China Economic Review 34 (2015) 64–82

Contents lists available at ScienceDirect

China Economic Review

Can China harness globalization to reap domestic carbon savings? Modeling international technology diffusion in a multi-region framework

Wei JIN *

School of Public Policy and Management, Zhejiang University, Hangzhou, China
Centre for Applied Macroeconomic Analysis, Crawford School of Public Policy, Australian National University, Canberra, Australia

ARTICLE INFO

Article history:
Received 17 September 2014
Received in revised form 12 March 2015
Accepted 12 March 2015
Available online 20 March 2015

Keywords:
Globalization
China
Endogenous technical change
International technology diffusion
Energy policy modeling

ABSTRACT

This paper is devoted to examine the effect of globalization, particularly the international technology diffusion (ITD), on China's domestic carbon savings. Building on a multi-region global modeling framework, we explicitly consider both indigenous R&D and foreign technology diffusion as the dual drivers of endogenous technical change (ETC) for domestic carbon savings. Simulation results show that 1) traditional economic globalization policies like trade and FDI liberalization can boost the growth of production output, but this is at the cost of more fossil energy uses and carbon emissions; 2) technology globalization policies like removals of technology transfer barriers can facilitate the inflows of foreign technologies for domestic carbon savings; and 3) domestic emission control policies have an effect to induce restructuring and reorganization of production technology into a knowledge-intensive one and thus help lower climate compliance costs. Consequently, to create China's domestic carbon savings from globalization, policy should focus on promoting cross-country technology diffusion, beyond traditional cross-border transactions of product and capital goods. Domestic emission-based climate regulation should also be implemented to create market demand for carbon-efficient technologies and thus induce inflows of foreign advanced technologies.

1. Introduction

In formulating prudent strategies to combat global warming, carbon emissions from every corner of the world should be considered due to the global nature of climate change mitigation (IEA, 2010; Stavins, 2011). Although most of emission abatement obligations rest with the industrialized countries, it is highly likely that many low-cost mitigation opportunities exist in the developing world. In particular, the fast-growing emerging economies have called for international transfer of carbon-efficient technologies to help support their indigenous climate efforts such that domestic climate compliance costs can be effectively mitigated (IPCC, 2000; Popp, 2011; World Bank, 2008).

While the traditional paradigm of international technology transfer (e.g., North–South Official Development Assistance Programs) is useful for climate negotiating agenda, it has become increasingly flawed due to a narrow conceptualization of the scope of international technology diffusion (ITD).[1] On the one hand, as national economies are increasingly integrated into an interdependent world

* School of Public Policy and Management, Zhejiang University, Hangzhou, China. Tel.:+86 571 56662028; fax: +86 571 56662019.
E-mail addresses: wj1019@zju.edu.cn, wei.jin@anu.edu.au.

[1] Technology is at the hand of private sectors and cannot be transferred at will by the government. The magnitudes of ODA programs remain quite small relative to private investments. The FDI is on the order of hundreds of billions of dollars per year, as compared with total ODA flows on the order of hundreds of millions (World Bank, 2007; UNFCCC, 2007; UNFCCC, 2010). As a result, the paradigms emphasizing the role of government neglect the working of market force in the process of ITD, which fundamentally brings about the impasse of climate negotiations and slows low-carbon technology transfers (Brewer, 2008, 2009).

http://dx.doi.org/10.1016/j.chieco.2015.03.006
1043-951X/

economy through international trade and investment flows, the traditional aspect of globalization – production globalization – enables an extensive dissemination of technologies via cross-border transactions of product and capital goods (UNCTAD, 2010a). On the other hand, as the internationalization of R&D enhances the tendency of cross-country technological interdependence and knowledge spillovers, the modern aspect of globalization – innovation globalization – would be harnessed by individual countries to facilitate domestic innovation and technological progress (OECD, 1997; UNCTAD, 2005).

Clearly, the overarching trend of globalization would create an opportunity of ITD and carbon savings for the world's top carbon emitter — China. To decouple carbon emissions from rapid economic growth, this nation has stepped up efforts to change its business-as-usual growth pattern through technological innovation (MOST, 2006). In addition to strong growth in indigenous R&D investment, China also seeks to harness the growing globalization to reinforce innovative capacities. First, Beijing has attached the same importance to import in foreign trade policy, with the purpose of assimilating foreign advanced technologies embodied in product imports (IMF, 2011; WTO, 2010). Second, China's rapid growth has created a huge consumer market, which attracts market-seeking multinational firms to undertake technology transfer through FDI for quality product development (UNCTAD, 2005). Thirdly, as the globalization of innovation has created an international mobility of ideas like scientific papers, patents, technical conferences, and academic networking, the worldwide spillovers of disembodied pure knowledge would favor technology learning and absorption by China (OECD, 1997).

Accordingly, in such a context where China's integration into the world economy not only boosts economic growth but also offers an opportunity of ITD for technological progress, both of which hold important implication for China's energy/climate performance. It is thus vital to investigate the effect of globalization, particularly ITD, on China's domestic carbon savings. In explicit, this paper is devoted to address the following issues. (1) What's the effects of indigenous R&D and ITD on China's domestic carbon savings? (2) Through which channels does China acquire ITD to complement indigenous R&D for technological progress? (3) Which policies can be designed to harness the beneficial effects of globalization for domestic carbon savings? (4) Can China's domestic emission-based climate policies induce foreign knowledge inflows to help mitigate domestic climate compliance costs.

To address these issues, we develop a multi-region global general equilibrium model, where the "stock of knowledge" method is used to represent the mechanism of endogenous technical change (ETC) in the spirit of Goulder and Schneider (1999) and Sue Wing (2001).[2] To advance most of the existing literature that only considers indigenous R&D within a closed economy, we extend the single-country modeling framework into a multi-region global one, so that the dual drivers of ETC – indigenous R&D and ITD – can be explicitly described. Such effort is particularly needed, because with the issue of ITD for climate mitigation placed high upon energy/climate policy agenda, there is a pressing need for researchers to examine carbon saving potentials from ITD (Gillingham, Newell, & Pizer, 2008; Grubb, Hope, & Fouquet, 2002; Hübler, 2011; Popp, 2006a; Popp, Newell, & Jaffe, 2010).[3]

While modeling ITD has become a fruitful avenue for future energy/climate policy analysis, the existing literature only has a few studies that explicitly considers the effect of ITD in energy/climate policy modeling. For example, Gerlagh and Kuik (2007) use the GTAP-E model to examine the mechanism of ITD through price-induced energy-saving ETC. Hübler (2011) develops a dynamic CGE model to investigate the mechanism of ITD through FDI. Leimbach and Baumstark (2010), Leimbach and Edenhofer (2007), and Leimbach and Eisenack (2009) provide multi-region models to examine ITD embodied in cross-country trade. Methodologically, these works use parametric methods to implicitly represent technology, where the mechanism of ITD is described as changes in productivity parameters as an outcome of the underlying drivers like trade and FDI. By contrast, the "stock of knowledge" approach gives an explicit representation of technology where ITD is specified as foreign R&D spillovers into domestic knowledge stocks for ETC, for example, Buonanno, Carraro, and Galeotti (2003), Bosetti, Carraro, Massetti, and Tavoni (2008, 2011), and Parrado and De Cian (2014).

While providing a good starting point for future modeling studies, the existing works still have some limitations in the sense that their modeling frameworks only capture a single type of ITD channel in isolation, taking no account of multiple ITD channels and their aggregate effects. [4] To fill this gap, this paper contributes to the modeling of ETC. for energy/climate policy analysis in the following ways: (1) Both indigenous R&D and ITD are explicitly considered as the dual drivers of innovation and ETC.; (2) A comprehensive framework is developed to fully capture ITD through both embodied and disembodied diffusion channels; (3) Knowledge absorptive capacity is modeled to reflect the compatibility between foreign diffused technologies and local technological conditions.

The rest of this paper is organized as follows. Section 2 introduces the modeling methods, with an emphasis on the basic structure and modeling ETC. Simulation results and discussion are presented in Section 3. Section 4 provides conclusions and policy implications.

[2] This method has theoretical origins in the endogenous growth literature, which highlights the relation between knowledge creation and technology progress (Acemoglu, 2002, 2009; Aghion & Howitt, 1998; Romer, 1990). In this direction, this is a growing trend in climate policy analysis to model technology using the "stock of knowledge" approach (e.g., Acemoglu, Aghion, Bursztyn, & Hemous, 2009; Buonanno et al., 2003; Goulder & Schneider, 1999; Jin, 2012; Löschel & Otto, 2009; Nordhaus, 2002; Popp, 2004; Sue Wing, 2006).

[3] Most of the existing literature focus on empirical evidences on environmentally friendly ITD (e.g., Dechezleprêtre, Glachant, & Meniere, 2008; Johnstone, Hascic, & Popp, 2010; Lanjouw & Mody, 1996; Lovely & Popp, 2011; Popp, 2006b; Popp, Hascic, & Medhi, 2010), and the number of numerical modeling in this field is still not sufficient.

[4] Empirical studies have shown that private firms do not just conduct a single type of economic activity associated with ITD such as international trade and investment, but also perform several such activities simultaneously (Clerides, Lach, & Tybout, 1998; Keller, 2004).