Integrating Economics and Natural Sciences

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1. Evaluation of introducing new technologies, such as GM (Genetic Modification)

Comprehensive evaluation of longer-term costs and benefits, including economic feasibility combined with health and environment factors, is needed.

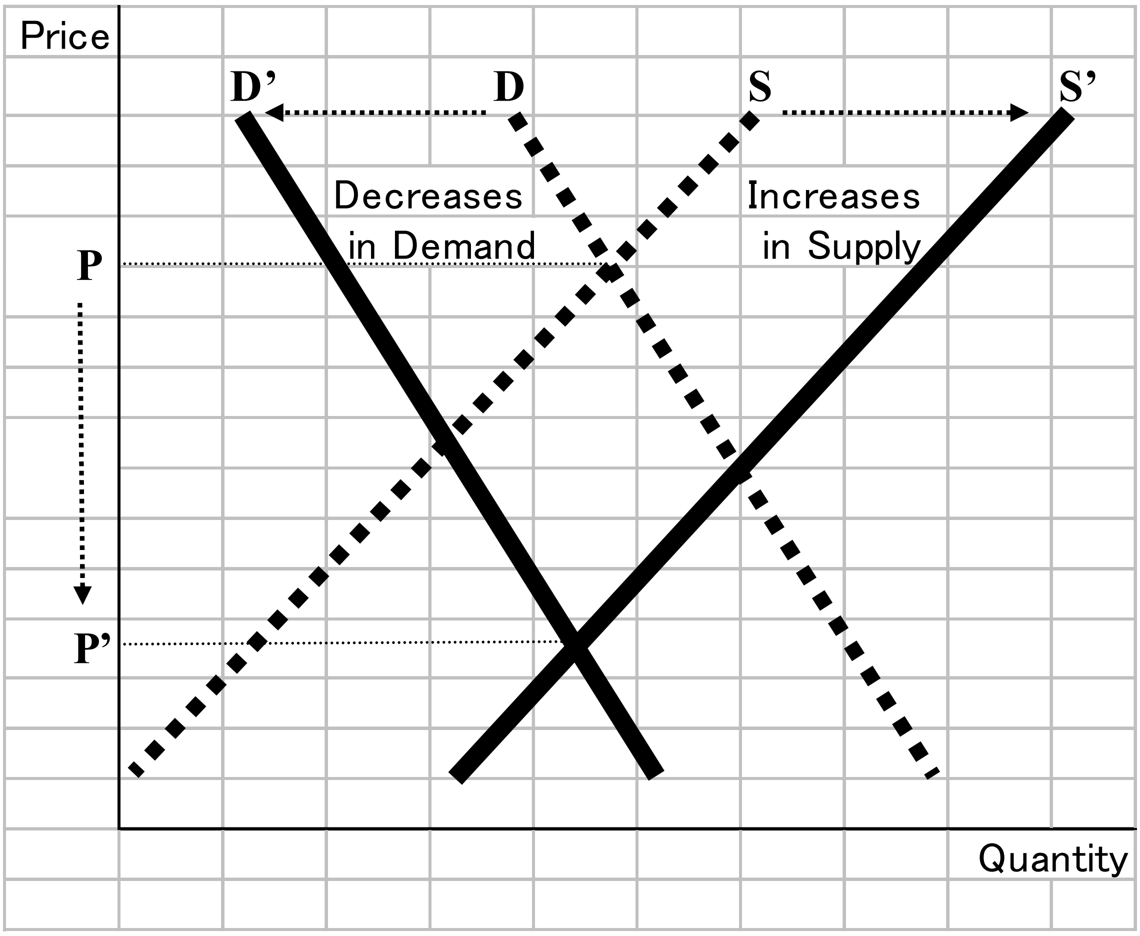
Cochrane(1959) *Theory of Treadmill*

New technology adoption→decrease in costs→decrease in price→no increase in income

=increase in supply

Especially about GM,

1) Small investment costs→speedy adoption→more supply increase→more price drop
2) Consumers' concern related to health and environment→possible demand decrease→more price drop



Example:

Comprehensive evaluation of adoption of rbST (recombinant bovine somatotropin developed by Monsanto using the GM technology), based on both social and natural sciences

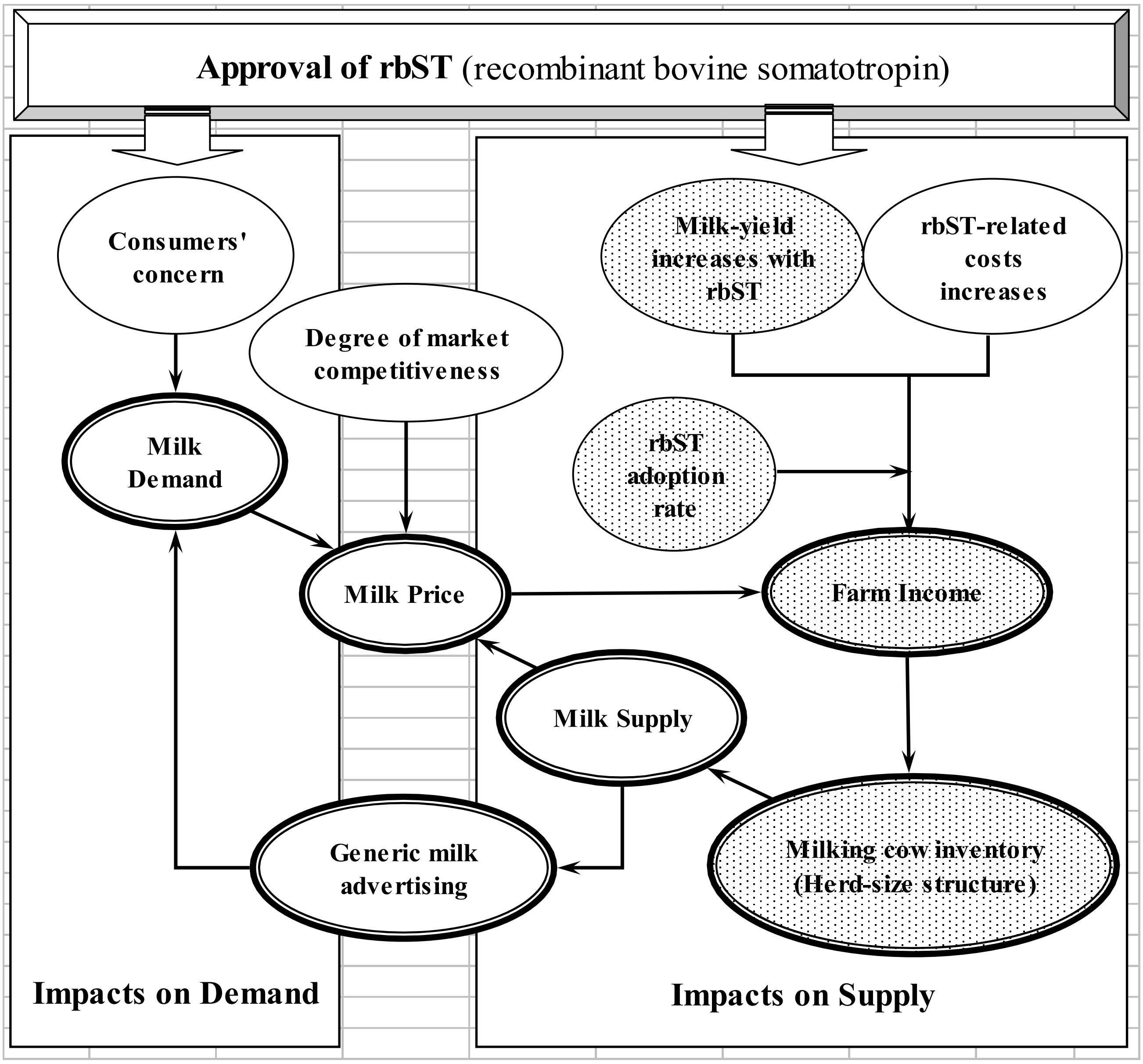


Figure 1. Basic flowchart of the rbST-model

Notes: A circle means exogenous, a double circle means endogenous, and a dotted means to have different values among herd-size cohorts.

Larger farmers are more positive than small farmers in adopting new technology.→different adoption rate by herd size.

Table 4. Differences in the key parameters' assumptions among scenarios

Scenario number	Demand decrease rates[c]	Adoption rates of rbST[d]	Market competitiveness	Milk advertising check-off money
(No-rbST baseline[a])				
Scenario 0	0%	0%, 0%, 0%	No change	Actual rates
(RbST scenarios[b])				
Scenario 1	0%, 0%	0%, 10%[e], 50%[e]	No change	Actual rates
Scenario 2	5%, 2.5%	*	*	*
Scenario 3	10%, 5%[e]	*	*	*
Scenario 4	*	50%[e], 50%[e], 50%[e]	*	*
Scenario 5	*	*	More competitive	*
Scenario 6	*	*	Less competitive	*
Scenario 7	*	*	*	25% lower rates
Scenario 8	*	*	*	25% higher rates

[a]Scenario 0 is used for trend projections assuming no rbST approval.
[b]Scenario 1 to 8 are assumed that rbST was approved in 2001.
[c]The rate for fluid and manufacturing milk respectively.
[d]The rate for small, middle, and large herd-size group, respectively.
[e]This is the value in 2001and thereafter increases one point every year from 2002.
* means the same as Scenario 1.

Herd-size cohorts:

Small farms (1-29 head),
Middle farms (30-49 head),
Large farms (50+ head).

rbST-related costs:

- rbST price: 13,464yen,
- Additional feed cost per milk-yield increase: 26.5yen ,
  (based on Hertnell(1995) and @120yen/$.)

Milk yield increases with rbST:

Small farms: 9%, Middle farms: 12%, Large farms: 15%.

Table 1. Simulation model

(1)[a] $H_1 = -22.232 + 0.905 H_1(\text{-}1) + 0.111\, I_1(\text{-}1)/\underline{CPI}(\text{-}1)$

(-1.66) (18.03) (1.21)

Adjusted R-squared = 0.99, DW=1.41, N = 13 (1988-2000)

(2)[a] $H_2 = 0.817 H_2(\text{-}1) + 0.275\, I_2(\text{-}1)/\underline{CPI}(\text{-}1) - 0.021\, \underline{PMEAT}/\underline{WPIF}$

(12.40) (2.53) (-1.06)

Adjusted R-squared = 0.95, DW=1.19, N = 13 (1988-2000)

(3)[a] $H_3 = 1.029 H_3(\text{-}1) + 0.311\, I_3(\text{-}1)/\underline{CPI}(\text{-}1) - 0.090\, \underline{PMEAT}/\underline{WPIF}$

(65.69) (5.75) (-4.64)

Adjusted R-squared = 0.99, DW=1.17, N = 13 (1988-2000)

(4) $Ii = P\,\underline{Yi}\left(1 + \underline{IRYi}\;\underline{ARi}\right) - \left(\underline{Ci} + ICi\;\underline{ARi}\right)$,

(5) $\underline{ICi} = \underline{ICF} + \underline{ICV}\;\underline{Yi}\;\underline{IRYi}$,

(6) $S = \sum_i Hi\,\underline{Yi}\left(1 + \underline{IRYi}\;\underline{ARi}\right) - \underline{U}$,

(7)[a] $ln\left(DM/\underline{N}\right) = 7.967 - 1.848\, ln\left(PS/\underline{CPI}\right) + 0.564\, ln\left(\underline{EXPEN}/\underline{CPI}\right)$

(1.44) (-5.45) (0.81)

$-0.003\, \underline{PCHEE}/\underline{CPI} - 0.082\underline{DY8700} - 0.121\underline{DY9000} - ln\left(1 + \underline{DDM}\right)$

(-1.35) (-1.50) (-1.82)

Adjusted R-squared = 0.93, DW=1.62, N = 20 (1981-2000)

(8)[a] $ln\left(DF/\underline{N}\right) = -5.088 - 0.210\, ln\left(PF/\underline{PGREEN}\right) + 1.107\, ln\left(\underline{EXPEN}/\underline{CPI}\right)$

(-2.00) (-1.29) (3.10)

$+0.014\underline{TEMP} + 1.825\underline{NR14} - 0.081\underline{DY8700}$

(1.51) (2.02) (-3.96)

$+0.069\, ln\left(AD(\text{-}1)/\underline{N(\text{-}1)}/\underline{CPI(\text{-}1)}\right) - ln\left(1 + \underline{DDF}\right)$

(2.17)

Adjusted R-squared = 0.91, DW=1.83, N = 20 (1981-2000)

(9) $AD = 2\,\underline{CORM}\; SM(\text{-}1) + \left(2 + \underline{COVER}\right)\underline{CORF}\; DF(\text{-}1) + \underline{GOV}$,

(10) $IMPT = DM - \underline{SM} - \underline{STOK(\text{-}1)} + \underline{STOK} + \underline{EXPT}$ until the year 2000 or

$DM = \underline{IMPT} + SM + \underline{STOK(\text{-}1)} - \underline{STOK} - \underline{EXPT}$ from the year 2001,

(11) $SM = S - DF$,

(12) $PS = PF\left(1 + \theta/\underline{\eta}\right)$,

(13) $P = \dfrac{PF\; DF + \left(\underline{PS} + \underline{DIFF}\right)\underline{MQ} + PS\left(SM - \underline{MQ}\right)}{S}$,

(14) $I = I_1 H_1 + I_2 H_2 + I_3 H_3$,

(15) $H = H_1 + H_2 + H_3$,

Notes: The underlined variable/parameter is assumed to be exogenous. (-1) indicates the value of a variable in the previous period. Subscript 1, 2 and 3 indicates small (1- 29 head), middle (30-49 head), and large (50+ head) herd-size group respectively.

[a]Numbers in parentheses under the functions are *t*-statistics. Adjusted R-squared is the adjusted coefficient of determination. D.W. is the Durbin-Watson statistics. N is the number of observations.

Table 2. Variables and parameters of the model

Symbolic Names	Definitions	Time Period	Unit	Sources
AD	Generic milk advertising expenses	FY	yen	Financial Report of the NDPRA[c]
ARi	RbST adoption rate (Percentage of rbST-injected cows to total milking-cow numbers)[a]		total =1	(Applicable from 2001 and zero until 2000.)
Ci	Cash expenses without rbST[a]	FY	yen/cow	Milk Production Costs Report, MAFF[b]
CORF	Check-off money from fluid milk	FY	yen/kg	Financial Report of the NDPRA
CORM	Check-off money from manufacturing milk	FY	yen/kg	Financial Report of the NDPRA
COVER	Percentage of fluid milk dealers who paid check-off	FY	total =1	Estimated from Equation (9).
CPI	Consumer price index for all commodities	CY	1995=100	Consumer Price Indices, The Bank of Japan
DDF	Fluid milk demand decrease rate due to rbST		total =1	(Applicable from 2001 and zero until 2000.)
DDM	Manufacturing milk demand decrease rate due to rbST		total =1	(Applicable from 2001 and zero until 2000.)
DF	Fluid milkquantity demanded, or domestic fluid milk supply	FY	kg	Food Balance Sheet, MAFF
DIFF	Government subsidy within payment quotas	FY	yen/kg	Milk and Milk Products Statistics, MAFF
DM	Manufacturing milk quantity demanded	FY	kg	Food Balance Sheet, MAFF
DY8700	Indicator for the revision of standard butterfat content	FY	1 or 0	(1 for the years from 1987 and zero otherwise.)
DY9000	Indicator for a change in milk consumption patterns	FY	1 or 0	(1 for the years from 1990 and zero otherwise.)
EXPEN	Average per capita food expenditure	CY	1,000 yen	Family Income and Expenditure Survey, Ministry of Public Management
EXPT	Exports of dairy products in raw milk equivalents	FY	kg	Food Balance Sheet, MAFF
GOV	Government subsidy for generic milk advertising	FY	yen	Financial Report of the NDPRA
H	Total milking-cow numbers	Feb.1	head	Calculated by Equation (15).
Hi	Milking-cow numbers[a]	Feb.1	head	Livestock Sattistics, MAFF
η	Own-price elasticity of fluid milk demand			Estimated from Equation (8).
I	Total farm income	FY	yen	Calculated by Equation (14).
Ii	Farm income[a]	FY	yen/cow	Statistics of Prices and Wages in Rural Area, MAFF
ICi	Cash expenses associated with rbST[a]		yen/cow	(Applicable from 2001 and zero until 2000.)
ICF	rbST price		yen/cow	(Applicable from 2001 and zero until 2000.)
ICV	Variable costs per unit of milk-yield increases with rbST		yen/kg	(Applicable from 2001 and zero until 2000.)
IMPT	Imports of dairy products in raw milk equivalents	FY	kg	Food Balance Sheet, MAFF
IRYi	Increase rate of milk yield with rbST[a]		total =1	(Applicable from 2001 and zero until 2000.)
MQ	Payment quotas for manufacturing milk	FY	kg	Milk and Milk Products Statistics, MAFF
N	Total population in Japan	Oct.1	person	Japan Statistical Yearbook, Ministry of Public Management
NR14	Percentage of the population under 14 years old in Japan	Oct.1	total =1	Japan Statistical Yearbook, Ministry of Public Management
P	Blend price paid to dairy farms	FY	yen/kg	Statistics of Prices and Wages in Rural Area, MAFF
PCHEE	CIF (cost, insurance and freight) price of imported natural cheese with tariffs in raw milk equivalents	CY	yen/kg	Japan Exports and Imports, Ministry of Finance
PF	Fluid milk price paid by processors	FY	yen/kg	Calculated by Equation (13).
PGREEN	Green tea price	CY	yen/liter	Family Income and Expenditure Survey, Ministry of Public Management
PMEAT	Carcass meat price for milking cows	CY	yen/kg	Meat Marketing Statistics, MAFF
PS	Manufacturing milk price paid by processors	FY	yen/kg	Milk and Milk Products Statistics, MAFF
θ	Degree-of-market-power parameter		$0 \leqq \theta \leqq 1$	Calibrated by Equation (12).
S	Domestic milk supply	FY	kg	Food Balance Sheet, MAFF
SM	Domestic manufacturing milk supply	FY	kg	Food Balance Sheet, MAFF
STOK	Ending stock of dairy products in raw milk equivalents	FY	kg	Food Balance Sheet, MAFF
TEMP	Average temperature in Tokyo	CY	℃	Meteorological Agency
U	On-farm milk use	FY	kg	Food Balance Sheet, MAFF
WPIF	Wholesale price index for food	CY	1995=100	Wholesale Price Indices, The Bank of Japan
Yi	Milk-yield without rbST[a]	FY	kg/cow	Milk Production Costs Report, MAFF

[a]Subscript *i* distinguishes herd-size groups (*i* =1,2,3).

[b]MAFF=Ministry of Agriculture, Forestry, and Fisheries.

[c]NDPRA=National Dairy Promotion and Research Association.

Impacts on herd-size structure.

(Results of Scenario 1)

- Milk price paid to farmers -3.8%,
- Total farm income -3.3%,
- Total milking-cow number -1.6%,
- Domestic milk supply +5.2%,
- Only the large farms benefit with the increasing cow number by +3.5% and per cow income by +6.2%.

Note: Percentages are the rates compared to Scenario 0 results.

Impacts of demand decreases.

(Results of Scenario 2 and 3)

- Milk price paid to farmers -4.1% and -4.3%,
- Total farm income -8.3% and -12.7%,
- Total milking-cow number -7.9% and -9.8%,
- Domestic milk supply +0.6% and -3.6%.

Note: Percentages are the rates compared to Scenario 0 results.

Whether small farms are better off using rbST?

(Results of Scenario 4)

The small farms' per cow income

- without rbST use (Scenario 1) -12.8%
- with rbST use (Scenario 4) -7.1%.

Note: Percentages are the rates compared to Scenario 0 results.

Table 4. Rates of return to rbST use in 2010:

Herd-size	Rate of return to rbST use[a] Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Small	0.991	0.939	0.894	0.878	0.773	1.225
Middle	1.337	1.292	1.253	1.239	1.148	1.540
Large	1.577	1.538	1.503	1.491	1.411	1.756

[a]Incremental per cow sales or a deviation from the sales in Scenario 0 divided by rbST-related per cow costs.

Table 5. Decreases in rbST profitability due to increases in rbST adoption rates:

Assumptions of rbST adoption rates for the small, middle, large farms	Rate of return to rbST use Small	Middle	Large
0%, 15%, 55%	1.136	1.469	1.699
0%, 20%, 60%	0.991	1.337	1.577
0%, 25%, 65%	0.547	0.952	1.238
0%, 30%, 70%	0.151	0.609	0.936

Notes: All assumptions other than rbST adoption rates are left as the 2010 values in Scenario 1 . The small farms' rbST adoption rate is assumed to be zero, but their rates of return to rbST use are provisionally computed.

Conclusions

- The rbST approval accelerates structural changes in Japan's dairy production toward fewer and lager farms.

- If Japan's dairy cooperatives can exercise greater market power, it is one effective way to counter the losses in farm income due to rbST approval.

- rbST is profitable for large farms, while it becomes less and less profitable for smaller farms along with the increasing rbST use in large farms.

2. **Agricultural Trade and Environment**
   How to incorporate environmental effects into trade models

Regarding TPP (Trance Pacific Partnership)

US professor→
Agriculture (1% GDP) lose
Other (99% GDP) benefit
Do not sacrifice 99% in order to protect only 1% agriculture.

Lori Wallach, Public Citizen→
Wrong.
1% protect 100% consumers.
Food security
Food safety
Environment
Local Community

Multi-functionality = external economy

Professor Stiglitz
TPP = Rule making to concentrate more money to 1% multinational company from other 99% people

1% Global companies gain
Other 99% lose

Rent seeking

Trickle-down (1% to 99%) is false
1% is thinking "99% to 1%".
Leveling the playing field or **equal footing** = more money to 1%
Sometimes, not deregulation but more regulation
Extension of medicine data protection periods is not deregulation.

ISDS
Global company's benefits > human health and environment
If regulations to protect health and environment decrease the company's profits, the loss has to be compensated.

Damage to health and environment = **external diseconomy**

Costs of external diseconomy have to be paid by the company itself = theory of economics, but not under ISDS

US president
Government get huge money from global companies like
Republican Monsanto, Pfizer, Philip Morris
Supported by Chicago school of economics
Milton freedman

Democrat supported by workers union, citizen's organization, environmentalists
supported by Stiglitz, Krugman

All of US president candidates are against TPP.
Pro-TPP people The current version is not enough
Unti-TPP people TPP is worse than expected.

Thus, evaluating effects of trade liberalization by narrow economic models is dangerous.
We should incorporate external effects (both positive and negative = external economy and external diseconomy) into our evaluation model.

Example:
Rice trade liberalization under a China-Korea-Japan FTA (Free Trade Agreement)

Model:
[1] Japan's rice supply: $Sj = 888.9\ (Pj / 269.3)^{1.173}$
[2] Japan's rice demand: $Dj = 899.5\ (Pj / 269.3)^{-0.01}$
[3] Japan's rice import: $Ij = Dj - Sj$
[4] Japan's rice price: $Pj = (Pc + 6.36) \times 6.3275$
[5] Korea's rice supply: $Sk = 668.7\ (Pk / 193.4)^{0.35}$
[6] Korea's rice demand: $Dk = 676.1\ (Pk / 193.4)^{-0.20}$
[7] Korea's rice import: $Ik = Dk - Sk$
[8] Korea's rice price: $Pk = (Pc + 2.89) \times 4.9476$
[9] China's rice supply: $Sc = 17634\ (Pc / 36.2)^{0.2}$
[10] China's rice demand: $Dc = 17616\ (Pc / 36.2)^{-0.12}$
[11] China's rice export: $Xc = Sc - Dc$
[12] China's rice price: $Pc = Pc\ (Dj + Dk + Dc) / (Sj + Sk + Sc)$
[13] Japan's total nitrogen absorption capacity in domestic farm land:
$Nmax = 1270 - (888.9 - Sj)/532 \times 250$
[14] Supply of food-derived nitrogen into Japan's environment:

$$N=2378+(Dj-899.5)\times 0.103\times 0.16-(888.9-Sj)/532\times 110$$

Where, 6.36=unit transportation cost from China to Japan, 2.89=unit transportation cost from China to Korea, 6.3275 means Japan's effective rice import tariff is 532.75%, 4.9476 means Korea's effective rice import tariff is 494.76%

We examined external effects including changes in nitrogen load, food miles, and virtual water. In Japan, population density is so high that the amount of nitrogen released into the environment is already excessive. According to a report released in 2004 by Japan's National Institute for Agro-Environmental Services (in Japanese), the maximum nitrogen level which Japan's farm land can circulate properly (the total farm land nitrogen capacity) is about 1,237 thousand tons (250kg/ha), while the domestic food-derived nitrogen supply is 2,379 thousand tons in 1997. The ratio of food-derived nitrogen supply to total farm land capacity is already 192%.

For our simulation analysis, the total nitrogen capacity in domestic farm land (*Nmax*) is calculated by:

$$Nmax=1237.3-(888.9-S)/532\times 250,$$

where S is Japan's annual rice production (888.9 thousand tons in 2002). A decrease in rice production ($888.9-S$) is divided by an average rice yield (532kg/10a in 2002) to get a decrease in farm land, and then it is multiplied by the per unit domestic farm land nitrogen capacity (250kg/ha) to get the value of *Nmax*. It is assumed that the diminished farm land is transformed into urban land and the urban land nitrogen capacity is zero. Domestic supply of food-derived nitrogen (N) is calculated by:

$$N=2379+(D-931.3)\times 0.0683\times 0.168\times 10-(888.9-S)/532\times 110,$$

where D is Japan's annual rice demand for direct consumption (931.3 thousand tons in 2002). A rice demand increment ($D-931.3$) is multiplied by protein content of rice (6.83%) and the nitrogen-to-protein conversion factor (16.8%) (Shindo et al., 2003) to get the total food-derived nitrogen supply, and then a decrease in fertilizer-derived nitrogen supply is subtracted to get the value of N. Nitrogen fertilizer input of rice farming is 110kg/ha according to a report by Japan's Ministry of Agriculture. The ratio of food-derived nitrogen supply to total farm land capacity is defined by $N/Nmax$.

The definition of food miles is: imports (ton) multiplied by transportation distance (km). This is an indicator of environmental load of energy consumption associated with food trade.

Virtual water is an indicator of changes in water demand/supply balance associated with substitution between domestic production and import of food. Oki et al. (2003) estimated that we need additionally 3,600 m^3 of water per ton per year if imported rice is replaced by domestic production in Japan.

The simulation results regarding market impacts, economic welfare, and environmental indicators are shown in Table 4, 5 and 6, respectively.

The results about market impacts (Table 4) showed that rice price significantly decrease except in the Japan-Korea FTA. In this analysis, these impacts can be somewhat overestimated with assumptions on Japan's highly elastic rice supply and perfect substitution between domestic and imported rice consumption. Nevertheless, the results sufficiently represent that the East Asian FTA and the WTO cases could have destructive impacts on Japan's rice production.

Japan's self-sufficiency rates of rice decline to unacceptable levels, 1.4 and 1.7%, in the East Asian FTA and the WTO cases, respectively.

The results about economic welfare (Table 5) showed that Japan will not gain in the Japan-Korea FTA. That's because rice price decrease only slightly while lost tariff revenues from China and the U.S. are larger. On the other hand, in the other two cases, Japan will gain nearly one trillion yen because free trade with China and the U.S. will hugely decrease rice price and increase consumer surplus. Interestingly, in these two cases, China and the U.S.'s gains derived from increases in exports are considerably small. That's because each country's consumer surplus shrinks due to increased rice price.

The results about environmental loads (Table 6) showed that the *N/Nmax* ratio, currently 192%, would increase to almost 266% either under the East Asian FTA or under the WTO. That's because farm land capacity sharply reduced by a decrease in domestic paddy fields but fertilizer-derived nitrogen supply decreased less.

The results of food miles showed that trade liberalization under the WTO would be the most energy-consuming regarding transportation, more than ten times the current food mile level. The East Asian FTA would also considerably increase food miles, about seven times the current level.

About 33 km^3 of virtual water trade, more than twenty times the current revel, would be generated either with the East Asian FTA or with the WTO cases. Increases in virtual water trade might cause water shortage in exporting countries.

As described above, our simulation results indicated that both the East Asian FTA and global free trade could similarly increase Japan's economic welfare, but severely increase environmental loads. Another point is that simulation results of the East Asian FTA and the WTO cases are very similar. The East Asian FTA will generate severe damage to Japanese and Korean agriculture because there are currently huge gaps in production costs between Japan/Korea and China.

Table 3. Data for rice supply, demand, and food miles.

Liner Supply Functions (in million tons, yen/kg)					
	Supply	Price Elasticity	Price	Slope	Intercept
Japan	8.889	1.173	269.3	3.87	-153.8
Korea	6.687	0.35	193.4	1.21	434.7
China	176.340	0.2	36.2	97.43	14107.2
U.S.	10.470	0.2	36.2	5.78	837.6
Exports (in thousand tons)					
	To Japan	To Korea	To China	To U.S.	Total
Japan	-	0	-106	-318	-424
Korea	0	-	-74	0	-74
China	106	74	-	0	180
U.S.	318	0	0	-	318
Liner Demand Functions (in million tons, yen/kg)					
	Demand	Price Elasticity	Price	Slope	Intercept
Japan	9.313	-0.01	269.3	-0.0346	940.6
Korea	6.761	-0.20	193.4	-0.699	811.3
China	176.160	-0.12	36.2	-58.40	19729.9
U.S.	10.152	-0.28	36.2	-7.85	1299.5
Distance Parameters for Food Miles					
	Japan	Korea	China	U.S.	
Japan	0	1.953	3.006	13.053	
Korea	1.953	0	1.371	14.097	
China	3.006	1.371	0	15.483	
U.S.	13.053	14.097	15.483	0	

Source: Hokazono (2006), Maeda and Kano (2005) and Suzuki (2006).

Note: The U.S. rice price, a yen equivalent of the target price under the 2002 Farm Bill, was almost the same as China's.

Table 4. Estimated impacts of WTO and FTAs on rice markets:
Supply, demand, and prices.

Variables		Unit	Actual	Japan-Korea FTA	Japan-Korea-China FTA	WTO
Japan	Supply	1,000t	8,889	8,256	161	131
	Demand	1,000t	9,313	9,319	9,391	9,391
	Self-sufficiency rate	%	95	89	2	1
	Market price	yen/kg	269	253	44	43
	Imports from China	1,000t	106	0	9,230	9,260
	Imports from the U.S.	1,000t	318	0	0	0
	Imports from Korea	1,000t	0	1,063	0	0
	Total imports	1,000t	424	1,063	9,230	9,260
Korea	Supply	1,000t	6,687	7,408	4,878	4,868
	Demand	1,000t	6,761	6,345	7,806	7,812
	Self-sufficiency rate	%	99	117	63	62
	Market price	yen/kg	193	253	44	43
	Imports from China	1,000t	74	0	2,929	1,684
	Imports from the U.S.	1,000t	0	0	0	1,260
	Total imports	1,000t	74	0	2,929	2,944
	Exports to Japan	1,000t	0	1,063	0	0
China	Supply	1,000t	176,340	176,227	183,829	183,070
	Demand	1,000t	176,160	176,227	171,671	172,126
	Self-sufficiency rate	%	100	100	107	106
	Market price	yen/kg	36	36	44	43
	Exports to Japan	1,000t	106	0	9,230	9,260
	Exports to Korea	1,000t	74	0	2,929	1,684
	Total exports	1,000t	180	0	12,158	10,944
U.S.	Supply	1,000t	10,470	10,335	10,335	10,870
	Demand	1,000t	10,152	10,335	10,335	9,610
	Self-sufficiency rate	%	103	100	100	113
	Market price	yen/kg	36	34	34	43
	Exports to Japan	1,000t	318	0	0	0
	Exports to Korea	1,000t	0	0	0	1,260
	Total exports	1,000t	318	0	0	1,260

Table 5. Estimated impacts of WTO and FTAs on rice markets:
Changes in economic welfare. (billion yen)

Variables		Japan-Korea FTA	Japan-Korea - China FTA	WTO
Japan	Consumer surplus	152.36	2108.06	2115.38
	Producer surplus	-140.20	-1020.04	-1020.16
	Government revenue	-98.83	-98.83	-98.83
	Total surplus	-86.67	989.18	996.39
Korea	Consumer surplus	-390.19	1089	1095.09
	Producer surplus	419.63	-864.53	-868.33
	Government revenue	-11.63	-11.63	-11.63
	Total surplus	17.81	212.84	215.13
China	Consumer surplus	20.35	-1336.92	-1202.92
	Producer surplus	-20.36	1384.34	1241.34
	Government revenue	0	0	0
	Total surplus	-0.01	47.42	38.42
U.S.	Consumer surplus	23.89	23.89	-68.25
	Producer surplus	-24.26	-24.26	73.70
	Government revenue	0	0	0
	Total surplus	-0.37	-0.37	5.45

Table 6. Estimated impacts of free trade under FTAs and WTO on rice markets: Changes in environmental indicators.

Variables		Unit	Actual	Japan-Korea FTA	East Asian FTA	WTO
Japan	Water-use inefficiency: Virtual water	km^3	1.5	3.8	33.2	33.3
	Nitrogen accumulation increase:					
	Total nitrogen capacity of farm land (A)	1,000t	1237.3	1207.5	827.2	825.8
	Domestic food-derived nitrogen supply (B)	1,000t	2379	2366	2199.4	2198.8
	B/A	%	192.3	195.9	265.9	266.3
	Deprivation of biodiversity:					
	Tadpole shrimp	million	4,456	4,138	81	66
	Tadpole	million	38,987	36,209	708	576
	Red dragonfly	million	371	345	7	5
World total	Transportation energy consumption: Food miles	points	457.1	207.6	3175.9	4790.6

Source: Estimates by Suzuki and Kinoshita.

3. Estimation of global warming effects on agricultural production including by economic factors

Example: The analysis of the impacts of climate change on maize yields in the U.S. and China

Examining the impacts of climate change on maize yields with only climatic factors considered should overestimate the true effects of climate change on maize yields. Moreover, technology improvement over the long term may mitigate the negative impacts of climate change on maize yields. Thus, the model developed for this study analysis differs from many previous models in that it accounts for regional climatic, geographic, and economic differences. This study also differs from others in that the analysis includes the consideration of the combined effects of climate variables, economic variables, and technology improvement variable on maize yields.

Linkages among climatic, economic, technology improvement and maize yield components in the model to analyze the impacts of climate change on maize yields and their relationships are illustrated in Figure 7. Temperature and precipitation as the two main climatic factors that are directly altered by climate change and correspond to the growing and developing time of maize crop are chosen for consideration in the model.

The "CO_2 fertilizer effect" which could possibly enhance maize yields with elevated atmospheric CO_2 concentration is a controversial topic among scientists, and how the interactions of this effect with other environmental factors work is also uncertain (Kaiser et al., 1993; Kaiser and Crosson, 1995). Furthermore, yield enhancement effects brought by an increased level of atmospheric CO_2 concentration are often examined under a controlled experimental environment where an extremely high concentration of CO_2 closes to the examined crop plants is released. Thus, under the current climate condition where the atmospheric CO_2 concentration is not extremely high, analyzing the links between CO_2 and maize yields is difficult. Based on these reasons, CO_2 fertilizer effect is assumed to have no enhancing effects on maize yields in this case study.

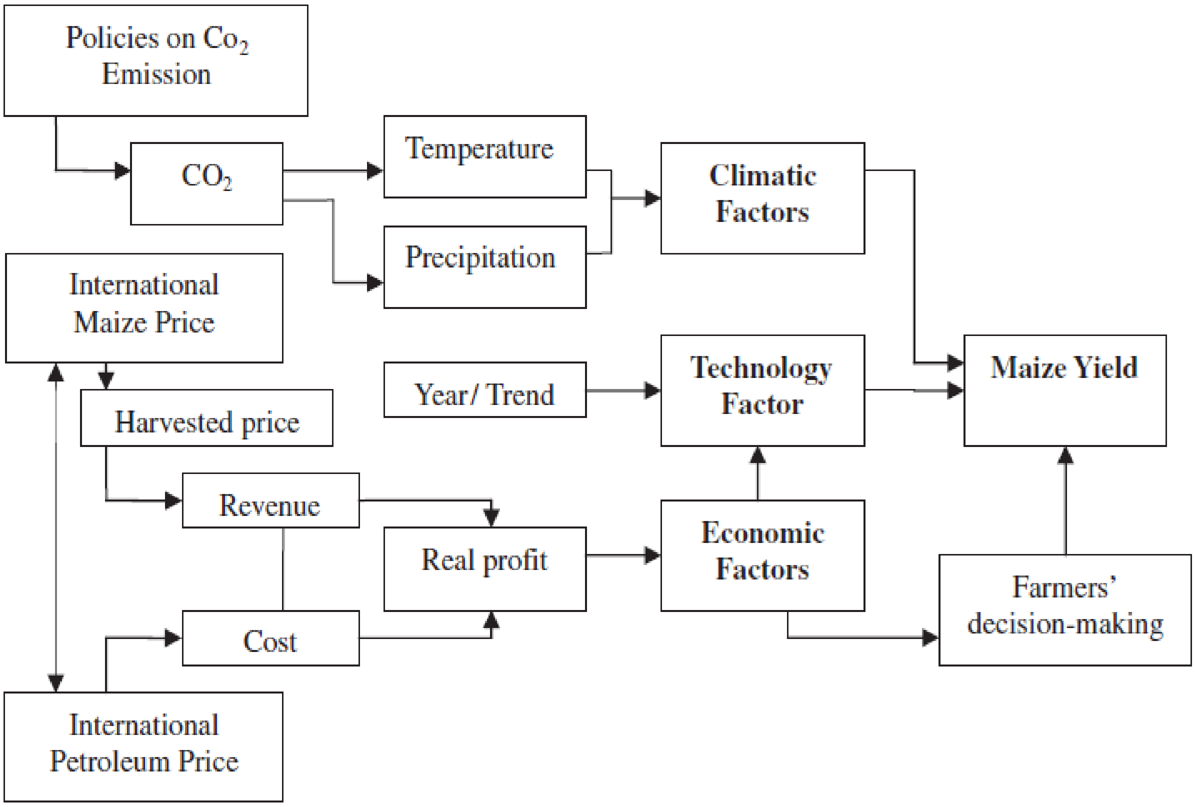


Figure7. The structure of the empirical model in this study

Equation

$\ln(Y) = c + d \cdot TECH + e \cdot \ln(\Pi) + f \cdot (Tp \cdot 0.5 + Tv \cdot 0.5) - g \cdot (Tp \cdot 0.5 + Tv \cdot 0.5)^2 + h*(Rp \cdot 0.5 + Rv \cdot 0.5) - i \cdot (Rp \cdot 0.5 + Rv \cdot 0.5)^2$

where

Y = maize yield expressed as bushel/acre

c, d, e, f, g, h, i = coefficient variables

TECH = Technology adaptation

Π= Average real profit in previous years

Tp = Temperature corresponds to the planting season of maize

Tv = Temperature corresponds to the key growing season of maize (vegetative stage, silking stage, and grain-filling stage)

Rp = Precipitation corresponds to the planting season of maize

Rv = Precipitation corresponds to the growing season of maize (vegetative stage, silking stage, and grain-filling stage)

Table 9. Description about 9 scenarios applied to the projections

Staying at 2000 level *Scenario1.* Staying at 368 ppm CO_2 concentration level in 2030 (2000 level)	For future prediction, -2000 level temperature (average of 1988-2002) -2000 level precipitation (average of 1988-2002) - Economic component stays at exactly current level (2007 level) - Technology improvement (e.g., year 2007= 2007)
Optimistic *Scenario2 (increase)/ Scenario3 (decrease).* Staying at 420ppm CO_2 concentration level in 2030	For future prediction, - 0.46℃ temperature increases (above 2000 level)[7] - 2.5% precipitation increases/ decreases (above /below 2000 level) - Economic component stays at exactly current level (2007 level) - Technology improvement (e.g., year 2007= 2007)
Moderate *Scenario4 (increase)/ Scenario5 (decrease).* Staying at 462.5 CO_2 concentration level in 2030	For future prediction, - 0.86℃ temperature increases (above 2000 level) [7] - 5% precipitation increases/ decreases (above/ below 2000 level) - Economic component stays at exactly current level (2007 level) - Technology improvement (e.g., year 2007= 2007)
Pessimistic *Scenario6 (increase)/ Scenario7 (decrease).* Staying at 527.5 ppm level in 2030	For future prediction, - 1.46℃ temperature increases (above 2000 level) [7] - 10% precipitation increases/ decreases (above/ below 2000 level) - Economic component stays at exactly current level (2007 level) - Technology improvement (e.g., year 2007= 2007)
Extreme *Scenario8 (increase)/ Scenario9 (decrease).* Staying at 527.5 ppm level in 2030	For future prediction, - 1.46 ℃ temperature increases (above 2000 level) [7] - 30% precipitation increases/decreases (above/ below 2000 level) - Economic component stays at exactly current level (2007 level) - Technology improvement(e.g., year 2007= 2007)

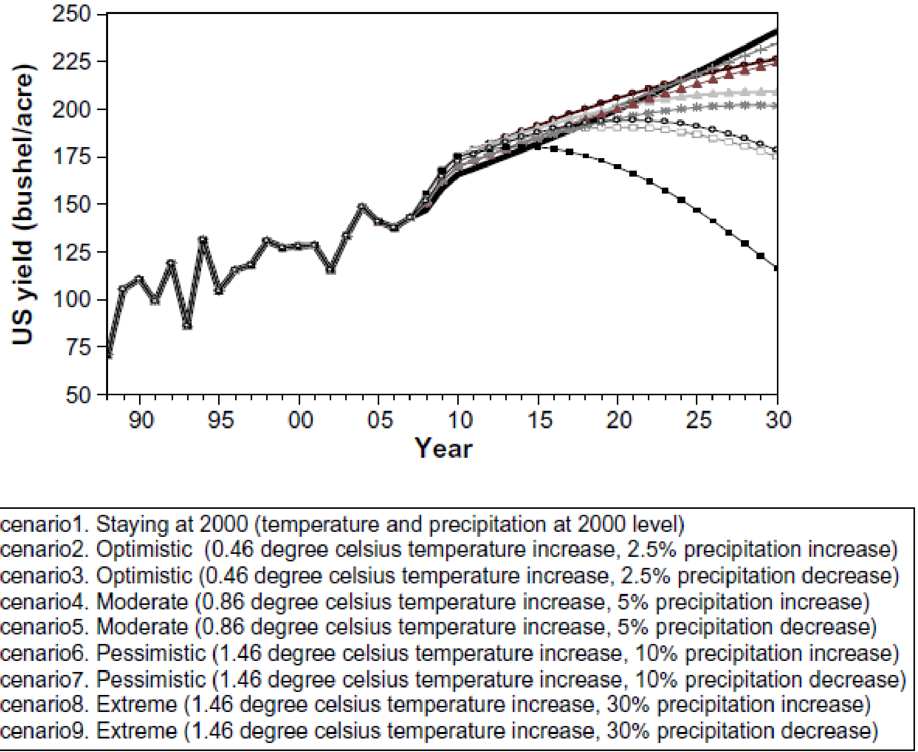
Results

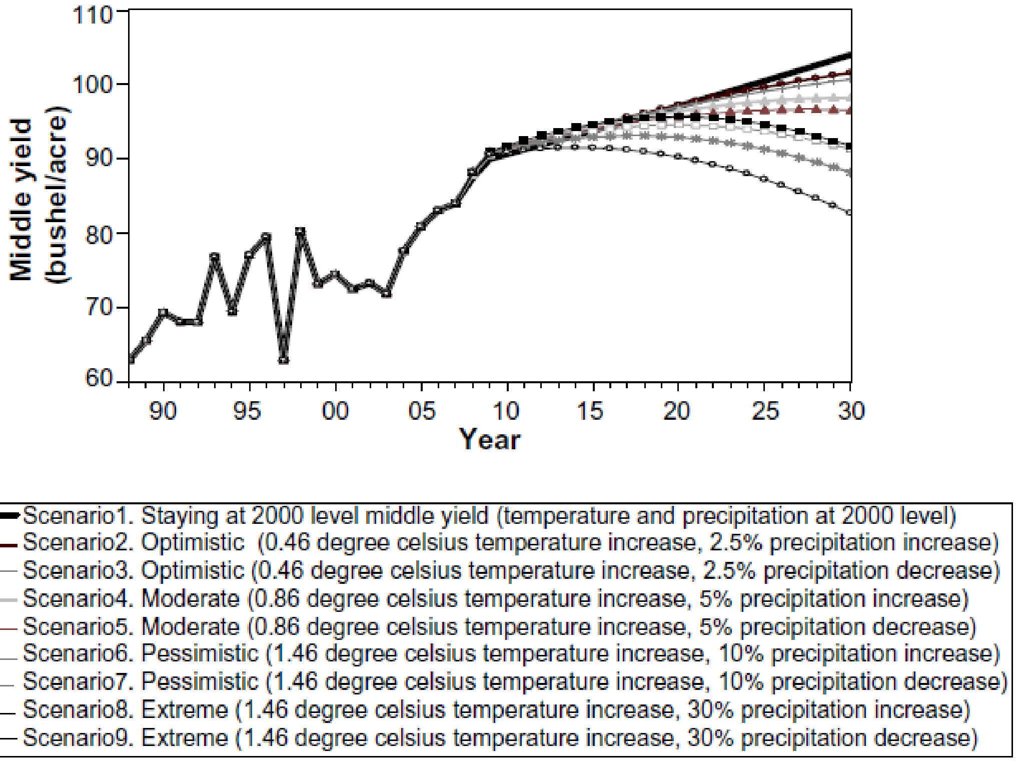
Table 10. Regression results of the Midwestern United States and Middle China

(1988-2007)

Explained variable, ln (yield)	The Midwestern United States	China Middle
Explanatory variables	Coefficient (*t*-values)	Coefficient (*t*-values)
Constant	−50.89138 (−4.85)	−33.61903 (−1.60)
TECH	0.018731 (3.97)	0.00689 (3.21)
$\ln(\prod)$	0.190611 (2.13)	0.18756 (2.31)
$(Tp{\cdot}0.5 + Tv{\cdot}0.5)$	1.786139 (1.81)	1.85333 (1.11)
$(Tp{\cdot}0.5 + Tv{\cdot}0.5)^2$	−0.053987 (−1.83)	−0.03860 (−1.12)
$(Rp{\cdot}0.5 + Rv{\cdot}0.5)$	0.059630 (1.97)	0.00905 (2.43)
$(Rp{\cdot}0.5 + Rv{\cdot}0.5)^2$	−0.000337 (−2.20)	−0.00004 (−2.14)
R squared	0.85	0.80
Adjusted R squared	0.76	0.69
D.W.	2.91	2.10

Simulation





Implications

The results in this simulation show that under severe climate change, changes in maize yields are not uniform throughout the world.

When the impacts of climate change on maize yields are analyzed with and without the consideration of further technology progress over the period 2008-2030, simulation results were found to be opposite in the Midwestern United States and Middle China. Under the same climate change scenario, an increase in both temperature and precipitation was found to have larger negative impacts on maize yields in the Midwestern United States (Scenario 8); an increase in temperature with a decrease in precipitation instead was found to have larger negative impacts on maize yields in Middle China (Scenario 9).

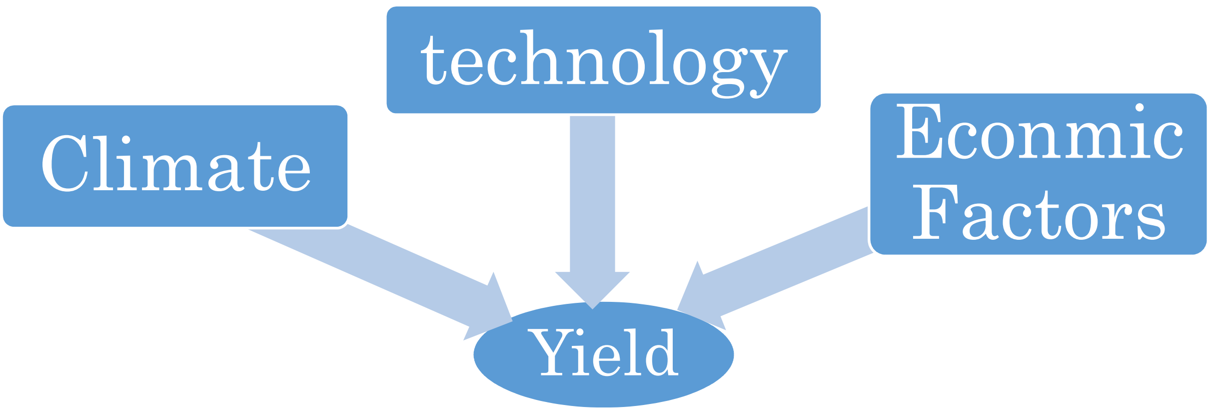
In the Midwestern United States, annual accumulated precipitation amount at 2000 level is already at its relatively higher level (834.46 mm), and the soil moisture content is the Midwestern United States is also abundant. Thus, water is not a limiting factor in this region. A further increase in precipitation in the near future would bring waterlogging issues to the land and causes damages to maize yields. Such a result corresponds to the result found by Rosenzweig *et al* (2002). Thus, the magnitude of the negative impacts of climate change on maize yields can be mitigated under the scenarios where a decrease in precipitation accompanied with an increase in temperature occurs.

Due to the geographic, climatic, and cultural differences between two regions, Middle

China usually has a relatively higher average temperature in summer, and the planting schedule of maize is behind that in the Midwestern United States. During the growing season of maize in summer, high temperature can quickly increase soil water evaporation rates. Thus, when the water is not adequately provided, water deficiency can become problems and starts to affect maize yields (He 2009). Furthermore, agriculture style in Middle China is highly weather-dependent. Source of water for agricultural use mainly comes from precipitation (He 2009). Thus, water availability during the hot summer plays an important role in controlling the magnitude of the water deficiency problems, which in turn becomes a key element to maize yields. Thus, an increase in both temperature and precipitation was found to have a better effect on maize yields in Middle China, opposite to that in the Midwestern United States.

Example 2:

Explaining Japan's regional rice yield by both technical and economic factors, and considering how to mitigate negative effects of global warming by switching technology



Data 1988～2007

Y= Yield per 10a（kg）

T= Average Temperature in August and September

RP=Average rice price index of past three years

F=Fertilizer quantity index

TR =Trend (1988～2007, proxy variable for technological improvements)

Regression results for Hokkaido

$Y=19004+479T-12.2T^2-0.36RP-1891\log F-9.80TR$

Then, by fixing RP＝ 103.1, log(F)＝1.81,TR＝2007, the function with Y and T in 2007 is generated.

Estimated Maximum Yields and Temperatures by region

Hokkaido	19.6℃	566kg	Kinki	26.2℃	505kg
$Y=-4135+479T-12.2T^2$			$Y=-3886+335T-6.39T^2$		
Tohoku	23.1℃	558kg	Chugoku	26.0℃	478kg
$Y=-11390+1037T-22.5T^2$			$Y=-6620+546T-10.5T^2$		
Hokuriku	25.9℃	532kg	Shikoku	27.0℃	484kg
$Y=-2760+254T-4.9T^2$			$Y=-5601+450T-8.32T^2$		
Kanto・Tozan	25.1℃	536kg	Kyushu	27.2℃	437kg
$Y=-4475+402.7T-8.09T^2$			$Y=-10723+821T-15.1T^2$		
Tokai	26.3℃	508kg			
$Y=-5637+468T-8.91T^2$					

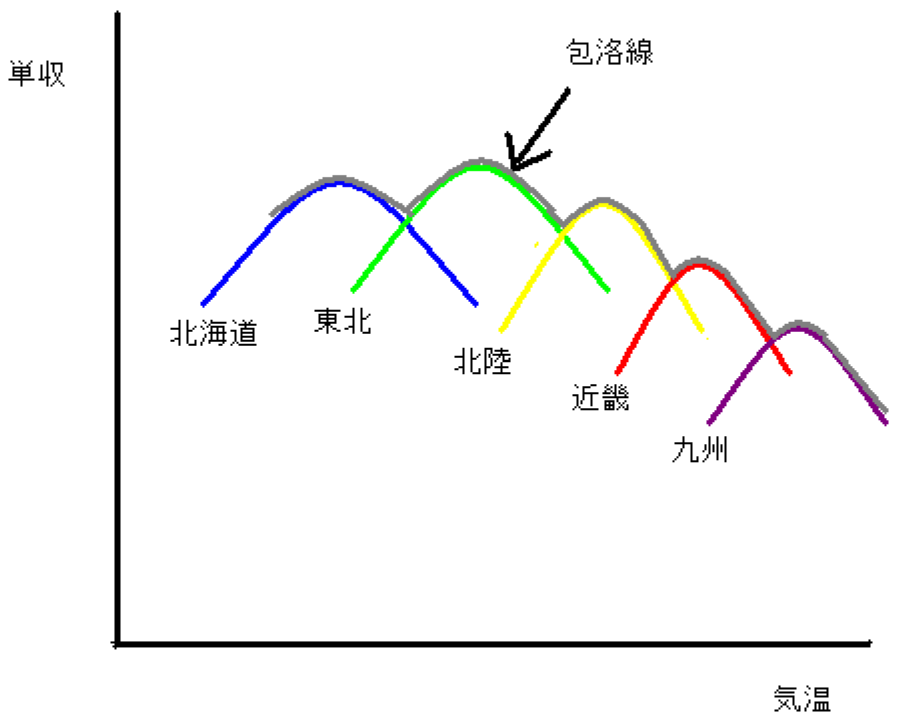


図　品種･技術の移行による温暖化への最適対応

The maximum yield and temperature differs by region.
In the northern regions, their maximum yields are realized by lower temperatures.
In case of global warming, Hokkaido can mitigate negative effects by switching the farming practice to Tohoku→Hokuriku→Kinki→Kyushu by following the **Envelope Curve**.

4. Skepticism about the major development economics
For whom are development policies?

In 2008, many researchers pointed out that rising food prices must be good news for farmers in developing countries.
However, it was wrong.
Why?
Export prices rose much, but prices paid to farmers did not rise much
Prices of fertilizers and pesticides rose much.
Why?
Exporters and middlemen have monopsony/oligopsony power over farmers and they pay unfairly low output prices to farmers.
In addition, they have monopoly/oligopoly power over farmers and they sell fertilizers and pesticides by unfairly high prices.

Thus, one of the biggest problems causing farmers' poverty is market distortion by monopoly/monopsony power.

So, prescriptions to solve this situation are:
(1) Anti-monopoly measures to reduce market power of exporters and middlemen
(2) Organizing farmers' cooperatives to intensify their countervailing power to exporters and is necessary.

But, Chicago economics (the major development economics) says, "No, monopoly is a temporal minor problem. Anti-monopoly policies should not be introduced. Farmers' unions should be eliminated. Only complete deregulation is necessary."

World Bank and IMF say, "If you want to get development aids and loans, eliminate all food tariffs, subsidies, farmers unions". = **conditionality**

Small farmers were destroyed and food imports from US were dramatically increased.
This is not poverty alleviation, but poverty acceleration.
If we complete deregulation under imperfect competition, the market is distorted more and 1% will get more benefits from the poor.
It is very suitable for 1%.

FAO was established to help small farmers and poor people.
It is not good for 1%.
So, US destroyed the function of FAO, role of development aids and loans moved to World Bank and IMF.

World Bank and IMF are controlled by US.

Thus, development policy is not for farmers in developing countries, but for global companies especially originated in US.

We should establish the real organization for 99%.
China- leading AIIB might be a good alternative against for 1%.

Chicago economics (the major development economics) is not for everyone, but for global companies.
“Free trade” is trade by which the global companies gain freely.

Poverty alleviation is not a real purpose.
Many developing policies are widening gap in income between rich and poor
They are concentrating more money to 1% multinational company from other 99% people.

So, economics is very political, not academic.
We should create the real economics for everyone to realize inclusive growth.

Note: **Inclusive growth** is a concept that advances equitable opportunities for economic participants during economic growth with benefits incurred by every section of society.

Researches to measure the degree of imperfect competition is needed.

Example:

Econometric Evidence for Unfairly Low Farmgate Rice Prices in Cambodia

Based on the data shown in the above sections, it seems that rice prices Cambodian farmers receive have been “unfairly” low. In addition, table 1 gives us another data. It shows that Cambodian millers obtain much more profit margins than Vietnam millers. This could be another evidence of unfairly low farmgate rice prices in Cambodia.

Table 1 Profit Shares in Rice Food Chain in Cambodia and Vietnam (2002)

	Farmer	Collector	Miller	Transporter	Exporter or Wholesaler	Retailer	Profit Total
Cambodia	40	1	36	3	11	8	100
Vietnam	82	7	12	1	-4	1	100

Source: Jehan Arulpragasam and Francesco Goletti (2002)

However, whether they are really “unfairly” low or not should be proved by evidence using an econometric analysis. This is the purpose of this section.

Methods

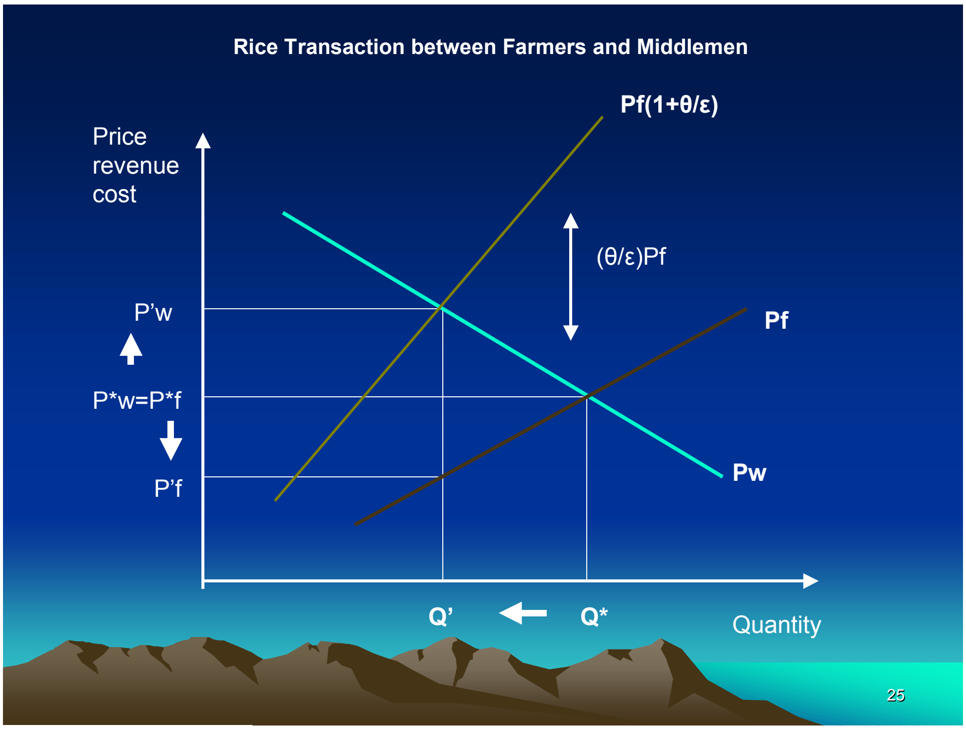
We consider the rice transaction between farmers and middlemen. If the market is perfectly competitive, middlemen's selling price, Pw, should be equal to middlemen's paying price to farmers, Pf, when it is assumed that middlemen's transaction costs are negligible.

Pw=Pf.

If there is only one middleman, or there are perfectly collusive middlemen in the market, the market is monopsony, and:

Pw=Pf(1+1/e).

We assume that the middleman is a price-taker in selling rice. Therefore, his marginal revenue is equal to Pw, or his average revenue from 1 kg of rice. The right hand side is his marginal cost per 1 kg of rice in buying rice from farmers. The symbol e is the price elasticity of farmers' supply. Farmers can be assumed to be price-takers.



By introducing θ (0≦θ≦1), we can express the actual degree of imperfect competition between perfect competition (θ=0) and monopsony (θ=1).

Pw=Pf(1+ θ /e).

The value for θ can be estimated by:

$\theta=e(Pw-Pf)/Pf$.

To obtain the value for e, we can use estimated Cobb-Douglas type production function parameters. When we specify the Cobb-Douglas type production function as:

$Q=\alpha V^a S^b L^c$,

where V is variable capital, S is land, and L is labor, the price elasticity of supply can be expressed as:

$e=(a+b+c)/[1-(a+b+c)]$ (when all inputs are not fixed),
$e=a/(1-a)$ (when land and labor are fixed),
$e=(a+c)/[1-(a+c)]$ (when land is fixed).

In Cambodia, we can consider that land and labor are almost fixed. Therefore, we will use $e=a/(1-a)$.

Next, we can define the degree of price transmission as:

$dPf/dPw=1/(1+\theta/e)$.

This shows that the farmgate price, Pf, rises by $1/(1+\theta/e)$ riel when the export price, Pw, rises by 1 riel.

In a perfectly competitive market, $dPf/dPw=1$.
In monopsony, $dPf/dPw=1/(1+1/e)$.

Estimation

We have the price data shown in table 2.

Table 2 Cambodian Rice Export and Producer Prices

	1996	1997	1998	1999	2000	2001	2002	2003
Milled Rice Export Quantity (Mt) (1)	5,625	3,600	600	2,200	630	1,500	3,846	3,046
(1)/0.65 (converted to paddy)	8,654	5,538	923	3,385	969	2,308	5,917	4,686
Milled Rice Export Value (1000$)	925	950	150	450	180	480	1,691	1,456
Milled Rice Export Price ($/t)	164.4	263.9	250.0	204.5	285.7	320.0	439.7	478.0
Paddy Rice Export Price ($/t) [Pw]	106.9	171.5	162.5	133.0	185.7	208.0	285.8	310.7
Paddy Rice Producer Price (Riel/t)	470,000	510,000	590,000	420,000	370,000	412,000	470,000	
Paddy Rice Producer Price ($/t) [Pf]	114.7	124.4	144.0	102.5	90.3	100.5	114.7	

Sources: FAO STAT and www.xe.com.
Notes: 1 Cambodian Riel (KHR) = 0.000243986 US Dollar (USD), mid-market rates as of 2005.11.24

We also have production function parameters estimated by Chea Saintdona (2005).

Table 3 Production Elasticities

Variable Capital [a]	0.439
Land [b]	0.309
Labor [c]	0.200

Source: Chea Saintdona (2005).

Using the values shown in table 3, we can estimate the price elasticities of supply.

Table 4 Price elasticities of Supply

e=(a+b+c)/[1-(a+b+c)] (all inputs are not fixed)	18.231
e=a/(1-a) (land and labor are fixed)	0.783
e=(a+c)/[1-(a+c)] (land is fixed)	1.770

Using e=a/(1-a), we can estimate the degree of imperfection in Cambodian rice transaction between farmers and millers.

Table 5 Estimation of Market Power Parameters

	1996	1997	1998	1999	2000	2001	2002
θ=e(Pw-Pf)/Pf	-0.053	0.296	0.101	0.233	0.827	0.837	1.168

Note: The marginal revenue equality Pw=Pf(1+θ/e) was solved for θ. We used e=a/(1-a).

Then, the degree of price transmission can be estimated.

Table 6 Price Transmission

	1996	1997	1998	1999	2000	2001	2002
Perfect Competition dPf/dPw=1	1	1	1	1	1	1	1
Current dPf/dPw=1/(1+θ/e)	1.073	0.725	0.886	0.771	0.486	0.483	0.401
Monopsony dPf/dPw=1/(1+1/e)	0.439	0.439	0.439	0.439	0.439	0.439	0.439

Implications

In 1996, the Cambodian rice market was very close to perfect competition. However, the degree of market imperfection has been intensifying and the market approximates to monopsony in 2002. When the export price rises by 1 riel, the farmgate price rises by about 1 riel in 1996, but in 2002, when the export price rises by 1 riel, the farmgate price rises only by 0.4 riel.

Because of data limitation, we did not consider the appropriate transaction costs paid to middlemen. Therefore, we might have overestimated the degree of imperfect competition in Cambodian rice market. However, we should note that the market power of middlemen has been increasing over time. This implies that an urgent action is required to improve the situation.

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Chea Saintdona, *A Study of the Effects of Off-farm Income from Industry on Rice Production and Farm Households' Socio-economic Status in Kandal Stueng District, Cambodia: A Case Study of Cheung Kaeub Commune*, MS Thesis, Kyushu University, June 2005.

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A problem to be solved in the future

Bilateral Oligopoly between Cooperatives and Processors and Between Processors and Retailers

When oligopsonistic processors face oligopolistic farmer cooperatives instead of price-taking individual farmers, we must consider a bilateral oligopoly model. This implies that models of processor oligopoly that assume that farmers are price-takers should be reconsidered. Although Suzuki et al. (1993, 1994a, 1994b) made a notable step regarding treatment of the farmer-side, they avoided incorporating the bilateral oligopoly problem by assuming that processors are price-takers.

The case of competition between processors and retailers is similar. Most previous models have assumed that one of the two is a price-taker. Retailers are often assumed to be price-takers when processors' oligopoly power is estimated. However, that assumption is questionable because the market share of large supermarkets has been rapidly increasing.

Sexton and Zhang (2001) discussed welfare losses caused by successive oligopoly and oligopsony models covering the whole food system from farmer to consumer. They assumed that farmers and consumers are always price-takers. Then, they presented two alternative models for the entire food system:

[Farmers] => <= [Processors] => <= [Retailers] => <= [Consumers].

(a) (b) (c) (d) (e) (f)

In the first model, they assumed that (a) = price-taker, (b) = price-setter, (c) = price-setter, (d) = price-taker, (e) = price-setter, and (f) = price-taker. In the second model, they assumed that (a) = price-taker, (b) = price-setter, (c) = price-taker, (d) = price-setter, (e) = price-setter, and (f) = price-taker.

The successive oligopoly model used by Sexton and Zhang (2001) is as follows:

Farmers' (price-takers') inverse supply function: $P^f = S(Q)$.

Processors' marginal expense to raw materials + unit processing costs = marginal revenue from sales to retailers: $P^f(1 + \theta^f/e^f) + c^w = P^w(1 - \lambda^w/\eta^w)$.

Supermarkets' purchase price from processors + unit retailing costs = marginal revenue from retail sales: $P^w + c^r = P^r(1 + \lambda^r/\eta^r)$.

Consumers' (price-takers') inverse demand function: $P^r = D(Q)$.

Similarly, the successive oligopsony model used by Sexton and Zhang (2001) is as follows:

Farmers' (price-takers') inverse supply function: $P^f = S(Q)$.

Processors' marginal expense to raw material from farmers + unit processing costs = wholesale price to retailers: $P^f(1 + \theta^f/e^f) + c^w = P^w$.

Supermarkets' marginal expense to the product from processors + unit retailing costs = marginal revenue from retail sales: $P^w(1 + \theta^w/\eta^w) + c^r = P^r(1 + \lambda^r/\eta^r)$.

Consumers' (price-takers') inverse demand function: $P^r = D(Q)$.

These are not empirical models, but, by assuming various degrees of conjectural elasticities, they illustrate how the distribution of economic welfare will move in response to degrees of successive oligopoly and oligopsony power at multiple stages of the market channel. Results from this simulation show that even modest market power can enable the marketing sector to capture large shares of market surplus from farmers and consumers. Although Sexton and Zhang's models are innovative because the entire food system is incorporated in them, one drawback is that the models avoided the bilateral oligopoly problems that exist between processors and retailers and between processors and farmers.

If retailers have market power and processors are price-takers, then the product price determined between processors and retailers should be at the lowest level that retailers can pay to processors based on the current degree of horizontal competition among retailers. Alternatively, if processors have market power and retailers are price-takers, then the market price should be at the highest level that processors can obtain from retailers based on the degree of horizontal competition among processors. In reality, since both retailers and processors likely have some degree of market power (i.e., bilateral oligopoly), the actual price lies somewhere between the highest and lowest level. A similar argument is true for market competition between farmer cooperatives and processors.

In these situations, estimates of the degree of balance in vertical power between sellers and buyers, the degree of horizontal competition among sellers, and the degree of competition among buyers should be made simultaneously. It becomes difficult to produce a unique solution in modeling such markets. Consequently, as previously mentioned, most studies have assumed that one side of the market is a price-taker while the other has completely dominant vertical power. However, because the actual observable price is at neither the highest nor the lowest possible level, such approaches are inherently biased. Azzam (1996) presented an innovative modeling approach for solving this problem between packers and retailers in the U.S. beef market. He examined the following part of the food system:

[Processors] => <= [Retailers]

(c) (d)

and assumed that (c) and (d) are both price-setters.

There are several hurdles such as identification problems to be overcome in simultaneously estimating vertical and horizontal competition parameters for the entire food system.[1] We explain them using a model including farmer, processor, and retailer levels. We first introduce a dual structure in the farmer side. When farmer cooperatives have two markets (the private market and the government market) and the government's purchase price is given, then the necessary condition for optimal allocation between the two markets that will maximize sales is:

(65) $PF(1 - \theta^f/\eta^f) = PG$,

1 Azzam (1996) also had an identification problem because there were six equations for seven variables in his model.

where PF is the price paid by processors to cooperatives, PG is the exogenously given government purchase price, η^f is the price elasticity of the processor demand that cooperatives face (in absolute value), and θ^f is a parameter representing cooperatives' degree of horizontal competition and ranges from zero to one.

It is important to note that equation (65) assumes that processors have no vertical market power; in other words, the power balance between cooperatives and processors is 1:0. Therefore, the price determined by equation (65) means that the price cooperatives or farmers receive (PF^U) based on their degree of horizontal competition (θ^f) is at the maximum level. PF^U can be rewritten as:

(66) $PF^U = PG / (1 - \theta^f/\eta^f)$.

Next, consider the processor level of the industry. The processors' profit-maximizing condition can be expressed as:

(67) $PW^U(1 - \theta^w/\eta^w) = PF^L(1 + \lambda^w/\varepsilon^w) + MC^w$,

where PW^U is the maximum or upper-limit price processors can receive from retailers when retailers have no vertical market power relative to processors, PF^L is the minimum or lower-limit price processors will pay to cooperatives when cooperatives have no vertical market power relative to processors, MC^w is the marginal processing and selling costs other than the raw material, η^w is the price elasticity of the retailer demand that processors face (in absolute value), θ^w is a parameter representing the processors' degree of horizontal competition in the processor-versus-retailer market (ranging from zero to one), ε^w is the price elasticity of the cooperative supply that processors face, and λ^w is a parameter representing the processors' degree of horizontal competition in the processor-versus-retailer market (ranging from zero to one). The minimum (lower-limit) price processors can pay to cooperatives (PF^L) is:

(68) $PF^L = [PW^U(1 - \theta^w/\eta^w) - MC^w] / (1 + \lambda^w/\varepsilon^w)$.

The actual price (PF) determined by transaction between cooperatives and processors is somewhere between PF^U (the upper limit) and PF^L (the lower limit):

(69) $PF = W^f PF^U + (1 - W^f)PF^L$ or

(70) $PF = W^f PG / (1 - \theta^f/\eta^f) + (1 - W^f)\,[PW^U(1 - \theta^w/\eta^w) - MC^w] / (1 + \lambda^w/\varepsilon^w)$,

where W^f is the parameter (ranging from zero to one) for the degree of vertical market power of cooperatives relative to processors and $(1 - W^f)$ is the parameter for the degree of vertical market power of processors relative to cooperatives.

Next, consider the retailer stage of the market. The retailers' profit-maximizing condition can be expressed as

(71) $PR(1 - \theta^r/\eta^r) = PW^D(1 + \lambda^r/\varepsilon^r) + MC^r$,

where PR is the actual retail price or the maximum (upper-limit) price retailers can get from consumers since consumers likely have no market power, PF^L is the lower-limit price retailers pay to processors assuming processors have no vertical market power relative to retailers, MC^r is marginal retailing costs, η^r is the price elasticity of consumers' demand (in absolute value), θ^r is the retailers' degree-of-horizontal-competition parameter in the retailer-versus-consumer market (ranging from zero to one), ε^r is the price elasticity of the processors' supply, and λ^r is the retailers' degree-of-horizontal-competition parameter in the retailer-versus-processor market (ranging from zero to one). The lower-limit price retailers can pay to processors, (PW^L), is:

(72) $PW^L = [PR(1 - \theta^r/\eta^r) - MC^r] / (1 + \lambda^r/\varepsilon^r)$.

On the other hand, from equation (67), the maximum or upper-limit price processors can obtain from retailers (PW^U) is:

(73) $PW^U = [PF^L(1 + \lambda^w/\varepsilon^w) + MC^w] / (1 - \theta^w/\eta^w)$.

The actual price (PW), determined by transaction between processors and retailers, is somewhere between PW^U and PW^L and is described as:

(74) $PW = W^w PW^U + (1 - W^w)PW^L$ or

(75) $PW = W^w[PF^L(1 + \lambda^w/\varepsilon^w) + MC^w] / (1 - \theta^w/\eta^w) + (1 - W^w)[PR(1 - \theta^r/\eta^r) - MC^r] / (1 + \lambda^r/\varepsilon^r)$,

where W^w is the degree of vertical market power of processors against retailers (ranging from zero to one) and $(1 - W^w)$ is the degree of vertical market power of retailers against processors.

Equations (70) and (75) have some common parameters. Therefore, simultaneous estimation of equations (70) and (75) with parameter constraints provides for all values for the degree of vertical and horizontal competition among cooperatives, processors, and retailers (W^f, W^w, θ^f, θ^w, θ^r, λ^w, and λ^r). However, the variables PF^L in equation (70) and PW^U in equation (75) are unobservable. Consequently, while this approach is good in theory, it is not a practical way to estimate these vertical and horizontal competition parameters.

Using some assumptions, we can treat equations (70) and (75) separately. Consider the case of bilateral oligopoly between processors and retailers by adjusting equation (75). Assuming that processors' vertical market power against cooperatives is 1:0, PF^L can be replaced by the actual PF in equation (75). When it can be assumed that processors' vertical market power against retailers is 0:1, then the term $PW^U(1 - \theta^w/\eta^w)$ can be replaced by the actual PW in equation (70). In addition, we can obtain price elasticities of supply and demand from extraneous sources by following Azzam (1996). Using these methods, we can find a practical way to identify the competition parameters.

A successful example of this approach appears in Kinoshita et al. (2004b). The authors developed a practical model that estimated the degree of balance of vertical power between fluid-milk processors and retailers and between dairy cooperatives and processors with simultaneous estimation of the degree of horizontal competition in each stage of the market. The authors' results were tentative due mainly to data constraints, but their study constituted the first econometric evidence supporting the general perception that retailers, though facing nearly perfect horizontal competition among themselves, have extremely dominant vertical market power over fluid-milk processors. Kinoshita et al. (2004b) also offered the first econometric evidence that processors may have some vertical market power over dairy cooperatives. Once more complete data sets are available, the method proposed by Kinoshita et al. would be a practical and useful way to analyze bilateral oligopoly in many situations. Their results are summarized in Figure 2.

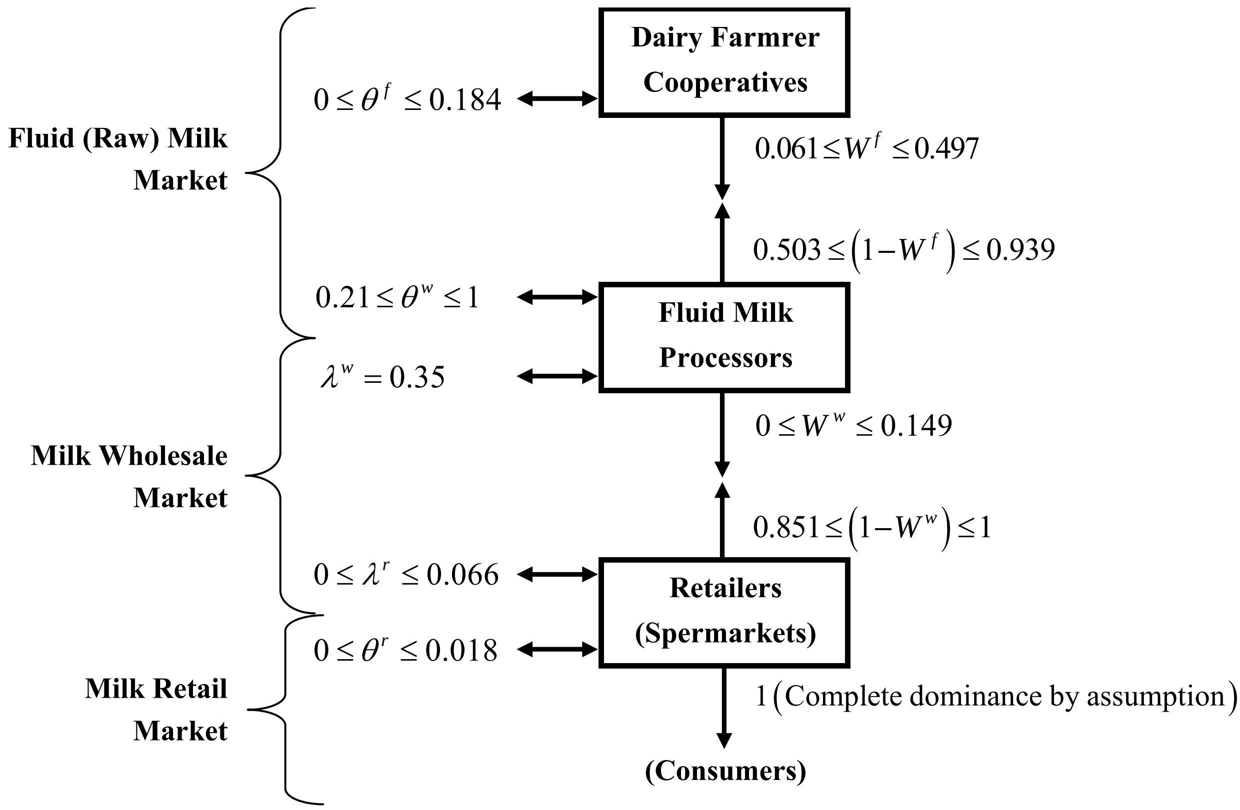

Figure 2. The Degree of Vertical and Horizontal Competition in Japan's Milk Markets

Notes: Parameters W^f and W^w indicate the degree of vertical power balance; that is, W^f : (1 – W^f) ranges from 0.061:0.939 to 0.497:0.503, W^w : (1-W^w) ranges from 0:1 to 0.149:0.851. Parameters θ^f, θ^w, θ^r, λ^w and λ^r indicate the degree of horizaontal competition.

Source: Kinoshita et al. (2004b).

Appendix

Thomas Piketty - Capital in the Twenty-First Century

$$g < r$$

has been observed at almost all periods in the human history. → widening income disparity
where g= economic growth rate ≒ wage growth rate, r= rate of return to capital ≒ capital growth rate
One of the reasons why g<r is imperfect competition or monopsony/oligopsony.
Unfairly low wage has been paid to labor.

Assignments

Based on the above discussions, please make your "virtual" research theme related to the above topics, and explain a brief outline of your research plan.