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A Dynamic Computable General Equilibrium (CGE) Model for Analysis of Rural Development Policies

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Ⅰ　Introduction

Japanese rural development policies have changed many times during the 21st century. For instance, asset management measures for prolonging durable years of irrigation and drainage facilities, drastic reduction in agricultural public investment, and direct payment to farmers for income support have been decided as new policies. In addition to these policies, the agricultural trade policy may change, because Japan has expressed an intention to participate in the meeting of the Trans-Pacific Partnership (TPP). These policy measures definitely affect agricultural production, prices of food and farmers' income. To evaluate policy measures, the degree of impacts must be quantified in view of economics.

The influences of changes in the rural development policy are not only confined to the agricultural sector but spread to various fields, such as other industrial production and employment. These influences are complicated. Furthermore, economies change according to exogenous conditions, such as a rise in the petroleum price, a rise in the im-

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port food price, and a decrease in population of rural areas, which simultaneously affect the real economies along with policy changes. As a matter of fact, it is difficult for researchers to see exact effects of policy changes by separating exogenous changes. In order to evaluate the new rural development policy, we have to quantify and designate the exact effect of policy changes before and after (or with-and-without) the introduction of a new policy. For this purpose, an economic model based on the economic theory that can duplicate real situations is important.

Actually, many models have been used for policy evaluation. Among these models, the computable general equilibrium (CGE) model can deal with all markets related each other and can measure the ripple effects of initial policy changes. Also, this model is based on the optimization of economic actors subject to a restriction of resources such as labor and land, so the trade-off effects caused by a policy change can be easily taken into account. Trade-off effects are realized in the real economies if an increase in resources of a certain sector decreases resource inputs in other sectors. Therefore, the CGE models are useful and applicable for policy evaluations.

Several previous studies analyzed the impacts of agricultural policy reform with CGE models. Kilkenny (1993) used an interregional rural-urban CGE model to show the effects of farm subsidies in the USA and reported that coupled farm subsidies were not as effective as decoupled (nonfarm) income transfers for promotion of rural prosperity. Taylor, Yunez-Nude and Dyer (1999) also examined the effects of the agricultural decoupling policy with a village based computable general equilibrium (CGE) model. Their results demonstrated that agricultural policies decoupled from price stimulated staple production in Mexico. Philippidis and Hubbard (2001) and Gohin (2006) also used the CGE model to show the effects of the EU's common agricultural policy (CAP) including decoupled support payments and partially decoupled support under cross-compliance. These studies showed that the EU's CAP has a marked effect on increasing the diversity of production through expansion of domestic food processing sectors, but the effects of this policy on both arable crop and beef production are negative.

As for the Japanese economies, Saito (2002) analyzed the effects of a farmland consolidation project as agricultural public investment. Kunimitsu (2009) measured the economic effects of irrigation and drainage facilities in Japanese agriculture. Akune (2010) analyzed the economic linkage in the green tea industry. The CGE model used in these studies were static models. The dynamic CGE model was used by Son et al. (2006), Shibusawa et al. (2007) and Ban (2007). They respectively analyzed transportation policies, environmental policies and regional effects of policy change. The application of the dynamic CGE model is ideally suited for evaluating public capital stocks. For evaluation of the public policy, the common CGE model used in the previous studies needs to be modified in its structure by introducing policy variables.

The present study develops a dynamic CGE model for policy evaluation and explains the structure of the model in detail. Features of this model are to introduce special structures for agricultural production and food consumption and to install a recursive dynamic structure.

Following this section, how to derive the equations in the model is presented based on the optimization behavior of the economic actors in the next section. The third section explains how parameters used in the model can be calibrated from real data. The fourth section shows the model closure, Walras' condition and the recursive dynamic structure. In the fifth section, we show examples of outputs calculated by this model to show how this model functions. The final section provides the conclusions.

Ⅱ Model

1 Outline of the model

CGE models are the non-linear simultaneous equations that estimated from actual economic data to duplicate and simulate how an economy might react to changes in policy, technology or other external factors. The equations are commonly based on neo-classical theory, often assuming optimizing behavior of producers, consumers and government.

The equations of the CGE model in this study are based on the course materials of EcoMod (2010) which is the world's leading research, advisory, and educational not-for-profit network dedicated to promoting advanced modeling and statistical techniques in economic policy and decision making. The equations with “*” are the same equations in these materials.

Tables 1 to 4 explain the parameters, coefficients and variables of the model. Some local variables are explained just after equations. Hereafter, the suffix, i, j, and k show the industrial sector and i, j and k =1, 2, ・・・・, n.

Table 1 Parameters for which values are established based on empirical studies

Parameters	Explanation
Φ	Initial value of Frisch parameter in nested-LES (Linear Expenditure System) utility function
η	Initial income elasticities of demand for commodity (sec)
σH	Elasticity of substitution between food consumption and other consumptions
$\sigma F2_i$	Initial elasticity of substitution between farmland and capital-labor bundle in the CES (Constant Elasticity of Substitution) function (second nest)
$\sigma F3_i$	Initial elasticity of substitution between capital and labor in the CES function (third nest)
σA_i	Initial substitution elasticities of the Armington function
σT_i	Initial elasticities of transformation in the CET (Constant Elasticity of Transformation) function

Table 2 Parameters for which values are estimated by the calibration

Parameters	Explanation
mps	Household's marginal propensity to save
αHF	Budget shares of CES household utility function in food consumption (CES-function)
$\alpha HLES_i$	Power in the nested household utility function (LES-function)
μH_i	Subsistence in the household consumption quantities (LES-function)
αI_i	Cobb-Douglas power of each commodity in the bank's utility function
αIG_i	Cobb-Douglas power of each commodity in the government investment function
αCGT	Cobb-Douglas power of the public consumption in the government budget
αCG_i	Cobb-Douglas power of each commodity in government utility function
$io_{i,j}$	Technical coefficients for intermediate inputs (first nest of production function)
$\gamma F2_i$	CES distribution parameter for farmland in the firms production function (second nest of production function)
$\gamma F3_i$	CES distribution parameter for capital in the firms production function (third nest of production function)
γA_i	CES distribution parameter of commodity in the Armington import function
γT_i	CET distribution parameter of commodity in the combination of domestic output and export output
$aF1_i$	Efficiency parameter for capital-labor-farmland bundle in the firm's production function (first nest)
$aF2_i$	Efficiency parameter in the firm's production function (second nest)
$aF3_i$	Efficiency parameter in the firm's production function (third nest)
aA_i	Efficiency parameter of Armington function of commodity (sec)
aT_i	Shift parameter in the CET function of firm (sec)

Table 3 Coefficients for which values are estimated by the social accounting matrix (SAM) data

Coefficients	Explanation
ty	Tax rate on income
tc_i	Tax rate on consumer commodities
tk_i	Tax rate on capital use
tl_i	Tax rate on labor use
tm_i	Tariff rate on imports
tv_i	Tax rate on value added production including gasoline tax
d_i	Depreciation rate for the firms capital stock
$growthz$	Initial steady state growth rate

Table 4 Variables used in the model

Variables	Explanation
Price	
P_i	Prices of composite commodities
PD_i	Prices of domestic commodities for producer
PDD_i	Price of domestic output delivered to home market
PK_i	Return to capital for firm
PL	Wage rate
PA	Rent for farmland
P_AKL_i	Price of farmland-capital-labor bundle
P_KL	Price of capital-labor bundle
PE_i	Export prices in national currency
PM_i	Import prices in national currency
ER	Exchange rate
PCF	Price of food bundle
PCM	Price of other bundle (not food)
$PCINDEX$	Consumer price index
Quantity	
X_i	Domestic sales of composite commodity (imported and domestic products)
XD_i	Gross domestic output
XDD_i	Domestic output delivered to home market
X_AKL_i	Demand of farmland-capital-labor bundle by firm (sec)
X_KL_i	Demand of capital-labor bundle by firms (sec)
E_i	Exports
M_i	Imports
LS^*	Labor supply
AS^*	Farmland supply
K_i	Demand of capital stock
L_i	Demand of labor
A_i	Demand of farmland
C_i	Demand of consumer for commodities
$CBUD$	Total expenditure for consumption
$CBUDF$	Total expenditure for food consumption
$CBUDM$	Total expenditure for commodities other than food
Y	Household income
SH	Household savings
IP_i	Demand of private investment for commodities
IG_i	Demand of public investment for commodities
CG_i	Demand of public consumption for commodities
SF^*	Foreign savings
SB^*	Primary balance in the government account (+ : debt from households, - : debt from government)
$TAXR$	Total tax revenues

(Note) Variables with "*" are exogenous variables and others are endogenous variables.

2 Production of firm

Figures 1 and 2 show the nested production function representing the decision process of a typical firm. According to the empirical research on Japanese agriculture, substitutability of farmland and other input factors such as labor and capital is limited (Egaitsu, 1985). For example, if the farmland areas are fixed, the production level can hardly change by changing other input factors. Considering these findings, the firms' optimization behavior is described as follows.

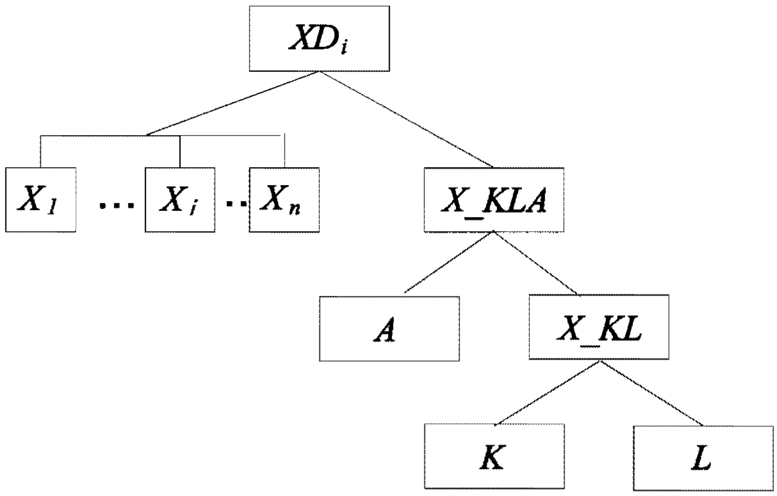


Fig.1 Structure of production in the agricultural sector

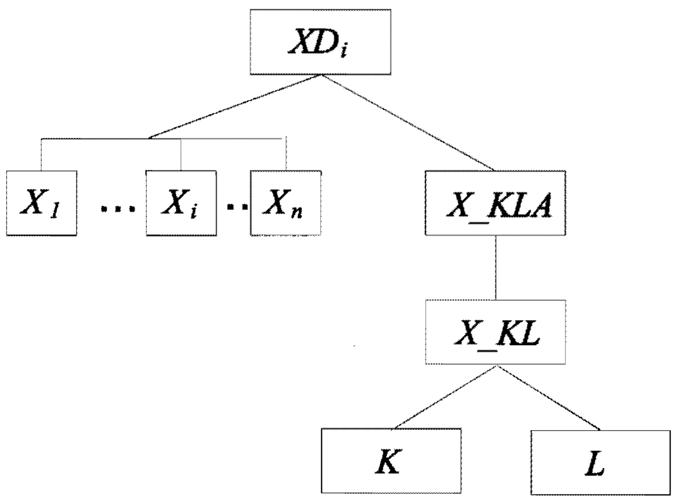


Fig.2 Structure of production in other industries

a Optimization at the 3rd level of the nested production function (K and L)

A firms' decision on selection of capital and labor for optimum production is defined as:

$$\min \quad Cost = (1+tk_i)PK_i \cdot K_i + (1+tl_i)PL \cdot L_i$$

$$s.t. \quad X\_KL_i = aF3_i\left[\gamma F3_i \cdot K_i^{\frac{\sigma F3_i - 1}{\sigma F3_i}} + (1-\gamma F3_i)L_i^{\frac{\sigma F3_i - 1}{\sigma F3_i}}\right]^{\frac{1}{\sigma F3_i - 1}} \tag{1}$$

From the first order condition (FOC) of Eq. (1), demands derived for capital and labor are:

$$K_i = \gamma F3_i^{\sigma F3_i} \cdot \{(1+tk_i)PK_i\}^{-\sigma F3_i} \left[\gamma F3_i^{\sigma F3_i}\{(1+tk_i)PK_i\}^{1-\sigma F3_i} + (1-\gamma F3_i)^{\sigma F3_i}\{(1+tl_i)PL\}^{1-\sigma F3_i}\right]^{\frac{\sigma F3_i}{1-\sigma F3_i}} \cdot \left(X\_KL_i \middle/ aF3_i\right) \tag{M1}$$

$$L_i = (1-\gamma F3_i)^{\sigma F3_i} \cdot \{(1+tl_i)PL\}^{-\sigma F3_i} \cdot \left[\gamma F3_i^{\sigma F3_i}\{(1+tk_i)PK_i\}^{1-\sigma F3_i} + (1-\gamma F3_i)^{\sigma F3_i}\{(1+tl_i)PL\}^{1-\sigma F3_i}\right]^{\frac{\sigma F3_i}{1-\sigma F3_i}} \cdot \left(X\_KL_i / aF3_i\right) \quad \text{(M2).}$$

Equations that have "M" in front of the number are used in the CGE model, and others are formulae for stages on the way.

The supply function derived from the zero profit condition is:

$$P\_KL_i \cdot X\_KL_i = (1+tk_i)PK_i \cdot K_i + (1+tl_i)PL \cdot L_i \quad \text{(M3).}$$

b Optimization at the 2nd level of the nested production function (*A* and *KL*-bundle)

Firms' decision on the selection of farmland and other input bundles are defined as:

$$\min \quad Cost = PA \cdot A_i + P\_KL_i \cdot X\_KL_i$$

$$s.t. \quad X\_AKL_i = aF2_i\left[\gamma F2_i \cdot A_i^{\frac{\sigma F2_i - 1}{\sigma F2_i}} + (1-\gamma F2_i)X\_KL_i^{\frac{\sigma F2_i - 1}{\sigma F2_i}}\right]^{\frac{1}{\sigma F2_i - 1}} \quad \text{(2).}$$

From the FOC of Eq. (2), demands derived for farmland and for the KL bundle are:

$$A_i = \gamma F2_i^{\sigma F2_i} \cdot PA^{-\sigma F2_i}\left[\gamma F2_i^{\sigma F2_i} \cdot PA^{1-\sigma F2_i} + (1-\gamma F2_i)^{\sigma F2_i} \cdot P\_KL^{1-\sigma F2_i}\right]^{\frac{\sigma F2_i}{1-\sigma F2_i}} \cdot \left(X\_AKL_i / aF2_i\right) \quad \text{(M4).}$$

$$X\_KL_i = (1-\gamma F2_i)^{\sigma F2_i} \cdot P\_KL_i^{-\sigma F2_i}\left[\gamma F2_i^{\sigma F2_i} \cdot PA^{1-\sigma F2_i} + (1-\gamma F2_i)^{\sigma F2_i} P\_KL_i^{1-\sigma F2_i}\right]^{\frac{\sigma F2_i}{1-\sigma F2_i}} \cdot \left(X\_AKL_i / aF2_i\right) \quad \text{(M5).}$$

The supply function derived from the zero profit condition is:

$$P\_AKL_i \cdot X\_AKL_i = PA \cdot A_i + P\_KL_i \cdot X\_KL_i \quad \text{(M6).}$$

c Optimization at the 1st level of the nested production function (Intermediate inputs and *AKL*-bundle)

We assume the Leontief-type production function is:

$$XD_i = \min\left(\frac{X\_AKL_i}{aF1_i}, \frac{IO_{1i}}{io_{1i}}, \cdots, \frac{IO_{ki}}{io_{ki}}, \cdots, \frac{IO_{ni}}{io_{ni}}\right) \quad \text{(3)*,}$$

where IO is the intermediate input for production. $aF1_i$ and io_{ki} $(i, k = 1, \cdots, n)$ are the constant technical coefficients.

Assuming that the output XD_i is produced at minimum cost, so that no waste of inputs occurs and the ratios $\frac{IO_{ki}}{io_{ki}}$ are the same for all i, we can rewrite the above equation as:

$$XD_i = \frac{X\_AKL_i}{aF1_i} = \frac{IO_{1i}}{io_{1i}} = \cdots = \frac{IO_{ki}}{io_{ki}} = \cdots = \frac{IO_{ni}}{io_{ni}} \quad \text{(4)*.}$$

This equation represents the familiar input-output relations for a particular firm:

$$X\_AKL_i = aF1_i \cdot XD_i \quad \text{(M7)* and,}$$

$$IO_{ki} = io_{ki} \cdot XD_i \quad \text{for i, k} = 1, \cdots, \text{n} \quad \text{(5)*.}$$

The supply function derived from the zero profit condition is:

$$PD_i \cdot XD_i = (1+tv_i)P\_AKL_i \cdot X\_AKL_i + \sum_k \left(P_k \cdot io_{ki} \cdot XD_i\right) \qquad \text{(M8)}.$$

3 Consumption demand of household

Figures 3 and 4 show the structure of household utilities and the decision process for household consumption. In this model, we assumed that changes in the consumption level of food are quite limited even if the relative price of

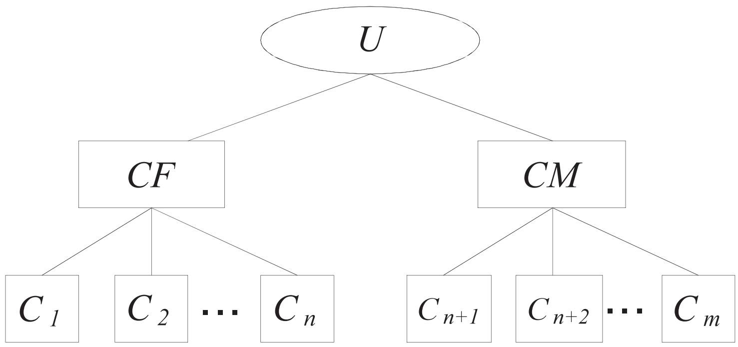


Fig.3 Structure of utilities of a representative household
(Note) *CF* and *CM* are total consumption for food relating commodities and non-food commodities.

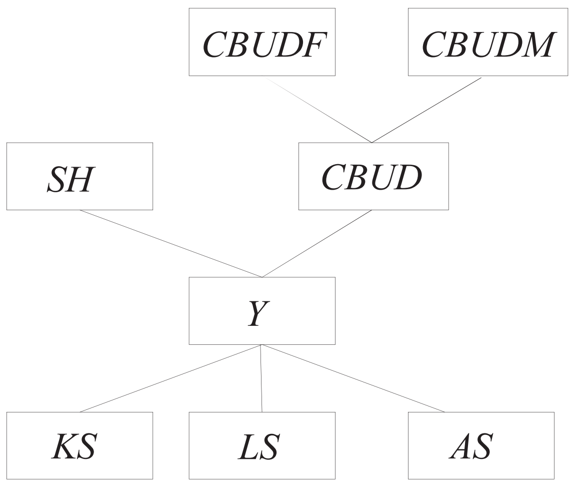


Fig.4 Decision processes of a household
(Note) *KS* shows nominal capital stocks owned by households and equals total demand for capital stocks in nominal value represented by $PK_i \cdot K_i$.

food decreases than other manufacturing products. Also, the basic consumption level exists in consumption behavior as defined by the Stone-Geary utility function (Neary; 1997, Sadoulet and de Janvry; 1995). The concrete equations for consumer behavior are derived as follows.

Household income comes from capital revenue, labor income and asset income from land.

(Income definition)

$$Y = \sum_i PK_i \cdot K_i + PL \cdot LS + PA \cdot AS \qquad \text{(M9)}.$$

Consumer saves a fraction (*mps*) of his/her income, so his/her nominal savings are:

$$SH = mps(1-ty)Y \qquad \text{(M10)*}.$$

Consequently, total budget for consumption is:

$$CBUD = (1-ty)Y - SH \qquad \text{(M11)*}.$$

After reaching the above income, the household decides how much budget is for food consumption and how much is for other consumptions. Next, each commodity in the food bundle and each commodity in the other commodity bundles are decided.

Using the above budget, the household optimizes their consumption for each commodity as follows.

a Optimization at the top level of utility

The household maximizes the CES utility function, subject to budget constraints as:

$$\max \quad U = \left[\alpha HF \cdot CF^{\frac{\sigma H - 1}{\sigma H}} + (1 - \alpha HF) CM^{\frac{\sigma H - 1}{\sigma H}} \right]^{\frac{1}{\sigma H - 1}}$$

$$s.t. \quad CBUD = PCF \cdot CF + PCM \cdot CM \tag{6}$$

Here, CF and CM are total consumption for food relating commodities and non-food commodities. From the FOC of Eq. (6), demand functions for the food bundle and other commodity bundles are:

$$PCF \cdot CF \equiv CBUD_F = CBUD \Bigg/ \left[1 + \left(\frac{1 - \alpha HF}{\alpha HF} \right)^{-\sigma H} \left(\frac{PCF}{PCM} \right)^{1 - \sigma H} \right] \tag{M12}$$

$$PCM \cdot CM \equiv CBUD_M = CBUD \Bigg/ \left[1 + \left(\frac{\alpha HF}{1 - \alpha HF} \right)^{-\sigma H} \left(\frac{PCM}{PCF} \right)^{1 - \sigma H} \right] \tag{M13}$$

Here, suffix F and M show classification of the food relating sectors and non-food sectors, respectively. Note that the total expenditure for food ($PCF \cdot CF$) and for other commodities ($PCM \cdot CM$) correspond to the total budget for consumption within the income ($CBUD_F$ and $CBUD_M$, respectively).

b Optimization at the 2nd level of utility

In terms of consumption of each food commodity, the household maximizes the Stone-Geary utility function defined as:

$$\max \quad U_F = \sum_{if} (C_{if} - \mu H_{if})^{\alpha HLES_{if}}$$

$$s.t. \quad CBUD_F = \sum_{if} (1 + tc_{if}) P_{if} \cdot C_{if} \tag{7}$$

Here, if , jf and kf all show the sector classification of the food relating sectors, im, jm and km show the sector classification of the non-food sectors. μH_{if} is the minimum required quantity that the consumer purchases first. In these functions, $C_{if} > \mu H_{if} \geq 0$ for if = 1,・・・,n, $\alpha HLES_{if} > 0$ and $\sum_{if} \alpha HLES_{if} = 1$. From the FOC of Eq. (7),

$$(1 + tc_{kf}) P_{kf} \cdot C_{kf} = (1 + tc_{kf}) P_{kf} \cdot \mu H_{kf} + \frac{\alpha HLES_{kf}}{\alpha HLES_{if}} (1 + tc_{if}) P_{if} (C_{if} - \mu H_{if}) \tag{8}$$

Income restriction in Eq. (7) is rewritten as:

$$CBUD_F = (1 + tc_{if}) P_{if} \cdot C_{if} + \sum_{kf, kf \neq if} (1 + tc_{kf}) P_{kf} \cdot C_{kf} \tag{9}$$

We substitute $(1 + tc_{kf}) P_{kf} \cdot C_{kf}$ in this equation for the first-order condition and derive the demand function for the if -th commodity in the food sector as follows.

$$CBUD_F = \frac{1}{\alpha HLES_{if}}(1+tc_{if})P_{if} \cdot C_{if} - \frac{1-\alpha HLES_{if}}{\alpha HLES_{if}}(1+tc_{if})P_{if} \cdot \mu H_{if} + \sum_{kf}(1+tc_{kf})P_{kf} \cdot \mu H_{kf} \qquad (10).$$

$$(1+tc_{if})P_{if} \cdot C_{if} = (1+tc_{if})P_{if} \cdot \mu H_{if} + \alpha HLES_{if}\left[CBUD_F - (1+tc_{if})P_{if} \cdot C_{if} - \sum_{kf}(1+tc_{kf})P_{kf} \cdot \mu H_{kf}\right] \qquad (11).$$

$$(1+tc_{if})P_{if} \cdot C_{if} = (1+tc_{if})P_{if} \cdot \mu H_{if} + \alpha HLES_{if}\left[CBUD_F - \sum_{sf=\forall sf}(1+tc_{sf})P_{sf} \cdot \mu H_{sf}\right] \qquad (M14).$$

As for commodities other than food, a household similarly maximizes the Stone-Geary utility function as follows.

$$\max \quad U_M = \sum_{im}(C_{im} - \mu H_{im})^{\alpha HLES_{im}}$$

$$s.t. \quad CBUD_M = \sum_{im}(1+tc_{im})P_{im} \cdot C_{im} \qquad (12).$$

From the FOC of Eq. (12), we derive the demand function for the *im*-th commodity as:

$$(1+tc_{im})P_{im} \cdot C_{im} = (1+tc_{im})P_{im} \cdot \mu H_{im} + \alpha HLES_{im}\left[CBUD_M - \sum_{sm=\forall sm}(1+tc_{sm})P_{sm} \cdot \mu H_{sm}\right] \qquad (M15).$$

Demand functions shown by Eqs. (M14) and (M15) are a linear expenditure system (LES) for the consumption function.

4 Export and import

Figure 5 shows the firms' decision on export and import.

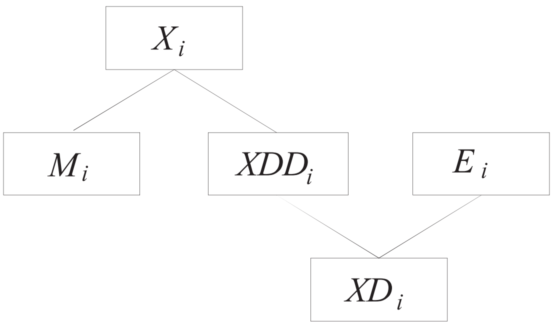


Fig.5 Firms' decision on export and import.

The firm chooses domestic market or foreign market to sell its commodities. It maximizes its sales under constraints of the constant elasticity of transformation (CET) function with the domestic commodities and export commodities as follows.

$$\max \quad Sales = PDD_i \cdot XDD_i + PE_i \cdot E_i$$

$$s.t. \quad XD_i = aT_i\left[\gamma T_i \cdot E_i^{(\sigma T_i - 1)/\sigma T_i} + (1-\gamma T_i)\, XDD_i^{(\sigma T_i - 1)/\sigma T_i}\right]^{\sigma T_i/(\sigma T_i - 1)} \qquad (13)^*.$$

From the FOC of Eq. (13), the functions for the domestic commodities and exported commodities are:

$$XDD_i = (1-\gamma T_i)^{\sigma T_i} \cdot PDD_i^{-\sigma T_i}\left[\gamma T_i^{\sigma T_i} \cdot PE_i^{1-\sigma T_i} + (1-\gamma T_i)^{\sigma T_i} \cdot PDD_i^{1-\sigma T_i}\right]^{\sigma T_i/(1-\sigma T_i)}(XD_i/aT_i) \qquad (M16)^*.$$

and

$$E_i = \gamma T_i^{\sigma T_i} \cdot PE_i^{-\sigma T_i}\left[\gamma T_i^{\sigma T_i} \cdot PE_i^{1-\sigma T_i} + (1-\gamma T_i)^{\sigma T_i} \cdot PDD_i^{1-\sigma T_i}\right]^{\sigma T_i/(1-\sigma T_i)}(XD_i/aT_i) \qquad \text{(M17)*.}$$

The supply function derived from the zero profit condition is:

$$PD_i \cdot XD_i = PE_i \cdot E_i + PDD_i \cdot XDD_i \qquad \text{(M18)*.}$$

The firm produces a composite commodity supplied to the domestic market by using the domestic and imported commodities. According to the Armington assumption, the optimization behavior is described as:

$$\min \quad Cost = PM_i \cdot M_i + PDD_i \cdot XDD_i$$

$$s.t. \quad X_i = aA_i\left[\gamma A_i \cdot M_i^{(\sigma A_i - 1)/\sigma A_i} + (1-\gamma A_i) XDD_i^{(\sigma A_i - 1)/\sigma A_i}\right]^{\sigma A_i/(\sigma A_i - 1)} \qquad \text{(14)*.}$$

From the FOC of Eq. (14), the import function and the function for domestic commodities are derived as:

$$M_i = \gamma A_i^{\sigma A_i} \cdot PM_i^{-\sigma A_i}\left[\gamma A_i^{\sigma A_i} \cdot PM_i^{1-\sigma A_i} + (1-\gamma A_i)^{\sigma A_i} \cdot PDD_i^{1-\sigma A_i}\right]^{\sigma A_i/(1-\sigma A_i)}(X_i/aA_i) \qquad \text{(M19)*.}$$

and

$$XDD_i = (1-\gamma A_i)^{\sigma A_i} \cdot PDD_i^{-\sigma A_i}\left[\gamma A_i^{\sigma A_i} \cdot PM_i^{1-\sigma A_i} + (1-\gamma A_i)^{\sigma A_i} \cdot PDD_i^{1-\sigma A_i}\right]^{\sigma A_i/(1-\sigma A_i)}(X_i/aA_i) \qquad \text{(M20)*.}$$

The supply function derived from the zero profit condition is:

$$P_i \cdot X_i = PM_i \cdot M_i + PDD_i \cdot XDD_i \qquad \text{(M21)*.}$$

5 Public spending

Figure 6 shows the revenues and expenditures of the government.

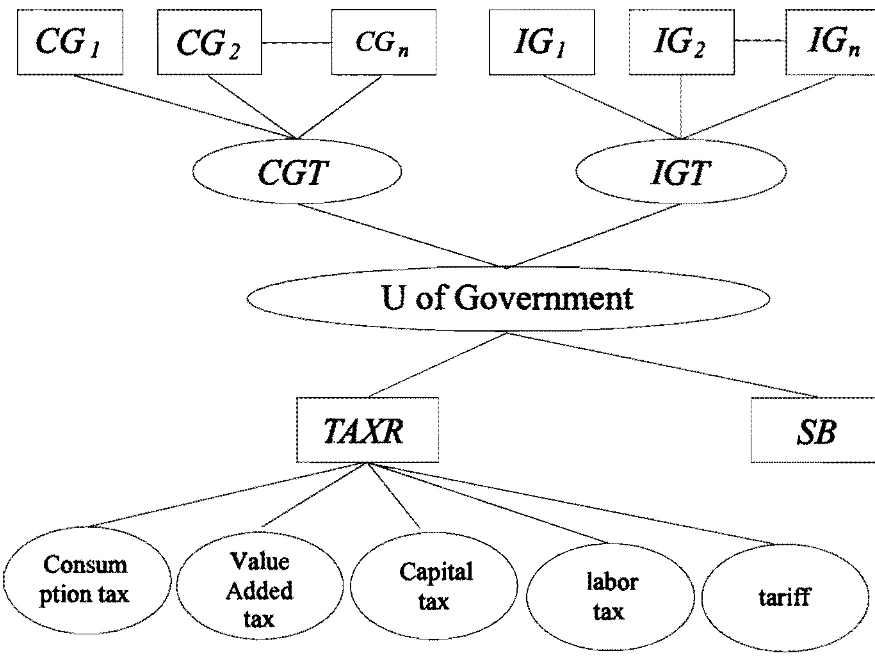


Fig.6 Government's decision on consumption and investment subject to revenues
(Note) *CGT* and *IGT* are total government consumption and total government investment, respectively.

At the stage of taxation, the government levies taxes on the consumption of commodities, on capital and labor use of firms and on the income of the household. In addition the government obtains revenue from tariffs. Consequently, the government tax revenues are:

$$TAXR = \sum_i \big(P_i \cdot tc_i \cdot C_i + tv_i \cdot P\_AKL_i \cdot X\_AKL_i + tk_i \cdot PK_i \cdot K_i + tl_i \cdot PL_i \cdot L_i + tm_i \cdot PWM^0{}_i \cdot ER \cdot M_i\big) + ty \cdot Y \tag{M22}$$

Here, PWM^0 is the initial world price of import commodities.

For expenditure part, we assumed that the government decides the share of public consumption and public investment according to public opinions expressed by the national election. In other words, due to political reasons, the share of expenditures on public consumption and public investment is fixed at the constant ratio against revenue. Total revenue is defined as:

$$TAXR + SB \cdot PCINDEX \tag{15}$$

Expenditures of public consumption and public investment are:

$$PCGT \cdot CGT = \alpha CGT\big(TAXR + SB \cdot PCINDEX\big) \tag{16}$$

$$PIGT \cdot IGT = \big(1 - \alpha CGT\big)\big(TAXR + SB \cdot PCINDEX\big) \tag{17}$$

Here, *CGT* and *IGT* are total government consumption and total government investment, respectively. Total government revenue denotes nominal values, but savings from the primary balance in the national account, *SB*, are defined as the real value. By definition, when the primary balance is in the red, *SB* becomes negative indicating the government savings are negative, and vice versa.

After deciding the expenditures, we assumed the efficient behavior of the government. That is, the government optimizes each expenditure by maximizing the Cobb-Douglas utility function subject to each budget for total public consumption and total public investment. Optimization decision of the government is defined as:

$$\max \quad U = \prod_i IG_i^{\alpha IG_i}$$

$$s.t. \quad PIGT \cdot IGT = \sum_i P_i \cdot IG_i \tag{18}$$

and

$$\max \quad U = \prod_i CG_i^{\alpha CG_i}$$

$$s.t. \quad PCGT \cdot CGT = \sum_i P_i \cdot CG_i \tag{19}$$

Here, $\sum_i \alpha IG_i = 1$ and $\sum_i \alpha CG_i = 1$. From the FOC of Eqs. (18) and (19) and former Eqs. (16) and (17), the demand for each commodity in public investment and public consumption can be defined as:

$$IG_i = \alpha IG_i \cdot P_i^{-1} \cdot (1 - \alpha CGT)(TAXR + SB \cdot PCINDEX) \tag{M23}$$

$$CG_i = \alpha CG_i \cdot P_i^{-1} \cdot \alpha CGT(TAXR + SB \cdot PCINDEX) \tag{M24}$$

6 Commodity demand by investment

Under macroeconomic restrictions, total savings is always equal total investment. In our model, total savings consist of total household savings, *SH*, the savings from the primary balance in the national account, *SB*, and trade surplus in the foreign account, *SF*. Note that *SB* is the real value. The agent “Bank” maximizes the utility defined by a Cobb-Douglas function subject to the Investment-Savings balance as:

$$\max \quad U = \prod_i IP_i^{\alpha I_i}$$

$$s.t. \quad \sum_i P_i \cdot IP_i = SH - SB \cdot PCINDEX + SF \cdot ER \tag{20)*.$$

Here, $\sum_i \alpha I_i = 1$. From the FOC of Eq. (20), we can derive the following demand function for investment commodities.

$$P_i \cdot IP_i = \alpha I_i \left(SH - SB \cdot PCINDEX + SF \cdot ER \right) \qquad \text{(M25)*.}$$

7　Market clearing conditions and price definitions

a　Market clearing conditions

In order to meet the demand with supply, the market-clearing conditions required in each market are:

Labor market: $\sum_i L_i = LS$ (21)*.

Farmland market: $\sum_i A_i = AS$ (M26)*.

Commodity market: $\sum_j io_{ij} \cdot XD_j + C_i + IP_i + IG_i + CG_i = X_i$ (M27)*.

Trade balance: $\sum_i PWM^0{}_i \cdot M_i = \sum_i PWE^0{}_i \cdot E_i + SF$ (M28)*.

Here, PWE^0 is the initial world price of export commodities.

b　Price definitions

This model uses the composite price index to adjust nominal variables to real variables. The indexes used here are:

Consumer price index: $PCINDEX = \sum_i (1 + tc_i) P_i \cdot C_i \Big/ \sum_i (1 + tc_i) P^0{}_i \cdot C^0{}_i$ (M29)*.

Price of food composite: $PCF = \sum_{if} (1 + tc_{if}) P_{if} \cdot C_{if} \Big/ \sum_{if} C_{if}$ (M30).

Price of other product composite: $PCM = \sum_{im} (1 + tc_{im}) P_{im} \cdot C_{im} \Big/ \sum_{im} C_{im}$ (M31).

Price of import commodity: $PM_i = \left(1 + tm_i\right) \cdot ER \cdot PWM^0{}_i$ (M32)*.

Price of export commodity: $PE_i = ER \cdot PWE^0{}_i$ (M33)*.

Ⅲ　Calibration

Using the data shown by the social accounting matrix (SAM), we can calibrate the parameters of each equation described above. The supply and demand in the SAM data are always balanced, so a model that uses calibrated parameters reaches equilibrium in price and commodity in the market. The equations for calibration are indicated by equation numbers with a "C". The variables with "0" over the right shoulder indicate the initial values for each variable shown by the SAM data.

1　Production parameters

From the FOC of Eq. (1), the technological parameters at the 3rd nest of the production function are calibrated by:

$$\gamma F3_i = \frac{1}{1+\dfrac{(1+tl_i)PL^0}{(1+tk_i)PK_i^0}\left(\dfrac{K_i^0}{L_i^0}\right)^{-1/\sigma F3_i}} \tag{C1}$$

$$aF3_i = X\_KL_i^0 \Big/ \left[\gamma F3_i \left(K_i^0\right)^{\frac{\sigma F3_i-1}{\sigma F3_i}} + \left(1-\gamma F3_i\right)\left(L_i^0\right)^{\frac{\sigma F3_i-1}{\sigma F3_i}}\right]^{\frac{\sigma F3_i}{\sigma F3_i-1}} \tag{C2}$$

In the same way, from the FOC of Eq. (2), the technological parameters at the 2nd nest are calibrated by:

$$\gamma F2_i = \frac{1}{1+\dfrac{P\_KL_i^0}{PA^0}\left(\dfrac{A_i^0}{X\_KL_i^0}\right)^{-1/\sigma F2_i}} \tag{C3}$$

$$aF2_i = X\_AKL_i^0 \Big/ \left[\gamma F2_i \left(A_i^0\right)^{\frac{\sigma F2_i-1}{\sigma F2_i}} + \left(1-\gamma F2_i\right)\left(X\_KL_i^0\right)^{\frac{\sigma F2_i-1}{\sigma F2_i}}\right]^{\frac{\sigma F2_i}{\sigma F2_i-1}} \tag{C4}$$

From Eq. (4), the technological parameters at the 1st nest are:

$$aF1_i = X\_AKL^0{}_i \Big/ XD^0{}_i \tag{C5*}$$

$$io_{ki} = IO^0{}_{ki} \Big/ XD^0{}_i \tag{C6*}$$

2 Consumption parameters

From the FOC of Eq. (6), distribution parameters at the top level utility are calibrated by:

$$\alpha HF = \left[1+\frac{PCM^0}{PCF^0}\left(\frac{CF^0}{CM^0}\right)\right]^{1/\sigma H} \tag{C7}$$

From the demand functions shown by Eqs. (M14) and (M15), we can derive the income elasticity for the demands for commodities as:

$$\eta = \frac{dC_i}{dCBUD}\frac{CBUD}{C_i} = \frac{\alpha HLES \cdot \left\{(1+tc_i)P_i\right\}^{-1} \cdot CBUD}{C_i} \tag{22*}$$

Using the empirical results of previous studies for the value of η allow us to obtain the parameter value of $\alpha HLES$ as:

$$\alpha HLES = \frac{\eta \cdot \left\{(1+tc_i)P^0{}_i\right\}^{-1} \cdot CBUD_h{}^0}{C^0{}_i} \tag{C8}$$

where h=F (for the food industry) or M (for another industry).

In case of LES, the Frisch parameter ϕ is equal to:

$$\phi = \frac{d\lambda}{dCBUD}\frac{CBUD}{\lambda} = -\frac{CBUD}{CBUD - \sum_i (1+tc_i)P_i \cdot \mu H_i} \tag{23*}$$

(Blonigen, et al., 1997). Here, λ is the marginal utility of expenditure and shown by the Lagrange multiplier in the optimization of household utility. The Frisch parameter indicates the expenditure elasticity of the marginal utility of expenditure and also indicates the money flexibility between essential and non essential goods. Using the empirical results for the value of ϕ and initial values for variables, μH_i can be calibrated as:

$$\mu H_i = C^0{}_i + \alpha HLES \cdot \left\{(1+tc_i)P^0{}_i\right\}^{-1} \cdot CBUD^0{}_h \cdot \phi^{-1} \tag{C9}$$

3 Parameters of export and import

From the FOC of Eq. (13), parameters in the export function are calibrated by:

$$\gamma T_i = 1/\left[1 + (PDD^0_i / PE^0_i)(E^0_i / XDD^0_i)^{-1/\sigma T_i}\right] \tag{C10}^*$$

$$aT_i = XD^0_i / \left[\gamma T_i \cdot E^0_i{}^{(\sigma T_i - 1)/\sigma T_i} + (1-\gamma T_i) XDD^0_i{}^{(\sigma T_i - 1)/\sigma T_i}\right]^{\sigma T_i/(\sigma T_i - 1)} \tag{C11}^*$$

From the FOC of Eq. (14), parameters in the Armington function are calibrated by:

$$\gamma A_i = 1/\left[1 + (PDD^0_i / PM^0_i)(M^0_i / XDD^0_i)^{-1/\sigma T_i}\right] \tag{C12}^*$$

$$aA_i = X^0_i / \left[\gamma A_i \cdot M^0_i{}^{(\sigma A_i - 1)/\sigma A_i} + (1-\gamma A_i) XDD^0_i{}^{(\sigma A_i - 1)/\sigma A_i}\right]^{\sigma A_i/(\sigma A_i - 1)} \tag{C13}^*$$

4 Parameters of public spending

Substituting the initial values of variables into Eqs. (16), (M23) and (M24), the values of αCGT , αIG and αCG can be calibrated as:

$$\alpha CGT = PCGT^0 \cdot CGT^0 / \left(TAXR^0 + SB^0 \cdot PCINDEX^0\right) \tag{C14}$$

$$\alpha CG_i = P^0_i \cdot CG^0_i / \left\{\alpha CGT\left(TAXR^0 + SB^0 \cdot PCINDEX^0\right)\right\} \tag{C15}$$

$$\alpha IG_i = P^0_i \cdot IG^0_i / \left\{(1-\alpha CGT)\left(TAXR^0 + SB^0 \cdot PCINDEX^0\right)\right\} \tag{C16}$$

By substituting initial values into Eq. (M25), αI can be calibrated as:

$$\alpha I_i = P^0_i \cdot IP^0_i \,/\, (SH^0 - SB^0 \cdot PCINDEX^0 + SF^0 \cdot ER^0) \tag{C17}$$

Ⅳ Model closure, Walras' law and recursive dynamics

Due to Walras' Law: when there are n markets of which (n-1) are cleared, then the n-th market is automatically cleared, and we have to fix a numeraire to solve the model. We chose to fix labor price, PL, to be 1 and eliminate the market clearing condition of labor market in Eq. (21). To check the Walras' condition, the following equations should equal zero.

$$walras = \sum_i L_i - LS \tag{28}$$

The recursive dynamic structure is composed of a sequence of several static equilibria. The first equilibrium in the sequence is given by the benchmark value at year, $t1$. In each time period, t, the model is solved for an equilibrium given the exogenous conditions. The sequential equilibria are connected to each other through capital accumulation.

Capital formation is based on the Putty-Clay assumption. Under this assumption capital stock can be converted from flexible capital into durable goods, but it cannot then be converted back into re-investable capital. Consequently, the amount of capital stocks by industries is fixed within the year, but investment which will be transformed to the capital in the next year can move from sector to another sector by searching more revenue. The endogenous determination of investment behavior is:

$$INV_i(t) = INV^0_i \cdot \left(\frac{PK_i(t)}{\overline{PK(t)}}\right)^{0.5} \tag{M34}$$

where $INV_i(t)$ is the investment in the i-th sector at year t and its initial value is $INV^0_i(t)$. $\overline{PK(t)}$ is the average service cost of the capital stock among sectors at year t and $\overline{PK(t)} = \frac{1}{n}\sum_i PK_i(t)$. The power coefficient, 0.5, is the elasticity of the change in investment with regard to change in the service cost of the capital stocks. Total investment to sectors corresponds to total investment demand calculated at the equilibria of the model, so investment to each sector is rescaled as:

$$INV_i(t) = \frac{INV_i(t)}{\sum_i INV_i(t)} \cdot \sum_i IP_i(t) \qquad \text{(M35)},$$

where $INVT(t)$ is the summation of $INV_i(t)$ in Eq. (M34).

Capital stock at year t is:

$$K_i(t) = (1 - d_i)K_i(t-1) + INV_i(t) \qquad \text{(M36)}.$$

V **Outputs of the model**

Figure 7 is future predictions of several variables for this model. In order to solve the model for simulation, the GAMS (version 2.3) is used. This software is developed by the GAMS corporation (http://www.gams.com/). To calibrate the parameters, we used the the SAM data on Japanese economies in 2005.

The growth rate of exogenous variables was set to zero and no technological progress was considered. Hence, this prediction is seemed to be the pessimistic case on Japanese economies and agriculture. In terms of values by sectors, we aggregated each sector into 3 groups, i.e. first industry, second industry and third industry to save space.

As time goes by, the total production of agriculture decreases because most of private investment concentrate in non-agricultural sectors which have relatively high productivity and high price of capital according to the basic assumption explained in Eq. (M34). In order to balance the demand and the supply, price of 1st industry goes down and consumption for mainly agricultural products also goes down. Also, the exports of the 1st industry decrease and the imports of 1st industry go up because of a rise in domestic market of food. Of course, if technological progress can be realized in the agricultural sector different from the settings of exogenous variables in this section, the decrease in agriculture can be avoidable. Since there is not enough space in this paper, such analysis will be conducted in the other paper.

In total, total income which is measured by the nominal term rises because of above changes. Prices of food and food relating products make comprehensive price index, *PCINDEX*, decrease. Also, the nominal tax revenue goes down as shown by the last graph. These changes simulated by the model are realistic when we consider actual situation in Japan. Hence, it can be said that the model captures the real Japanese economies.

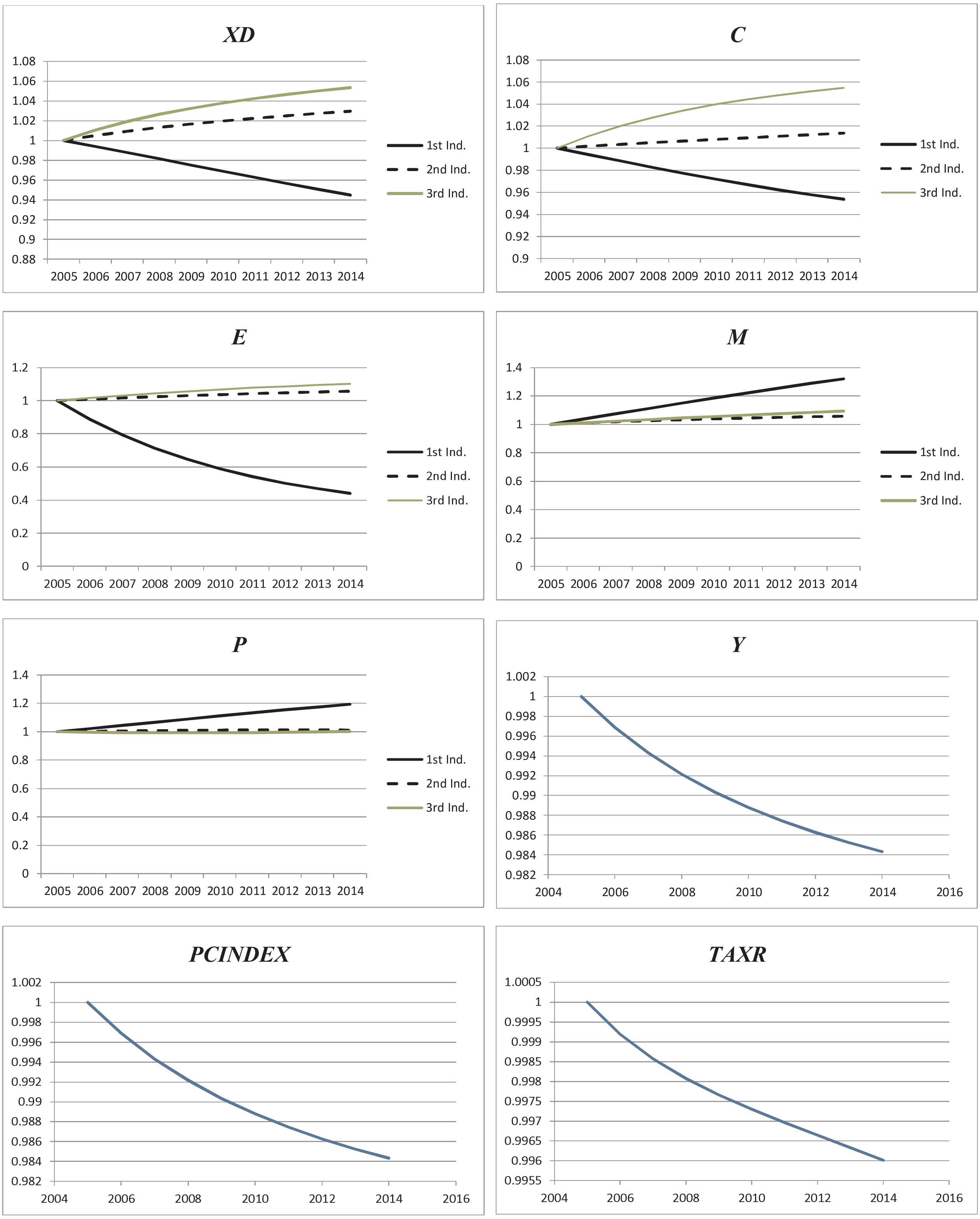
VI **Conclusion**

The present study developed a dynamic CGE model for evaluation of rural development policies and explained the structure of the model in detail. Features of this model are as follows.

First, the nested production structure was used in agriculture by considering farmland. Each nest for production was determined by the constant elasticity of a substitution (CES) type function and had different substitution elasticities. Especially in agriculture, the substitutability of farmland to other input factors, such as capital and labor, was assumed to be low according to previous studies. This indicates that if farmland input is fixed and other input factors are changed, the changes in agricultural production are limited. Such situations are possibly realistic in Japanese agriculture where a set aside program is mandated and possession of farmland is relatively unchangeable. Using such a production structure, it is easy for researchers to consider policy measures that affect agricultural productivity in the future.

Second, the nested consumption function was used by assuming that the substitutability of food consumption and other consumptions was low. At the bottom nest of the utility function, the Stone-Geary utility function was used to describe consumer behavior within the food sectors and other sectors. Because of such a structure, if the price of food becomes low, a decrease in food consumption seems to be low as compared to previous models used in other studies where a simple utility function was used. In Japan, consumption of rice is continuously declining and the price of rice is decreasing, so the above structure can be accorded with this real situation to make the model simulation more realistic.

Third, the recursive dynamic structure was introduced to consider the chronological accumulation of capital stocks. Asset management measures that aim to prolong the life time of capital stocks are deeply related to the capital formation process, so the above dynamic structure is necessary for evaluation of capital stock policies.



(Note) Each line shows the ratio of the annual values compared to the values in 2005.

Fig.7　Predictions by variables

Using this model, the chronological changes in production and price at the market can be predicted by sector and the situations with-and-without policy changes can be forecast. However, there are several issues remaining. Concrete rural development policies need to be evaluated by this model and real data. The model structure also needs to be improved to consider the oligopoly situation in certain industries. Furthermore, improvement of the CGE model structure by considering a forward looking process and overlapping generation structure may be useful to evaluate future situations.

Appendix

Table A1 shows the value of each parameter for simulation on Japanese economic situation. These values are based on the GTAP (Global Trade Analysis Program) database developed by the Purdue University and most of them were estimation results of previous empirical data.

Table A1 Parameters for which values are established based on empirical studies

Parameters	Set values
Φ	-1.1
η	Sec 1-7, 15: 0.5 Others : 1.1
σH	0.4
$\sigma F2_i$	0.1
$\sigma F3_i$	0.8
σA_i	Sec 1-14: 2.0 Sec 15: 3.0
σT_i	Sec 1-14: 2.0 Sec 15: 3.0

The sample data of the social accounting matrix (SAM) for the dynamic CGE model on Japanese economies were composed from the Input-Output data of Japan in 2005. The SAM data are shown in Table A2.

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Table A2　SAM data

$ billion			Paddy	Other Crop Farming	Animal Husbandry	Forestry, Agri. Service, Compost, Woody Prod.	Fishery	Food Process–ing	Beverage Prod.	Mining, Material Prod.	Machine	Construct–ion, Water, Waste Treatment	Commer–ce, Finance, Insurance	Transport, Telecomm–unication	Catering	Other Sevice	Energy
			Sectors														
			sec1	sec2	sec3	sec4	sec5	sec6	sec7	sec8	sec9	sec10	sec11	sec12	sec13	sec14	ENG
Sectors	Paddy	sec1	0.6	0.0	1.0	1.4	0.0	10.1	1.1	0.6	0.1	0.3	0.0	0.0	1.2	1.0	0.0
	Other Crop Farming	sec2	0.0	1.2	2.1	2.9	0.0	21.6	2.3	1.3	0.2	0.6	0.1	0.0	2.6	2.2	0.0
	Animal Husbandry	sec3	0.2	0.3	3.3	0.1	0.0	21.1	0.0	0.1	0.0	0.0	0.0	0.0	1.1	0.7	0.0
	Forestry, Agri. Service, Compost, Woody Prod.	sec4	1.8	3.8	10.7	2.9	0.2	0.2	0.0	4.2	0.0	0.1	0.0	0.0	0.3	0.8	0.0
	Fishery	sec5	0.0	0.0	0.0	0.0	0.8	10.4	0.0	0.0	0.4	0.0	0.0	0.0	2.3	1.2	0.0
	Food Processing	sec6	0.0	0.0	0.3	3.1	0.7	42.0	3.9	1.8	0.0	0.0	0.0	0.0	30.5	12.1	0.0
	Beverage Prod.	sec7	0.0	0.0	0.0	0.0	0.2	0.3	3.2	0.0	0.0	0.0	0.1	0.0	15.1	3.3	0.0
	Mining, Material Prod.	sec8	2.3	4.9	0.7	1.9	0.7	13.8	12.3	495.6	206.1	169.6	37.5	31.0	3.4	139.0	2.2
	Machine	sec9	0.0	0.0	0.0	0.0	0.8	0.1	0.1	3.5	498.5	12.6	3.5	10.1	0.4	81.6	0.0
	Construction, Water, Waste Treatment	sec10	0.1	0.3	0.2	0.2	0.0	1.2	0.8	16.8	5.9	10.2	43.4	11.7	5.4	43.5	12.9
	Commerce, Finance, Insurance	sec11	1.3	2.8	1.5	2.6	1.2	25.3	5.6	86.2	94.7	54.9	199.6	68.8	29.1	156.7	14.8
	Transport, Telecommunication	sec12	1.0	2.1	1.9	2.1	0.7	9.9	2.6	48.9	39.1	50.9	131.2	123.9	8.9	155.8	13.3
	Catering	sec13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Other Sevice	sec14	0.6	1.3	0.3	3.0	0.3	9.5	4.6	79.6	126.3	63.8	143.3	144.5	8.2	197.0	22.0
	Energy	*ENG*	0.4	0.9	0.3	0.8	1.4	4.6	1.1	62.5	16.3	14.8	23.1	62.7	5.9	41.8	159.4
Factors	Capital	*KZ*	4.2	6.8	4.9	15.7	5.2	29.7	15.7	131.2	93.7	61.2	883.3	175.7	25.0	439.3	50.3
	Labor	*LZ*	4.3	11.4	2.6	6.8	3.0	37.1	8.8	204.0	227.5	248.4	560.3	285.0	61.2	925.4	25.5
	Land	*AZ*	2.2	4.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Household		*CZ*															
Government		*CGZ*															
Taxes	T on commodities	*TRCZ*	0.3	0.6	0.1	1.4	0.1	6.8	2.3	3.7	6.1	0.8	44.0	9.9	8.0	22.1	4.4
	T on Labor	*TRLZ*	0.3	0.7	0.2	0.4	0.2	2.3	0.5	12.4	13.8	15.1	34.0	17.3	3.7	56.1	1.5
	T on Capital	*TRKZ*	0.2	0.4	0.3	0.9	0.3	1.7	0.9	7.5	5.4	3.5	50.8	10.1	1.4	25.3	2.9
	T on Energy	*TREZ*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	T on value added	*TRVZ*	0.5	1.2	−0.1	12.6	0.2	−6.1	14.1	22.7	10.8	17.5	−13.6	16.0	−4.4	−1.2	47.8
	Tariffs	*TRMZ*	0.3	0.7	0.1	4.1	0.3	5.4	1.0	12.7	9.4	0.0	0.0	0.1	0.0	0.0	13.7
	T on Income	*TRYZ*															
Savings	Government	*IGZ*															
	Private	*IKZ*															
		ISZ															
ROW		ROW	4.9	10.4	0.4	7.2	2.9	37.5	3.9	169.0	183.4	0.0	12.1	43.8	9.1	43.5	149.2

Table A2 SAM data (continue)

$ billion		Factors of Production			Household Consump-tion	Govern-ment consump-tion	Taxes							Investment			ROW
		Capital	Labor	Land			T on commo-dities	T on Labor	T on Capital	T on Energy	T on Value added	Tariffs	T on Income	Public	Private	Inventory	
		KZ	*LZ*	*AZ*	*CZ*	*CGZ*	*TRCZ*	*TRLZ*	*TRKZ*	*TREZ*	*TRVZ*	*TRMZ*	*TRYZ*	*IGZ*	*IKZ*	*ISZ*	ROW
Sectors	sec1				8.0	0.0								0.0	0.1	0.0	0.1
	sec2				17.2	0.0								0.0	0.3	0.0	0.1
	sec3				2.1	0.0								0.0	1.6	0.1	0.0
	sec4				38.2	0.0								0.0	0.0	6.7	0.3
	sec5				3.9	0.0								0.0	0.0	0.0	0.4
	sec6				182.8	3.3								0.0	0.0	1.8	2.1
	sec7				61.0	0.0								0.0	0.0	1.1	0.2
	sec8				98.9	0.1								−0.1	7.3	6.6	130.5
	sec9				163.2	0.0								12.1	327.7	4.8	418.6
	sec10				21.6	6.3								205.4	335.8	0.0	2.4
	sec11				1184.2	0.4								4.1	123.6	2.0	92.9
	sec12				265.9	−0.4								11.1	81.1	0.6	60.0
	sec13				216.1	0.0								0.0	0.0	0.0	2.4
	sec14				595.9	900.7								5.6	22.5	0.0	18.4
	ENG				117.8	0.0								0.0	0.0	−3.0	9.2
Factors	*KZ*																
	LZ																
	AZ																
Household	*CZ*	1941.9	2611.4	6.9													
Government	*CGZ*						110.6	158.3	111.7	0.0	117.9	47.7	535.4				
Taxes	*TRCZ*																
	TRLZ																
	TRKZ																
	TREZ																
	TRVZ																
	TRMZ																
	TRYZ				535.4	0.0											
Savings	*IGZ*				66.9	171.3											
	IKZ				960.4	0.0											−60.6
	ISZ				20.7	0.0											
ROW	ROW																

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農業政策の評価のための応用一般均衡モデルの構造

國光洋二

要　約

2000 年代に入り，農家の戸別所得補償やストックマネジメントといった新しい政策が導入される中，これら農業政策を評価するため、現実の状況を再現でき，経済理論と整合性の高いモデルが必要と考えられる．本研究の目的は，日本の農業政策の評価のために開発した応用一般均衡モデルの構造を詳細に説明することにある．このモデルの特徴は，第 1 に，農業生産において重要である農地を生産要素として考慮するとともに，農地と他の生産要素（労働，資本）の代替の弾力性が限定的であるという実証研究の結果を考慮したモデル構造としていること，第 2 に，人間生活にとって欠かすことのできない食料消費と他の財・サービスの消費の代替性が低いことや，消費において守られるべき最低限の水準があることを考慮した消費構造としていること，第 3 に，資本の蓄積過程を通じた農業生産の変化を評価するため，逐次動学体系になっていること，等である．このモデルを用いることにより，農業政策の影響を価格と生産の両面から，時系列的に見ることが可能となる．

キーワード : 生産要素，代替弾力性，逐次動学体系，資本，労働，農業生産，均衡価格，均衡数量