evidence from China



Yue-Jun Zhang^{a,b,*}, Yu-Lu Peng^{a,b}, Chao-Qun Ma^{a,b}, Bo Shen^c

^a Business School, Hunan University, Changsha 410082, China

^b Center for Resource and Environmental Management, Hunan University, Changsha 410082, China

^c Energy Analysis and Environmental Impacts Division, Lawrence Berkeley National Laboratory, Berkeley, CA 94720, United States

ARTICLE INFO

JEL classification:

Q56
Q58
O38
O25
O44

Keywords:

Environmental innovation
Carbon emissions trading
China
SGMM
PSM-DID

ABSTRACT

Environmental innovation has been recognized as an efficient way of addressing environmental problems. However, how environmental innovation may affect carbon emissions in China and whether the effect may differ among various environmental innovation variables remain to be investigated. Therefore, based on the panel data of China's 30 provinces during 2000–2013, we use a system generalized method of moments (SGMM) technique to estimate the effect of environmental innovation on carbon emissions in China. Also, we evaluate the effect on carbon emission reduction of China's initial carbon emissions trading (CET) scheme. Empirical results indicate that, most environmental innovation measures in China reduce carbon emissions effectively. Among the various environmental innovation factors, energy efficiency exerts the most evident effect on carbon emissions abatement in China; meanwhile, resources for innovation and knowledge innovation also play prominent roles in this regard. However, the impact of governmental environmental policies on curbing carbon emissions reduction suffers from a lag effect, which mainly occurred during 2006–2013. Finally, despite the short time of operation and incomplete market mechanism, the pilot CET in China has appeared relatively promising with regard to carbon emissions reduction.

1. Introduction

Since the reform and opening up in 1978, China has experienced relatively long-period economic success. According to the World Bank, China's average annual growth rate of GDP arrived at 6.93% during 1978–2015 (2000 as the base year).¹ This rapid growth has escalated demand for energy and resulted in increasing carbon emissions, which caused tremendous pressure on the environment in China (Zhang and Da, 2015). In fact, China has become the world's largest carbon emitter in 2006 and the largest energy consumer in 2009; specifically, the CO₂ emissions in China reached 9.15 billion tons in 2015, accounting for 27.3% of the world total (BP, 2016). Under such circumstances, China is facing a severe situation requiring energy conservation and emission reduction, especially in some metropolitan areas such as Beijing, Shanghai, and Guangzhou, where environmental deterioration has gradually become a threat to the public health of urban residents.

Under dual pressure from domestic environmental deterioration

and international climate negotiations, Chinese Government has made an array of ambitious commitments to CO₂ emissions reduction. For instance, China aimed to peak its CO₂ emissions by 2030 in the China-US Joint Announcement on Climate Change.² Further, the promise has been made to lower CO₂ emissions *per* unit GDP (*i.e.*, carbon emission intensity) by 60–65% by 2030, based on the 2005 level.³ Hence, how to formulate suitable policies and take effective measures to restrain carbon emissions and realize the peak in carbon emissions earlier is an urgent and practical problem to be solved.

To date, there are some well-known measures to reduce carbon emissions. First, the improvement of energy efficiency proves an effective way of reducing carbon emissions (Buchanan and Honey, 1994; Álvaro López-Peña et al., 2012). For instance, Buchanan and Honey (1994) find that energy conservation and efficiency improvement are the optimal carbon emissions reduction strategy in the short term. Álvaro López-Peña et al. (2012) hold that energy efficiency would be cheaper than renewable in Spain for curbing carbon emissions in the

* Corresponding author at: Business School, Hunan University, Changsha 410082, China.
E-mail address: zyjmis@126.com (Y.-J. Zhang).

¹ <http://data.worldbank.org.cn/>.

² http://www.gov.cn/xinwen/2014-11/13/content_2777663.htm.

³ Enhanced Actions on Climate Change: China's Intended Nationally Determined Contributions, released in June 2015. Available at: http://news.xinhuanet.com/english/china/2015-06/30/c_134369837.htm.

short- and medium-term future. Second, the adjustment of energy demand structure and the reduction in energy intensity are also important factors. Chang et al. (2008) use the structural decomposition method to identify the major factors contributing to CO₂ emissions changes in Taiwan during 1984–2004. Their results indicate that the highway, petrochemical materials, and steel and iron industries are primary sources of carbon emissions, highlighting the decisive effect of optimal energy demanding structure. Similarly, Tian et al. (2013) mainly emphasize energy intensity improvement and industrial structure change in decarbonizing Beijing. Besides, there are other significant contributors of carbon emissions reduction, such as foreign direct investment spill-over (Elliott et al., 2013; Lee, 2013), and trade mode (Davis et al., 2011; Peters et al., 2012).

However, the measures elaborated above have ignored the role of innovation. In fact, innovation is the key to transforming and optimizing a nation's economic structure. In the 18th National Congress of the Communist Party of China in 2012, Chinese government proposed the Innovation-Driven Development Strategy,⁴ which calls for the economic development mode to be transformed from the old-fashioned production factor- and investment-driven patterns towards a modern innovation-driven pattern. In theory, throughout the whole process of economic structure transformation, the innovation-driven mode may be vital for transforming developing drivers and patterns as well as enhancing economic performance. However, for the sake of achieving the commitment to peaking carbon emissions, what different possibilities within different innovation revolutions, and how to exploit the innovation to promote carbon emissions reduction remain realistic problems to be solved. In particular, to realize the GHG emissions control target at lower costs while promoting market mechanisms and accelerating economic structure transformation in China, the National Development and Reform Commission (NDRC) of China initiated a carbon emission trading (CET) scheme in 2011,⁵ which covers seven jurisdictions, *i.e.*, Beijing, Tianjin, Shanghai, Chongqing, Shenzhen, Guangdong, and Hubei. As a transformational environmental innovation initiative, the CET in China aims to fulfill carbon abatement commitments in response to climate change and has received extensive attention from academia. Specifically, extensive discussions have been focused on various aspects of China's CET scheme, including CO₂ emissions allowance allocation (Zhang et al., 2014; Zhang and Hao, 2015; Zhou and Wang, 2016), operational framework and mechanism (Zhou et al., 2013; Jiang et al., 2014; Xiong et al., 2015), market efficiency and economic impact (Zhao et al., 2015; Wang et al., 2016), as well as its impact on related enterprises' strategies, product pricing and low-carbon investment (Zhang et al., 2015; Wang et al., 2016).

Therefore, this paper is aimed at the role of environmental innovation and assesses its effect on carbon emissions on the provincial level in China. In particular, we attempt to detect whether the CET pilot program works out to reduce carbon emissions in China in recent years, so as to propose some constructive suggestions for the related environmental policy makers in China. Overall, this paper contributes to the previous literature in the following three ways: first, current research on environmental innovation mainly focuses on several specific aspects (*i.e.*, market demand, environmental technology, environmental regulation, *etc.*), but lacks integral systematic consideration. Thus, we develop a relatively comprehensive environmental innovation variable system, which consists of four dimensions, *i.e.*, Innovation Performance, Innovation Resources, Knowledge Innovation, and Innovation Environment. Second, previous related studies mainly concentrate on firms or sectors, without much consideration to the regional level. To that end, we apply a system generalized method of moments (SGMM) technique to determine the dynamic effect of environmental innovation on carbon emissions from

a regional view in China. Third, to separate the policy effect of CET on carbon emissions reduction and avoid selection bias, we propose a difference in difference based propensity score matching (PSM-DID) method, so as to provide a rigorous reference for relevant policymaking in China.

The remainder of this paper is organized as follows: Section 2 provides a literature review, Section 3 describes the data and variables definitions, as well as methods for empirical analysis, Section 4 presents empirical results and discussions, and Section 5 concludes the paper with some key policy implications.

2. Relevant literature review

2.1. Environment innovation

Environmental innovation refers to all measures of relevant entities (firms, unions, private households), which develop new ideas, introduce efficient processes or apply new technologies, aiming at contributing to a reduction of environmental burdens and ecologically specified sustainability (Rennings, 2000). Thus, it is an efficient way to reconcile economic growth and environmental protection and promote sustainable development (Aggeri, 1999). When economic development conflicts with environmental targets, the externality of the “public good” nature of environmental innovation may reduce the related firms' incentives to innovation investment (Rennings, 2000).

Overall, the majority of recent studies on environmental innovation basically include three categories, *i.e.*, the determinants, the performance, and the effect on reducing carbon emissions.

First of all, many studies briefly pool the determinants of environmental innovation into four parts, *i.e.*, firm specific factors, technology push, market pull, and government policies (Rehfeld et al., 2007; Horbach et al., 2012; Costantini et al., 2015). For instance, Costantini et al. (2015) confirm that the technological capabilities and environmental regulation may spur innovative activities in different technological phases in the bio-fuels sector. Triguero et al. (2013) draw upon a database of 27 European countries and find that prioritizing existing regulations shapes eco-innovations. In particular, more and more relevant studies stress the role of governmental policy in recent years (Horbach, 2008; Johnstone et al., 2010; Kneller and Manderson, 2012).

Second, in view of the performance, existing literature mainly focuses on the firm level, and generally relies on the data from industrial surveys or questionnaires (Eiadat et al., 2008; Sierzchula et al., 2012; Cai and Zhou, 2014). For instance, Eiadat et al. (2008) claim that environmental innovation fully mediates, and positively associates, between certain environmental pressures and business performance, based on data from chemical industry in Jordan. Cai and Zhou (2014) investigate environmental innovation's internal drivers (*i.e.*, technological ability, environment management systems, and innovation initiative) and external drivers (*i.e.*, environmental regulations, customers' green demands and competitors' pressure), and highlights their roles in reinforcing firms' integrative capability.

Finally, in recent years, considerable research has gradually revealed the positive effect of environmental innovation variables on carbon emissions (Huaman and Tian, 2014; Lee and Min, 2015). For example, Huaman and Tian (2014) hold that the development of carbon capture and storage (CCS) technology proves a vital component to reduce future carbon emissions in the global fight against climate change. Lee and Min (2015) use a sample of Japanese manufacturing firms during 2000–2010, and find that the green R&D for eco-innovation may decrease carbon emissions and increase firm value. Among various environmental innovation variables, market supervision and governmental regulation are increasingly deemed to reduce carbon emissions in relevant studies (Foulon et al., 2002; Shimshack and Ward, 2008; Zhao et al., 2015; Borghesi et al., 2015). For instance, Zhao et al. (2015) investigate the impact of three different environ-

⁴ http://www.gov.cn/gongbao/content/2015/content_2843767.htm.

⁵ http://www.sdpc.gov.cn/zcfb/zcfbtz/201201/t20120113_456506.html.

Download English Version:

<https://daneshyari.com/en/article/5105853>

Download Persian Version:

<https://daneshyari.com/article/5105853>

[Daneshyari.com](https://daneshyari.com)