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Productive efficiency in the iron and steel sector under state planning: The case of China and former Czechoslovakia in a comparative perspective

Hana Nielsen*

Department of Economic History, Lund University, SE-221 00 Lund, Sweden

HIGHLIGHTS

- Central-planning system does not have to be detrimental to energy efficiency.
- The key role of nation-wide policies in facilitating efficiency improvements.
- Further monitoring and supervision might prove essential in case of China.

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ABSTRACT

State-ownership has often been discussed as one of the major causes of poor industrial energy efficiency performance. This paper utilizes long-run historical data on the energy and material use in one specific industrial sector – the iron and steel production – in countries with both central-planning and market-based system, with a particular focus on former Czechoslovakia paralleled with the developments in China. Czechoslovak productive efficiency of the iron and steel sector fluctuated below the energy efficiency frontier. Until the early 1970s, the country's iron sector was one of the least efficient ones in our sample. It was, however, during the decades of 1970s and 1980s that efficiency measures were adopted and the energy efficiency of the Czechoslovak iron and steel sector increased significantly to, despite of a priori expectations, reach the energy efficiency frontier. Empirical results for other planned economies show similar development of catching-up to the market economies, particularly in the iron production sector during 1980s. A pattern of efficiency convergence was identified. In China, despite its move toward more market oriented economy, the productive efficiency lagged behind as recently as in 2000 (20–35 percent below the efficiency frontier). The relatively late adoption of energy conservation programs and the persistent government control of the sector in certain provinces slowed down the efficiency improvements. In the socialist economies of Eastern Europe, though, central-planners were able to achieve satisfactory productivity increases, primarily driven by efficiency and saving policies and adjustments in existing technology. It is likely, that as was the case of Eastern Europe, the adoption of vigorous energy policies with clearly defined targets accompanied by monitoring and supervision, will have a tremendous impact on the energy intensity as well as the absolute energy use of the sector in China.

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1. Introduction

Currently, at a global level, the largest emitters of industrial greenhouse gas emission (GHG) are the cement (23 percent), pulp and paper (20 percent), chemical and petrochemical (20 percent)

and the iron and steel industries (14 percent) [1]. The magnitude of the savings potential and industrial efficiency generally differs across various regions and processes. In the iron and steel sector, the savings potential in developing countries remains large at over 30 percent. China, a significant steel manufacturer since 1990, now produces more than 50 percent of global steel. Several studies have placed Chinese levels of energy efficiency of the steel sector below that of its Western counterparts [2,3]. Currently, in China average

* Tel.: +46 462220367.

E-mail address: hana.nielsen@ekh.lu.se

consumption of energy per unit of output is 20 percent higher than in the developed countries [4]. Besides other multiple possible drivers, state-ownership has been discussed as one of the major causes of poor industrial energy efficiency performance in countries with a centrally-planned economy and high degree of state ownership [5,6]. For China, studies have found a faster rate of improvement in energy efficiency in enterprises which were either private or at least outside of the direct supervision of the former Ministry of Metallurgical Industry (MMI) [7]. Nevertheless, this topic remains largely unexplored in recent studies of energy efficiency in the iron and steel sector. It is here where this paper challenges the existing research by providing quantitative cross-country evidence on the energy and material efficiency of the steel sector under two various systems of economic planning. By taking a historical perspective in the differences of energy efficiency under planned and market system, a lesson can be learned about the potential improvements in today's context.

The structure of energy use in a centrally-planned economy differed significantly from other Western countries and is considered wasteful and polluting. The negative institutional impact and particularly the inefficient centralized allocation of resources has become a mere statement in the research field. Historically, there has been a fair deal of anecdotal evidence on the misallocation of resources during the era of state socialism; however there is little quantitative evidence on the actual “magnitude of the losses resulting from the improper allocation of resources under central planning” [8]. Previous research has shown an East–West gradient in respect to new technology diffusion and scaling of the sector [9,10]. At the same time, energy use of the sector, as in many Western countries, was significant but little is known about its actual energy efficiency, particularly prior to 1990s. Previous studies on productive efficiency under the two political regimes show that market economies were much more efficient in their allocation of resources though studies commonly research the overall economy and not specific sectors [11]. Planning is considered detrimental to industrial efficiency via two mechanisms [12]. First, it slows down adoption of new technology while at the same time keeping inefficient processes in place [12]. Second, the system is also characteristic of inefficient resource allocation. Under the system of planned material allotment, supply of raw materials and other factors of production to various industrial sectors is largely determined by administrative decisions [13]. Material balances were used both for short-term planning purposes but also as a basis of long-term planning and forecasts. In the early stages of central planning in Eastern Europe, the major input of material balances was simply based on the latest production figures and matched with future output targets. During the 1960s, planners realized some of the deficiencies of the detailed centralized planning adopted from the Soviet Union and a series of reforms implemented across the region, the most radical ones being in Czechoslovakia and Hungary [8]. In China, before 1980 all iron and steel sector enterprises were under the direct control of the Ministry of Metallurgical Industry (MMI) and virtually all were state-owned [7]. Although, major reforms were introduced in the late 1970s as enterprises were given greater autonomy and with an overall shift toward a more market-oriented economy, by 1993 still only some 20 percent of the output of the iron and steel sector was produced in non-state enterprises and this rate increased to some 30 percent in 1997 [7].

It is the aim of this paper to provide more insights into the developments in productive efficiency of the iron and steel sector under two different systems of economic planning and to contribute to the debates surrounding the Soviet style system. By utilizing historical data of the sector's energy and material

use data, the paper sheds more light on the actual energy productivity of the Czechoslovak and Chinese steel sector in relation to other major steel producing countries, both under capitalism and state socialism. The results of this study show an interesting pattern of energy efficiency changes between the two groups of countries. By disaggregating the steel production process into first pig iron production and the latter steel refining, the results show a clear pattern of efficiency convergence in the production of pig iron. This is important because it is the actual production of pig iron which accounts for the bulk of the sector's energy use.

1.1. Debates

Until recently, the common notion in the literature assumed that central planning was a failure. The rigidness of the system where production targets and prices were set by the government instead of the market itself is usually linked to significant inefficiencies. This is even despite the fact that socialist economies accepted many of the assumptions of neoclassical economics such ‘minimizing producer costs’ [11]. Most studies comparing the productivity under central planning identify some forms of inefficiency [11,14,15]. By using input–output tables for a panel of capitalist and socialist economies, Gomulka and Rostowski [14] identify a significantly higher material intensity of the planned economies. On the other hand, modeling a capitalist demand structure on the socialist economies, the authors did not find any improvements in the material intensity [14]. Following the oil shocks of early 1970s, the energy productivity improved swiftly in the capitalist economies whereas socialist economies were more ‘cushioned’ against the price shocks through their internal energy market and reacted later to these developments [14]. According to the authors (ibid), this has triggered the growth in the energy efficiency gap between the East and the West. At the same time, Gomulka and Rostowski discuss alternative causes of this development, such as the nature of technological change and the spread of flexible model of production after 1975. This explanation correlates with the recent study on industrial labor productivity [16] according to which productivity increases in the Czechoslovakian industries grew faster than in the United Kingdom during the period of mass production but “deteriorated sharply during 1980s”. Similarly, new calculations on the Soviet economic growth found, in fact, heavy industrialization to be the primary driver of rapid developments in the early stages of central planning [17]. Empirically, analysis of productive efficiency of an economy under capitalism and state socialism showed superiority of the free market planning [11]. Particularly since 1970, the economy became less dependent on the production of uniform goods and the change in the nature of economy occurred [11]. In this respect, planned economy was never successful in producing high technology goods and while the West raced ahead, this has led to an ever increasing efficiency gap with the East [11]. Interestingly, the role of technology is not only frequently discussed in the field of productive efficiency of the planned economy, there is a significant body of research devoted to its slow adoption of new technology on the iron and steel sector [9,18–22]. Another mechanism of state dominance is the impact of planning-system on energy prices which in turn does not signal scarcity and thus further reduces the need for technological innovation. According to Lin and Wang [23], energy price reform is one of the key energy efficiency tools and the eventual removal of price ceilings on energy would reduce energy use [4].

On the specific pattern of changes in the energy intensity of the iron and steel sectors, Worrell et al. [24] provides cross-country comparisons, though with a more recent time scope. Here, by using

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