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CGE Analysis of Regional Policy in the Northern Kyushu Area

(Analisis CGE pada Dasar Serantau di Kawasan Utara Kyushu)

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ABSTRACT

This study develops a policy model in the context of the hierarchical administration system for a regional economy in Japan. In Japan's case, as a hierarchy of national, prefectural, and municipal (city) administration exists, a different regional policy is established for each level of the hierarchy. Generally, the policy and its evaluation differ according to the priority given either to national interests or to each region's interests. This was examined by conducting a quantitative analysis using the computable general equilibrium (CGE) model. Particularly, Kitakyushu and Fukuoka cities constitute an administrative region at the city level. Moreover, these two cities along with the rest of Fukuoka Prefecture represent Fukuoka Prefecture. Alternatively, a case for including the adjacent prefecture, Yamaguchi Prefecture in these regions exists. The entire area is called the Northern Kyushu area by combining Fukuoka and Yamaguchi Prefectures. Such a large area gains importance in regional policy because it is placed higher in the hierarchy. This study focuses on five regions, including the rest of Japan. Moreover, given the availability of the input–output tables for these regions, the database to develop the CGE model can be estimated after tabulating the interregional input–output table.

Keywords: Northern Kyushu; hierarchy of administration; regional policy; CGE model

ABSTRAK

Kajian ini membangunkan model dasar dalam konteks sistem pentadbiran hierarki bagi ekonomi serantau di Jepun. Dalam kes Jepun, sebagai hierarki negara, prefectural, dan perbandaran (bandar) pentadbiran wujud, dasar serantau yang berbeza ditubuhkan untuk setiap peringkat hierarki. Secara umunya, dasar dan penilaian yang berbeza-beza mengikut keutamaan yang diberikan sama ada untuk kepentingan negara atau kepentingan setiap rantau ini. Ini telah diperiksa dengan menjalankan analisis kuantitatif yang menggunakan model keseimbangan dihitung am (CGE). Terutama sekali, Kitakyushu dan bandar-bandar Fukuoka merupakan wilayah pentadbiran di peringkat bandar. Selain itu, kedua-dua bandar ini termasuk Wilayah Fukuoka yang lain adalah mewakili Wilayah Fukuoka. Sebagai alternatif, kes termasuk wilayah bersebelahan, Wilayah Yamaguchi di kawasan-kawasan ini wujud. Keseluruhan kawasan dikenali sebagai kawasan Kyushu Utara dengan menggabungkan Fukuoka dan wilayah Yamaguchi. Sebahagian besar wilayah adalah penti ng dalam dasar serantau kerana ia diletakkan lebih tinggi dalam heararki. Kajian ini memberi tumpuan kepada lima wilayah, termasuk seluruh Jepun. Lebih-lebih lagi, wujudnya jadual input-output bagi kawasan-kawasan ini, pangkalan data untuk membangunkan model CGE boleh dianggarkan selepas tabulating antara jadual input-output.

Kata kunci : Kyushu Utara; hierarki pentadbiran; dasar serantau; model CGE

INTRODUCTION

This study develops a policy model in the context of the hierarchical administration system for a regional economy in Japan. In the regional analysis, regions selected for consideration were often at the same level of administrative hierarchy or economic development. For example, two regions are often analyzed in economic theory to simplify the problem. Moreover, because administrative region and city were established according to hierarchy, regional analysis considering the hierarchical system was necessary. Scholars have made numerous attempts to show the hierarchical system of the city in the field of urban economics (for example, Fujita et al. 1999; and Fujita et al. 2004). Empirical analysis of the hierarchical system was possible if the data is completed. For instance, because income data at the provincial level and prefectural (county) level are available in China and Indonesia, it is possible to analyze the income disparity among hierarchical regions (for example, Akita 2003; and Sakamoto 2008). However, few studies have tried to analyse the hierarchical regional system with respect to the economic policy. To solve this problem, this study provides a policy model to analyse the hierarchical administrative region.

Japan's administrative regions, akin to some other countries, are hierarchical. There is a limit regarding regional policy because an administrative region holding

a subordinate position in the hierarchy is small in area and in population and not diversified industrially. Nevertheless, efforts to activate such a region were not neglected and the same effort is applied in an administrative region of a higher hierarchy. An administrative region that is high in the hierarchy can execute regional policy with a wider perspective. For instance, when infrastructure, such as airports and harbors is maintained at the country level, the national government may decide on a location for such infrastructure that maximizes the national interest. On the other hand, for lower administrative regions, subsequent treatment will change if the location (of political importance) is chosen from a higher administration. Therefore, each administration is expected to compete with another region for the policy to activate in its own region.

The Northern Kyushu area, which is the focal region in this study, is located on the west side of Japan near the Korean peninsula. This area's features allow us to focus on Asia, including South Korea and China, while at the same time considering the capital of Tokyo with regard to economic and/or regional policy. A major concern for this area is whether to focus on Tokyo alone or on Asia as well. Moreover, no unified idea exists for the region because of the following reasons. First, this area has not been defined properly. The Northern Kyushu area, whose centre is Fukuoka Prefecture, is typically composed of the surrounding area including Fukuoka Prefecture (Figure 1 and Figure 2). The prefectures surrounding Fukuoka Prefecture are Yamaguchi, Saga, Nagasaki, Oita, and Kumamoto Prefectures. However, as the administration is independent at the prefectural level, it is difficult to implement a unified policy for the area.

Second, there are two major government-designated cities in Fukuoka Prefecture. One is Fukuoka city, the central city in Fukuoka Prefecture. The other is Kitakyushu city, a large city with a population of about one million. The relationship between the two cities is not without problems. Because the two cities are

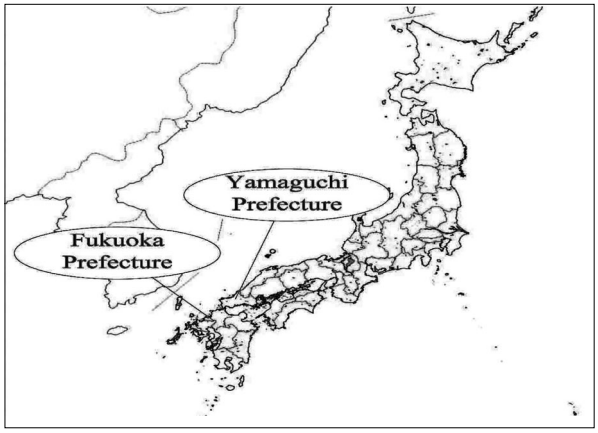

FIGURE 1. Fukuoka Prefecture and Yamaguchi Prefecture in Japan

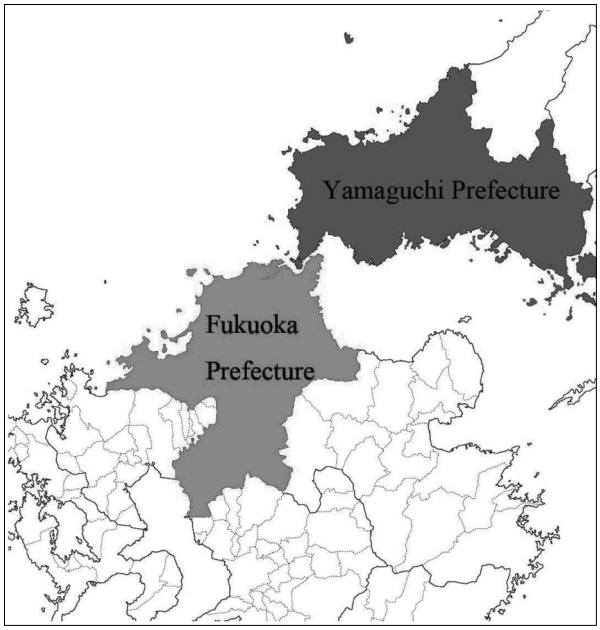

FIGURE 1. Fukuoka Prefecture and Yamaguchi Prefecture in Japan

administered independently, each government can execute the policy that best suits its own interest. To express the hierarchical administration in this study, Fukuoka Prefecture was divided into Fukuoka and Kitakyushu cities, and others (Figure 3). In addition, five regions including Yamaguchi Prefecture and other prefectures of Japan were analysed. The policy was analysed by conducting a quantitative analysis using the computable general equilibrium (CGE) model. The economic effect of regional policy is analysed using the CGE model.

FIGURE 3. Fukuoka City and Kitakyushu City in Fukuoka Prefecture

The hierarchical administration system of Japan and the features of the region under consideration are explained in the next section. Section 3 explains the model and data, whereas Section 4 explains the simulation design. Section 5 gives the results of the simulations. The final section concludes the paper.

HIERARCHICAL ADMINISTRATION SYSTEM OF JAPAN

First, we explain Japan's hierarchical administration system applying the government's definition. Japan has three levels of government: national, prefectural, and municipal. The nation is divided into 47 prefectures. Japan's prefectures are 47 subnational jurisdictions: one "metropolis (to in Japanese), " Tokyo; one "circuit (do)," Hokkaido; two urban prefectures (fu), Osaka and Kyoto; and 43 other prefectures (ken). Prefectures are governmental bodies larger than cities, towns, and villages (from Wikipedia, "Prefectures of Japan"). Each prefecture consists of numerous municipalities. There are four types of municipalities in Japan: cities (*shi* in Japanese), towns (*cho*), villages (*son*), and special wards (the *ku* of Tokyo). Under the current Local Autonomy Law, each prefecture is further subdivided into cities (shi) and districts (gun). Each district is further subdivided into towns (cho or machi) and villages (son or mura). For example, Hokkaido has 14 subprefectures that act as branch offices (shicho) of the prefecture. Moreover, other prefectures have branch offices that carry out prefectural administrative functions outside the capital (from Wikipedia, "Prefectures of Japan"). The status of a municipality, if it is a village, town, or city, is decided by the prefectural government. Generally, a village or town can be promoted to a city when its population increases above 50 000, and a city can (but need not) be demoted to a town or village when its population decreases below 50 000 (from Wikipedia, "Municipalities of Japan").

Furthermore, a city designated by government ordinance (*seirei shitei toshi*) is known as a designated city (*shitei toshi*) or government ordinance city (*seirei shi*), when the population is greater than 500 000 and has been designated by an order of the cabinet of Japan under Article 252, Section 19 of the Local Autonomy Law (appendix table).

Designated cities are delegated many of the functions normally performed by prefectural governments in fields, such as public education, social welfare, sanitation, business licensing, and urban planning. In general, the city government is delegated with various minor administrative functions in each area, while the prefectural government retains authority over major decisions. Furthermore, designated cities are required to subdivide themselves into wards (*ku*), each of which has a ward office that conducts various administrative functions of the city government, such as resident registration and tax collection. In some cities, ward offices are responsible for business licensing, construction permits, and other administrative matters. The structure and authorities of the wards are determined by municipal ordinances.

As mentioned previously, there are two government-designated major cities in Fukuoka Prefecture, Fukuoka and Kitakyushu cities. Because these two cities are government-designated major cities, an original regional policy can be implemented for each of them. However, this regional policy is probably designed specifically for one city, and its influence on another region was not considered. This often leads to policy competition between the two cities. For example, the international airport is in both the cities, in Fukuoka Prefecture. Fukuoka city is hoping to enhance its international airport and transfer some of its functions to Kitakyushu airport because it has reached almost maximum capacity.

Yamaguchi Prefecture is located next to Fukuoka Prefecture, and a fair amount of economic interchange exists between them. In particular, Shimonoseki city near Kyushu Island has the deepest economic ties with Kyushu, although the prefectural government in Yamaguchi Prefecture is Yamaguchi city. Therefore, Shimonoseki city is often included in the Northern Kyushu area. However, Shimonoseki city has a very small population and no input–output table was made for it. Therefore, in this study the Northern Kyushu area comprises of Fukuoka and Yamaguchi prefectures.

Table 1 shows basic statistics for the Northern Kyushu area. In 2007, the 2000 price of gross regional product (GRP) of Fukuoka Prefecture accounted for about 3.5% of Japan's total GRP, whereas Yamaguchi Prefecture accounted for only 1.1%. Moreover, the GRP of Yamaguchi Prefecture is less than that of Fukuoka city. The GRP of Kitakyushu city is half or more than half that of Fukuoka city. Yamaguchi Prefecture's GRP per capita is below the national average, but is higher than that of Fukuoka Prefecture's. Kitakyushu city's GRP per capita is lower than Yamaguchi Prefecture's, although Fukuoka city's is higher than Yamaguchi Prefecture's. However, Fukuoka Prefecture's population shows an increasing trend while Yamaguchi Prefecture shows a decreasing trend. Nevertheless, the increasing trend of Fukuoka Prefecture's population differs greatly between Fukuoka and Kitakyushu cities. The trends for workers are similar. In Fukuoka city, the ratio of manufacturing is extremely low and indicates a city type of economic structure. That of Kitakyushu city is the same as that of the national economy, and the Yamaguchi Prefecture's ratio of manufacturing is higher than that of the national economy. Therefore, it is understood that differences in economic structure exist among prefectures.

MODEL AND DATA

Quantitative analysis using the CGE model proves reliable for analyzing the hierarchical regional system in the Northern Kyushu area. Dozens of models have been

TABLE 1. Economy of Northern Kyushu Area

2000 price GRP (Billion yen)								
	2000	2001	2002	2003	2004	2005	2006	2007
Fukuoka prefecture	18,062	17,837	18,105	18,512	18,774	19,208	19,473	19,717
Fukuoka city	6,943	6,840	6,863	6,885	7,026	7,237	7,127	7,270
Kitakyushu city	3,682	3,606	3,613	3,668	3,685	3,803	3,780	3,865
Yamaguchi prefecture	5,788	5,687	5,892	5,836	5,942	6,165	6,122	6,252
All prefectures	522,030	515,897	521,556	529,949	539,189	552,666	562,455	567,833
per capita GRP (Thousand yen)								
	2000	2001	2002	2003	2004	2005	2006	2007
Fukuoka prefecture	3,601	3,546	3,593	3,669	3,718	3,804	3,853	3,900
Fukuoka city	5,176	5,051	5,016	4,989	5,053	5,165	5,039	5,095
Kitakyushu city	3,640	3,575	3,590	3,656	3,684	3,828	3,816	3,915
Yamaguchi prefecture	3,788	3,733	3,884	3,864	3,955	4,131	4,127	4,243
All prefectures	4,113	4,052	4,091	4,150	4,219	4,326	4,402	4,444
Population (10 thousand persons)								
	2000	2001	2002	2003	2004	2005	2006	2007
Fukuoka prefecture	502	503	504	504	505	505	505	506
Fukuoka city	134	135	137	138	139	140	141	143
Kitakyushu city	101	101	101	100	100	99	99	99
Yamaguchi prefecture	153	152	152	151	150	149	148	147
All prefectures	12,693	12,732	12,749	12,769	12,779	12,777	12,777	12,777
Workers (10 thousand persons)								
	2000	2001	2002	2003	2004	2005	2006	2007
Fukuoka prefecture	239	237	234	233	234	236	237	238
Fukuoka city	83	83	83	83	84	84	82	82
Kitakyushu city	49	48	48	47	47	46	46	46
Yamaguchi prefecture	76	75	74	74	73	73	72	73
All prefectures	6,435	6,389	6,342	6,303	6,278	6,276	6,284	6,294
Share of secondary industry (percent)								
	2000	2001	2002	2003	2004	2005	2006	2007
Fukuoka prefecture	21.83	20.51	20.33	20.23	20.01	20.05	20.18	20.22
Fukuoka city	10.01	9.22	9.57	8.53	8.85	8.78	8.56	7.87
Kitakyushu city	28.84	27.78	25.89	25.41	25.41	26.62	25.98	25.97
Yamaguchi prefecture	35.69	34.67	36.09	35.09	35.40	36.55	35.96	36.17
All prefectures	27.49	25.87	25.52	25.40	25.58	25.44	25.65	25.32

Source: Kenmin Keizai Keisan, Cabinet Office, Government of Japan.

developed. The CGE model adopts the productive structure of a nested type of production function at each stage, and these structures were adopted in this study. Moreover, as we intend to construct a multiregional CGE model, the movement of the productive factor between regions becomes important. In particular, because a small region (city) exists in the prefecture, it is necessary to make a special assumption of movement between regions of the model. The model may be called a spatial CGE (SCGE) model (for example, Bröcker et al. 2010; Ishiguro & Inamura 2005; and Ueda et al. 2005). The representative of the CGE model for multi-region (multi-country) analysis is the GTAP (Global Trade Analysis Project) model (Hertel 1997). Obviously, dozens of multi-region models have been developed (for example, Böhringer & Welsch 2004; Das et al. 2005; Horridge and Wittwer 2008; and Latorre et al. 2009; Li et al. 2009). However, the regional partition of these studies is often the same administrative hierarchy. A concrete formulation, can be seen as shown in Table 2.

The model was constructed using 5 regions and 18 industries (A-1). The productive factor produces value-added products by using the constant elasticity of substitution (CES) function of capital and labor (E-1, E-2, and E-3). Furthermore, following assumptions were made about the factor market. First, the factor market enables free movement between industries. Second, free movement within a prefecture is possible although the factor market cannot move between prefectures. Therefore, because Fukuoka Prefecture comprises Fukuoka and Kitakyushu cities and the rest of Fukuoka Prefecture, capital and labor movement between these three regions is free. For instance, various methods for

TABLE 2. Model description

A-1. Set

r, s, u	Region
fc: Fukuoka City	
kc: Kitakyushu City	
of: other Fukuoka Prefecture	
yp: Yamaguchi Prefecture	
op: other Prefectures	
i, j	Industry
*a*001: Agriculture	
*i*002: Food products	
*i*003: Textile, wearing apparel and wooden products	
*i*004: Chemical products	
*i*005: Metal products	
*i*006: Machinery	
*i*007: Electronic products	
*i*008: Transport equipment	
*i*009: Other manufacturing (including mining)	
*i*010: Construction	
*s*011: Electricity, gas and water supply	
*s*012: Trade	
*s*013: Banking	
*s*014: Real estate	
*s*015: Transport	
*s*016: Telecommunication	
*s*017: Public services	
*s*018: Other services	

A-2. Parameters

$ntax_{r,i}$	The value added tax rate on goods
$itax_r$	The income tax rate of the private institution
psr_r	The saving rate of the private institution
gsr_r	The saving rate of the government
$\alpha^{PC}_{r,s,i}$	The share parameter of the goods for private consumption
$\alpha^{GC}_{r,s,i}$	The share parameter of the goods for government consumption
$\alpha^{PI}_{r,s,i}$	The share parameter of the goods for private investment
$\alpha^{GI}_{r,s,i}$	The share parameter of the goods for government investment
$\alpha^{IN}_{r,s,i}$	The share parameter of the goods for inventory
$\alpha^{FCL}_{r,j}$	The share parameter of labor in the production function
$\alpha^{FCK}_{r,j}$	The share parameter of capital in the production function
$\alpha^{FC}_{r,j}$	The productivity parameter of the value added in the production function
$\alpha^{FC}_{r,j}$	The share parameter of the composite goods for the Leontief function
$\alpha^{XM}_{r,i,s,j}$	The share parameter of the composite goods for the Leontief function
$\alpha^{QY}_{r,j}$	The share parameter of the intermediate goods produced domestically
$\alpha^{QM}_{r,j}$	The share parameter of the intermediate goods imported
$\alpha^{Q}_{r,j}$	The productivity parameter of the intermediate goods
$\alpha^{FC}_{r,j}$	Elasticity of substitution between labor and capital
$\alpha^{M}_{r,j}$	Elasticity of substitution between composite goods and imported goods

A-3. Endogenous variables

$PC_{r,s,i}$	The consumption demand by the private institution
$GC_{r,s,i}$	The consumption demand by the government
$PI_{r,s,i}$	The investment demand by the private institution
$GI_{r,s,i}$	The investment demand by the government
$IN_{r,s,i}$	The inventory
$L_{r,j}$	The labor demand by firm
$K_{r,j}$	The capital demand by firm

$FC_{r,j}$	The composite factor
$XM_{r,i,s,j}$	The intermediate goods
$Y_{r,j}$	The composite goods
$M_{r,j}$	The imported goods
$Q_{r,j}$	The aggregated goods
$E_{r,i}$	The exported goods
$D_{r,i}$	The domestic goods
PL_r	The price of labor
PK_r	The price of capital
$PFC_{r,j}$	The price of the composite factor
$PY_{r,j}$	The price of the composite goods
$PM_{r,j}$	The import price of the intermediate goods
$PQ_{r,i}$	The goods price
$PE_{r,i}$	The export price of the goods
$PD_{r,i}$	The domestic price of the goods
$INCOME_r$	The income of the private institution
$GOINCO_r$	The income of government
$INVEST_r$	The investment by the private institution
$GOINVE_r$	The investment by the government

A-4. Exogenous variables

$L^*_{r,j}$	The labor supply
$K^*_{r,j}$	The capital supply
$E^*_{r,i}$	The export goods
$PM^*_{r,j}$	The import price of the intermediate goods
$PE^*_{r,i}$	The export price of the goods
$INVN^*_r$	The inventory transfer
$RTR^*_{r,s}$	The regional transfer
FTR^*_r	The foreign transfer

A-5. Equations

1. Value added (CES)

$$L_{r,j} = \left(\alpha^{FCL}_{r,j} \, PFC_{r,j} \Big/ PL_r \right)^{-\sigma^{FC}_j} \left(\gamma^{FC}_{r,j} \right)^{-\sigma^{FC}_j - 1} FC_{r,j} \qquad \text{(E-1)}$$

$$K_{r,j} = \left(\alpha^{FCK}_{r,j} \, PFC_{r,j} \Big/ PK_r \right)^{-\sigma^{FC}_{r,j}} \left(\gamma^{FC}_{r,j} \right)^{-\sigma^{FC}_j - 1} FC_{r,j} \qquad \text{(E-2)}$$

$$PFC_{r,j} = \left(\left(\alpha^{FCL}_{r,j} \right)^{-\sigma^{FC}_j} \left(\frac{PL_r}{\gamma^{FC}_{r,j}} \right)^{1+\alpha^{FC}_j} + \left(\alpha^{FCK}_{r,j} \right)^{-\sigma^{FC}_j} \left(\frac{PK_r}{\gamma^{FC}_{r,j}} \right)^{1+\alpha^{FC}_j} \right)^{1/1+\alpha^{FC}_j} \qquad \text{(E-3)}$$

2. Labor market

$$\sum L_{(fc),j} + \sum L_{(kc),j} + \sum L_{(of),j} = \sum L^*_{(fc),j} + \sum L^*_{(kc),j} + \sum L^*_{(of),j} \qquad \text{(E-4)}$$

$$\sum L_{(yp),j} = \sum L^*_{(yp),j} \qquad \text{(E-5)}$$

$$\sum L_{(op),j} = \sum L^*_{(op),j} \qquad \text{(E-6)}$$

3. Capital market

$$\sum K_{(fc),j} + \sum K_{(kc),j} + \sum K_{(of),j} = \sum K^*_{(fc),j} + \sum K^*_{(kc),j} + \sum K^*_{(of),j} \qquad \text{(E-7)}$$

$$\sum K_{(yp),j} = \sum K^*_{(yp),j} \qquad \text{(E-8)}$$

$$\sum K_{(op),j} = \sum K^*_{(op),j} \qquad \text{(E-9)}$$

4. Composite (Leontief)

$$FC_{r,j} = \delta^{FC}_{r,j} \cdot Y_{r,j} \qquad \text{(E-10)}$$

$$XM_{r,i,s,j} = \delta^{XM}_{r,i,s,j} \cdot Y_{s,j} \qquad \text{(E-11)}$$

$$PY_{r,j} \cdot Y_{r,j} = PFC_{r,j} \cdot FC_{r,j} + \sum PD_{u,j} \cdot XM_{u,i,r,j} \qquad \text{(E-12)}$$

5. Import (CES)

$$PM_{r,j} = PM^{*}_{r,j} \qquad \text{(E-13)}$$

$$Y_{r,j} = \left(\alpha^{QY}_{r,j} \frac{PQ_{r,j}}{PY_{r,j}} \right)^{-\sigma^{M}_{j}} \left(\gamma^{Q}_{r,j} \right)^{-\sigma^{M}_{j}-1} Q_{r,j} \qquad \text{(E-14)}$$

$$M_{r,j} = \left(\alpha^{QM}_{r,j} \frac{PQ_{r,j}}{PM_{r,j}} \right)^{-\sigma^{M}_{j}} \left(\gamma^{Q}_{r,j} \right)^{-\sigma^{M}_{j}-1} Q_{r,j} \qquad \text{(E-15)}$$

$$PQ_{r,j} = \left(\left(\alpha^{QY}_{r,j} \right)^{-\sigma^{M}_{j}} \left(\frac{PY_{r,j}}{\gamma^{Q}_{r,j}} \right)^{1+\sigma^{M}_{j}} + \left(\alpha^{QM}_{r,j} \right)^{-\sigma^{M}_{j}} \left(\frac{PM_{r,j}}{\gamma^{Q}_{r,j}} \right)^{1+\sigma^{M}_{j}} \right)^{1/1+\sigma^{M}_{j}} \qquad \text{(E-16)}$$

6. Export (exogenous)

$$PE_{r,i} = PE^{*}_{r,i} \qquad \text{(E-17)}$$

$$E_{r,i} = E^{*}_{r,i} \qquad \text{(E-18)}$$

7. Market clearing

$$D_{r,i} = Q_{r,i} - E_{r,i} \qquad \text{(E-19)}$$

$$D_{r,i} = \sum \left(PC_{r,s,i} + GC_{r,s,i} + PI_{r,s,i} + GI_{r,s,i} + IN_{r,s,i} \right) + \sum \sum XM_{r,i,s,j} \qquad \text{(E-20)}$$

$$PD_{r,i} = PQ_{r,i} \left(1 + ntax_{r,i} \right) \qquad \text{(E-21)}$$

8. Private consumption

$$PD_{s,i} \cdot PC_{s,r,i} = \alpha^{PC}_{s,r,i} \left(1 - itax_{r} - psr_{r} \right) \cdot INCOME_{r} \qquad \text{(E-22)}$$

$$INCOME_{r} = \sum \left(PL_{r} \cdot L_{r,j} + PK_{r} \cdot K_{r,j} \right) \qquad \text{(E-23)}$$

9. Government consumption

$$PD_{s,i} \cdot GC_{s,r,i} = \alpha^{GC}_{s,r,i} \left(1 - gsr_{r} \right) \cdot GOINCO_{r} \qquad \text{(E-24)}$$

$$GOINCO_{r} = itax_{r} \cdot INCOME_{r} + \sum \left(ntax_{r,j} \cdot PQ_{r} \cdot D_{r,j} \right) \qquad \text{(E-25)}$$

10. Private investment

$$PD_{s,i} \cdot PI_{s,r,i} = \alpha^{GC}_{s,r,i} \left(INVEST_{r} - INVN^{*}_{r} - \sum RTR^{*}_{r,u} + FTR^{*}_{r} \right) \qquad \text{(E-26)}$$

$$INVEST_{r} = psr_{r} \cdot INCOME_{r} + \sum RTR^{*}_{u,r} \qquad \text{(E-27)}$$

11. Government investment

$$PD_{s,i} \cdot GI_{s,r,i} = \alpha^{GI}_{s,r,i} \cdot GOINVE_{r} \qquad \text{(E-28)}$$

$$GOINVE_{r} = gsr_{r} \cdot GOINCO_{r} \qquad \text{(E-29)}$$

12. Inventory

$$PD_{s,i} \cdot IN_{s,r,i} = \alpha^{IN}_{s,r,i} \cdot INVN^{*}_{r} \qquad \text{(E-30)}$$

movement, such as Shinkansen exist between Kitakyushu and Fukuoka cities (which connects between both cities within 20 minutes), by which people can travel frequently in the Northern Kyushu area. Therefore, it is believed that a setting that can be moved in the productive factor comparatively freely is relatively appropriate for a small regional model. When free movement is possible, the factor price of Fukuoka Prefecture becomes equal at equilibrium. Therefore, the factor price is different in the three regions of Fukuoka, Yamaguchi, and other prefectures (E-4, E-5, E-6, E-7, E-8, and E-9).

Intermediate goods are composed with a value-added product using the Leontief function. In this case, intermediate goods between regions were included in this function (E-10, E-11, and E-12). Moreover, goods imported from foreign countries were composed using the CES function (E-13, E-14, E-15, and E-16), completing the total productive structure of the nested type.

Goods exported to foreign countries were made exogenous in the study (E-17 and E-18). Goods, except exported goods, were used for domestic demand (E-19 and E-20).

Domestic demand was divided into private consumption, private investment, government consumption, government investment, and inventory adjustment. Although inventory is made exogenous, other

demands are distributed according to the Cobb-Douglas demand function. This demand function extends from industry to region.

Private sector income was based on the price (wage) and the amount of the productive factor obtained from the factor market (E-23). The private sector pays a part of its income to the local government in the form of income taxes, and then consumes final goods within the range of its disposable income, except for private savings (E-22). All private savings are allocated to investments, excluding exogenous inventory adjustments (E-26, E-27, and E-30). The income of the government sector comes from private income taxes and value-added taxes (E-21, consumption tax in Japan's case) on the sale of goods (E-25). A part of government revenue is saved, and the government consumes final goods (E-24). All government savings are allocated to government investments (E-28 and E-29).

Other balances of international payments and balances of regional payments are properly treated as transfers, and all supply functions have corresponding demand in the model.

The data used for constructing the CGE model is mostly from input–output tables. Moreover, in Japan, the input–output table at the prefectural level is available, enabling regional analysis to be done by using that table. Furthermore, two government-designated cities that belong to Fukuoka Prefecture, Fukuoka and Kitakyushu cities, provide an input–output table. Therefore, analysis that divides Fukuoka Prefecture further at the city level becomes possible. Given the availability of the input–output table of these regions, a database used to develop the CGE model is estimated after tabulating the interregional input–output table. The following input–output tables were used for estimating the interregional input–output table: Japan, Fukuoka and Yamaguchi prefectures, Fukuoka and Kitakyushu cities, and an interregional table comparing Fukuoka Prefecture and the rest of Japan. The base year is 2000. These tables are available on the respective administration's website. The disaggregated interregional input–output table of the five regions is estimated mechanically in the study using the RAS method. Certainly, it is possible to update the table using recent data. However, because the Japanese economy is assumed to have stagnated after the asset-inflated (bubble) economy from 1990 to the present, the necessity of an update is insignificant. Initial equilibrium solution was calibrated to correspond to the database with initial price variables set to 1. Since elasticity of substitutions cannot be estimated from the database, the results from existing research were used.

SIMULATION

In the study, we conducted eight simulations in on four major variables (see Table 3). The first and second simulations are conducted to examine the impacts of increase and decrease in the productive factors in a sensitivity test. The third, fourth and fifth simulations are conducted to examine the impacts of adjustments in local income taxes. The next two simulations are conducted to examine impacts of adjustments in government spending. The final simulation examines the impact of an adjustment of the national tax. The productive factor of the Fukuoka Prefecture can be moved freely in each simulation on the basis of the base model assumptions. As a result, an adjustment to the quantity of the productive factor within the Fukuoka Prefecture is expected, and an interregional effect on regional economic policy can be expected.

SENSITIVITY

We assume 10% reduction and 10% increase in the labor stock and capital stock, respectively, of Fukuoka Prefecture as sensitivity tests (Simulations 1 and 2). No significant meaning is attached to the 10% setting in this simulation. The degree of change after simulations changes linearly and proportionally compared with the setting. Furthermore, there is a high possibility for the amount of labor to show a decreasing trend as Japan's population shows a decreasing trend. Therefore, a reduction in the labor stock is real in this respect. Conversely, an increase in capital stock is an orthodox phenomenon seen with normal economic growth.

TABLE 3. Simulation Design

	Purpose	Detail	Model
Simulation 1	Sensitivity	Exogenous labor stock is decreased by 10% in Fukuoka Prefecture	*LS (fc, kc, of)*0.9*
Simulation 2	Sensitivity	Exogenous capital stock is increased by 10% in Fukuoka Prefecture	*KS (fc, kc, of)*1.1*
Simulation 3	Local tax	Local income tax rate is reduced by 10% in Fukuoka City	*itax (fc)*0.9*
Simulation 4	Local tax	Local income tax rate is reduced by 10% in Kitakyushu City	*itax (kc)*0.9*
Simulation 5	Local tax	Local income tax rate is reduced by 10% in Fukuoka Prefecture	*itax (fc, kc, of)*0.9*
Simulation 6	Government expenditure	Fukuoka City's government buys the goods from Fukuoka City	$á_{gc}$ *(fc),* $á_{gi}$ *(fc)*
Simulation 7	Government expenditure	Kitakyushu City's government buys the goods from Kitakyushu City	$á_{gc}$ *(kc),* $á_{gi}$ *(kc),*
Simulation 8	National tax	National consuming tax rate is raised by up to 100% in all regions	*ntax (fc, kc, of, yp, op)*2*

LOCAL TAXES

There are local taxes besides the national tax, and income taxes can be collected at both the prefectural level and the city level. Another example of analyzing tax policy in Japan is by using the CGE model of Bessho and Hayashi (2005). Sakamoto (2009) measured the economic effect of a change in the tax system of Japan using the CGE model. In this case, Monte Carlo experiments under conditions of uncertain productivity of value-added production were examined. As a result, the various local governments can bolster regional economic policy by adjusting the local tax rate. The adjustment simulation of the local tax rate is done as part of the economic policy of the local government. However, the amount of capital and labor might be adjusted among the three regions in Fukuoka Prefecture and because it is possible to move freely, the expected effect might not be necessarily achieved. In the simulation, the income tax rate of Fukuoka city was decreased by 10% given an adjustment at the city level (Simulation 3) and the same was applied for Kitakyushu city (Simulation 4). Moreover, the economic policy effect at the prefectural level can similarly be observed through decreasing the income tax rate of Fukuoka Prefecture by 10% (Simulation 5).

GOVERNMENT EXPENDITURES

The economic policy that the local government may voluntarily enforce is limited. Nevertheless, the local government considers various measures for the development of its region. Many regions pursue a policy of maintaining infrastructure and attracting enterprises that offer large-scale employment. Moreover, attracting a new university related to this is noticed. However, if the policy emphasizes agriculture then local production for local consumption is advocated. It can be assumed that these policies involve sacrificing another region by moving goods and factors from other regions to one's own region. The model can simulate such a protectionist policy by changing parameters. For instance, an approach can be designed wherein the local government buys goods for consumption and makes investments only in its own region and not in other regions. This is because production demand in its own region is expected to increase with such a change in purchase demand. Then, we assume the case where all government purchases are done in its own city, Fukuoka city (Simulation 6) as well as for Kitakyushu city (Simulation 7). As a technique of the model, calculating the effects of these changes becomes possible by changing the goods purchasing share parameters, $\acute{a}^{GC}_{r,s,i}$ and $\acute{a}^{GI}_{r,s,i}$ from all regions to a particular region's purchases.

NATIONAL TAXES

The national tax adjustment is discussed in the conclusion. Japan is facing a large fiscal deficit because of the issue of government bonds, which is a serious problem for the Japanese economy. However, there are only two methodologies to solve the problem: one is to increase income taxes and the other is to reduce government spending. Thus, an income tax increase simulation is preferable. The only realistic method to increase income taxes is through a consumption tax (value-added tax). Hence, the value-added tax rate was doubled in the study (Simulation 8).

RESULTS

Table 4 through Table 6 display simulation results of all scenarios. Results shown in the tables are changes from the base case solution.

TABLE 4. Change of Capital and Labor

		S1	S2	S3	S4	S5	S6	S7	S8
Capital growth	*fc*	1.0654	1.0427	1.0026	0.9981	0.9950	1.0587	0.9973	0.9962
	kc	0.9313	1.1201	0.9986	1.0050	1.0035	0.9668	1.0646	1.0089
	of	0.9850	1.1354	0.9987	0.9988	1.0021	0.9708	0.9663	0.9982
Labor growth	*fc*	0.9643	0.9494	0.9980	1.0007	0.9983	1.0694	0.9967	0.9924
	kc	0.8285	1.0168	1.0014	0.9967	1.0042	0.9613	1.0920	1.0034
	of	0.8828	1.0318	1.0009	1.0010	0.9994	0.9636	0.9600	1.0044
Capital price	*fp*	1.5332	0.5987	0.9998	0.9992	0.9787	1.1663	1.1917	0.8315
	yp	0.9974	0.9933	0.9999	1.0001	0.9995	0.9964	1.0004	0.9826
	op	0.9925	1.0028	1.0000	1.0000	1.0004	0.9973	0.9973	0.9373
Labor price	*fp*	1.8691	0.6762	0.9953	0.9943	0.9565	1.1828	1.2052	0.8735
	yp	0.9949	0.9940	0.9998	0.9999	0.9987	0.9949	0.9970	1.0618
	op	0.9919	1.0031	1.0000	1.0000	1.0002	0.9970	0.9970	0.9929

(Note) *fc*: Fukuoka City; *kc*: Kitakyushu City; *of*: other region in Fukuoka Prefecture (rest of Fukuoka Prefecture); *fp*: Fukuoka Prefecture; *yp*: Yamaguchi Prefecture; *op*: other Prefectures (rest of Japan).
Source: Author's calculation

TABLE 5. Change of Total Macro Value

	S1	S2	S3	S4	S5	S6	S7	S8
Output total	0.9986	1.0005	1.0000	1.0000	1.0000	1.0002	1.0003	0.9915
Income total	1.0151	0.9908	0.9999	0.9999	0.9990	1.0036	1.0045	0.9671
Real income total	0.9978	1.0014	1.0000	1.0000	1.0000	1.0000	1.0000	0.9946

Source: Author's calculation

SENSITIVITY

When the labor stock is reduced, the decreased rate of labor for the Fukuoka city is low, and it remained at 4% or less. Therefore, capital tends to be concentrated in Fukuoka city. When capital stock increases, the capital growth rate of Fukuoka city is low, and the increase of capital in the other two regions is 10% or more. Labor migrates to the other two regions along with capital.

However, the factor price (capital and labor) rises greatly with a reduction in the labor stock, and the factor price falls greatly with an increase in the capital stock. It can be assumed that this model shows considerable price fluctuation.

Therefore, the nominal value of regional income changed greatly. However, real income is in keeping up with movements in the productive factor. Kitakyushu city will experience the economic effects of the simulations mostly in terms of per labor unit because labor is moving within Fukuoka Prefecture. As the ratio of manufacturing in Kitakyushu city is comparatively high, as shown in Table 1, it appears that it received a significant share of the change in the productive factor in Fukuoka Prefecture. Moreover, the economic effect on Yamaguchi and other prefectures is small, and the economic effect increased capital as a whole.

LOCAL TAXES

Income tax reductions increase capital and decrease labor in a particular region. The productive factor tends to be concentrated in Kitakyushu city due to the factor movement resulting from tax reductions at the prefectural level. The change in factor price is not very large. Reducing taxes at the prefectural level does not necessarily induce an economic effect, although reductions in income tax induce an economic effect on the particular region; thereby reducing real income per labor. Therefore, even if it is effective for regions to implement an economic policy only in their own regions, when policy competition is aroused among regions there is no guarantee of an economic effect. Tax reductions at the prefectural level may be interpreted as being equivalent to three regions' simultaneous tax reductions. Moreover, the nationwide effect of tax reductions is small and does not lead to a substantial rise in the income of the entire country.

GOVERNMENT EXPENDITURES

The government can concentrate a lot of the productive factors (capital and labor) in its own region by purchasing all the goods from its own region. However, because factor prices rise by approximately 20%, the influence of price fluctuations should be considered. Certainly, nominal regional income rises with an increase in prices. Because labor also increases, the economic effect per labor becomes negative, although real regional income is increasing in the region that executed the policy. The effectiveness of the policy is different depending on the policy assessment standard. Moreover, the policy may be substantially effective if it has a nationwide economic effect on the nominal value of income, leading to a steep rise in prices.

NATIONAL TAXES

The factor price has fallen greatly although the productive factor tends to be concentrated in Kitakyushu city as a result of a nationwide tax increase. In contrast, the effect of a decrease in the capital price on other prefectures and a rise in labor prices on Yamaguchi Prefecture are remarkable. Because the amount of labor increases, the economic effect is negative per labor although the real income of Kitakyushu city increases. However, the size of this negativity is small in any region. It can be assumed that tax increases do not influence the economy.

These results show that part of the reason for the movement of the productive factor between regions is the difference in the parameters of the industrial structure and the production function. Moreover, the various changes expected through movements in the productive factor between industries are not reported because of space constraints.

What can we learn from these results? Economic effects occur when one administration unilaterally implements a regional policy. However, when policy competition erupts between regions, the desired effect is not necessarily achieved. Local regional authorities should note policy trends in other regions. In addition, must conduct further studies to evaluate how policy competition will affect factor movements.

CONCLUDING REMARKS

This study investigated the effectiveness of economic policy in the region in the context of a hierarchical administration by using the CGE model for the Northern Kyushu area. The results show that policy trends in another region and the method of evaluating the economic effects are important. It is difficult to obtain a conclusion using theoretical analysis. The local

TABLE 6. Change of Regional Macro Value

		Output	Income	Real income	Output / Labor	Income / Labor	Real income / Labor
S 1	*fc*	1.0443	1.7304	1.0057	1.0829	1.7944	1.0429
	kc	0.9178	1.4916	0.8739	1.1078	1.8004	1.0549
	of	0.9302	1.5813	0.9219	1.0537	1.7912	1.0443
	yp	1.0005	0.9976	0.9999	1.0005	0.9976	0.9999
	op	0.9999	0.9925	1.0000	0.9999	0.9925	1.0000
S 2	*fc*	0.9537	0.6382	0.9835	1.0045	0.6722	1.0359
	kc	1.0252	0.6842	1.0582	1.0083	0.6729	1.0407
	of	1.0535	0.6991	1.0707	1.0210	0.6776	1.0377
	yp	0.9991	0.9932	1.0000	0.9991	0.9932	1.0000
	op	1.0000	1.0028	1.0000	1.0000	1.0028	1.0000
S 3	*fc*	0.9993	0.9972	1.0001	1.0013	0.9992	1.0021
	kc	1.0001	0.9975	1.0003	0.9987	0.9961	0.9988
	of	1.0001	0.9972	1.0001	0.9992	0.9963	0.9992
	yp	1.0000	0.9998	1.0000	1.0000	0.9998	1.0000
	op	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
S 4	*fc*	0.9995	0.9959	0.9997	0.9987	0.9952	0.9990
	kc	0.9995	0.9969	1.0005	1.0029	1.0002	1.0039
	of	1.0002	0.9964	1.0002	0.9992	0.9954	0.9992
	yp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	op	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
S 5	*fc*	0.9944	0.9629	0.9973	0.9961	0.9645	0.9990
	kc	1.0010	0.9703	1.0042	0.9969	0.9663	1.0000
	of	1.0009	0.9671	1.0014	1.0015	0.9677	1.0021
	yp	0.9999	0.9990	1.0000	0.9999	0.9990	1.0000
	op	1.0000	1.0003	1.0000	1.0000	1.0003	1.0000
S 6	*fc*	1.0820	1.2512	1.0657	1.0118	1.1699	0.9965
	kc	0.9779	1.1314	0.9644	1.0172	1.1769	1.0032
	of	0.9721	1.1333	0.9667	1.0088	1.1761	1.0033
	yp	1.0000	0.9961	1.0000	1.0000	0.9961	1.0000
	op	0.9999	0.9972	1.0000	0.9999	0.9972	1.0000
S 7	*fc*	1.0109	1.1946	0.9978	1.0143	1.1986	1.0011
	kc	1.0871	1.2923	1.0800	0.9955	1.1834	0.9890
	of	0.9691	1.1510	0.9629	1.0095	1.1990	1.0031
	yp	1.0012	0.9992	1.0003	1.0012	0.9992	1.0003
	op	0.9999	0.9972	1.0000	0.9999	0.9972	1.0000
S 8	*fc*	0.9805	0.8521	0.9867	0.9880	0.8586	0.9943
	kc	0.9935	0.8644	1.0013	0.9902	0.8614	0.9979
	of	0.9921	0.8611	0.9918	0.9878	0.8574	0.9875
	yp	0.9895	1.0292	0.9906	0.9895	1.0292	0.9906
	op	0.9916	0.9705	0.9948	0.9916	0.9705	0.9948

Source: Author's calculation

government is not interested in the economy of other regions although it is interested in its own region's economy. Therefore, it is not because the local government knows the influence of economic policy in the region has on other regions. Instead, the government is likely to be interested in the influence of those economic policies of other regions that have on its region. Because this model is multiregional, the economic spillover effect between regions can be measured. Moreover, the model can propose the effects of economic policies on government authorities that are not interested in other regions.

The concern for other cities of the government remains poor although the two cities in the Northern Kyushu area are very small. Many local governments seem indifferent in the activities of other regions.

Therefore, it is important to construct a model between multiregions and to clarify the regional spillover structure. Moreover, the importance of cooperation suggests an economic policy between regions in this model (paradoxically). In a word, if the policy is jointly created, it can bring about a mutual effect as opposed to a situation where one region devises a policy that influences other regions. Therefore, the model should be multiregional. However, this simple model requires enhancement depending on the availability of data. Further analysis is necessary.

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APPENDIX TABLE METROPOLITAN CITIES OF JAPAN

Tokyo Metropolis	Special wards of Tokyo (Adachi, Arakawa, Bunkyo, Chiyoda, Chuo, Edogawa, Itabashi, Katsushika, Kita, Koto, Meguro, Minato, Nakano, Nerima, Ota, Setagaya, Shibuya, Shinagawa, Shinjuku, Suginami, Sumida, Toshima, Taito)
Designated cities	Chiba, Fukuoka, Hamamatsu, Hiroshima, Kawasaki, Kitakyushu, Kobe, Kyoto, Nagoya, Niigata, Okayama, Osaka, Sagamihara, Saitama, Sakai, Sapporo, Sendai, Shizuoka, Yokohama
Core cities	Akita, Amagasaki, Aomori, Asahikawa, Fukuyama, Funabashi, Gifu, Hakodate, Higashiosaka, Himeji, Iwaki, Kagoshima, Kanazawa, Kashiwa, Kawagoe, Kochi, Koriyama, Kumamoto, Kurashiki, Kurume, Maebashi, Matsuyama, Miyazaki, Morioka, Nagano, Nagasaki, Nara, Nishinomiya, Oita, Okazaki, Otsu, Shimonoseki, Takamatsu, Takatsuki, Toyama, Toyohashi, Toyota, Utsunomiya, Wakayama, Yokosuka
Special cities	Akashi, Atsugi, Chigasaki, Fuji, Fukui, Hachinohe, Hirakata, Hiratsuka, Ibaraki, Ichinomiya, Isesaki, Joetsu, Kakogawa, Kasugai, Kasukabe, Kawaguchi, Kishiwada, Kofu, Koshigaya, Kumagaya, Kure, Matsumoto, Mito, Nagaoka, Neyagawa, Numazu, Odawara, Ota,·Sasebo, Soka, Suita, Takarazuka, Takasaki, Tokorozawa, Tottori, Toyonaka, Tsukuba, Yamagata, Yamato, Yao, Yokkaichi
Prefectural capitals (not included above)	Fukushima, Tsu, Naha, Saga, Matsue, Tokushima, Yamaguchi

(Note 1) A core city (*Chukakushi*) is a class of Japanese city created by the first clause of Article 252, Section 22 of the Local Autonomy Law of Japan. Core cities are delegated many functions normally carried out by prefectural governments, but not as many as designated cities. To become a candidate for core city status, a city must satisfy the following condition: A population greater than 300,000.

(Note 2) Special Cities (*Tokureishi*) of Japan are cities with populations of at least 200,000, and are delegated a subset of the functions delegated to core cities. This category was established by the Local Autonomy Law, article 252 clause 26. They are designated by the Cabinet after a request by the city council and the prefectural assembly.

Source: Wikipedia, "City designated by government ordinance."