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Industrial relocation and energy consumption: Evidence from China

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ABSTRACT

With economic development and the change of industrial structure, industrial relocation is an inevitable trend. In the process of industrial relocation, environmental externality and social cost could occur due to market failure and government failure. Little attention has been paid to this issue. In this paper, we address it with a theoretical analysis and an empirical investigation on the relationship between China's industrial relocation in the early 1990s and energy consumption which is the primary source of CO_2 emission, an environmental externality that causes increasing concerns. The macro-policy analysis suggests that there would be a positive link between China's industrial relocation in the early 1990s and energy saving (and environmental externalities reduction). Using fixed-effect regression model and simulation method, we provide an empirical support to this argument. In order to further reduce environmental externalities and social cost in the process of industrial relocation, we provide policy suggestions as follows: First, strengthen the evaluation of environmental benefits/costs; Second, pay more attention to the coordinated social-economic development; Third, avoid long-lived investment in high-carbon infrastructure in areas with industries moved in; Fourth, address employment issue in the areas with industries moved out.

1. Introduction

Energy consumption in China has been growing very rapidly since 1953, especially after 1978 when economic reform was launched (see Fig. 1). Over the period of 2000–2008, China's energy consumption has increased at an average rate of 9.1% per annum. In 2009, China's energy consumption accounted for one-quarter of the world's total. The increase of energy consumption poses two challenges: First, China heavily relies on fossil-based energy which takes up more than 90% of its total energy consumption (DRCSC, 2009). As a result, China has become the largest CO_2 emitter, contributing one-third of the world's total CO_2 emission. As climate change becomes an increasingly pressing concern, China now is facing mounting international and domestic pressures to cut back CO_2 emission. Second, the pressure for China to reduce energy consumption also comes from the need to secure energy independence. Fig. 2 displays China's oil import and export during the period from 1980 to 2007. It is clear that China's net oil import has increased quickly since the year 1993. China has now become the world's second largest consumer of oil, although its per capita oil endowment is only 6.1% of the world's average (Jiang, 2008). According to a recent study, China's dependence on imported oil has been close to 50% (Zhong, 2009). International Energy Agency (IEA) predicts that it will be close to 77% in 2020 (China's Energy Outlook, 2004). Hence, energy saving has become an important and urgent issue that China must address in its future economic development.

Scholars have explored factors that drive energy consumption and ways to reduce it. Economic growth is considered as one of the most important factors affecting energy consumption. A large body of literature (Zhao and Yang, 2009; Akinlo, 2008; Shiu and Lam, 2004; Ockwell, 2008; Karanfil, 2008; Narayan and Smyth, 2008; Yuan et al., 2008; Lee and Chang, 2008) shows that increased energy consumption is a natural result of economic growth. As Stern (2006, 2010) argued, the ignorance of environmental externalities during the process of economic development is recognized as one of the significant factors to aggravate environmental degradation. The Chinese government has set its GDP growth goal at a rate of 7.2% per annum between 2000 and 2020 (Yang, 2008). The goal is largely based on the needs of maintaining employment and social stability in China. As a developing country, it is beyond doubt that China has an urgent task to develop its economy at a relative higher rate. As Vennemo et al. (2009) argued, developing countries often find it difficult to

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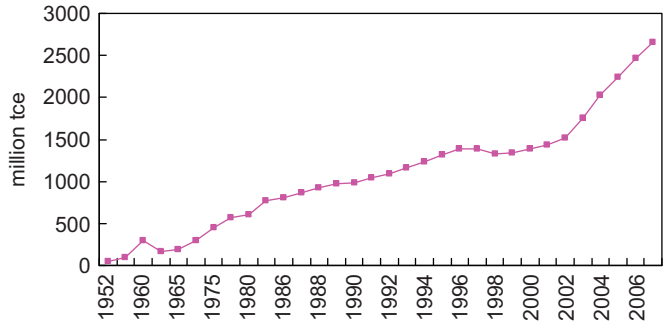

Fig. 1. Total energy consumption in China (1952–2007).
Source: China Statistical Yearbooks (2008).

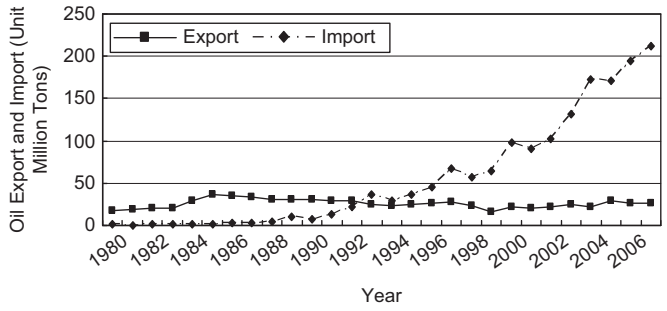

Fig. 2. Oil import and export in China.
Source: China Energy Statistical Yearbooks.

commit to an emission reduction since it might interfere with the much-needed development of their economies. However, on the other hand, if China excessively strengthens its economic development and fails to pay enough attention to environmental protection and CO_2 emission, the resultant economic and social cost would be huge not only for China, but also for the entire world in the future. As Stern (2006) noted, the global losses caused by climate change have increased dramatically in the recent past, and the climate change is noted as the greatest failure ever known. China could not continue the economic development mode that caused great adverse impact on the environment as that in the United States and the United Kingdom. In the future, China needs to better integrate the consideration of environmental externalities and social cost into its economic development strategy.

The second factor that has been found to have an important impact on energy consumption is the adjustment of industrial structure. The close relationship between the change of industrial structure and energy consumption has been well recognized (Zhao and Yang, 2009; Liu et al., 1992; Ang, 1995; Vicent and Rosa, 2004; Zhou and Li, 2006; Kambara, 1992). In the "Twelfth-Five Year Plan", Chinese government emphasized again to save energy consumption and reduce CO_2 emission via further adjusting industrial structure. In general, industrial relocation would happen along with the adjustment of industrial structure. Since 1978, when the economic reform was launched, China has experienced two major industrial relocations. The first took place in the early 1990s, major industries were transferred to the eastern coastal areas from Northeastern areas, Western areas, and some Middle areas. Fujita et al. (2003) and Huang and Li (2006) illustrate that one characteristic of China's industrial development in the last two decades was relocation and geographical specialization. Jin et al. (2006) noted that the share of eastern coastal provinces in the nation's total industrial production increased quickly, while the share of western and northeastern provinces decreased as a whole. Industrial production also retreats from Beijing, Shanghai, and Tianjin.

The second industrial relocation happened in the 20th century, and industries (mainly labor intensive and resource intensive ones) were transferred to Middle areas and Western areas from the eastern coastal areas (Jiang, 2009; Wu, 2009). Industrial relocation would have great impact on the involved areas on a series of economic and social issues, such as economic growth, employment, energy consumption, and environment. In this paper, we will focus on the impact of industrial relocation on energy consumption, and environmental externalities. We first provide a theoretical analysis on the relationship between industrial relocation and energy consumption and then offer an empirical investigation of the relationship. To our best knowledge, little attention has been paid to the relationship between industrial relocation and energy consumption (environmental externalities). This study should prove useful for policy makers and scholars that concern about the externalities of industrial relocation.

The rest of the paper proceeds as follows. Section 2 analyzes the externalities and social cost of industrial relocation. Section 3 explores how public policies could have an impact on energy saving and externalities in the process of industrial relocation. Policy lessons regarding what policy factors would help China achieve energy saving are presented. Section 4 introduces the regression model and simulation method we use to empirically study the impact of China's industrial relocation on energy consumption in the early 1990s. The factors that contribute to the positive correlation between China's industrial relocation in the early 1990s and energy consumption are discussed in Section 5. Section 6 concludes the paper with a summary of main finding and a discussion of policy implications.

2. Externalities and social cost of industrial relocation

Industrial relocation is driven by both administrative power and market power in China. The administration-oriented industrial relocation aims to improve the environment quality in key cities. For example, the Capital Iron and Steel Corporation , which used to the worst source of pollution in Beijing, has moved its primary production capacity to Hebei before the 2008 Olympic Game, and the remaining manufacturing capacity will be transferred to Hebei before the end of 2010.

The majority of industrial relocation in China is driven by market power. The market-oriented industrial relocation can be divided further into two types: the first is to pursue higher operation efficiency, and transferred to areas with cheaper production factors or lower transaction costs. For example, recently, some industries moved to the Western and Middle areas from the eastern coastal areas in order to get cheaper labor and energy sources, while in the early 1990s, some industries moved to the eastern coastal areas which have more convenient transportation, broader market, and lower transaction cost. The second type of market-oriented industrial relocation is to escape the strict environmental regulation in key and large cities. In general, as environmental regulations are more strictly enforced in wealthier urban areas, industries are moving to less affluent cities or rural sites, taking their pollution with them (Holdaway, 2010). There are numerous reports about villages with a high prevalence of cancer (Lora-Wainwright, 2010) and a variety of other environment-related risks (Fang and Gerry, 2010).

Both administration-oriented and market-oriented industrial relocation would cause environmental externalities due to "government failure" and "market failure". An externality is an unpriced benefit or cost directly bestowed or imposed upon one agent by the actions of another agent (Söderholm and Sundqvist,