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DOES REGIONAL SIZE MATTER IN REGIONALIZATION OF NATIONAL INPUT-OUTPUT TABLE BY THE FLQ FORMULA? -A CASE STUDY OF CHINA-

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DOES REGIONAL SIZE MATTER IN REGIONALIZATION OF NATIONAL INPUT–OUTPUT TABLE BY THE FLQ FORMULA?†
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Abstract

This paper employed the regionalization method of the use of location quotient family such as Location Quotient (LQ), Cross Industry Quotient (CIQ), Flegg's Location Quotient (FLQ) and the augmented FLQ (AFLQ), that take the regional size into consideration, by using the Chinese national input–output table. The paper examines the accuracy of the output multiplier derived by the estimated regional input–output tables, comparing with the survey-based Provincial input–output tables. The result shows us that LQ and CIQ of 10 provinces (one third of the total region) is better than FLQ, and AFLQ gives better estimates in all regions under the appropriate δ value, compared to LQ and CIQ. However, a reasonable value for δ, which has been reported a relatively stable in previous research, would be widely distributed for both FLQ and AFLQ for all provinces. Therefore, the regional size does not matter in regionalization by the FLQ formula based on empirical evidence.

JEL Classification: O53, R10, R15

Keywords: Regionalization, Input–Output analysis, FLQ, Regional size, Regional specialization

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1. INTRODUCTION

The Xi Jinping/Li Keqiang regime in China commenced in 2012. Li Keqiang stressed on urbanization after being appointed the new Premier of the State Council of the People's Republic of China. In order to analyze the effect of this urbanization on the economy, the input–output model becomes useful. However, although China began publishing input–output tables at the provincial level, tables for cities and sub-regions still do not exist. Chinese provinces are considered regions; however, with an average population of about 40 million people and a GDP of about $150 billion, each province may seem as large as an entire country. If there were input–output models at the levels ranging from province to city and sub-region, it would greatly help in analyzing regional development in China.

How would one estimate an input–output model for cities and sub-regions? One effective method would be to regionalize the currently available provincial input–output table by city and sub-region. However, it would be difficult to examine the effectiveness of regionalizing the provincial input–output table without having a survey-based input-output table at the city and sub-regional level.

Thus, this paper uses the national and provincial input–output tables that are available, regionalizes the national input–output table to estimate a provincial input–output model, and examines the effectiveness of the model by comparing it to the actual provincial input–output table. Specifically, the paper examines the applicability of the FLQ and AFLQ formulas proposed by Flegg et al. (1995), Flegg and Webber (1997), and Flegg and Webber (2000), that take the "Regional Size" into consideration.

This paper is organized as follows. After providing an overview of the regionalization methods in the next section, and the data actually used, I report in Section 3 the results of the regionalization performed by using the national input–output table of China, and provide a summary at the end.

2. MODEL AND DATA

2.1 Regionalization Methods

A common method of studying regionalization has been to derive the regional input coefficient by multiplying the national technical coefficient[1] with data related to the regional input coefficient. Therefore, it is expressed as:

$$a_{ij}^{r} = (\alpha_{ij}^{r})(a_{ij}^{d}).$$

Here, a_{ij}^{r} is the input coefficient of region r, a_{ij}^{d} is the national technical coefficient (excluding imported goods), and α_{ij}^{r} is the coefficient that reflects the input of the region. However, due to the difficulty in obtaining the data, it is often assumed that $\alpha_{ij}^{r} = 1$ or $a_{ij}^{r} = a_{ij}^{d}$. This paper also maintains the same assumption.

Next, since the regional input coefficient includes goods brought in from other regions, the regional technical coefficient, to show that the region inputs goods only from within, is calculated by multiplying the regional input coefficient with the regional self-sufficiency rate β_{ij}^{r}.

$$a_{ij}^{rr} = (\beta_{ij}^{r})(a_{ij}^{r})$$

Since it is hard to obtain the regional self-sufficiency rate β_{ij}^{r}, location coefficients (location quotient (LQ) and its derivative quotients) have been used as substitutes. This is based on the logic that the region is self-sufficient when the location coefficient is greater than 1, as it implies that the industry is more concentrated in the region than in the rest of the country. Likewise, it is assumed that the industry is less concentrated in the region than in the rest of the country when the location coefficient is less than 1, indicating that the region imports the difference from other regions.

Specifically, location quotient is calculated and regionalization is done by it as follows:

[1] Miller and Blair (2009) distinguish national input coefficient, which includes imported goods in the national input-output table, and national technical coefficient, which does not include imported goods. This paper employs these terms.

$$LQ_i^r = \left(\frac{x_i^r/x^r}{x_i^n/x^n}\right) = \left(\frac{x_i^r/x_i^n}{x^r/x^n}\right)$$

$$a_{ij}^{rr} = \begin{cases} (LQ_i^r)a_{ij}^d & if\ LQ_i^r < 1 \\ a_{ij}^d & if\ LQ_i^r \geq 1 \end{cases} \cdots (1)$$

Here, x_i^r and x_i^n refer to gross output data (employment, added value, etc.) for region r and nation n, respectively. The national technical coefficient is slightly adjusted downward based on how small the location coefficient is, only when the location coefficient is less than 1.

This regionalization is a uniform adjustment that takes only the supply side (the row side) into consideration. Therefore, the Cross Industry Quotient (CIQ), a method that takes the demand side sectors (the column side) into consideration, was developed. This method considers the relative importance of the transaction value between the supply side sector *i* and the demand side sector *j* in the region and nation. The CIQ and its regionalization is written as:

$$CIQ_{ij}^r = \left(\frac{x_i^r/x_i^n}{x_j^n/x_j^n}\right) = \left(\frac{LQ_i^r}{LQ_j^r}\right)$$

$$a_{ij}^{rr} = \begin{cases} (CIQ_{ij}^r)a_{ij}^d & if\ CIQ_{ij}^r < 1 \\ a_{ij}^d & if\ CIQ_{ij}^r \geq 1 \end{cases} \cdots (2)$$

This implies that the inputs from sector *i* to sector *j* in the region are completely covered by the supply within the region, when the gross output of sector *i* in the region relative to the nation is greater than the gross output of sector *j* in the region relative to the nation *(*$CIQ_{ij}^r > 1$*)*. Likewise, when the positioning of sector *i* is relatively small compared to sector *j (*$CIQ_{ij}^r < 1$*)*, it indicates that although the inputs of sector *j* in the region are partially supplied by sector *i* within the region, the rest is purchased from other regions.

Because $CIQ_{ii}^r = \left(\frac{LQ_i^r}{LQ_j^r}\right)$, and the diagonal cells are $CIQ_{ii}^r = 1$, those cells are sometimes adjusted separately by using the LQ formula (Smith and Morrison (1974), Flegg et al. (1995)).

$$a_{ij}^{rr} = \begin{cases} (CIQ_{ij}^r)a_{ij}^d & if\ CIQ_{ij}^r < 1 \\ a_{ij}^d & if\ CIQ_{ij}^r \geq 1 \end{cases} for\ i \neq j\ \cdot\cdot (3\text{-}1)$$

$$a_{ij}^{rr} = \begin{cases} (LQ_i^r)a_{ij}^d & if\ LQ_i^r < 1 \\ a_{ij}^d & if\ LQ_i^r \geq 1 \end{cases} for\ i = j\ \cdots (3\text{-}2)$$

However, the CIQ does not take regional size into account. Since it is possible for imports from other regions to increase when regional size is small, the Flegg's Location Quotient (FLQ) was developed (Flegg et al. (1995), Flegg and Webber (1997, 2000)).

$$FLQ_{ij}^r = (\lambda)CIQ_{ij}^r\ \ (i \neq j)$$
$$FLQ_{ij}^r = (\lambda)LQ_i^r\ \ (i = j)$$

Here, because $\lambda = \{log_2[1 + \left(\frac{x_E^r}{x_E^n}\right)]\}^{\delta},\ 0 \leq \delta < 1$, regionalization is performed as follows:

$$a_{ij}^{rr} = \begin{cases} (FLQ_{ij}^r)a_{ij}^d & if\ FLQ_{ij}^r < 1 \\ a_{ij}^d & if\ FLQ_{ij}^r \geq 1 \end{cases} \cdots (4)$$

Employment is used as a variable that indicates "Regional size". When regional size is the same as the size of the nation, it is depicted as $log_2\left[1 + \left(\frac{x_E^r}{x_E^n}\right)\right] = 1$. This is based on the assumption that the inflow and import will diminish as regional size increases.[2]

In this model, the size of the parameter δ becomes the focus of argument. Flegg et al. (1995)

[2] Miller and Blair (2009) question this logic. In addition, imports tend to increase in China as per capita GDP—rather than the size of the region—becomes higher (Okamoto, 2013).

deems δ = 0.3 to be appropriate. Subsequently, Flegg and Tohmo (2013) examined the case of 20 regions in Finland, indicating that the range of 0.25 ± 0.05 fits well despite regional differences.[3] Studies by Bonfiglio and Chelli (2008) and Bonfiglio (2009) that use the Monte Carlo simulation state that 0.3 ± 0.05 produces a good fit. For an industry-by-industry δ, Kowalewski (2013) shows that the best fit in the case of Germany is between 0.11 and 0.17. These previous empirical analysis provide the facts that regional size does matter in the regionalization of national input-output table.

Another augmented version of the FLQ has been proposed by Flegg and Webber (2000) in response to the argument by McCann and Dewhurst (1998) that purchases within the region would increase when a sector is clustered in that region (regional specialization). It is assumed that regionalization reduces the input coefficient in the national table; however, if there is a regional specialization of a sector, that fact must be incorporated (i.e. the technical coefficient becomes larger than the national technical coefficient). Thus, the augmented FLQ (AFLQ) was proposed.

$$AFLQ_{ij}^{r} = \begin{Bmatrix} [log_2(1 + LQ_j^r)]FLQ_{ij}^r \; if \; LQ_j^r > 1 \\ FLQ_{ij}^r \qquad if \; LQ_j^r \leq 1 \end{Bmatrix}$$

$$a_{ij}^{rr} = \begin{Bmatrix} (AFLQ_{ij}^r)a_{ij}^d \; if \; LQ_j^r > 1 \\ (FLQ_{ij}^r)a_{ij}^d \; if \; LQ_j^r \leq 1 \end{Bmatrix} \cdots (5)$$

$log_2(1 + LQ_j^r)$ represents the regional specialization of sector j. The national technical coefficient is adjusted upward when this density becomes 1 or higher.[4]

This paper proposes another version of a quotient in the LQ family. As mentioned above, McCann and Dewhurst (1998) were skeptical of the approach to reduce the technical coefficients based on regional size, and stressed the need to consider the effect of specialization. Therefore, a specialized LQ that excludes the size of the region from the AFLQ (referred to as CIQ with Specialization, or CIQS in this paper) is defined as follows:

$$CIQS_{ij}^r = [log_2(1 + LQ_j^r)]CIQ_{ij}^r \;\; (i \neq j)$$

$$CIQS_{ij}^r = [log_2(1 + LQ_j^r)]LQ_i^r \;\; (i = j)$$

Therefore, regionalization is performed as follows:

$$a_{ij}^{rr} = \begin{Bmatrix} (CIQS_{ij}^r)a_{ij}^d \; if \; LQ_j^r > 1 \\ (CIQ_{ij}^r)a_{ij}^d \; if \; LQ_j^r \leq 1 \end{Bmatrix} for \; i \neq j \;\; \cdots (6\text{-}1)$$

$$a_{ij}^{rr} = \begin{Bmatrix} (CIQS_{ij}^r)a_{ij}^d \; if \; LQ_j^r > 1 \\ (LQ_i^r)a_{ij}^d \; if \; LQ_j^r \leq 1 \end{Bmatrix} for \; i = j \;\; \cdots (6\text{-}2)$$

In other words, it would increase the technical coefficient of the industries listed with a high LQ in the regionalized table, based on the CIQ (except for the diagonal cells which are based on the LQ), and would reflect regional specialization.

2.2 Data

China provides its input–output table at the national and provincial levels, based on the competitive import type that includes inflow and import (National Bureau of Statistics, ed. (2011)). Specifically, the table is presented in the following format.[5] It must be observed that the most detailed level of sector classification extends to 42 sectors.

[3] According to the results in Table 4, 0.35 and 0.15 fit well for the five large regions and two small regions, respectively.

[4] According to Flegg and Tohmo (2013), it is sufficient to use FLQ because the empirical results on AFLQ and FLQ are almost the same (AFLQ actually has a slightly better result).

[5] If region r is replaced with nation n, it translates into a national table.

$Z^r = [z^r_{ij}]$	$f^r = [f^r_i]$	$e^r = [e^r_i]$	$m^r = [m^r_i]$	$x^r = [x^r_i]$
$v^{r\prime} = [v^{r\prime}_j]$				
$x^{r\prime} = [x^{r\prime}_j]$				

Figure 1 Configuration of Input–Output Table for Provinces, Cities, and Autonomous Regions

$Z^r = [z^r_{ij}]$: Intermediate goods trade matrix of region *r*
$f^r = [f^r_i]$: Column vector of ultimate demands of region *r*
$e^r = [e^r_i]$: Column vector of outflow and export of region *r* (export only in the case of country *n*)
$m^r = [m^r_i]$: Column vector of inflow and import of region *r* (import only in the case of country *n*)
$x^r = [x^r_i]$: Column vector of the gross output of region *r*
$v^{r\prime} = [v^{r\prime}_j]$: Row vector of value added (prime denotes transpose)
$x^{r\prime} = [x^{r\prime}_j]$: Row vector of gross inputs (Transposed gross output column vector)

Here, the goods balance equation in the direction of the row is:

$$x^r = Z^r i + f^r + e^r - m^r \cdots (7)$$

i is a column vector with one element as well as a summation vector to calculate the row total.

Here, the intermediate goods input required per unit, or input coefficients A, is calculated by dividing the intermediate inputs by the gross inputs:

$$A^r = Z^r \hat{x}^{r-1},\ A^r = [a^r_{ij}]$$

($\hat{\mathbf{x}}$ is a diagonal matrix in which the vector components are placed on the principal diagonal.)

By plugging this into the balance equation of the input coefficient and the row direction, an input–output model that uses the well-known Leontief Inverse is derived:

$$x^r = A^r x + f^r + e^r - m^r \cdots (8)$$
$$x^r = (I - A^r)^{-1}(f^r + e^r - m^r) \cdots (9)$$

It must be noted that $(I - A^r)^{-1}$ is the Leontief Inverse (so-called output multiplier), which represents the amount of input goods directly and indirectly required to fulfill the ultimate demand.

However, the problem here is that both the input coefficient and the Leontief Inverse include inflow and import. In order to regionalize the national input coefficient (A^n), the technical coefficient must exclude imports (A^d). Further, the regional technical coefficient (A^{rr}), which is obtained by regionalizing the national technical coefficient, must exclude inflows and imports and be distinguished from the regional input coefficient (A^r), which includes inflows and imports.

Now, assuming that the inflow and import is determined based on the regional demand, we define the regional self-sufficiency rate *c* as follows:

$$c^r_i = \frac{(x^r_i - e^r_i)}{(x^r_i - e^r_i + m^r_i)} = \frac{\sum_j z^r_{ij} + f^r_i - m^r_i}{\sum_j z^r_{ij} + f^r_i} = 1 - \frac{m^r_i}{\sum_j z^r_{ij} + f^r_i} \cdots (10)$$

The balance equation of the regional goods (Equation 8) using the regional self-sufficiency rate in Equation 10 is written as below:

$$x^r_i = c^r_i \sum_j z^r_{ij} + c^r_i f^r_i + e^r_i \cdots (11)$$

Alternatively, it is as follows when written in the form of the matrix equation 6:

$$x^r = \hat{c}^r Z^r i + \hat{c}^r f^r + e^r \cdots (12)$$

When the input coefficient $A^r = Z^r \hat{x}^{r-1},\ A^r = [a^r_{ij}]$ is introduced, the input–output model of the regional (domestic) goods would be:

$$x^r = \hat{c}^r A^r x^r + \hat{c}^r f^r + e^r \cdots (13)$$

$$x^r = (I - \hat{c}^r A^r)^{-1}(\hat{c}^r f^r + e^r) \cdots (14)$$

Therefore, the national technical coefficient (A^d) is defined based on Equations 13 and 14, while its Leontief Inverse (L^d) is defined as in Equation 15 or 16. Meanwhile, the provincial technical coefficient (A^{rr}) and its Leontief Inverse (L^{rr}) are defined as in Equations 17 and 18, respectively:

$$A^d = \hat{c}^n A^n \cdots (15)$$

$$L^d = (I - \hat{c}^n A^n)^{-1} \cdots (16)$$

$$A^{rr} = \hat{c}^r A^r \cdots (17)$$

$$L^{rr} = (I - \hat{c}^r A^r)^{-1} \cdots (18)$$

3. EMPIRICAL ANALYSIS

This paper takes China's national input–output table data (A^d) (Equation 15) and regionalizes it using the FLQ and AFLQ. By comparing the outcome to the actual provincial input–output table (A^{rr}) (Equation 17), I examine whether the FLQ and AFLQ are effective in the case of China, and in particular, whether they are more effective than the LQ and CIQ or the CIQS which takes specialization into consideration. I then consider the size of δ, which takes focus as the issue in the FLQ and AFLQ.

3.1 Characteristics of Each Province

Table 1 below summarizes the characteristics of each Chinese province, following Table 1 in Flegg and Tohmo (2013) which examines regionalization by taking Finland as their model case.[6]

Table 1 shows regional characteristics in terms of size, using various indicators. As expected, population size and the number of employed workers are highly correlated (r = 0.99), as is the correlation between GDP and gross output (r = 0.99). On the other hand, although they are correlated, the relationship between the number of employed workers and gross output is weaker (r = 0.71) compared to other relationships. This is because the availability of capital and the productivity of labor vary by region. For example, gross output is large (by two to three fold) in Beijing and Shanghai even though the number of employed workers is small. It implies that productivity of labor is higher. Furthermore, the size of all coastal regions is larger when perceived in terms of gross output rather than the number of employed workers, while the size of inland regions is larger when considering the number of employed workers.

In terms of economic scale (GDP and gross output), the largest region is Guangdong (11.3% based on GDP), followed by Jiangsu, Shandong, and Zhejiang. While Guangdong is a region that initiated the Chinese Economic Reform, Jiangsu and Zhejiang are regions that have attracted many foreign companies by virtue of surrounding Shanghai. Shandong, as with the city of Qingdao, is also a region where foreign companies are expanding, in addition to its reputed agricultural product processing. The smallest regions are Qinghai and Ningxia (0.3% in GDP), which are underdeveloped regions among other northwestern regions.

In terms of the land area, the largest is Xinjiang (19.8%), followed by Inner Mongolia, Sichuan, and Heilongjiang. The smallest regions are Shanghai (0.1%), Tianjin (0.1%), and Beijing (0.2%), which are municipalities of China.

[6] However, the Herfindahl-Hirschman Index mentioned in Table 1 of Flegg and Tohmo (2013) is excluded because it is not related to the themes in this paper.

TABLE 1 Characteristics of Each Province (2007)

	Land area(%)	Population (%)	Employment (%)	GDP(%)	Total Output (%)	LQ>1	$\sum_i a_{ij}^{rr} > \sum_i a_{ij}^{d}$
Beijing	0.2%	1.3%	1.6%	3.4%	3.4%	17	2
Tianjin	0.1%	0.9%	0.6%	1.8%	2.0%	16	0
Hebei	2.3%	5.4%	5.0%	5.0%	5.1%	14	0
Shanxi	1.9%	2.6%	2.2%	2.1%	1.8%	13	8
Inner Mongoria	14.1%	1.9%	1.5%	2.2%	1.7%	15	1
Liaoning	1.7%	3.3%	2.9%	4.0%	4.0%	17	2
Jilin	2.2%	2.1%	1.5%	1.9%	1.7%	22	2
Heilongjiang	5.4%	2.9%	2.3%	2.6%	2.0%	20	3
Shanghai	0.1%	1.4%	1.2%	4.4%	5.5%	19	2
Jiangsu	1.2%	5.9%	5.9%	9.4%	10.7%	12	2
Zhejiang	1.2%	3.9%	5.1%	6.8%	8.0%	19	2
Anhui	1.7%	4.7%	5.1%	2.7%	2.4%	23	0
Fujian	1.4%	2.8%	2.8%	3.4%	3.1%	20	2
Jiangxi	2.0%	3.4%	3.1%	2.0%	1.9%	15	8
Shandong	1.9%	7.2%	7.4%	9.4%	10.3%	13	12
Henan	2.0%	7.2%	8.1%	5.5%	5.3%	15	6
Hubei	2.2%	4.4%	3.9%	3.4%	2.8%	24	7
Hunan	2.5%	4.9%	5.3%	3.3%	2.7%	22	3
Guangdong	2.1%	7.3%	7.4%	11.3%	12.5%	17	1
Guangxi	2.8%	3.7%	3.9%	2.2%	1.7%	17	3
Hainan	0.4%	0.7%	0.6%	0.4%	0.4%	18	5
Chongqing	1.0%	2.2%	2.5%	1.5%	1.4%	15	1
Sichuan	5.8%	6.3%	6.7%	3.8%	3.2%	19	9
Guizhou	2.1%	2.9%	3.2%	1.0%	0.8%	21	0
Yunnan	4.7%	3.5%	3.7%	1.7%	1.4%	20	1
Shaanxi	2.4%	2.9%	2.7%	2.0%	1.6%	19	0
Gansu	5.4%	2.0%	1.9%	1.0%	0.8%	20	3
Qinghai	8.6%	0.4%	0.4%	0.3%	0.2%	18	7
Ningxia	0.8%	0.5%	0.4%	0.3%	0.3%	17	4
Xinjiang	19.8%	1.6%	1.1%	1.3%	1.0%	17	1

(Source) Prepared by the author based on China Statistical Yearbook by the National Bureau of Statistics (2011).

The right side of Table 1 lists the number of sectors with an LQ greater than 1, as well as the number of sectors with a column total of provincial technical coefficients greater than the column total of the national technical coefficient.

There is no particular trend regarding the number of sectors with an LQ greater than 1. The largest number is 24 for Hubei, followed by 23, 22, and 22 for Anhui, Jilin, and Hunan, respectively. The regions with the smallest numbers are Jiangsu (12), Shanxi (13), and Shandong (13).

The regions that have a column total of technical coefficient greater than the column total of the national technical coefficient are Shandong (12), Sichuan (9), Shanxi (8), and Jiangxi (8), while Tianjin, Hebei, Anhui, Guizhou, and Shaanxi had none. Because LQ-based regionalization reduces the national technical coefficient, the error due to the regionalization could increase for the provinces with many sectors, which have a larger technical coefficient than the national technical coefficient.

3.2 Examination of the Accuracy of the FLQ and AFLQ

The FLQ and AFLQ-based regionalization areconducted by using the national technical coefficient derived from the national input–output table. Its accuracy is then examined by comparing the output multiplier derived for each region to the output multiplier for each province. I examine the output multiplier because, like previous studies, the primary purpose of creating a sub-regional input–output table is to analyze the impact on attracting new industries and formulating development policies.

Although there are several methods for measuring how far or close the estimated output multiplier is from the actual output multiplier, the average percentage difference to measure the difference in output multiplier per one sector—the most frequently used method among the above-mentioned previous studies—is used here. It is defined by the formula below:

$$\mu = \frac{1}{n}\left(\sum_j (\widehat{m_j} - m_j)/m_j\right) \cdot\cdot\cdot (19)$$

Here, $\widehat{m_j}$ is the estimated (regionalized by using the FLQ) output multiplier of sector *j*, m_j is the output multiplier of sector *j* derived from the actual provincial input–output table, and *n*, which is 42, is the number of sectors.

The characteristics of regionalization based on the FLQ and AFLQ are regional size and the value of parameter σ. As seen in the discussion on the previous studies, it has been reported that an appropriate value of σ would lie around 0.2 to 0.3. Therefore, I calculated the average percentage difference in output multipliers by using the values between 0.05 and 0.325 by the increment of 0.025.

Table 2 shows the results estimated by the LQ, CIQ, and FLQ while Table 3 shows the results estimated by the CIQS, and AFLQ. We look at Table 2 (FLQ) first.

It is generally known that the LQ-based regionalization overstates the regional multiplier by understating regional inflow, and that the CIQ slightly improves this condition. The results in Tables 2 and 3 also show that while the LQ-based regionalization overstates provincial output multipliers by 8.2% on average (by 7.8% on a weighted average based on the gross output size), the CIQ-based regionalization overstates provincial output multipliers by 6.9% (likewise by 5.9% on a weighted average). The results generated by the FLQ vary by region and σ; however, when an appropriate value is assigned to σ, the accuracy improves greatly compared to that of the LQ and CIQ. For example, if we look at the average, the best fit for σ is found between 0.05 and 0.075 where the average percentage difference in output multiplier comes down to the 1% level. However, this σ value is considerably lower compared to what has been suggested in the previous studies. In addition, the accuracy of this σ value is poor in some regions: the LQ is more accurate than the FLQ in 5 out of 30 provinces (Jiangxi, Shandong, Henan, Hubei, and Hainan) while the CIQ is more accurate than the FLQ in 3 provinces (Shanxi, Heilongjiang, and Sichuan). Under the applicable values of σ, the accuracy of the CIQ and LQ is better for 2 provinces, Hunan and Chongqing, respectively.[7] In the case of China, the FLQ-generated results are better for 20 provinces, which account for two-thirds of the nation. Even within these provinces, the value of σ varies between two groups: the accuracy is most precise between 0.2 and 0.25 for 6 provinces (Tianjin, Hebei, Jilin, Anhui, Guangdong, and

[7] However, it has been verified that the FLQ will produce a better result if the value of σ is reduced to about 0.01.

TABLE 2: Average Percentage Difference from the Actual Provincial Output Multiplier (FLQ)

	LQ	CIQ	FLQ											
			0.05	0.075	0.1	0.125	0.15	0.175	0.2	0.225	0.25	0.275	0.3	0.325
Beijing	2.3%	6.5%	2.5%	0.7%	-0.9%	-2.5%	-4.0%	-5.3%	-6.6%	-7.9%	-9.2%	-10.4%	-11.5%	-12.6%
Tianjin	30.0%	28.3%	21.5%	18.4%	15.5%	12.6%	9.4%	6.4%	3.7%	1.3%	-0.9%	-3.0%	-4.9%	-6.6%
Hebei	32.8%	29.5%	22.0%	18.4%	16.1%	12.0%	9.1%	6.5%	4.0%	1.7%	-0.6%	-2.6%	-4.5%	-6.4%
Shanxi	-13.4%	-11.2%	-14.5%	-16.2%	-17.5%	-19.5%	-21.2%	-22.7%	-24.1%	-25.3%	-26.5%	-27.7%	-28.9%	-30.1%
Inner Mongoria	6.4%	6.0%	1.6%	-0.3%	-1.6%	-4.2%	-6.3%	-8.5%	-10.4%	-12.2%	-13.8%	-15.3%	-16.6%	-17.9%
Liaoning	14.4%	11.0%	4.5%	1.2%	-1.0%	-5.3%	-8.4%	-11.1%	-13.7%	-16.0%	-18.0%	-19.9%	-21.6%	-23.2%
Jilin	20.8%	23.5%	18.1%	15.2%	12.1%	9.2%	6.5%	3.9%	1.6%	-0.5%	-2.4%	-4.1%	-5.6%	-7.0%
Heilongjiang	-4.3%	-4.0%	-8.2%	-10.3%	-11.6%	-14.8%	-16.7%	-18.6%	-20.3%	-21.9%	-23.4%	-24.7%	-25.9%	-27.0%
Shanghai	18.0%	9.8%	5.8%	3.9%	2.6%	0.2%	-1.5%	-3.2%	-4.9%	-6.4%	-7.9%	-9.3%	-10.6%	-11.8%
Jiangsu	3.1%	4.6%	1.0%	-0.7%	-0.3%	-4.2%	-6.0%	-7.7%	-9.3%	-11.0%	-12.6%	-14.2%	-15.7%	-17.1%
Zhejiang	9.6%	6.4%	2.7%	0.8%	0.7%	-2.9%	-4.7%	-6.6%	-8.7%	-10.5%	-12.2%	-13.8%	-15.3%	-16.8%
Anhui	34.8%	28.7%	20.1%	15.9%	13.5%	8.6%	5.3%	2.2%	-0.7%	-3.2%	-5.5%	-7.6%	-9.5%	-11.2%
Fujian	11.3%	7.7%	0.7%	-2.8%	-5.0%	-9.4%	-12.2%	-14.8%	-17.2%	-19.3%	-21.2%	-22.9%	-24.4%	-25.7%
Jiangxi	0.9%	-2.2%	-8.1%	-10.9%	-11.7%	-16.2%	-18.6%	-20.9%	-23.1%	-25.0%	-26.8%	-28.4%	-29.9%	-31.2%
Shandong	-10.9%	-13.5%	-16.8%	-18.3%	-19.3%	-21.3%	-22.9%	-24.4%	-26.0%	-27.6%	-29.1%	-30.6%	-31.9%	-33.2%
Henan	-10.1%	-11.9%	-16.2%	-18.5%	-20.2%	-22.7%	-24.5%	-26.3%	-27.9%	-29.4%	-30.8%	-32.2%	-33.6%	-34.9%
Hubei	-2.4%	-4.0%	-10.3%	-13.5%	-14.7%	-18.9%	-21.4%	-23.6%	-25.6%	-27.5%	-29.1%	-30.6%	-31.9%	-33.0%
Hunan	7.6%	2.4%	-4.2%	-7.2%	-9.3%	-12.9%	-15.4%	-17.8%	-19.9%	-21.8%	-23.5%	-25.1%	-26.7%	-28.0%
Guangdong	17.6%	14.2%	10.2%	8.2%	6.8%	4.6%	2.9%	1.3%	-0.2%	-1.7%	-3.1%	-4.5%	-5.8%	-7.1%
Guangxi	14.2%	14.4%	8.6%	5.9%	5.1%	0.1%	-2.8%	-5.4%	-7.7%	-9.7%	-11.5%	-13.2%	-14.7%	-16.1%
Hainan	-11.0%	-11.8%	-16.1%	-18.2%	-19.3%	-21.8%	-23.5%	-25.0%	-26.3%	-27.6%	-28.8%	-29.9%	-30.9%	-31.8%
Chongqing	1.1%	1.9%	-4.9%	-7.9%	-10.5%	-13.3%	-15.6%	-17.6%	-19.5%	-21.1%	-22.6%	-23.9%	-25.2%	-26.3%
Sichuan	-7.6%	-7.1%	-13.1%	-15.8%	-17.3%	-20.8%	-23.0%	-25.0%	-26.9%	-28.6%	-30.2%	-31.7%	-33.0%	-34.2%
Guizhou	14.5%	11.9%	5.8%	2.7%	1.1%	-2.6%	-5.0%	-7.2%	-9.1%	-10.9%	-12.7%	-14.4%	-15.9%	-17.3%
Yunnan	4.5%	3.7%	-1.0%	-3.3%	-3.6%	-7.6%	-9.5%	-11.3%	-13.3%	-15.0%	-16.6%	-18.0%	-19.3%	-20.4%
Shaanxi	25.7%	25.3%	18.0%	14.7%	12.2%	8.6%	6.0%	3.5%	1.3%	-0.8%	-2.8%	-4.7%	-6.4%	-8.0%
Gansu	12.8%	12.0%	6.4%	3.8%	1.5%	-1.6%	-4.1%	-6.4%	-8.6%	-10.5%	-12.2%	-13.8%	-15.3%	-16.6%
Qinghai	10.9%	9.5%	2.8%	-0.3%	-2.1%	-6.1%	-8.8%	-11.4%	-13.8%	-15.8%	-17.6%	-19.0%	-20.4%	-21.6%
Ningxia	14.8%	12.1%	4.0%	-0.2%	-3.6%	-7.2%	-10.1%	-12.7%	-15.3%	-17.4%	-19.4%	-21.0%	-22.5%	-23.8%
Xinjiang	-1.2%	3.4%	-1.2%	-3.2%	-5.0%	-7.0%	-8.7%	-10.3%	-11.8%	-13.3%	-14.7%	-15.9%	-17.1%	-18.3%
Average	8.2%	6.9%	1.4%	-1.2%	-2.9%	-6.2%	-8.5%	-10.7%	-12.7%	-14.5%	-16.2%	-17.7%	-19.2%	-20.5%
Weighted Average	7.8%	5.9%	1.0%	-1.4%	-2.7%	-5.8%	-7.9%	-9.9%	-11.8%	-13.5%	-15.2%	-16.7%	-18.2%	-19.5%

TABLE 3: Average Percentage Difference from the Actual Provincial Output Multiplier (AFLQ)

	CIQS	AFLQ											
		0.05	0.075	0.1	0.125	0.15	0.175	0.2	0.225	0.25	0.275	0.3	0.325
Beijing	16.4%	11.1%	8.7%	6.5%	4.5%	2.6%	0.8%	-1.0%	-2.8%	-4.4%	-6.0%	-7.5%	-8.8%
Tianjin	44.5%	34.8%	30.5%	26.5%	22.6%	18.1%	13.8%	10.2%	6.9%	4.1%	1.1%	-1.4%	-3.6%
Hebei	46.5%	36.3%	31.7%	27.4%	23.4%	19.7%	16.3%	13.1%	10.1%	7.2%	4.6%	2.2%	-0.6%
Shanxi	2.7%	-2.4%	-4.8%	-7.1%	-9.6%	-12.1%	-14.3%	-16.2%	-18.0%	-19.6%	-21.6%	-23.8%	-25.7%
Inner Mongoria	22.7%	15.6%	12.4%	9.6%	6.3%	2.8%	-0.7%	-3.7%	-6.4%	-8.7%	-10.8%	-12.7%	-14.4%
Liaoning	21.6%	13.0%	8.8%	4.7%	0.4%	-3.5%	-7.0%	-10.1%	-12.9%	-15.3%	-17.6%	-19.6%	-21.4%
Jilin	44.3%	36.4%	32.2%	27.7%	23.5%	19.8%	16.4%	13.2%	10.5%	8.1%	5.9%	4.0%	2.2%
Heilongjiang	6.4%	0.5%	-2.4%	-5.6%	-8.6%	-11.3%	-13.7%	-16.0%	-18.1%	-19.9%	-21.6%	-23.2%	-24.6%
Shanghai	23.8%	17.9%	15.2%	12.6%	10.1%	7.6%	5.3%	2.9%	0.8%	-1.2%	-3.1%	-4.9%	-6.5%
Jiangsu	20.3%	15.1%	12.7%	10.3%	7.8%	5.3%	2.9%	0.6%	-1.8%	-4.2%	-6.5%	-8.6%	-10.5%
Zhejiang	27.5%	21.5%	18.6%	15.6%	12.7%	9.8%	6.7%	3.4%	0.4%	-2.2%	-4.6%	-6.8%	-8.9%
Anhui	40.0%	28.9%	23.6%	18.8%	14.5%	10.4%	6.7%	3.2%	0.1%	-2.6%	-5.1%	-7.3%	-9.3%
Fujian	17.1%	8.3%	3.9%	-0.2%	-4.3%	-7.8%	-11.0%	-13.8%	-16.3%	-18.5%	-20.4%	-22.2%	-23.7%
Jiangxi	7.1%	-0.7%	-4.3%	-7.7%	-11.0%	-14.1%	-17.2%	-19.9%	-22.4%	-24.6%	-26.5%	-28.3%	-29.8%
Shandong	-2.4%	-7.0%	-9.2%	-11.3%	-13.3%	-15.5%	-17.7%	-19.8%	-22.1%	-24.2%	-26.1%	-27.8%	-29.5%
Henan	-0.1%	-6.3%	-9.4%	-12.3%	-15.2%	-17.7%	-20.0%	-22.2%	-24.2%	-26.1%	-28.0%	-29.7%	-31.4%
Hubei	6.1%	-2.2%	-6.5%	-10.3%	-13.7%	-16.8%	-19.7%	-22.3%	-24.5%	-26.5%	-28.3%	-29.9%	-31.3%
Hunan	12.1%	3.6%	-0.2%	-4.1%	-7.6%	-10.7%	-13.6%	-16.2%	-18.6%	-20.7%	-22.7%	-24.5%	-26.1%
Guangdong	29.4%	23.9%	21.3%	18.9%	16.6%	14.3%	12.2%	10.2%	8.2%	6.4%	4.6%	2.8%	1.2%
Guangxi	28.2%	20.1%	16.4%	12.4%	7.8%	3.7%	0.0%	-3.1%	-5.8%	-8.2%	-10.4%	-12.4%	-14.1%
Hainan	-3.5%	-9.4%	-12.2%	-14.8%	-17.1%	-19.4%	-21.5%	-23.3%	-25.0%	-26.6%	-28.1%	-29.3%	-30.5%
Chongqing	15.0%	6.2%	2.4%	-1.1%	-4.3%	-7.1%	-9.6%	-11.8%	-13.7%	-15.5%	-17.1%	-18.5%	-19.9%
Sichuan	2.0%	-5.7%	-9.1%	-12.4%	-15.5%	-18.3%	-20.9%	-23.3%	-25.5%	-27.4%	-29.2%	-30.8%	-32.3%
Guizhou	37.2%	26.9%	22.0%	17.6%	13.7%	9.6%	6.1%	2.9%	0.0%	-4.3%	-8.4%	-11.3%	-13.6%
Yunnan	20.8%	12.4%	8.6%	4.8%	1.6%	-1.3%	-3.9%	-7.3%	-10.2%	-12.6%	-14.6%	-16.4%	-18.0%
Shaanxi	37.8%	28.1%	23.7%	19.5%	15.8%	12.5%	9.4%	6.6%	4.0%	1.6%	-0.8%	-3.1%	-5.1%
Gansu	29.0%	19.7%	15.6%	11.1%	7.1%	3.1%	-0.5%	-3.7%	-6.4%	-8.7%	-10.9%	-12.8%	-14.5%
Qinghai	27.7%	16.4%	11.5%	6.7%	2.0%	-2.5%	-6.8%	-10.3%	-13.2%	-15.5%	-17.4%	-19.1%	-20.6%
Ningxia	34.2%	21.3%	15.1%	9.5%	4.4%	0.2%	-4.5%	-9.7%	-13.3%	-16.2%	-18.5%	-20.6%	-22.3%
Xinjiang	11.8%	5.9%	3.3%	0.8%	-1.5%	-3.6%	-5.5%	-7.5%	-9.4%	-11.1%	-12.7%	-14.2%	-15.8%
Average	20.9%	13.0%	9.3%	5.8%	2.4%	-0.7%	-3.7%	-6.5%	-9.0%	-11.3%	-13.4%	-15.3%	-17.0%
Weighted Average	19.7%	12.9%	9.7%	6.6%	3.6%	0.8%	-1.9%	-4.5%	-6.9%	-9.1%	-11.1%	-13.0%	-14.8%

Shaanxi) while it is most precise between 0.05 and 0.125—particularly between 0.075 and 0.1—for the remaining 14 provinces.

The FLQ would not fit well in some regions, unlike in the previous studies, because the provinces with highly accurate LQ and CIQ have a national technical coefficient sufficiently reduced by the CIQ (overstating the interregional trade) (See Equations 1 through 3). We can see this from the negative values shown under the CIQ. The FLQ ends up further increasing the margin of error because it estimates interregional trade to be larger as the regional size becomes smaller, compared to the CIQ-based results (Equation 4).

Next, let us look at the results generated by the CIQS and AFLQ, which take regional specialization into account (Table 3).

The CIQS improved the accuracy for Shandong, Henan, Hainan, and Sichuan, which did not have good results based on the FLQ. However, the accuracy declined for Tianjin, Hebei, Jilin, and Anhui, which had overestimated regional inputs based on the LQ. This is a case in which the error increases because the CIQS increases the technical coefficient.

The AFLQ improved the results better than the FLQ; in fact, the accuracy of the AFLQ improves in all provinces as long as an appropriate σ is assigned. In terms of average and weighted average, the accuracy of the AFLQ is best when σ = 0.15. The value of σ is not uniquely determined as it has a wider distribution compared to the case of the FLQ.

We may ask why the AFLQ provided a better fit than the FLQ. This is because the technical coefficient of the sectors with clustered industries (LQ > 1) may have been larger than the national technical coefficient, as explained in Equation 5, minimizing the overstated interregional trade and relatively overstating the understated regional input. The AFLQ improved the accuracy of output multiplier for all 10 provinces that could not be improved by the FLQ; however, as far as σ goes, it is not possible to assert what value should be used because it varies even more than the FLQ.

4. CONCLUSION

This paper looked at the case of China and examined a series of Flegg LQ-based regionalization analyses, starting with Flegg et al. (1995).

When the industries in the region are not concentrated as the national average, the LQ-based regionalization adjusts the technical coefficient downward, based on the assumption that the region is importing from other regions. Whereas the LQ focuses on the supply capacity of the industry, the CIQ adjusts the technical coefficient by taking into account the demand and supply capacity between industries. The FLQ adjusts the technical coefficient by considering the “Regional size” and assuming that smaller regions import more, in addition to making the CIQ-based adjustment. The AFLQ also considers industry’s regional specialization in addition to the regional size.

When China’s national input–output table is regionalized through these coefficient adjustments, the examination results that emerge are as follows:

(1) Unlike previous studies, the accuracy of the FLQ is sometimes not higher than the accuracy of the LQ and CIQ.[8]

(2) Unlike previous studies, the value of δ is considerably lower and widely distributed. 14 provinces fall under the range of 0.05 to 0.125. (values between 0.05 and 0.075 provide a relative better fit on average).

(3) The AFLQ improves the accuracy of output multipliers and raises the overall value of δ more than the FLQ does.

The FLQ, which takes regional size into account, fails to estimate for one-third of the provinces, such as Jiangxi, Hunan, and Chongqing. The CIQS, which considers regional specialization, can improve the estimates for Shandong, Henan, Hainan, and Sichuan, which the FLQ fails to estimate. However, it generally fails to estimate for provinces such as Tianjin, Hebei, and Jilin. The AFLQ, which considers regional size and regional specialization, can improve the overall accuracy of the estimation. But the parameter δ is not stable. Based on this empirical evidence, it can be concluded that the regional size that is taken into consideration in regionalization by the FLQ formula does not

[8] Miller and Blair (2009), who examined the LQ, CIQ, FLQ, and AFLQ in a simple case of three sectors by using China’s regional table, concluded that the FLQ and AFLQ had the worst fit when they had used $\delta = 0.3$.

matter in the case of China. However I do not deny that the regional size may influence on the regionalization of national input-output table. It is true that we can estimate the regional technical coefficient only if the good value of parameter δ can be found. But this is difficult in case of China.

This study revealed another issue pertaining to the question of why the estimated value of the δ parameter in the case of China largely differs from the values in the previous studies. It is possible to imagine that there is a problem with the statistical accuracy in preparing the provincial input–output table, and that other factors such as regional specialization have a stronger effect on the inflow in China than does regional size. The industry structure created by past industrial policies (e.g. during the establishment of a full-set industrial structure in line with the self-reliance policy) might have affected this because China's economy is transitional from the plan to the market economy. Either way, it is necessary to investigate the determinants of regional inflow in China. These may be left as future tasks.

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