



Can foreign direct investment harness energy consumption in China? A time series investigation



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ABSTRACT

This study assesses the long-run relationship and short-run dynamics between foreign direct investment (FDI) and energy consumption in China. Applying the bounds testing approach to annual data from 1982 to 2012, we find that a stable FDI–energy nexus exists in the long run and a 1% increase in FDI reduces energy consumption by 0.21%. However, this study shows a positive association between FDI and energy consumption in the short run, attributing to the dominance of the scale effect. Our results remain robust to different measurements and estimators. It is suggested that the Chinese government shall support the inward FDI in the tertiary and energy sectors and strengthen local absorptive capacities to fully internalize FDI-related knowledge spillovers in energy conservation.

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1. Introduction

China's share in global energy consumption nearly tripled from a mere 6.10% in 1979 to a staggering 16.25% in 2008 (Global Energy Statistical Yearbook, 2015). Beginning from 2009 the Chinese economy has consistently ranked ahead of the United States as the world's leading energy consumer. Quantitatively, in 2015 it consumed around 4300 million tons of standard coal equivalent (SCE) (EIA, 2016). Unfortunately, such unprecedented rise in energy consumption has transformed China from an energy exporter to an energy importer since 1993 (Naughton, 2007). This supply gap can be seen in Fig. A1 in appendix where the average growth rate of energy consumption and domestic energy production for the 1979–2014 period is 5.76% and 5.11%, respectively. However, given that stable and affordable supplies of energy are indispensable to national security and economic growth, this increasing reliance on foreign energy supply has put China in a precarious position (Bloch et al., 2015; Leung, 2011; Odgaard and Delman, 2014).

Apart from energy security, environmental degradation arising from this massive energy consumption represents another challenge for the Chinese government. According to the National Bureau Statistics

(2015), in 2014 China emitted a total of 19.76 million tons of Sulphur dioxide (SO₂), 20.78 million tons of nitrogen oxide (N₂O) and 17.41 million tons of smoke and dust into the air. Recently, the notorious particulate matter 2.5 (PM_{2.5}) twice triggered the red alert in Beijing that seriously dampened the public's confidence on the government's resolve to abate air pollution (BBC News, 2016). Although both energy security and energy conservation were listed as key priorities back in the 10th Five-Year Plan (2001–2005), genuine effort to combat these challenges has only been made in the 13th Five-Year Plan (2016–2020) where the policy makers set ambitious targets, including a cap of five-billion-ton SCE and a goal of 15% non-fossil fuel in the energy mix. Undoubtedly, solving these difficult challenges is quintessential towards a sustainable lifestyle in China.

Historically, electrification, energy inefficiency and a rapidly growing economy contributed much of China's rising energy consumption during the Reform era. However, an important driving force behind these changes has been the emergence of foreign direct investment (FDI) in the Chinese economy. It is apparent from Fig. A2 that the first wave of FDI did not occur in China after the reassurance by then the Chinese leader, Deng Xiaoping, regarding continual economic reform during his 1992 tour to Special Economic Zones in southern China. Meanwhile, China's accession to the World Trade Organization (WTO) in 2001 marked the start of the second wave of FDI, with its cumulative

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stock exploding from US\$203.14 billion in 2001 to US\$1085.29 billion in 2014. Unsurprisingly, several lines of evidence have shown that FDI not only contributed directly to output, job creation and the volume of exports, but also indirectly through technology spillovers and real wage growth (Berthélemy and Démurger, 2000; Karlsson et al., 2009; Whalley and Xin, 2010). Put differently, FDI serves as the catalyst for modernizing the Chinese economy in recent decades.

From the outset, the rise to prominence of FDI would not have been possible without a stable supply of energy in China. In part, this is because during the early 1990s, FDI was concentrated in the export-orientated secondary sector where the access to affordable and reliable energy supply represented a major competitive advantage for penetrating the world market. To put this into perspective, the *China Energy Statistical Yearbook* reported that the tertiary sector accounted for <15% of the annual energy consumption over the 1991–2010 period. However, Fig. A3 shows that since 2010 the share of FDI in the tertiary sector has overtaken the secondary sector, with Real Estate, Leasing, Finance and Business Services, Scientific Research and Wholesale and Retail Trade as the leading host industries.¹ Given relatively smaller energy demand by the tertiary sector, such sectoral shift carries important implications for the energy market. For example, a negative association between FDI and energy consumption may capture positive spillovers in energy-conserving practices introduced by foreign-invested enterprises (FIEs) in the tertiary sector that strengthens the case for pursuing industrial upgrading and attracting additional FDI to the sector.

In theory, the FDI–energy nexus can be decomposed into the scale, technique and composition effects. Specifically, the scale effect refers to the increase in energy consumption brought about by vibrant economic activity fueled by FDI. In contrast, the technique effect describes a negative association between FDI and energy consumption that stems from foreign investors introducing energy efficiency not only in their own facilities, but also disseminate such knowledge to the wider community. Finally, the nature of the composition effect is ambiguous as it depends on the sectoral distribution of FDI and the level of economic development in the host country. For example, the concentration of FDI in the tertiary sector of a developed country encourages a negative FDI–energy nexus, whereas such concentration in the secondary sector of a developing country promotes an opposite effect. Against these countervailing effects, it is imperative for the Chinese policy makers to understand the fundamental relationship between FDI and energy consumption when designing energy policy that not only addresses energy security but also maintains economic stability.

The Chinese government has taken proactive measures to encourage foreign participation in the energy sector. For instance, around 100 foreign-invested power plants emerged in the electricity industry shortly after the promulgation of the *Electricity Law* in 1995 that protects the rights of foreign investors (World Bank, 2000). Meanwhile, the annual flow of FDI into the electricity, gas and water industries doubled within a decade from US\$1.1 billion in 2004 to US\$2.2 billion in 2014. This ascending trend is expected to continue in the near future as the latest *Catalogue for the Guidance of Foreign Investment Industries* has identified clean energy projects as a key priority, with the government planning to invest an estimated US\$1.54 trillion in partnerships with FIEs (NDRC, 2015). Notwithstanding major national security concerns the government believes that foreign participation raises productivity and efficiency in the energy sector. With this backdrop, a study on the FDI–energy nexus in China is timely.

To date the extant literature only offers a handful of empirical studies with mixed findings on the FDI–energy nexus. For example, while Mielnik and Goldemberg (2002) and Doytch and Narayan (2016) find a negative association between FDI and energy consumption for a group of countries, Sadorsky (2010) and Lee (2013) conclude that FDI raises energy consumption in the host countries. On the other extreme,

this nexus is shown to be either insignificant or heterogeneous among developing countries (Hübler and Keller, 2010; Paramati et al., 2016). In the case of China, although the consensus supports the energy-conserving bias of FDI, it is important to point out that the majority of the existing studies have not investigated the long-run dynamics between FDI and energy consumption (Blackman and Wu, 1999; Fisher-Vanden et al., 2004; Elliott et al., 2013). Unlike portfolio investment, FDI represents a long-term commitment by foreign investors where the Chinese government must be aware of the cumulative effect of FDI on energy consumption over time. Furthermore, most studies have overwhelmingly focused on the FDI–energy nexus prior to the early-2000s, neglecting recent events such as the pursuit of industrial upgrading in the FDI regime and the accession to the WTO. Hence, this study is designed to fill these gaps by analyzing the FDI–energy nexus throughout the Reform era in China.

This study investigates the FDI–energy nexus in China from 1982 to 2012 using the autoregressive distributed lag (ARDL) model. In general, our empirical results show cointegration in the energy–income–trade–FDI linkage. Furthermore, we find a negative relationship between FDI and energy consumption in the long run and attribute it to the technique and composition effects associated with energy-conserving practices adopted by foreign investors and the demand for cleaner goods among affluent local residents. In contrast, we argue that the scale effect brought about by foreign investors prioritizing output expansion over energy conservation is responsible for a positive FDI–energy consumption in the short run. Finally, our results show that FDI provides an effective mechanism for reducing non-renewable energy in the long run and rejects the conventional wisdom that foreign investors only utilize cheap non-renewable energy during production. Our empirical results remain robust to different measurements and estimators.

The rest of this paper is organized as follows. Section 2 examines recent literature regarding various facets of energy consumption, with an explicit emphasis on China. Section 3 describes the model, data and methodology. Section 4 discusses the empirical results and a series of robustness checks. Finally, Section 5 concludes.

2. Literature review

Much of the extant literature on the relationship between energy consumption, economic growth, FDI and international trade has ignored potential interactions among these variables. However, such neglect may produce misleading results for China where a series of economic reform is known to induce permanent structural changes in its macro-economic variables. Before establishing our a priori expectations on these variables in a unified framework, we individually review the bilateral relationship between growth and energy consumption, FDI and energy demand and trade and energy use.

2.1. The growth–energy nexus

Starting from Kraft and Kraft (1978), rapid economic growth and rising energy consumption in many industrialized economies during the postwar period has prompted vibrant research in the growth–energy nexus. Theoretically, this nexus could arise from potential complementarity (or substitutability) between energy and other factor inputs in the production process (Stern, 1993; Bloch et al., 2012). Empirically, most studies in this genre have examined either the conservation hypothesis (unidirectional Granger causality running from growth to energy) or the growth hypothesis (unidirectional Granger causality running from energy to growth) (Ozturk, 2010; Smyth and Narayan, 2015). A definite answer to this nexus matters because if the conservation hypothesis holds, then attempts by policy makers to alter energy consumption will not impart any adverse impact on growth. In contrast, if the growth hypothesis holds, then any mandatory reduction in energy consumption will disrupt the growth trajectory. Apart from these two competing hypotheses, researchers have also identified feedback loops

¹ We only report the sectoral composition of FDI from 2004 and onwards because of a different classification system for the tertiary sector prior to that time.

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