Developing a multi-regional CGE model for China based on China interregional input-output model

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Abstract: With the economic growth in past decades, increasing regional disparity has become a severe problem and alleviation of regional disparity has been the key issue of regional policy in China. Meanwhile economic linkages across regions are increasing with liberalization and privatization of economic system and then pose impacts on regional economy. This paper developed a multi-regional CGE model for China (MRCGE2002) to provide a policy analysis tool for regional development issues. MRCGE2002 includes thirty regions and sixty sectors. To depict regional differences in economic scale and industrial structure and economic interaction across regions, MRCGE2002 consists of seven parts. The first three parts are *Production technology*, *Local final demands*, *Import and export demands*, which describe economic activities for each region. The next three parts are *Interregional commodity flows*, *Interregional investment allocation*, *Interregional labor allocation*, which present the main economic linkages across regions. The last part is macroeconomic closure and equilibrium. The database of MRCGE2002 for description of economic linkages across regions comes from China interregional input-output model 2002. MRCGE2002 simulation results may provide insights on differences in response of different regions to a microeconomic policy or a regional policy in China.

Key Words: China; multi-regional CGE model; regional differences; interregional linkage; interregional input-output model

1. Introduction

Input-output models, econometric models, and computable general equilibrium (CGE) models have been applied for analysis of regional development and regional policy. Comparing with CGE models, input-output models may lead to overestimates of economy-wide net benefits because of their fixed-price, perfectly elastic supply and no constrains with supply[1], while econometric models typically lack sufficient structure for complex policy analysis, which results in lacking required policy levers and made them subject to the Lucas critique[2]. CGE models have more advantages than other methods in analysis of regional economy. When we need insight of policy impacts on several regions, multi-regional CGE (MRCGE) models have more advantages than single regional CGE models, because multi-regional CGE models can reveal regional differences and economic interactions across different regions.

China is featured by diversity of natural environment and resources and spatial heterogeneity of social-economic development because of its large scale of territory. Meanwhile economic linkages across regions, such as commodity flows, labor flows and capital flows, are increasing with liberalization and privatization of economic system. So a multi-regional CGE model is necessary for analysis on China's regional development issues. This paper focuses upon the framework of a multi-regional CGE model for China that is expected to provide a useful tool for analysis of regional economy and regional policy.

There are some researches on multi-regional (multi-national) CGE models, such as GTAP[3], LINKAGE[4] and GTEM[5] (multi-national CGE models), MMRF[6], MMRF-Green[7], and TERM[8] (multi-regional CGE models). Only few trials on multi-regional CGE model have been made for China up to now. Li Shantong and her colleagues made a three regions CGE model [9]which focuses on the trade and environmental issues and a two regional CGE-model[10] which focuses on the impact on Beijing industrial structure change due to Olympic Games. Wang Fei [11]and Xu Zhaoyuan[12] made a 30 regions CGE model respectively, the former focuses on the impacts of labor migration and government investment and the latter focuses on the impacts of labor migration and capital flows. However, most of these models are lack of description of economic interaction across regions. The model presented in this paper aims to describe economic interaction across regions in detail, including commodity flows, labor flows and capital flows.

This paper is organized as follows. Part 2 discusses some characteristics of multi-regional CGE models. Part 3 explains the framework of the multi-regional CGE model for China. Part 4 shows the data, and the conclusions and further research in part 5 closes the paper.

2. Characteristics of Multi-regional CGE Models

There are some distinctions of multi-regional CGE models differing from single regional CGE models, in addition to same characteristics to single regional CGE models. The distinctive features of multi-regional CGE models may be concluded as follows.

(1) Each region should be modeled separately as an individual economy. The model contains region-specific prices, region-specific industries, region-specific consumers, and so on. Based on region-specific modeling, regional differences can be depicted.

(2) The model should reflect economic linkages and interactions across regions, such as interregional commodity flow, labor flow and capital flows and so on. Based on description of these linkages of economic activities across regions, the impacts of one region on other regions can be analyzed.

3. Framework of Multi-regional CGE Model for China

The basic framework of multi-regional CGE model for China (MRCGE2002) includes seven parts: production technology, local final demands, import and export demands, interregional commodity flows, interregional investment allocation, interregional labor allocation, and macroeconomic closure and equilibrium. Production technology, local final demands, and import and export, kinds of economic optimal behaviors (producers, consumers, importers, exporters etc.) are characterized at regional level rather than national level. Interregional commodity flows, interregional investment allocation and labor allocation present the main economic linkages across

regions and are the most important parts in our model.

3.1 Production technology

The model assumes each region includes n sector, and recognizes two broad categories of inputs in each sector: intermediate inputs and primary factors. Producers are constrained in their choice of inputs by a two–level nested production technology (see Figure 1). At the first level, intermediate-input bundles and primary-factor bundles are used in fixed proportions to output (Leontief function). These bundles are formed at the second level. Intermediate-input bundles are CES（Constant Elasticity of Substitution）combination of labor and capital.

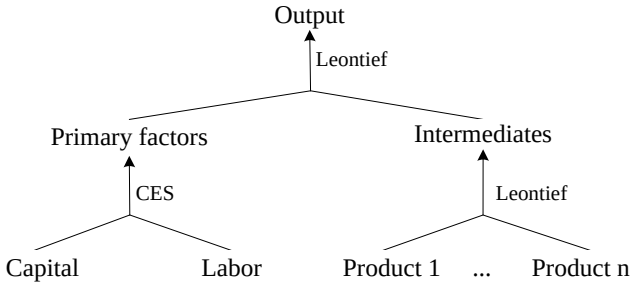

Figure 1 The structure of production

3.2 Local final demands

Local final demands include rural household consumption, urban household consumption, government's consumption, gross fixed capital formation, and inventory investment. In each region, the household buys bundles of goods to maximize a Stone-Geary utility function subject to a household expenditure constraint. A linear expenditure system (LES) consumption function determines household expenditure. Government is not divided into regional governments and central government but only one government sector. A Cobb-Douglas (C-D) consumption function determines government's expenditure. Considering technological relationships between investment products, we use Leontief function to determine various investment products demands. Inventory investment in each regional sector is assumed to be fixed in the model.

3.3 Import and export demands

In each region, the Armington function is applied to this model to account for the imperfect substitutability between locally produced output and imports in the local market. In minimizing costs with the Armington function, the demand for local imports is determined by the sales of locally produced products and the price of locally produced products relative to the world market price. Local imports and locally produced products are formed into composite goods (CES), which supply intermediate demand of producers, rural and urban household consumption, government's consumption, gross fixed capital formation, and inventory investment (see Figure 2).

Likely, it is assumed that exports from different regions have the imperfect substitutability, and the ratio of regional exports results from the relative difference between local prices of regional exports. All regional exports can be added into China total exports. The demand of China

total exports to the world market can be determined as an exponential function of the world market price relative to the price of China total exports. This exponent is a positive elasticity parameter, and its value can reflect the degree of influence of China exports to the world market.

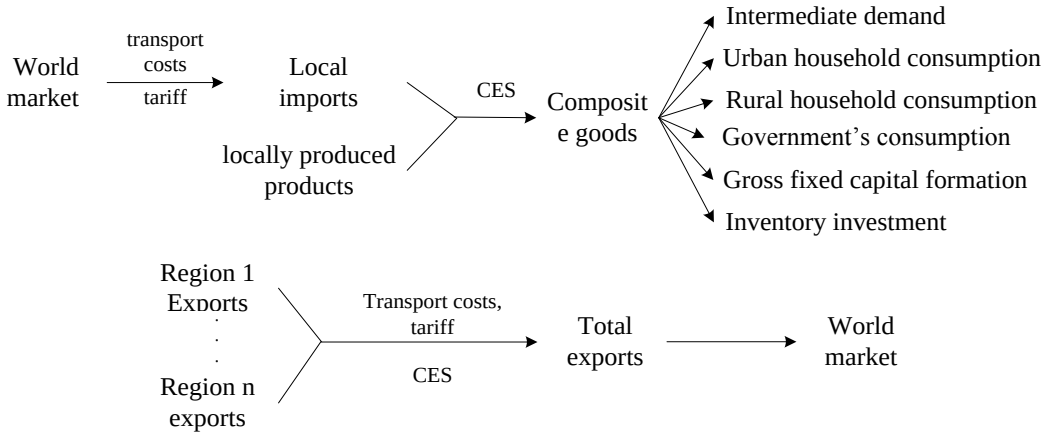

Figure 2 The structures of imports and exports

3.4 Interregional commodity flows

Interregional commodity flows in the model involve intermediate demand of producers, rural and urban household consumption, government's consumption, gross fixed capital formation, and inventory investment. The commodities of their consumption can be not only from composite goods (local imports and locally produced products) but also from other region goods. Accordingly, CES function can be account for the substitutable relationship between them (see Figure3).

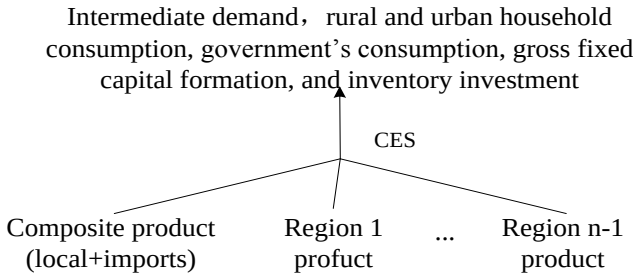

Figure 3 The structure of interregional commodity flows

Similarly, the commodities in each region can be provided not only for local market but also for other regions or export. In the model, transport costs are neglected when local commodities supply for local market. When local commodities supply for other regions, ex-factory price plus transport costs are equal to consumer price of destination.

3.5 Interregional investment allocation

According to Bai Chong'en et al.[13], the differences of capital return rate between regions in China have become small in recent ten years. So, in our model investment /capital is assumed to be mobile across regions. Capital usually can move from low-return region to high-return region,

but this will lead to a decline of expected return rate in high-return region because of competition. Finally, in a long-run, all regional expected return rate are equal to national average expected return rate. This is an investment allocated way in the long-run closure. According to this way, in the model each regional aggregate investment is endogenous. Given the quantity of real regional investment ($INVR_r$), the rate of depreciation ($depre_r$) and the regional capital stock at the beginning of a year (KB_r), the regional capital stock at the end of a year (KE_r) can be defined as equation (1):

$$KE_r = INVR_r + (1 - depre_r) \cdot KB_r \quad (1)$$

Given the regional rental price ($RENTAL_r$), the average investment cost ($PRINV_r$), the regional capital return rate can be determined by equation (2):

$$RORC_r = RENTAL_r / PRINV_r \quad (2)$$

The net expected return rate $RORE_r$ can be defined as equation (3), where $rorflex_r$ is a elasticity and aex_r is a scale parameter.

$$RORE_r = aex_r \cdot (KE_r / KB_r)^{-rorflex_r} \cdot RORC_r \quad (3)$$

Finally, all regional expected return rate are equal to national average expected return rate, which is presented in equation (4):

$$RORE_r = RORG \quad (4)$$

3.6 Interregional labor allocation

Labor flow across regions is a necessary problem to be handled in multi-regional CGE model. In our model, we design a mechanism to reflect regional labor flows and wage differences between regions and sectors.

An exogenous total national labor supply ($TTQL$) is assumed, and regional labor supply (TQL_r) is endogenous (Equation (5) is the labor supply constraint equation). Labors can be mobile across regions but move imperfectly, so there are wage differences between regions. A regional distortion coefficient ($distort_r$) is applied to represent differences between regional wage and national average wage, and regional wage ($WAGE_r$) is equal to national average wage ($TWAGE$, endogenous) multiplies the regional distort coefficient (Equation (6)).Through this way, each regional labor supply can be endogenously determined. Similarly, a sectoral distortion coefficient ($distl_{i,r}$) is applied to represent differences between sectoral wage ($PL_{i,r}$) and

regional average wage due to imperfect labor movement across regional sectors (Equation (7)), and each sectoral labor supply can be endogenously determined after the determination of regional labor supply. The two distortion coefficients are exogenous, and their value can increase or decrease to reflect the degrees of the distortions between regions and sectors.

$$TTQL = \sum TQL_r \quad (5)$$

$$WAGE_r = distort_r \cdot TWAGE \quad (6)$$

$$PL_{i,r} = distl_{i,r} \cdot WAGE_r \quad (7)$$

3.7 Macroeconomic closure and equilibrium

Neoclassic closure is applied in this model. Governmental savings rate is exogenous, and governmental expenditure is endogenous. Exchange rate is exogenous, and the ration of foreign savings (equals imports minus exports) to GDP is endogenous. The numeraire is the average price of national urban consumption.

There are mainly three kinds of equilibriums. (1) Labor. Adding all regional labor supply equal total national labor supply, and adding all regional sectoral labor supply equal regional labor supply. (2) Capital. Adding all sectoral capital supply in one region equal this regional capital supply. (3) IS equilibrium. Total national investment equal total national savings.

4. Data

Multi-regional CGE models usually need an interregional input-output model/table as database for description of these linkages of economic activities across regions. However, this interregional input-output model/table is not easily available that leads to a constraint to application of multi-regional CGE model.

China interregional input-output model 2002 including thirty regions and sixty sectors is developed by the Research Center on Fictitious Economy & Data Science CAS. It is constructed on the basis of China thirty provincial input-output tables by using typical survey and non-survey methodologies, which is the base for description of economic linkages across regions. In the MRCGE2002, we use it as the basis of database.

5. Conclusions and perspective

This paper constructed a multi-region CGE model for China 2002 using China interregional input-output model 2002. It can reflect the sizes of economies and differences in industrial structures and main economic interrelations across regions. By using MRCGE2002, it is possible to simulate the effects of a microeconomic policy or a regional policy on regional development in China. The further research needs to develop a dynamic multi-regional CGE model for China to provide a more powerful analytical tool for regional development.

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