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Green economy in China: Regional variations and policy drivers

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ABSTRACT

For policy makers in China, the development of a green economy presents opportunities and challenges not only for the central government, but also for provincial and city governments. This study measures clean energy economy at the city level in China, by counting green jobs and firms through an analytical approach. As shown in this study, green jobs and green firms are distributed unevenly across different regions in China. This study also quantifies provincial clean energy policies in China and finds significant variations in clean energy policy actions. Spatial error model (SEM) analyses indicate that local clean energy policies, along with socio-economic factors such as population, per capita gross domestic product, educational attainment, emissions of sulfur dioxide, and marketization of the regional economy, explain the variation in green economy across cities. Cities located in a province with clean energy policies have 54.3% more green jobs and 61.8% more green businesses, compared with cities located in a province without such policies.

1. Introduction

The Chinese government has increasingly recognized the transition to a green economy as a long-term strategy, to boost its economic growth along a sustainable path and protect its environment from further deterioration (Pan et al., 2011). This industrial and energy transition is evidenced by China's adoption of energy and economic policies in recent years. Of the 4 trillion Renminbi (RMB) Yuan economic stimulus package adopted in 2008, 210 billion RMB (5.25%) was invested in energy savings, greenhouse gas emissions reduction, and environmental engineering projects (Cai et al., 2011). The Twelfth Five Year Plan (FYP) (2011–2015) aims at reducing the country's energy intensity by an additional 16% (relative to the Eleventh FYP) and carbon emissions per unit of gross domestic product by 17% (relative to 2010) (Li and Wang, 2012).

The rationales behind the transition to a green economy are driven by environmental, economic, and social considerations. Rapid economic development in China has left the country with a heavy environmental toll, which includes deteriorating air quality due to coal burning and other industrial pollutions, surging greenhouse gas emissions from fossil fuel consumptions, degrading water quality and resources, and worsening rural environments and land-based ecosystems (Pan et al., 2011). These environmental challenges have not only obstructed China's sustainable development, but also have led to an ongoing and escalating public health crisis. The World Bank (2007) estimated that the health costs of air and water pollution in China amounted to about 4.3% of its overall gross domestic product (GDP). Therefore, a transition to a low carbon society has become a priority on China's policy agenda to address environmental problems and upgrade economic and industrial structures simultaneously.

Green jobs and businesses are critical for a green economy and a low carbon society. For Chinese government, fast economic and employment growth are both important policy goals. But except for a few forecasting studies based on input–output models, there are no empirical data measuring the number of green jobs and businesses in China, as well as their geographic distributions. The lack of empirical data not only makes it hard to evaluate the current status of green economy in China, but also makes evaluation of clean energy policies an impossible task.

This paper is an effort to address several related research questions. First, we address the need to count green jobs and businesses in China through a bottom-up data collection process. Instead of using project-level data and questionnaires (Wei et al., 2010; European Wind Energy Association (EWEA), 2009; Kenley et al., 2009), we resort to using establishment level data to assess the clean energy economy across 22 provinces, 5 autonomous regions, and 4 direct-controlled municipalities in China (we refer to them as "provinces" for the rest of the paper), with specific green jobs data on 287 prefecture-level cities. We then formulate and

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test the relationship between China's subnational (provincial) green energy policies and the number of green jobs in Chinese cities by employing spatial error regression models to test the impacts of these energy policies on the growth of green jobs in cities.

This paper fills the gaps in the extant literature by focusing on the empirical data of green jobs and assessing the employment effect of subnational green energy policies in China. It contributes to the existing literature on green jobs and clean energy policies, and provides empirical evidence to support policy decisions.

The structure of the paper is organized as follows: Section 2 examines the extant literature on China's energy policies and sustainability, as well as the literature on green job studies and evaluations. Then in Section 3 we review and quantify the green energy policies in China at provincial level of government. In Section 4 we present our methodology used to collect and aggregate data on green jobs in China. Two spatial error regression models are then employed to analyze the employment effects of green energy policies in China. We present the statistical results of factors influencing the green jobs and businesses in Chinese cities in Section 5. Finally, this paper concludes in Section 6 with policy implications for policymakers and suggestions for future research.

2. Literature review

Several studies have been conducted to forecast how China's economy will respond to its energy, climate, and environmental policies. Resnier et al. (2007) evaluated the economic and environmental benefits of the clean development mechanism (CDM) and found that the CDM tax/subsidy optimization model (CDMTSO model) would bring the CDM projects an internal rate of return close to around 10%. Bayer et al. (2013) found that Chinese provinces with high electricity consumption, low per capita income and low foreign direct investment have more CDM implementation. Lin et al. (2010) investigated the impacts and constraints of China's energy saving and carbon dioxide emissions on energy structures using an optimal model and computational general equilibrium (CGE) model. They found that the government's plan for renewable energy has a positive impact on reducing CO_2 emissions, but has a negative impact on economic growth. Similarly, Zhang et al. (2012) assessed the quantified economic impact of CO_2 intensity reduction targets under the Twelfth-Five Year Plan (2011–2015) and found that the single national carbon intensity reduction target has significant consumption loss at the national level, but substantial differences in its regional impacts.

Very few studies have been done to specifically explore the connection between China's clean energy policy and green jobs. Based on analytical and input–output models, Cai et al. (2011) estimated that China's greenhouse gas (GHG) mitigation policies in the power generation sector would result in 44,000 net job losses from 2006 to 2009, but 472,000 net job gains from 2006 to 2010. Wang et al. (2013) found that by the end of 2011, CDM projects led to about 99,000 net direct jobs losses, but also created about 3.08 million indirect jobs. However, no empirical data were collected to assess the number and distribution of green jobs across Chinese cities.

In the international context, Fankhauser et al. (2008) discussed the job creation impacts of climate policy in the short, medium, and long term. They concluded that in the short term, climate policy should have a positive effect on employment due to the nature of labor-intensiveness of low-carbon technologies. In the medium term, leaders of low-carbon technology countries may reap job gains by exporting products and services. In the long term, the economy's structural adjustment could lead to job creation, productivity improvement, and growth (Fankhauser et al., 2008). On the other hand, Frondel et al. (2010) argued that German renewable energy policy subverted market incentives without positive impacts on employment. Wei et al. (2010) employed an analytical job creation model for the US power sector from 2009 to 2013, and found that the clean energy industry could generate more jobs per unit energy than traditional industries. Similar studies on green jobs and green economy were conducted in other international contexts (Davies, 2013; Lund and Hvelplund, 2012; Tourkolias and Mirasgedis, 2011; Lambert and Silva, 2012; Moreno and López, 2008; Sastresa et al., 2010; Chakrabarty and Islam, 2011; Qi et al., 2012; Lin et al., 2013), predicting the job creation potentials of relevant clean energy technology and policy scenarios, using input–output (I–O) analyses.

In the context of United States, the discussions on the burgeoning green economy have attracted attention from beyond the academic community. There are academic discussions regarding what are considered as "green jobs". It is important to note that a green job may not necessarily come from a green industry, and that not all jobs in a green industry are green. To address the accounting of green jobs, different organizations came up with different definitions as to what are "green jobs". The U.S. Bureau of Labor Statistics (BLS) defines green goods and services as "jobs in businesses that produce goods and provide services that benefit the environment or conserve natural resources". The Brookings Institution proposes that a clean economy can be measured through business establishments and jobs associated with them. The clean economy "produces goods and services with an environmental benefit or adds value to such products using skills or technologies that are uniquely applied to those products" (Muro et al., 2011). The Pew Charitable Trust defines the clean energy economy as an economy that "generates jobs, businesses and investments while expanding clean energy production, increasing energy efficiency, reducing greenhouse gas emissions, waste and pollution, and conserving water and other natural resources"(, p. 5). As shown later, this paper adopts the definition of Pew Charitable Trust, relying on a list of SIC codes, which capture all jobs in the green industry. The potential problem with this approach is that it may overestimate the green jobs from the green industry, as not all jobs in the green industry are green. It may also underestimate green jobs in a way that it did not capture green jobs in non-green industries. But the advantage here is obvious, the approach we employ in this paper, using the SIC codes defined by Pew Charitable Trust, is the only feasible way to collect green jobs data in the context of China.

Some studies also made initial efforts to connect clean energy policies and green jobs, using an *ex-post* approach. Yi (2013) empirically evaluated the impact of clean energy policies on green jobs in US metropolitan areas, and found moderate to positive associations among state clean energy tools, local climate policies and the number of green jobs. Bowen et al. (2013) pointed out that the state renewable energy portfolio standards (RPS) in the United States did not have a significant effect on green job growth, but did help create green businesses, a result also confirmed in another study (Yi, 2014). This study applies the same logic to the relationship between clean energy policies and green jobs in China, with a goal to test the associations between provincial energy policies and green jobs.

3. Energy policies in China

3.1. National energy policies and plans

The National Renewable Energy Laboratory (NREL) (2004) categorized China's renewable energy policies into three categories: first-level, second-level, and third-level. First-level policies provide general guidance and direction about the development of