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Industry location in Chinese provinces: Does energy abundance matter?☆

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ABSTRACT

We identify the driving factors of manufacturing activity across Chinese provinces with a particular focus on energy endowments. A model of production location is estimated, including both comparative advantage and economic geography determinants. The data set used consists of a panel of 28 Chinese provinces and 12 manufacturing industries over the period 1999–2009. Results confirm the relative importance of energy endowments. We find that larger energy endowments are significantly correlated with larger production of energy-intensive sectors. Disaggregation across energy carriers shows that coal exhibits the strongest impact. These results are robust across alternatives.

1. Introduction

Although energy resources have long been recognized as a crucial factor for long-run growth, their impact as a potential determinant of comparative advantage has received more attention only recently. The emerging evidence suggests that, along with other traditional determinants of comparative advantage and geographic concentration, energy endowments are significantly associated with specialization in energy-intensive products. This is verified both across nations (e.g. Gerlagh et al., forthcoming) and across subnational entities (e.g. Michielsen, 2013, for the US). However, the evidence is still scant, and more studies are required to strengthen the empirical support, with a particular emphasis on country or regional studies like the present one, which allow for a better control of unobserved trade barriers, technological differences and heterogeneous preferences. Hence we abstract from investigating international trade flows between China and the rest of the world. This is beyond the scope of this paper, although it is of great interest and should be addressed in future work. Given that trade-embodied CO_2 emissions, which are tightly linked to energy use, are much larger in interprovincial trade than those embodied in international trade (Guo et al., 2012), we are confident that our analysis is of empirical relevance.

This paper investigates the role of energy endowments in shaping the industrial specialization of Chinese provinces during the last decade. The Chinese case is interesting for at least four reasons. First, more than 30 years have passed since the pro-market reforms were launched at the end of the 70s, so it can be expected that the present locational decisions by firms are based on cost minimization, in particular energy costs in energy-intensive sectors. Second, China has overtaken Germany as the world's largest exporter in 2009 (WTO, 2010), confirming that structural change in China has also been impressive, not only its growth performance. Third, according to the estimates of the International Energy Agency, China may also have become the world's largest energy consumer (IEA, 2010). This is so because, in spite of government efforts and substantial improvements in energy efficiency, the Chinese production structure remains biased towards heavy industries (over the sample period 70% of total energy consumption is used in the industry and 54% in heavy industries). Fourth, Chinese provinces differ widely in terms of energy sources with energy-rich provinces mainly based in the North. Although the Chinese energy market is heavily regulated, energy-rich provinces can offer lower energy prices, in particular for those energy sources like coal, which are characterized by large transport costs.

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The empirical methodology is based on the previous analysis of the Chinese industrial structure by Batisse and Poncet (2004), who relied on the economic geography cum factor endowments model proposed by several recent studies in the field (e.g. Midelfart-Knarvik et al., 2001). We extend the existing literature by applying this model to Chinese provincial data over a reasonably long and recent time period (1999–2009) and by taking particular care of the relative importance of energy as a production factor. Energy carriers have high transport costs relative to their value (see Cristea et al., 2013), a treatment different from traditional intermediate goods is therefore justified. The paper tests the following three hypotheses: 1) Is industrial location in China determined by both new economic geography mechanisms and comparative advantages? 2) Is the activity of relatively energy intensive industries higher in relatively energy abundant provinces? and 3) Is the comparative advantage effect larger for immobile energy production factors that are subject to higher transport costs?

The next section outlines the literature review. The framework and methodological background are given in Section 3. Section 4 exposes the data sources, variable definitions and some stylized facts. Section 5 presents and discusses estimation results and Section 6 concludes.

2. Literature review

We provide a brief review of the main existing empirical frameworks used to analyze industry location and then present studies referring more specifically to the Chinese case.

2.1. Energy endowments and determinants of industrial location

There is an extensive literature illustrating how the predictions of the basic factor-endowment or Heckscher–Ohlin model (HO) can be improved by relaxing some key simplifying assumptions. Allowing for technological differences across countries, imperfect competition or transport costs substantially improve the explanatory power of the model. For example, Hakura (2001) shows that, by calculating a separate technological matrix for each of the four EU countries analyzed in 1970, the sign matches between factor endowments and trade orientation increase from 58% to 94%. By combining Krugman's (1980) monopolistic competition model and transport costs with the HO framework, Romalis (2004) obtains a deviation from factor price equalization which implies that locally abundant factors are relatively cheap. Therefore, relative industry output prices, which are built upon the interaction between industry and country characteristics (factor intensity and factor abundance) define a country's share in total production.

By endogeneizing the locational choice of firms facing transport costs and increasing returns to scale, the New Economic Geography approach (NEG) initiated by Krugman (1991) allows analyzing industry agglomeration and thereby the pecuniary effects of supply and demand linkages. These NEG forces have been proved to be important factors in firms' locational choices. Davis and Weinstein (1999) argue however that the downside of NEG is that it cannot include input composition and demand structure and that it therefore should be combined with determinants from the factor endowment theory. Hence, studies increasingly include both NEG and HO components. Of particular importance for the present study is the contribution of Midelfart-Knarvik et al. (2001), who include both HO and NEG effects into a common framework. Their empirical application is based on a panel of industries in 14 EU countries over the period 1980–1997, letting both country and industry characteristics interact. They suggest that growing economic integration in the EU has given way to a larger impact of both NEG and HO determinants of industry location. Note that industrial location models tend to perform better when the analysis is limited to a given region or country as this limits the problems linked to technological differences or barriers to trade (see e.g. Hakura, 2001; Kim, 1999).

Another frequent extension of the HO framework is to increase the number of factors considered. However, in spite of their economic, environmental and geopolitical importance, energy endowments have rarely been considered, and almost exclusively in the US case. Hillman and Bullard (1978) address the Leontief paradox (1954) by including energy as a production factor and not only as an intermediate input. The authors argue that the US is actually abundant in labor and capital but scarce in energy, which "distorts" the basic capital–labor trade-embodied calculations. Much later, using a combined HO–NEG framework Ellison and Glaeser (1999) include interaction variables on electricity, natural gas and coal endowments interacted with the corresponding intensities as determinants of employment shares. They find that the estimated energy interaction terms are quite large, explaining a substantial part of the total comparative advantage in US states over the period 1989–1991. Gustavsson et al. (1999) find that energy-intensive sectors tend to exhibit a larger coefficient of specialization (i.e. the ratio of domestic production to domestic consumption) in OECD countries with low energy prices, but the direction of causality remains unsettled. Klein and Crafts (2012) used coal abundance in relation with steam power use as a determinant for industry location in the US between 1880 and 1920. Only in 1880 a significant effect is observed.

Gerlagh et al. (forthcoming) assess the effects of energy endowments on trade using a panel of 14 OECD countries over the period 1970–1997. They find that energy-abundant countries have 7 to 10% higher employment and 13 to 17% point higher net exports per value added in energy-intensive sectors vis-à-vis otherwise comparable countries. Michielsen (2013) performs a country analysis on industry location in US regions, regressing value added on six different energy carrier interaction variables (electricity intensity with coal, natural gas and hydropower abundance and fuel intensity with oil and natural gas abundance) in addition to the usual factor endowment variables (labor, skilled labor and capital) and new economic geography interaction variables (market potential with economies of scale and intermediate input intensity). Energy endowments are found to play a significant role in determining US industrial activity.

To sum up, only very few studies have directly addressed energy in location studies. Apart from Klein and Crafts (2012), who focus on industry location in the US at the turn of the XIXth century, Gerlagh et al. (forthcoming) who look at OECD countries and Michielsen (2013) at US provinces, are, to the best of our knowledge, the only recent exceptions. In the present paper we use a similar framework to these last two papers, but focus on Chinese regions and include systematically new economic geography variables.

2.2. Industrial location and energy resources in China

Few studies have so far investigated the determinants of industry location for Chinese provinces. On the one hand, this could be explained by important constraints regarding data availability (e.g. information that varies across time, industries and provinces) and reliability (e.g. consistency between national and provincial data). On the other hand, market forces have only recently developed their effects on industry location. After three decades of a centrally planned economy, China generally reported a very weak degree of specialization across provinces, due to the central government's efforts to generate a widespread security of supply in case of foreign invasion. Young (2000, p. 7) argues: "With material supplies only ensured when one actually produced them oneself, and with the central regime actively encouraging and funding the local development of industries, each province, county, city and locality tried to develop its own duplicate set of industries." Herein lies the particular interest of a recent regional study on China: the opening reforms initiated in 1978 are still under development and have allowed market mechanisms to exercise a growing influence on economic activity. Nevertheless, as confirmed by the studies quoted below, the country continues to maintain high trade barriers at the international as well as the regional level, also impeding domestic trade. Protectionism not only limits geographic concentration and the