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Review Article

Integrated Evaluation Model of Local Climate Policies and Regional Characteristics

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Abstract

This paper analyzed the effects of the local climate policies with "3E (Economy-Energy-Environment) model". This model is to analyze the effects to the local economies, energy demands, and CO2 emissions by introducing the policies for anti-global warming in the local area. The 3E model of Tokai region (Aichi, Gifu, and Mie Prefecture) of this paper consists of the local macro econometric model, the local input-output model, and the local energy demand-supply model. The findings of this paper are that the production spillover effect of introducing CO2 reduction policies was larger by 0.2-0.7% than the BAU effect of BAU case. And the effect of employment was greater by about 1000-4000 employments.

Keywords: Local climate policy; 3-E model; Economic effect

Introduction

To advance the local climate policies such as reduction of CO_2 emission, it is important to make a choice about policies. The effects of local climate policies depend on the difference of regional characteristics such as economic and social structure, or geographic situations of each region. It is necessary to introduce more effective policy package matching with each regional characteristic.

To analyze the CO_2 emission and economic effects of local climate policies, the integrated model for analyzing the economic, energy and environment (CO_2 emissions) effect is necessary. This paper calls this model to "3-E (economy-energy-environment) model". This study such as analyzing the economic, energy and environment effects by introducing the local climate policies was little. Matsumoto et al. [1] analyzed the employment effect of solar and wind power industries with the expanded Japanese Input-Output table in 2005. Engel et al. [2] estimated the employment creation effect of each energy sector, and showed the greater employments by renewable energy industries than nuclear power industries. Furthermore, Federal Ministry of Environment [3] showed the simulated results of employment creation effects in Germany. Sugiyama et al. [4] simulated the economic effects of two type policies (national-based policies or local-based policies) in Aichi prefecture of Japan.

This paper analyzed the effects of the local climate policies with "3-Emodel" in Tokai region (Aichi, Gifu and Mie prefecture). The analysis compared the results between BAU (business as usual) case which take a current local situation as given and another case that the local climate policies were introduced.

Estimating "3-E Model"

The data to analysis used economic indicators (consumption, investment, GRP, income and employment), social indicators (population), energy consumption, and input-output (I-O) table in Tokai region (Aichi, Gifu, and Mie prefecture) within 1990 to 2010. This model consists of regional econometric model, I-O model and energy model.

Figure 1 showed the structure of model and steps of simulation. In the first step, regional macro econometric model and I-O model were constructed to understand the structure of regional economic structure. In the second, I construct the energy model based on the results of regional macro econometric model and I-O model for understanding energy demand and supply within region. In the third step, BAU (business as usual) case was estimated which keeps the current trends on future. In the fourth step, the case of introducing CO_2 reduction policies was formulated, and in the fifth step, the economic effects of macro-economic indicator (GRP, industry activities, employments and so on) were estimated with regional macro econometric and I-O model.

Regional macro econometric model explains the interaction between economic activities. This model is the type of demand determinant. In this model, the demand within region determines the quantities of industry activities, income distributions, and local government expenditure. And, price and wage level within region determine nominal expenditures and employments. Besides estimating these endogenous variables, this model uses the data of Japan and international level such as GDP, interest, and population as exogenous variable. The estimation of this model analyzed with

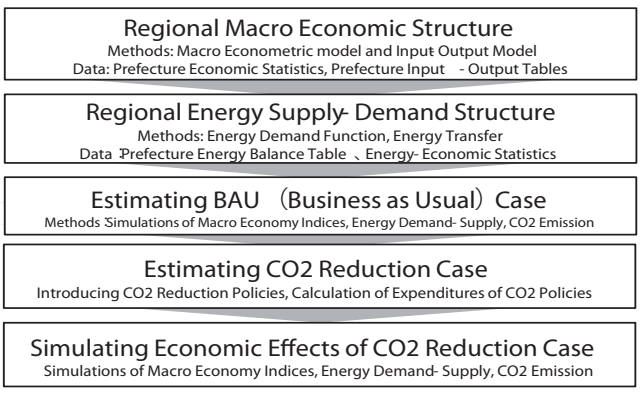

Figure 1: Structure and Methodologies of "3-E model".

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Table 1: Comparison of actual values and the results of BAU case (summary).

	Aichi		Gifu		Mie	
	2005	2030	2005	2030	2005	2030
GRP (1billion JY)	38,716	42,139	7,856	7,774	8,315	10,733
Income (1billion JY)	25,172	23,291	5,994	5,056	5,820	6,344
Employment	3,426	2,061	928	839	824	791
Tax revenue (1billion JY)	1,089	847	223	152	228	277
Products of manufacturing (1billion JY)	4,440	4,377	572	501	1,063	1,498

Table 2: Products values of each industry in 2030 (BAU case, unit: 1billionJY).

	Aichi		Gifu		Mie	
Agriculture	282	(-1.3%)	119	(1.2%)	182	(-0.8%)
Construction	21	(-0.1%)	696	(-1.4%)	542	(-0.7%)
Chemistry	1,325	(-0.4%)	389	(-0.6%)	1,427	(0.0%)
Steel	4,939	(1.5%)	406	(-0.7%)	804	(0.1%)
Machine	22,169	(-0.4%)	2,227	(-0.6%)	5,248	(0.1%)
Other manufacturing	11,968	(0.1%)	1,522	(-0.7%)	3,132	(0.0%)
Water, Waste	533	(0.0%)	161	(1.2%)	163	(0.3%)
Commerce, Finance	15,880	(0.2%)	2,249	(-0.6%)	2,266	(0.1%)
Public service	7,413	(0.1%)	1,865	(-0.3%)	1,789	(0.6%)
Business services	4,595	(0.6%)	665	(1.0%)	350	(-0.8%)
Customer services	3,138	(0.1%)	619	(-0.6%)	767	(0.5%)
Other services	8,765	(0.7%)	1,369	(0.0%)	1,434	(0.0%)
Total	81,029	(0.1%)	12,287	(-0.5%)	18,104	(0.1%)

Note: Percent figure in this table is the average change rate per year in 2030 below 2005.

Table 3: Forecast values of energy demands in 2030.

Energy	Aichi	Gifu	Mie	Sector	Aichi	Gifu	Mie
Coal	0.993	0.909	1.579	Agriculture	0.915	0.689	0.953
Coal products	0.953	0.963	1.516	Construction	0.972	0.869	1.157
Light oil	0.975	0.833	0.954	Chemistry	0.960	0.923	1.080
Heavy oil	0.917	0.925	1.043	Steel	1.031	0.892	1.335
LPG	1.011	0.988	1.044	Machine	0.915	1.468	1.321
LNG	1.281	1.213	1.163	Other manufacturing	0.847	0.944	0.988
City gas	1.030	0.987	1.108	Shipping	0.972	0.748	0.935
Renewable	1.021	1.016	1.033	Car	0.865	0.658	0.822
Electricity	0.940	0.949	1.075	Office	1.008	0.942	1.095
Heat	0.934	0.958	1.072	Household	0.986	1.017	1.066
Total	0.964	0.924	1.055	Total	0.964	0.924	1.055

Note: Values in table means Energy Demand in 2030/Energy Demand in 2005.

multiple regression and definitional equations. The numbers of endogenous variables in Aichi prefecture are 51, those in Gifu prefecture are 56, and in Mie prefecture are 53. The numbers of exogenous variable in three prefectures are 23.

Next, the future I-O table was forecasted in 3 prefectures with the growth rates of expenditures which were estimated on regional macro econometric model. Constructing the future I-O tables forecast the trends of input coefficients based on actual tables, and simultaneously estimate import coefficients and converters. The data sources of this model are three actual I-O tables of each prefecture in 1995, 2000 and 2005.

Energy model explains to the determinants of primary energy supply, energy conversion and energy demand within regions. The energy demands of manufacturing industries were calculated by multiplying the specific energy consumptions by estimated product values in each industry. The energy demands of other sectors (agriculture, construction, service industries, household, public sector, transportation, and so on) were estimated by energy demand functions. The data of this model were energy consumptions in each prefecture within 1990 to 2010. The data source is Agency for Natural Resources and Energy [5].

Table 4: Forecasting emission in 2030(BAU case) and actual emission of CO_2.

	Aichi	Gifu	Mie
Emissions in 1990 (10 thousands ton unit CO_2)	7,112	1,298	2,489
Emissions in 2005 (10 thousands ton unit CO_2)	8,038	1,341	2,733
Forecast emissions of BAU case in 1990 (10 thousands ton unit CO_2)	7,564	1,314	2,697

Table 5: CO_2 Reduction Policies and the Quantities of CO_2 Reduction in Tokai region.
(Expenditure: 10 thousands JY, Reduction:10 thousands ton of CO_2, Accumulated total within 2011-2030)

CO_2 reduction policies	Aichi		Gifu		Mie	
	Expenditure	Reduction	Expenditure	Reduction	Expenditure	Reduction
Electric car	5,263	19.0	526	2.0	1,053	3.0
Photovoltaic	27,368	26.0	8,211	8.0	8,211	6.0
Wind power	3,158	13.0	1,053	4.0	10,526	34.0
Gasoline vehicle mileage	29,974	38.0	29,974	15.0	29,974	24.0
Light oil vehicle Mileage	2,240	25.0	2,240	5.0	2,240	3.0
Green home electronics	8,960	15.0	8,960	6.0	8,960	4.0
Green OA equipment	1,680	14.0	1,680	4.0	1,680	4.0
Middle or small hydroelectric generation	9,316	40.0	24,842	265.0	62,105	82.0
Geothermal energy	6,211	8.0	24,842	77.0	62,105	31.0
Combined heat and power	98,684	323.0	13,158	43.0	19,737	65.0
Gas conversion in plants	974	48.4	105	4.0	385	19.0
Community bicycle	5,920	8.0	296	0.0	1,480	2.0
Biomass Methane	157,895	141.0	15,789	14.0	39,474	35.0
Woody biomass	610	4.0	4,880	28.0	49	0.0
Green reforming of House	38,737	108.0	7,747	21.6	3,874	10.8
Fuel change in generations	16,500	165.0	0	0.0	330	2.0
RPF	3,126	7.0	0	0.0	2,084	5.0
Greening in urban area	15,789	0.0	15,789	0.0	15,789	0.0
Total	432,405	1,002.4	234,620	496.6	195,530	329.8

Simulation of BAU Case in 2030

Table 1 shows the results of simulation analysis of BAU case in 2030. Compared with actual values in 2005, the average rate of change of gross regional products (GRP) was increased by 0.0-1.0% in each prefecture.

Table 2 shows the result of BAU case estimation with forecast I-O table of 3 prefectures in 2030. The forecast products of each industry was 0.1% growth per year in Aichi and Mie, and was -0.5% declining in Gifu from 2005 to 2030. The results of each industry show that most of industries in Aichi and Mie were grown up, in contrast those in Gifu were declined such as steel, other manufacturing, commerce and finance, public service and customer service.

Energy model used the forecast values which were estimated in macro econometric and I-O model, and in addition, energy prices which was estimated in International Energy Agency [6] as exogenous variable. Table 3 shows the results of forecasting energy demands on 3 prefectures in 2030 compared with the actual values in 2005.

Table 4 shows the results of forecasting emission based on estimated energy demands in 2030, and of actual emissions in 1990 and 2005.

Simulation of Introducing Local Climate Policies

Table 5 shows the policy package to achieve CO_2 reduction and its expenditures within each prefecture. Based on these expenditures to introduce the policy package, the economic effects of introducing CO_2 reduction policies was simulated with macro econometric and I-O model.

Table 6 shows the result of simulation with macro econometric model. The change of GRP by introducing CO_2 reduction policies was larger by 0.2-0.7% than BAU case. Similarly, that of income by doing their policies was greater by 0.5-2% than BAU case.

Table 7 shows the result of simulation with I-O model (forecasting I-O table in 2030). This result means that the spillover effect to production by introducing CO_2 reduction policies was larger by 0.5-1.3% than that of BAU case in each prefecture. According to the results of each industry productions of agriculture and construction industries increased by 4-9% more than those of BAU case. The share of the spillover effects in each industry was about 20-30% in each prefecture. Employment creation effect within each industry was that machine, public service and business service industries were greater

Table 6: Economic Effects of Introducing CO_2 Reduction Policies with Estimating Macro Econometrics Model (summary).

		CO_2 reduction(A)		BAU(B)		(A)-(B)	
		2020	2030	2020	2030	2020	2030
GRP (1billion JY)	Aichi	41,673	42,409	41,402	42,139	271	270
	Gifu	7,642	7,789	7,630	7,774	12	15
	Mie	9,926	10,736	9,911	10,733	15	3
Income (1billion JY)	Aichi	24,880	23,418	24,746	23,291	134	127
	Gifu	5,555	5,195	5,417	5,056	138	138
	Mie	6,529	6,468	6,379	6,344	150	124
Employment	Aichi	3,028	2,065	3,020	2,061	7.9	3.8
	Gifu	885	840	884	839	0.6	0.7
	Mie	813	791	813	791	0	0
Tax revenue (1billion JY)	Aichi	1,043	864	1,027	847	16	17
	Gifu	187	162	177	152	10	10
	Mie	285	284	275	277	10	7
Products of manufacturing (1billion JY)	Aichi	4,628	4,436	4,569	4,377	59.2	59.2
	Gifu	521	506	517	501	3.8	4.8
	Mie	1,370	1,505	1,368	1,498	1.4	6.2

Table 7: Production Spillover Effect and Employment Creation Effect (Summary, unit: Production: 1 Brillion JY).

	Aichi		Gifu		Mie	
	Production	Employment	Production	Employment	Production	Employment
Agriculture	18	255	11	186	8	46
Construction	2	191	51	185	22	88
Chemistry	1	58	0	10	1	14
Steel	22	219	4	60	1	29
Machine	124	955	40	492	28	246
Other manufacturing	19	161	6	132	6	90
Water, Waste	35	79	4	96	10	32
Commerce, Finance	412	443	22	127	11	152
Public service	9	511	6	201	2	119
Business services	41	857	8	371	6	175
Customer services	13	401	3	93	1	90
Other services	23	278	8	71	4	30
Total	719	4,408	162	2,024	99	1,109

than other industries in each prefecture. But, the second-largest share of industry about employment creation effect was service industries such as commerce and customer service industries in Aichi and Mie prefecture, whereas that was agriculture and construction industries in Gifu prefecture.

Conclusion

This paper used "3E model" and analyzed the economic effect in case of introduction of the local climate policies on Tokai region. As the result of the simulations, the production spillover effect of introducing CO_2 reduction policies was larger by 0.2-0.7% than the BAU effect of BAU case. The effect of employment was greater by about 1000-4000 employments. Furthermore, the result with forecasted I-O table is that the effect of the production spillover and employment creation in the machine industry was largest within all industries. The result shows that the effect was different in 3 prefectures; in one hand the effect to machine industry was larger in Aichi; on the other hand, the same to agriculture and construction industries were greater in Gifu and Mie prefecture. The future researches should be undertaken to improve the simulation model for utilizing the endogenous technological changes to CO_2 reduction policies, and to measure the feasibilities of CO_2 reduction policies within regions.

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