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Analysis of regional productivity growth in China: A generalized metafrontier MPI approach

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ABSTRACT

This paper analyzes the dynamics of China's productivity for the period 1996–2004 with a newly developed methodology — generalized metafrontier Malmquist productivity index (gMMPI). Implementing the gMMPI, this paper reviews the inequality of the coastal and non-coastal provinces, as well as the latent impact of scale efficiency change (SEC) for China. Using provincial data for the years 1996–2004, the empirical results are as follows. On average, China demonstrates an annual 3.191% productivity change, which is lower than 4.729% for the conventional MPI and accounts for about 26.508% of output growth over the period 1996–2004. Most of this change is propelled by technical progress, while a fraction is driven by the adjustment in production scale, and the efficiency change has an adverse effect. Furthermore, regional inequality is also found in this empirical work, and the productivity change of the coastal region is actually stronger than that of the non-coastal region. This paper also casts some focus on the China Western Development policy. Indeed, we do not find any outstanding achievement from the policy in the sample period, except that the west region sustained its rate of productivity change after 2000. Moreover, the SEC is found to be trivial in the advanced coastal region, but plays an important role in the relatively laggard non-coastal region. The implication of the positive SEC in the non-coastal region means that China's Western Development policy will improve the scale efficiency and the TFP growth of the west region.

1. Introduction

Ever since the initiative of an "open door policy" in the late 1970s, China has witnessed continuously spectacular economic growth, at an average rate of 9.8% over the past three decades. While the change in state policy on international investment and trade has been widely recognized to contribute to the economic growth,[1] technological progress is alternatively regarded as the critical ingredient for sustained economic growth and catching up. Is China's remarkable growth driven principally by factor accumulation? Is there nothing miraculous about its growth, as in Young's (1995) critique on East Asian growth? These issues have inspired a boom of empirical studies to assess productivity growth in China.

One line of research pays attention to examining economy-wide productivity growth in China by adopting total factor productivity (TFP) as a measure of technological change.[2] Using the growth accounting approach, Borensztein and Ostry (1996),

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[1] Please see Yao (2006) for a comprehensive survey.

[2] Another line of research focuses on examining sector-wide productivity growth. Of these studies, a common conclusion is that there is a considerable high rate of agricultural productivity growth in the 1980s, while the conclusion on productivity growth of the manufacturing sector is mixed. For example, see Mcillian, Whalley, and Zhu (1989), Wu (1995), Young (2003), and Szirmai, Ren, and Bai (2005).

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Hu and Khan (1997), Fleisher and Chen (1997), Ezaki and Sun (1999), Wang and Yao (2003), and Islam, Dai, and Sakamoto (2006) provided assessments of TFP growth in the post-reform period and found that there was a considerable TFP growth rate in China, between 2.41% and 3.90%, during the post-reform period of 1980 to 1995.[3] The accuracy and reliability of the growth accounting approach depend heavily on accurate data and on a complicated calculation process regarding the factor price, while Young (2003) and Islam et al. (2006) strongly warned of the problems in China's national income accounts data.

In contrast to the growth accounting approach, a branch of studies is emerging that uses the frontier production approach with a more flexible assumption to production behavior to measure TFP growth in China. Wu (2000) first applied the Malmqist index of TFP growth to examine whether China's economic growth is sustainable and found an increasing trend of TFP growth over the period from 1987 to 1995. Chen (2001) found positive average TFP growth during the period from 1992 to 1999, because technology improvement was found to be a larger component for TFP growth. Zheng and Hu (2006) presented considerable average productivity growth for most of the data periods during 1979 to 2001. In their estimate, the TFP growth figure was 5.34% during the 1980s and 2.60% in the 1990s. However, TFP growth slowed significantly between 1995 and 2001, and the weighted average TFP growth rate during that time was only 1.11%. Shiu and Heshmati (2006) used the panel econometrics estimation approach for measuring provinces' TFP growth during 1993 to 2003. They found a spectacular TFP growth rate of nearly 9% across provinces, but they also identified a general trend for TFP growth decline.

When using the MPI approach to analyze China's TFP growth, there is nevertheless a serious limitation to a rigorous study — that is, for a long time the regional inequality between the coastal and non-coastal regions has persistently been a problem inside China's economy,[4] which implies that the coastal and non-coastal regions have different production frontiers. In light of this discrepancy, we should estimate separate production frontiers for these different regions. Indeed, production units in different regions face different production opportunities that force them to make choices from different sets of feasible input–output combinations. This difference can be attributed to the available stocks of physical, human, and financial capital, economic infrastructure, resource endowments, and any other characteristics of the physical, social, and economic environment in which production takes place (O'Donnell, Rao, & Battese, 2008). Hence, when using the conventional MPI to estimate the frontiers of the two regions separately to obtain the productivity change, the direct cross-sets comparison is restrained, but it requires a construction of some common function that defines the existing technologies. Fortunately for meeting the requirement, in view of the assumption that all producers in different groups (countries, regions, etc.) have potential access to the same technology, Battese, Rao, and O'Donnell (2004) had proposed a framework of metafrontier production function model. The advantage of this framework is that the cross-sets comparison of production efficiencies measured under different frontiers can be conducted on a common basis of potential technology. O'Donnell et al. (2008) subsequently formally utilized distance functions to define and illustrate the framework of the metafrontier production function, while extending the concept of the metafrontier to the domain measuring the total factor productivity; i.e., the metafrontier Malmquist productivity index (MMPI). Therefore the adoption of the MMPI should have more of a methodological advantage than the conventional MPI for investigating China's TFP growth, since the strong assumption regarding all provinces operating under the same frontier and the limitation in cross-sets comparison could be relaxed.

Nonetheless, it is also worth noting that the MMPI is still an incomplete measure in nature, since the potential impact of scale efficiency change (SEC) is not taken into account. From the perspective of industrial economics, the technological frontier of a production unit comprises three fractions: increasing return to scale (IRS), constant return to scale (CRS), and decreasing return to scale (DRS). As long as the used technology has variable return to scale, regardless of IRS or DRS, it invariably implies that there is room to improve the average product (productivity) through adjusting the operating scale. As Ray (1998) argued, even a fully efficient production unit operating on the frontier might not necessarily imply an optimal scale of production. Only the input–output combinations of the CRS level can harmonize the point of maximum average product.[5] Frisch (1965) termed the operating scale corresponding to the CRS as the technically optimal productive scale (TOPS). Therefore, from a static viewpoint, the scale efficiency refers to a ratio of the potential productivity of the current scale on the frontier (i.e., the productivity level without loss of technical efficiency) to the productivity level of the TOPS. Then, from a dynamic viewpoint, the scale efficiency change can be defined as a cross-period adjustment in scale efficiency toward the TOPS (Coelli, Rao, O'Donnell, & Battese, 2005).

Indeed, the problem of a productivity index measure ignoring the effect of SEC has been discussed in the literature. Under the conventional MPI framework, the issue is systematically addressed in both non-parametric and parametric contexts.[6] Since the MMPI is a productivity measure extended from the MPI that takes the metafrontier as its basis, it should be noted that the imperfection of MPI by ignoring the effect of the SEC, as criticized in the literature, should also be embedded in the MMPI. This study adopts a generalized MMPI framework (gMMPI), therefore further taking into account the effect of SEC in the MMPI.

The main purpose of this article is to provide new empirical evidence on China's regional productivity growth. It attempts to contribute in line with the existing empirical literature by providing the following three distinct types of empirical evidence. First, this study develops a generalized MMPI framework (gMMPI), which further takes into account the effect of SEC in the MMPI to reassess China's regional productivity growth during 1996–2004. Second, the study discusses the extent of productivity change

[3] Islam et al.'s (2006) study claimed that the average TFP growth was 2.95% for the longer period from 1978–2002.

[4] There is an abundance amount of studies showing that there is a growing regional imbalance in China — for example, Chen and Fleisher (1996), Yao and Zhang (2001), and Kanbur and Zhang (2005).

[5] The VRS correspond to a figure of scale elasticity deviating from unity and the CRS correspond to a figure of scale elasticity equal to unity. Banker (1984) also characterized the operating scale with scale elasticity equal to unity as the most productive scale size (MPSS).

[6] See Fare, Grosskopf, Norris, and Zhang (1994) and Grifell-Tatje and Lovell (1999) for the non-parametric context. Concerning the parametric context, please refer to Balk (2001) and Orea (2002).