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Understanding rural restructuring in China: The impact of changes in labor and capital productivity on domestic agricultural production and trade

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ABSTRACT

In China, the provinces of Shandong and Henan are the leading provinces for grain production and also have the highest populations. In this study, we quantitatively analyze the impact of the two primary factors that indicate rural restructuring (namely, an increase in labor- and capital-augmenting technical change, represented by labor and capital productivity) on wheat production in Shandong and Henan provinces, and the consequent effects on exported and imported wheat volumes in other provinces through to 2020. For the analysis, we use The Enormous Regional Model (TERM), an established multi-region computable general equilibrium model. The results show that the magnitude of change generated by the increase in labor productivity is larger than that generated by the increase in capital productivity. Therefore, great importance should be attached not only to increasing capital technical change but also improving labor technical change. This study also reveals that regional competitive industry can easily shape absolute competition superiority, which consequently exerts a large impact on the homogeneity of products. Rural China is moving into a critical stage of restructuring, and therefore the government should provide rational top-down guidance. The central government should avoid adopting a "one size fits all" policy and simply supporting a single industry or particular development patterns. Rural China should form stable, sustainable, and specialized agricultural production arranged by geographic areas, which would not only guarantee China's food security, but also improve the nation's competitive capacity in the international market.

1. Introduction

Rural China has been undergoing restructuring because the nation's rapid economic development has accelerated the transformation of agricultural development pathways from extensive to intensive means in rural areas, given the diminishing marginal returns for Chinese agriculture (Li et al., 2015; Long and Woods, 2011; Long, 2014). The rapid economic growth has been driven mainly by a reallocation of labor between labor-intensive and capital-intensive sectors of the economy (Song et al., 2011). Agriculture is a typical labor-intensive sector; however, the migration of farmers to industry or service sectors has contributed greatly to development in China in the past several decades (Liu et al., 2013b; Long and Woods, 2011), with the huge population shift essentially guaranteeing the unprecedented rate of economic growth observed during the last 35 years. The wide disparities in income, social welfare, habits, and customs between rural and urban areas have encouraged rural labor to move to the cities (De Brauw et al., 2002; Liu et al., 2013a). This migration has caused heavier burdens to be placed on the elderly and children, who have disproportionately remained in rural areas (Chang et al., 2011); this in turn may have an influence on food security, because the decrease in the amount of available labor will result in a decrease in total grain production volume. However, training farmers, namely, improving labor-augmenting technical change, will reduce the cost of production and protect the environment (Huang et al., 2012), and may also mitigate the risk of food insecurity.

Capital is another important factor for agricultural production. Since 2004, the direct effect of agricultural capital on production in China has increased (Tao and Zhang, 2013). Agricultural investment

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possesses the characteristics of low profitability and high risk, and Chinese agricultural capital underwent the predicament of scarcity and low accumulation for a long period (Xue, 2012). Because the Chinese central government has always attached great importance to agriculture, the government has invested in agriculture directly, and, in accordance, this policy of support has attracted capital from the market to agricultural production. These measures implemented by the Chinese central government helped agricultural production to accumulate capital effectively, with an annual growth rate of 10% between 2000 and 2010 (Luo, 2013). The future development of China's agriculture will depend on technical changes rather than just on an increase in the quantity of input of primary factors, such as labor and capital. In short, labor- and capital-augmenting technical change will continue to be important to agricultural production in the future, and it is imperative that these two resources are used effectively if issues such as food production and food security are to be properly addressed.

In studies of the agricultural economy, labor- and capital-augmenting technical change are usually measured and represented by labor and capital productivity, respectively (Acemoglu, 2000). Several studies have investigated the improvement in and influential factors of agricultural labor and capital productivity (Chen et al., 2012; Li et al., 2012; Tao and Zhang, 2013). However, there have been few studies of the impact of grain production in the large grain-producing provinces of China on other provinces, including with particular respect to the effects of labor- and capital-augmenting technical change on grain production, import and export volumes. Therefore, in this paper, we use a multi-region general equilibrium model with a scenario design method to analyze the impact of labor- and capital-augmenting technical change (represented by labor productivity and capital productivity) on grain (wheat) production and export volume in Shandong and Henan, and the consequent effects on other provinces in terms of domestic exported and imported volumes of wheat. Shandong and Henan provinces were chosen because they are the largest and second-largest grain-producing provinces in China, respectively.

The combined grain production of Shandong and Henan accounted for almost 18% of the national total, which is approximate 6×10^9 tons in 2014 (NBSC, 2014). Furthermore, in 2014 these two provinces accounted for almost half of the nation's wheat production (NBSC, 2014). In addition, there are almost 200 million people living in Shandong and Henan provinces, together representing about one-sixth of China's population (NBSC, 2014). Guaranteeing food security in Shandong and Henan provinces is therefore very important for China (Lin et al., 2013). As such, there is a need to study the effects of labor- and capital-augmenting technical change on wheat production in Shandong and Henan provinces and the further effects on other provinces with respect to domestic wheat export and import. The results should inform the creation of policy options for structural adjustments in China's agricultural production.

The remainder of the paper is organized into three sections. Section 2 describes data collation and the theory of the model, as well as the design of four scenarios to analyze the effect of labor-augmenting technical change and capital-augmenting technical change on wheat production in Shandong and Henan. Section 3 presents the results of the simulations and interpretations with respect to the agricultural economy and food security. Section 4 provides concluding remarks.

2. Data and methodology

2.1. General framework

First, we collected and collated statistical yearbook data and input–output data to construct a database for The Enormous Regional Model (TERM), including data for the 31 provinces and municipalities of the mainland, based on China's IO table of 135 sectors of economic activity for 2007. Second, as the study focused on agriculture, we examined agriculture in detail by splitting it into 22 sectors,[1] and aggregated manufacture sectors into a single sector and service sectors into a single sector. In this paper, grain production means wheat production because wheat is the dominant grain in these two provinces. Third, we set up four scenarios using TERM to analyze the effects of changes in labor and capital productivity in Shandong and Henan on the production of wheat in Shandong province and Henan province, as well as the amount of change in net export volume from Shandong province and Henan province to the remaining provinces and municipalities by the year 2020. In this paper, "export" and "import" refer to trade in the domestic market, namely, the trade among 31 provinces and municipalities in China.

The first scenario was a "business as usual" (BAU) scenario following the trend of previous years, with an increase in labor-augmenting technical change in both provinces and an increase in capital-augmenting technical change in Shandong province and a decrease in Henan province, as expected. The second scenario was an increase in capital-augmenting technical change for wheat production in both Shandong and Henan. The third scenario was an increase in labor-augmenting technical change for wheat production in both Shandong and Henan. The fourth scenario was the combination of the second and the third scenarios (i.e., an increase in both capital- and labor-augmenting technical change). The analysis focuses on discovering the value difference between the BAU scenario and the other three scenarios, and is able to show how a single variable affects the whole system, which is one of the advantages of using TERM. This analysis reveals both the separate and combined impacts of labor- and capital-augmenting technical change on the production of wheat in both Shandong province and Henan province, as well as the amount of change in net exports from Shandong province and Henan province to other provinces by the year 2020 (Fig. 1).

2.2. TERM model

TERM is a representative "bottom-up" multiregional Computable General Equilibrium (CGE) model and is able to analyze the regional impacts transmitted from other regions (Wittwer, 2012; Wittwer and Horridge, 2010). TERM was developed by the Centre of Policy Studies (CoPS), Victoria University, Australia. The theory of TERM is similar to that of the common CGE model, which is a simplified representation of the economic system. The outstanding feature of TERM is its treatment of trade relationships between regions (Horridge et al., 2005). The model simulates the condition that all agents use the primary factors of labor, capital, and land to produce commodities; these commodities are traded among different regional markets and finally consumed by consumers, and the system in the model maintains a dynamic balance between supply and demand. A more detailed description of TERM is available in Horridge et al. (2005). For the present study, we draw attention to the three basic assumptions about trade relationships in TERM: (1) Common proportions, whereby all users in a given

[1] These 22 agricultural sectors include 11 farming sectors (soybean, corn, wheat, rice, potato, vegetables, oilseed, apple, grape, cotton and other planting crops), 4 livestock husbandry (pig, cattle, sheep and other livestock), 4 sectors of meat slaughtering and processing (pork, beef, mutton, and other meat), forestry, fishery, and sector of services in support of agriculture. The details on how these 22 agricultural sectors have been generated is presented in Fig. 2 and Section 2.3.