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An effects analysis of China's metal mineral resource tax reform: A heterogeneous dynamic multi-regional CGE appraisal

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ABSTRACT

The heterogeneity in resource endowment and the "resource curse" require different tax rates for different regions in resource tax ad valorem reform. Considering that copper is critical, widely distributed and closely related to the economy, a dynamic multi-regional computable general equilibrium (CGE) model is constructed to investigate the impacts of different copper resources tax rates on regional economies, thus obtaining the optimised resource tax rate due to the "resource curse" in different regions. Under different policy scenarios of the copper resource tax, namely, 2%, 5% and 8%, this paper estimates the impacts of resource tax ad valorem reform on copper consumption, macroeconomic variables and sector outputs among 4 representative regions, which is significantly different from the results from national perspective in previous studies. The simulated results are as follows: resource tax ad valorem reform has an enormous influence on copper consumption and has slightly positive impacts on resident income, government revenue, total consumption and real gross domestic product (GDP), while it affects copper-related sectors outputs in a negative way. Additionally, the impacts under the same scenario are significantly different among 4 regions. Moreover, under different tax rate scenarios, copper consumption increases first and then decreases, resulting in an inverted U-shaped pattern. This paper built a dynamic computable general equilibrium (DCGE) model of copper resource tax ad valorem reform from a regional perspective, thus improving the CGE model on a national scale compared to previous studies and providing an analytical paradigm for the reform of other strategic metal mineral resource taxes in China.

1. Introduction

As key components in China's industrial development, metal minerals are crucial to national defence and strategic emerging industries that support the development of major national strategies such as national large-scale aircraft construction, aerospace engineering, nuclear power engineering and high-speed traffic engineering. Therefore, many minerals (including copper) are defined as national strategic mineral resources (Hao and Li, 2015). Over a long period of time, however, the defect in the metal mineral resource policy of China has given rise to a series of problems. For example, from 2003 to 2013, the base reserves of nine kinds of minerals such as coal, chromite and phosphorus dropped by more than 20%, and reserves of antimony, germanium, indium and tin decreased by more than one-third (in Yu et al., 2015). The main reason for these situations could be the adoption of a specific duty resource tax in China. This means that the cost of intergenerational externalities and environmental externalities cannot be transferred to the price of mineral resources, leading to the excessive and wasteful consumption of mineral resources. For a similar reason, the adoption of a specific duty resource tax partly leads to the blindness choice in the export policy of rare metal resources, which has resulted in a series of trade disputes over rare metal resources between China and other countries (Zhu et al., 2018). Therefore, there is an urgent need for China to formulate more scientific and effective resource policies to internalize the cost of intergenerational externalities and environmental externalities and thereby achieve mineral supply security, ecological security and intergenerational security.

As a useful resource and environmental management tool, the core of resource tax policy design is the collection method and standard of taxation. An effective and reasonable resource tax should be designed based on the scarcity and intrinsic value of nature resources, thus containing resource depletion costs and external losses (Lin and Liu, 2012). Additionally, the external costs could be transmitted to resource prices by adopting ad valorem taxation, which to some extent restrains the wasteful consumption of resources. For this reason, China piloted resource tax reform on crude oil and natural gas in Xinjiang province in 2010 and has expanded the resource tax reform comprehensively since 2016. The collection of resource tax has been transformed from a

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specific duty into an ad valorem taxation. The tax rate range for a certain resource is formulated by the central government, while the specific tax rate is set by the local government of each province in view of differences in resource endowment (Xie and Gu, 2017).

Many scholars have defined and calculated the standard of resource taxation, especially for energy and metal mineral resources. Hoteling (1931) noted the depreciation of the limited stock of non-renewable resources, which could be regarded as the user cost for the development and utilization of non-renewable resources. Hartwick (1977) proposed that this depreciation is the depletion value of resources. Serafy (1981) developed a theoretical framework for calculating the depletion cost of non-renewable mineral resources. Experience shows that a reasonable resource tax system can not only make resource users bear the relevant costs, improve resource use efficiency, reflect the value of resource consumption, and correct the negative externalities of resources but also reasonably control the speed of resource exploitation and ensure the fairness of the intergenerational allocation of resources (Dasgupta and Heal, 1980; Gamponia and Mendelsohn, 1985; Lin and Liu, 2012). According to previous studies, many scholars have drawn on and revised the theoretical framework for fruitful exploration, and the user costs of resources are calculated as the theoretical standard of resource tax. Adelman (1991) and Lin and He (2008), Lin and Liu (2012) used the user cost method to calculate the user cost of energy minerals (coal, oil, natural gas) in companies. Young and Motta (1995), Blignaut and Hassan (2002), and Zhong et al. (2016) calculated the user costs of metal minerals in Brazil, South Africa and China, respectively, in application of the user cost method.

There are plenty of methods for estimating the impact of resource tax policy outlined in previous studies. Early scholars generally adopted the qualitative analysis method according to resource characteristics and resources and environmental policies from a macro perspective (Gupta and Mahler, 1995; Groth and Schou, 2007; Eisenack and Stecker, 2012). Subsequently, the method of quantitative analysis in application of the globalisation model or national model has gradually replaced the qualitative analysis method. Examples include econometric models (Hung and Quyen, 2009; Lv and Guo, 2009), input-output models (Llop and Pié, 2008; Gemechu and Butnar, 2014), tax transfer models (Du and Wang, 2015; Zhu et al., 2016) and computable general equilibrium (CGE) models (Ferran, 2010; Anton and Harald, 2012; Lin and Liu, 2012; Doumax and Philip, 2014; Guo and Zhang, 2014; Anton, 2015a, 2015b; Shi and Tang, 2015; Xu and Xu, 2015; Zhong and Zeng, 2016; Tang and Shi, 2017; Zhang and Yang, 2017). Compared with other methods, the CGE model owes its unique merit in tax policy simulations to providing a comprehensive analysis under the general equilibrium framework.

The CGE model is widely employed in resource policy analysis (Löfgren and Harris, 2015; Dixon and Rimmer, 2016). Considering that the taxation cost will be transferred to different economic agents, the sensitivity and impacts on the macro economy, society and the environment must be estimated to obtain the optimal resource tax rate. Therefore, many scholars construct CGE models at the national level (Lin and Mou, 2008; Lin and Liu, 2012; Tang et al., 2015; Liu et al., 2015; Zhong et al., 2016). An obvious shortcoming of CGE models on a national scale, however, is the implementation of uniform policy standards, which will widen the regional gap and impede balanced and sustainable development among regions (He and Li, 2009). Because the taxation situation varies from region to region, a CGE model on the national scale is not suitable for regional analysis. The multi-regional CGE model is based on the single-area CGE model, however, which has increased the description of interregional economic linkages, especially the interregional flows of commodities and factors. It is an optimal tool for analysing regional policies and regional development issues (Yuan et al., 2016). Li et al. (2009), Xu (2012), Zhang et al. (2013) and Wang et al. (2015a, 2015b) constructed dynamic CGE models from regional perspective to simulate and analyse the effects of the carbon tax, the coal resource tax, and the water resource tax on regional economic development, energy conservation, emissions reduction and the "resource curse" problem, respectively.

Previous studies have mostly focused on the impacts of energy resources taxes, such as taxes on petroleum and coal, for the significant influence on economy and environment and effective data collection. The resource tax of metal minerals has rarely been utilised in existing studies, however, especially when applying a CGE model. The main reason lies in the difficulty of obtaining metal-related data that satisfy the application of CGE models. Moreover, many studies analyse the impacts of resource tax ad valorem reform at the national level, ignoring the heterogeneity in resource endowment and the "resource curse". Since it has been proven that relatively scarce and limited resources are the bottlenecks that restrict regional development (Zhang et al., 2007; Zhang and Liang, 2010), the implementation of a resource tax rate should satisfy the actual situations of different regions.

Under these circumstances, copper is selected as the exemplar metal resource in this paper because it is widely distributed and critically important: it was rated one of the top 24 important strategic mineral resources in China by the National Mineral Resources Planning (2016–2020). Further, Zhong et al. (2016) proved that there is a close correlation between copper consumption and macroeconomic variables, making the choice of copper suitable for performing CGE simulation analysis. In addition, this paper analyses the heterogeneity of copper resource endowment and the resource curse in different provinces to account for the deficiency in the current taxation policy and built a dynamic multi-regional CGE model of copper resource tax reform that takes the flows of factors and commodities between regions into consideration. Moreover, considering the complex problems of copper mining in different regions, such as low-grade, associated and difficult-to-dress copper ores, the resource tax module in this paper contains the sales revenue of copper mines linked with the extract and concentration recovery rate, which is more in line with the actual resource endowment of different regions.

Generally speaking, this paper constructs a dynamic multi-regional CGE model to estimate the overall impact of China's copper resource tax ad valorem reform on regional economies and the resource dilemma, in order to obtain the optimised resource tax rate in consideration of resource endowments and the "resource curse" among different regions. The remainder of the paper is organised as follows. Section 2 analyses the heterogeneity of provincial copper resource endowment and degree of "resource curse". Section 3 describes the construction of the dynamic multi-regional CGE model. Section 4 provides the tax rate scenario design and simulation results analysis, while Section 5 contains the conclusion and policy implications.

2. The analysis of the regional copper endowments and resource curse heterogeneity

2.1. Heterogeneity analysis of copper in different regions

Resource endowment refers to the resource advantages of a region, which includes not only natural resources but also other economic and non-economic factors affecting economic development (Li and Li, 2015). To distinguish between the differences in the mineral resource endowment in different regions, according to mineral resource endowment advantage theory (Pan and Harris, 1991; Shen and Cao, 2009), a mineral resource endowment evaluation index system is constructed. This system includes the agglomeration degree of mineral resources, mineral resource quality, the reserve-production ratio of mineral resources, and mineral resource reserves, accounting for four types of national indicators. When the index value is larger, the resource endowment is stronger. By using the analytic hierarchy process (AHP) approach, the weights of the four indicators in the index system were determined to be 0.097, 0.309, 0.060 and 0.534, respectively, to obtain the comprehensive evaluation scores of the mineral resource endowments in different regions. According to the "China Statistical