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Market distortions and aggregate productivity: Evidence from Chinese energy enterprises

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HIGHLIGHTS

- We estimate market distortions and productivity growth of China's energy sector.
- We use a large sample of Chinese energy enterprises.
- There are evidences of the existence of factor and product market distortions.
- Aggregate productivity growth is largely driven by firm-level technological change.
- China's energy sector can realize productivity gains from resource reallocations.

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ABSTRACT

Market distortions can generate resource misallocations across heterogeneous firms and reduce aggregate productivity. This paper measures market distortions and aggregate productivity growth in China's energy sector. We use the wedge between output elasticities and factor shares in revenues to recover a measure of firm-level market distortions. Using data on a large sample of Chinese energy enterprises from 1999 to 2007, our estimations provide strong evidence of the existence of both factor and product market distortions within and across China's various energy industries. The productivity aggregation and decomposition results demonstrate that the estimated aggregate productivity growth (APG) is, on average, 2.595% points per year, of which technological change, resource reallocation, and firm entries and exits account for 1.981, 0.068, and 0.546% points, respectively. The weak contributions of resource reallocation and firm turnover to APG are also found in energy sub-industries, except in the coal industry. Our research suggests that China's energy sector has major potential for productivity gains from resource reallocation through the reduction of market distortions.

1. Introduction

The energy industry is crucial for economic development and is critically important for a country's security and independence. Driven by growing energy demands that are associated with its rapid economic growth, China has been the world's largest energy consumer since 2010. Despite the remarkable increase in its domestic production capacity, China has been facing continuous pressure to secure energy supply and has become heavily dependent on energy imports. Although the era of dramatic economic growth has ended, China's energy demand is still expected to maintain stable growth, creating two major challenges: energy shortages and environmental issues. To confront these challenges, the principal solution involves reducing energy intensity, on the one hand, and increasing the energy sector's efficiency, on the other hand. The existing literature primarily focuses on the demand side, while the supply side has attracted less scholarly attention. Therefore, understanding the productivity dynamics of the energy sector is important because they may help develop China's energy policymaking for sustainable development.

In recent decades, China has undergone tremendous economic reforms, transforming itself from a centrally planned economy to an increasingly market-driven economy. However, market-orientated reforms and restructuring in the energy sector are widely acknowledged to be overcautious and conservative compared with the remarkable reforms in other areas (Bo et al., 2015). At present, substantial market distortions arising from the existing energy

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policies, regulations and organizations still exist. As China's economy is entering a new growth pattern that prioritizes efficiency improvements, both academics and practitioners increasingly call for the acceleration of energy market reforms and liberalizations. To convince policymakers of the need for energy sector reforms, the existence and characteristics of market distortions and the ways in which they affect the productivity of China's energy sector via firm-level channels must be explored.

This paper uses a large sample from a firm-level dataset to evaluate market distortions in China's energy industries. Rather than focusing on specific types of distortions, we develop an indirect approach to measure market distortions, which estimates the wedge between a firm's output elasticities and factor shares in revenues. The estimated wedge is used as a measure of firm-level market distortions. To examine the existence and characteristics of market distortions, we compare the estimated results among different energy industries – between state-owned enterprises (SOEs) and non-SOEs and between large companies and small firms. Although our approach heavily relies on the estimation of output elasticities and firm productivity, we find that the results are robust to different specifications of production functions.

In addition, we not only aggregate the productivity of the energy sector as a whole but also decompose this productivity among four sub-industries. The estimated aggregate productivity growth is then decomposed into firm-level components, including technological change, resource reallocation, and firm entries and exits. These components are consistent with the theoretical literature, which describes the micro-channels through which market distortions affect APG. Therefore, they enable us to infer the effects of market distortions on APG in China's energy sector. Combined with the market liberalization processes of the four sub-industries, the cross-industry comparisons of APG patterns also provide strong evidence of the nexus between market distortions and APG in China's energy sector.

The remainder of this paper is structured as follows. Section 2 outlines the literature review. Section 3 presents the methodology. Section 4 describes the data. Section 5 analyses the estimated results. Section 6 concludes the paper and provides some policy implications.

2. Literature review

Understanding the underlying sources of APG has been a central focus in economics research. According to neoclassical growth models, in a perfectly competitive market without distortions, the dynamics of aggregate productivity are characterized by technological change within representative firms (Solow, 1956; Swan, 1956). However, various policies and institutions can derail an economy from this ideal setup. Meanwhile, empirical evidence has shown that firms are heterogeneous in terms of productivity, as considerable and persistent productivity differences exist across firms, even within narrowly defined industries (Foster et al., 2001). Therefore, APG is also determined by how efficiently resources are allocated across heterogeneous firms. In other words, aggregate productivity can be improved through the reallocation of resources towards more efficient incumbents, the entry of productive firms and the exit of inefficient firms. Even keeping individual firms' technologies constant can improve aggregate productivity.

By identifying the causes of resource misallocations, the recent literature on misallocations and productivity have documented market distortions as a key factor in resource misallocations across firms and as a cause of aggregate productivity losses. The seminal work by Restuccia and Rogerson (2008) investigates policies that create idiosyncratic distortions in firms' decisions and that lead to resource reallocation across firms. They find that policy distortions can lead to sizeable decreases – ranging from 30 to 50% – in aggregate productivity. Hsieh and Klenow (2009) include capital and output distortions in a monopolistic competition model with heterogeneous firms. Their study concludes that China and India can realize substantial productivity gains by reducing resource misallocations. Studies increasingly focus on particular types of distortions and their impacts on aggregate productivity. The investigated distortions include financial frictions, firing costs, regulations, trade barriers, taxation, and mark-ups (Boedo and Mukoyama, 2012; Buera et al., 2011; Fernald and Neiman, 2011; Gilchrist et al., 2013; Moll, 2014; Peters, 2013; Petrin and Sivadasan, 2013; Waugh, 2010). Although these studies investigate this relationship in diverse settings, the general conclusion is that market distortions may have negative impacts on aggregate productivity via resource misallocations. Moreover, some studies find that distortions can not only generate resource misallocations but also discourage firm-level incentives to improve productivity (Gabler and Poschke, 2013; Ranasinghe, 2014).

In the framework above, few studies focus on the energy sector, as the existing empirical evidence primarily focuses on manufacturing industries as well as service industries (Foster et al., 2001; Vries, 2014). This research gap is surprising because energy sector has always been regarded as one of the most regulated and distorted industries in many countries. However, instead of examining the productivity of energy industries themselves, the existing literature usually considers energy a factor input that can be used to investigate energy efficiency or aggregate productivity in manufacturing industries (Fan et al., 2007; Geng et al., 2014; Li and Lin, 2015; Petrin et al., 2011; Zhang et al., 2011). Meanwhile, a few studies' approaches to identifying the sources of productivity growth in energy industries are fairly different from the aforementioned framework (Heshmati et al., 2014; Rossi, 2001). For example, See and Coelli (2013) estimate the total factor productivity of the Malaysian electricity generation industry and decompose it into efficiency change, technical change and scale change using stochastic frontier analysis. Therefore, the extent to which market distortions affect the energy sector's aggregate productivity through firm-level channels (e.g., technological change, resource reallocation and firm entries/exits) remains unclear.

The research investigating market reforms and energy industry performance is closely related to our study (Abbott, 2006; Çelen, 2013; Jaraitė and Di Maria, 2012; Wang and Chen, 2012; Wu, 2003; Xu and Chen, 2006; Zhang et al., 2008). Since the 1980s, the energy sector has witnessed a worldwide privatization and liberalization, leading to positive and globally widespread efficiency gains (Pollitt, 2012). Although China's energy sector has also undergone remarkable market-orientated reforms, it is still far from being a competitive market due to intensive regulations and monopolies (Bo et al., 2015; Qiu and Li, 2012; Wang and Chen, 2012). Studies evaluating the impact of market reforms are fairly fragmented with respect to specific energy industries or countries. Using a data envelopment analysis approach, Nakano and Managi (2008) show that regulatory reforms contribute to productivity growth in Japan's steam-power generation sector. In their investigation of Brazil's oil industry, Bridgman et al. (2011) demonstrate that privatization and market competition increase the productivity of state-owned enterprises. Applying a translog stochastic frontier production method, Shi and Grafton (2010) conclude that transitional reforms significantly improve the technical efficiency of China's coal enterprises. Efficiency gains from market reforms are also identified in electricity generation and distribution industries (Fabrizio et al., 2007; Goto and Sueyoshi, 2009; Mou, 2014; Zhao and Ma, 2013).

Based on the aforementioned studies, this paper attempts to measure market distortions and APG based on Chinese energy