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Technological change and China's regional disparities — A calibrated equilibrium analysis ☆

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ABSTRACT

We in this paper assess the impacts of technological change on China's regional disparities using a general equilibrium model of multiple regions and multiple sectors. We use the most recent available Chinese interregional data to calibrate the model parameters for 1987 and 2000. We then assess the impacts of neutral, biased, and aggregate technological changes on China's regional disparity by conducting counter-factual experiments. The results generally suggest that China's overall technological change between 1987 and 2000 has increased China's regional disparities. The results also suggest that neutral technological change reduces China's regional disparities while biased technological change increases disparities and the influences of the latter outweigh those of the former and the net effects of technological changes on regional disparities are increasing.

1. Introduction

China has seen widening regional disparities along with rapid GDP growth rate in the last few decades. This increased regional divide has caused great concern over both the sustainability of economic development and social stability in China. A growing body of literature has investigated the causes of these pronounced regional disparities.[1] This literature sheds analysis of the causes of China's pronounced regional gap from a range of perspectives, including natural resource endowments (Zhang et al., 2008; Démurger et al., 2002); factor market distortions (Cai et al., 2002; Lu, 2008; Jones et al., 2003); exports, trade liberalization, and globalization (Zhang and Zhang, 2003; Sha et al., 2007); and policies (Jones et al., 2003; Chen and Zheng, 2008; Zhang et al., 2008; Démurger et al., 2002).

It is however well recognized that China's technological change has contributed substantially to China's rapid GDP growth and this factor, to our knowledge, remains unanalyzed. China's different regions have experienced different GDP growth rates over the last few decades. Has China's technological change in different regions contributed to the enlarging regional disparities? Technological change may influence China's regional disparities via several channels. Technological changes may vary across regions as well as commodities and hence may have led to natural resources, labor, and capital inputs reallocation which may in turn result in changes in regional disparities. The goal of this paper is to assess the impacts of observed technological change on China's regional disparities.

In this paper we use a general equilibrium (GE) model of China capturing multiple regions and multiple sectors. We use the most recently published (and unique) set of China's interregional input–output tables to calibrate the parameters of the general equilibrium model. The earliest and latest available Chinese interregional and international trade flows and input–output data are for 1987 and 2000. Our results suggest that technological change significantly increases China's regional disparities in terms of both GDP per capita and aggregate regional GDP. We differentiate two types of technological changes, neutral and biased technological changes. Our counterfactual results suggest that neutral and biased technological changes affect China's regional disparities in different ways. The observed neutral

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[1] For a comprehensive review of the literature concerning the convergence or divergence associated with regional disparity please refer to Sha et al. (2007).

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technological change substantially reduces China's regional disparities while biased technological change increases regional disparities. The impacts of biased technological change on regional disparities outweigh those of observed neutral technological change and hence technological change has seemingly led to a rise in China's regional disparities.

The rest of the paper is structured as follows. Section 2 sets out the general equilibrium model that we use to investigate the impacts of observed technological changes between 1987 and 2000 on China's regional disparities. Data sources and model parameters calibrated to 1987 and 2000 data are reported in Section 3. We then introduce the technology parameters as of 1987 into the 2000 model to conduct counterfactual experiments and the results assessing the impact of technological changes on regional disparity are prescribed in Section 4. Section 5 briefly concludes and draws policy implications.

2. A numerical general equilibrium model

The numerical general equilibrium model consists of eight regions (seven Chinese regions and the rest of the world) and six commodities, with the rest of the world (ROW) output of the six commodities exogenously given. We use r to represent the seven Chinese regions, w the rest of the world, and s the eight regions. The seven Chinese regions are North-east (including Heilonjiang, Jilin, and Liaoning), North (including Beijing, Tianjin, Hebei, Shandong, and Inner Mongolia), East (including Jiangsu, Shanghai, and Zhejiang), South (including Fujian, Guangdong, and Hainan), Central (including Shanxi, Henan, Anhui, Hubei, Hunan, and Jiangxi), North-west (Including Shannxi, Ningxia, Gansu, Qinghai, and Xinjiang), and South-west (including Sichuan, Chongqing, Guangxi, Yunnan, Guizhou, and Tibet). The six commodities are Agriculture, Mining, Light Industry, Heavy Industry, Construction, and Services.

Production functions of the seven Chinese regions and utility functions in each of the eight regions are assumed to be nested constant elasticity of substitution (CES), but parametrically different across regions and commodities. We also assume firms used different combinations of inputs to produce commodities.

On the production side, a three-stage production structure is used to describe the production of the six commodities in the seven Chinese regions. At the top-level firms are assumed to maximize profits using two aggregate inputs, value added (an aggregate of labor and capital) and aggregate intermediate inputs (an aggregate of the six commodities) according to Eq. (1):

$$Q_{rc} = A_{rc}\left[\sum_{h=v,i} \alpha_{rch} x_{rch}^{(\sigma_{rc}-1)/\sigma_{rc}}\right]^{\sigma_{rc}/(\sigma_{rc}-1)} \tag{1}$$

where Q_{rc} is the output of commodity c produced in region r; x_{rch} is aggregate inputs ($h=v$, i; v for aggregate value added and i for aggregate intermediate inputs) used in the production of Q_{rc}; A_{rc} is a constant that embodies the technology; α_{rch} is the corresponding share parameter; and σ_{rc} is the elasticity of substitution between aggregate value added and aggregate intermediate inputs. Both output and input markets are assumed competitive.

First order conditions of cost minimization yield the associated derived demand functions for aggregate value added and aggregate intermediate inputs,

$$x_{rch} = \frac{Q_{rc}}{A_{rc}}\left[\frac{\alpha_{rch}\left(\sum_{h}\alpha_{rch}^{\sigma_{rc}}p_{rch}^{1-\sigma_{rc}}\right)^{1/(1-\sigma_{rc})}}{p_{rch}}\right]^{\sigma_{rc}} \tag{2}$$

where p_{rch} is the price of x_{rch}, which in turn is given by a unit cost price index constructed using the second level production functions for the commodity c.

At the second level, value added is also assumed to be a CES function of labor (l) and capital (k) (Eq. (3)), while aggregate intermediate input is a CES function of the six commodities (Eq. (4)).

$$x_{rcv} = \left[\sum_{g=k,l}\left(\alpha_{rcv\cdot g}x_{rcv\cdot g}^{(\sigma_{rcv}-1)/\sigma_{rcv}}\right)\right]^{\sigma_{rcv}/(\sigma_{rcv}-1)} \tag{3}$$

$$x_{rci} = \left[\sum_{c'=c}\alpha_{rcc'}G_{rcc'}^{(\sigma_{rci}-1)/\sigma_{rci}}\right]^{\sigma_{rci}/(\sigma_{rci}-1)} \tag{4}$$

Where $x_{rcv\cdot g}$ ($g=l$, k), is the labor or capital inputs used in the production of x_{rcv} and $\alpha_{rcv\cdot g}$ is the corresponding share parameter; $G_{rcc'}$ is the input of aggregate commodity c' (c' is the alias of c) in the production of x_{rci}; $\alpha_{rcc'}$ is the share parameter of $G_{rcc'}$; σ_{rcv} is the elasticity of substitution between labor and capital inputs involved in the production of x_{rcv}; and σ_{rci} is the elasticity of substitution between $G_{rcc's}$.

The unit cost price indices used at the top level generated from the second level parameters and prices are,

$$p_{rcv} = \left[\sum_{g}\alpha_{rcv\cdot g}^{\sigma_{rcv}}w_g^{1-\sigma_{rcv}}\right]^{1/(1-\sigma_{rcv})} \tag{5}$$

$$p_{rci} = \left[\sum_{c'}\alpha_{rcc'}^{\sigma_{rci}}p_{rcc'}^{1-\sigma_{rci}}\right]^{1/(1-\sigma_{rci})} \tag{6}$$

where w_g is the wage rate for labor and returns for capital, $p_{rcc'}$ is the price of $G_{rcc'}$, which in turn is given by a unit cost price index constructed using the bottom level production functions for $G_{rcc'}$.

First order conditions of cost minimization yield the associated demand functions for labor, capital, and $G_{rcc'}$,

$$x_{rcv\cdot g} = x_{rcv}\left[\frac{\alpha_{rcv\cdot g}p_{rcv}}{w_g}\right]^{\sigma_{rcv}} \tag{7}$$

$$G_{rcc'} = x_{rci}\left[\frac{\alpha_{rcc'}p_{rci}}{p_{rcc'}}\right]^{\sigma_{rci}}. \tag{8}$$

The bottom level CES function is,

$$G_{rcc'} = \left[\sum_{s}\left(\alpha_{rcc's}Z_{rcc's}^{(\sigma_{rcc'}-1)/\sigma_{rcc'}}\right)\right]^{\sigma_{rcc'}/(\sigma_{rcc'}-1)} \tag{9}$$

where $Z_{rcc's}$ is the intermediate input demand for region s in the production of $G_{rcc'}$.

The unit cost price index used at the second level generated from the bottom level parameters and prices is,

$$p_{rcc'} = \left[\sum_{s}\alpha_{rcc's}^{\sigma_{rcc'}}p_{cs}^{1-\sigma_{rcc'}}\right]^{1/(1-\sigma_{rcc'})} \tag{10}$$

where p_{cs} is the price of commodity c from region s. And, the derived demand for commodity c from region s is,

$$z_{rcc's} = G_{rcc'}\left[\frac{\alpha_{rcc's}p_{rcc'}}{p_{cs}}\right]^{\sigma_{rcc'}}. \tag{11}$$

Final demands are generated in each of the eight regions by maximizing utility, choosing a bundle of agriculture, mining, light industry, heavy industry, construction, and service goods each aggregated over the corresponding regional products (Eq. (12)). Top-level CES preferences (denoted by utility D_s) in the various regions s are given by,

$$D_s = \left[\sum_{c}\alpha_{sc}x_{sc}^{(\sigma_s-1)/\sigma_s}\right]^{\sigma_s/(\sigma_s-1)} \tag{12}$$

where x_{sc} is the aggregate demand for commodity c in region s, α_{sc} is the corresponding share parameter, and σ_s is the elasticity of substitution at the first stage of final demand.