Demographic Factors' Influence on Regional Productivity Growth

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Improving total factor productivity is an important way for China's economy to avoid the middle income trap. Demographic changes are believed to have significant impacts on productivity growth. Analyzing data from China's prefecture administrative units on both 2000 and 2010 provides solid evidence supporting the impact of demographic changes on productivity growth. First, population density plays an important role in both years. There is an inverted U-shaped relationship between population density and productivity growth. Second, human capital stock has a significant positive impact in both years while human capital inequality becomes insignificant in 2010. This is likely a result of China's education equality policies. Third, the impact of the aging of workers and their migration status on productivity growth also changed over the decade. Different cohorts of workers and migrants have had different influences on productivity growth because of their different access to higher education.

demographic factors | total factor productivity | exploratory spatial data analysis (ESDA)

1. The Demographic Effects on Productivity

Since Malthus put forward two assumptions of population growth and food production in his famous essay in 1798 [1], how to improve productivity and avoid the Malthusian trap has become a hot research topic. Unified growth theory [2][3][4] explores the theoretical discussion about the relationship between population factors, technological progress, productivity, and economic growth. In the Malthusian epoch, population growth was an engine for accumulation of new ideas, but labor productivity might become stagnant, sometimes even fall back, due to the limited availability of land. When technological innovation passed a threshold point and the growth rate of output is greater than that of the population, the Malthusian trap can then be broken, and economic development transfers to the post-Malthusian phase. In this phase, increased fertility rates and migration from traditional agricultural areas provide sufficient labor forces to encourage a growth in overall productivity. At a certain point, the rising demand for skills and knowledge embodied in human capital leads to the decline in fertility rate, which might temporarily increase the proportion of a working age population (because of the increased number of female workers). With demographic transitions and the accumulation of human capital, the economy will gradually enter the third phase of modern economic growth, which is mainly sustained by technology based productivity growth [2][3].

Previous studies often look at the influences of population size, age structure, human capital, and migration on productivity. Studies have found the impact of each factor on productivity growth to be complex and, sometimes, even contradictory [5][6][7][8][9][10][11]. Kremer [12], in his study on population growth and technological change, found that population size positively influences technological progress over a long historical period. Similar statements

can be found in North [13]. Generally, it is easy to understand that a larger population promotes productivity growth due to more potential inventors, more intensive intellectual contacts, greater labor specialization and a bigger size of markets. Some empirical research has argued for the effect of population size on productivity growth as well [5] [12]. On the other hand, when population size becomes overly large, a larger population might decrease productivity because of the increased duplication of efforts and decreased available capital stock per capita (the typical crowding effect) [12]. These studies suggest that there is a turning point in the influence curve of population size on productivity growth.

Aging is another important population factor that attracts much attention in the studies on productivity growth. From a physiological perspective, Shephard [8] argues that, because aging is associated with progressive changes in power, thermoregulation, reaction speed and the acuity of the special senses, the productivity of the elderly will decrease, particularly in self paced activities. In addition, compared to younger people, the aged are believed to be less innovative and receptive to new technologies, which blocks productivity improvement [14]. On the other hand, Gordo and Skirbekk [15] find that older workers are better able to adapt to technological changes. Ang and Madsen [9] point out that aging need not to be a drag on productivity. They argue that experience and knowledge developed tends to improve older workers' productivity.

Although it is widely believed that human capital investment is conducive to long-term economic growth, a consensus is yet to be reached about the impact of human capital on productivity [16][10][11]. Benhabib and Spiegel [10] argue that human capital helps workers to create, learn and use more advanced and newer technologies, thus it is helpful to improve productivity by promoting technology progress and diffusion. Miller and Upadhyay [17] point out that the effect of human capital on productivity in low income countries is changeable. It moves from negative to positive as the country moves from low to high levels of openness. Pritchett [11] even shows a significant negative relationship between human capital and total factor productivity. Gong [18] focuses on both the stock and inequality of human capital and believes that high quality human capital has a positive effect on productivity by affecting technology innovation, and human capital inequality has a negative effect on productivity by affecting technology diffusion.

The dualistic economic structure theory proposed by Arthur Lewis [19] is often used to explain the phenomenon of migration on productivity. It is assumed that urban sectors have higher productivity. Rural–urban migration could promote overall economic productivity. In other words, population migration is essentially a reallocation of human resources, and it brings obvious impacts on productivity for both inflow and outflow areas, which is a Pareto improvement for individuals, enterprises, and countries [20][21]. However, the empirical research on this topic has failed to reach a consensus [6][7]. Paserman [22] argues that, because of the different characteristics of migrants, especially their skill levels, they play various roles in the dissemination of new ideas and technologies. Low skilled migrants have little impact on technological diffusion in the receiving areas, and an excessive dependence on manual labor is not conducive for enterprises to improve production efficiency. In summary, the influence mechanism of migration on productivity is mainly in technology adoption, human capital formation, innovation process and knowledge spillovers [22][23][24].

2. Productivity Measure and Other Control Variables

There are many indices for measuring overall economic productivity, such as per capita output, labor productivity (LP), multifactor productivity (MFP) and total factor productivity (TFP). Among them, here contend that total factor productivity might provide a more comprehensive understanding of the productivity changes caused by the different factors input of production. Total factor productivity is a preferable measure to productivity in many previous studies [18][25][22][26]. To fully understand how population factors impact on productivity, need to control for other factors affecting productivity. Studies suggest that openness, trade orientation, foreign direct investment, industry structure, government expenditure, and geographical location are important factors [18][17][16][27][26][28][29].

3. The Advance and Application of Spatial Data Analysis Methods

In empirical studies of the social sciences, regional socioeconomic data are often used in many studies [18][25][7][26]. When conventional econometric methods are used, these studies implicitly assume that the observations collected with geographical information are independent and there is no connection between regions. However, according to the First Law of Geography [30], spatial data are inherently interconnected and interdependent between different spatial units, and the strength of such interdependence depends on geographical distance. This suggests that socioeconomic development in a certain region might very likely be closely related to the surrounding regions. Such interconnectedness and interdependence are often collectively called spatial autocorrelation among observations collected over geographic space [31][32]. The existence of spatial autocorrelation violates the independence assumption of observations in traditional statistical analysis. For instance, when investigating relationships between demographic factors and productivity, if employing the common OLS regression estimator for geographic data, here might produce potentially unreliable and even misleading results due to the potential existence of spatial autocorrelation in the regression residuals. Instead, the estimator based on the maximum likelihood (ML) method is usually proposed as an effective alternative [31]. Some existing studies have noticed the limitations of using traditional regression methods to analyze spatial data [25][21] and scholars have tried to use spatial econometric methods to explain the influence mechanism on productivity [26][29].

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