A General Equilibrium Analysis of Japanese Rice Market Trade Liberalization

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Abstract

The main interest of this study is to simulate the domestic rice market under full trade liberalization. Results show that full trade liberalization is welfare enhancing for non-farm as well as farm households, primarily through lower consumer prices. These simulation results apparently undermine the government's argument against trade liberalization.

Key Words: CGE analysis, Japan, Rice, and Trade liberalization.

Acknowledgement

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I Introduction

Rice is the most important staple food for Asian countries. The Japanese government has historically utilized price supports and trade restrictions. These policies have aimed to achieve two goals: to maintain wage and income parity between farmers and non-farmers and to keep national self-sufficiency of rice production. In order to achieve parity, the government introduced price supports for rice, while international trade has been controlled by the Japan Food Agency (JFA) until recently. Price supports combined with trade restrictions have resulted in an excess supply of rice. In order to reduce excess supply and the fiscal costs of storage, the Japanese government introduced acreage control. Thus, Japanese rice policy is characterized by two contradictory policies: price supports and acreage control.

As a result of the GATT Uruguay round, Japan faced pressure to liberalize the rice markets, and this pressure will be greater under forthcoming WTO negotiations. Under this environment, the Japanese government accepted tarrification on rice in 1999. Japanese policymakers are concerned, however, about the income of farmers under full trade liberalization as well as national food security, conceived of as 100% self-sufficiency in rice production. Many previous studies support the government's concern; they predict that Japanese rice farmers would be devastated by liberalization.

The main interest of this study is to simulate the domestic rice market under full trade liberalization. We simulate the impact on income of farm households and national self-sufficiency. We apply a CGE (Computable General Equilibrium) model of Japan to analyze Japanese rice policies including acreage control and tariff. In order to utilize the CGE model, we built a twelve-sector SAM (Social Accounting Matrix) based on a 1995

Japanese input-output table, where households were divided into farm and non-farm categories. Policy scenarios and model simulation focus on WTO negotiations; we set the current tariff rate as three hundred per cent of c.i.f. import price, which is gradually reduced to zero per cent. It is assumed that imported rice is an imperfect substitute for domestic rice. We calculate the compensating variation welfare changes caused by full trade liberalization.

In section II, we review the data source and social accounting matrix (SAM), which is the base data for computable general equilibrium (CGE) modeling. In section III, there is a brief introduction to CGE modeling and model description. In section IV, the simulation results are presented, and summary and extension in section V follows.

II. Data Source and Social Accounting Matrix

This section describes the structure of the micro-consistent data set. In order to conduct CGE modeling analysis, one often constructs a Social Accounting Matrix (SAM), which captures all transactions amongst agents in the market. In this study, a 1995 input-output table by Management and Coordination Agency, Government of Japan is used as a base table. **Table 1** shows a schematic SAM. **Table 2** describes the algebraic SAM. **Table 3** shows the SAM used in this analysis. There are 12 sectors in this study. **Table 4** shows those twelve sectors. Husked rice and milled rice are separated as the different sectors, since the original Input-Output table defines as it is.

A farm household can be divided in many ways. In this study, we classify farm household for three types: the “Business Farm Household” (BFH), the “Semi Business Farm Household” (SeBFH), and the “Side Business Farm Household” (SiBFH). For classification, we follow the official definition of Ministry of Agriculture, Forestry, and

Fisheries (MAFF 1997). We believe this classification is suitable for our analysis. The average age of farm household in Japan tends to be old in recent years, and this classification does not include farmers over 65 years old. Old farmers in general receive pension, and the pension is included as income in other classifications. In another word, income from economic activities is not separated from transfer payment, which would lead to the misspecification of the model, especially income. This definition avoids overestimate of pure farming income by dropping farmers who receive pension.

III Model Description

Most previous studies in this area are partial equilibrium studies, concentrating only on the rice market itself of the Japanese economy[1]. The biggest advantage of general equilibrium study is that the general equilibrium model can capture the effect of trade liberalization on both production and consumption side. One of the critical shortcomings of partial equilibrium modeling is to ignore the differences between Japanese and foreign rice as well as the other sectors and foreign countries in order to determine post-liberalization equilibrium. The general equilibrium approach minimizes the misspecification from the ceteris paribus assumption, on which partial equilibrium analysis is based. By using Japanese SAM, this study investigates magnitude and direction of trade liberalization on households and production sectors.

An overview of the model is given in **Figure 1**. The primary factors, labor and capital, are supplied by households. Using these primary factors, industry produces

[1] Name but a few, see Jabara, C. L. (1981). "Interaction of Japanese Rice and Wheat Policy and the Impact on Trade." *Southern Journal of Agricultural Economics*, 133-139., Riethmuller, P., and Roe, T. (1986). "Government Intervention in Commodity Markets: The Case of Japanese Rice and Wheat Policy." *Journal of Policy Modeling*, 8(3), 327-349., Hayami, Y., and Godo, Y. (1995). "Economics and Politics of Rice Policy in Japan: A Perspective on the Uruguay Round." *National Bureau of Economic Research Working Paper: 5341*., and Kako, T., Gemma, M., and Ito, S. (1997). "Implication of the minimum access rice import on supply and demand balance of rice in Japan." *Agricultural Economics*, 16, 193-204.

commodity outputs. Industry activities and commodities are not distinguished in this study. Commodities are either consumed by domestic demand sectors or exported to the rest of the world. In addition to domestic production, there are imports from the rest of the world. Industry pays competitive wages or capital rents to the input suppliers at a determined price. Government corrects tax and tariff revenue, and distributes it to demand sectors in the form of transfer payments and subsidy. Production function is in Generalized Lentief type, and consumption function is Linearly Approximated Almost Ideal Demand system (LA/AIDS)[2].

In order to model trade policy issues, empirical studies tend to depart from the standard perfectly competitive models. One possible way to incorporate imperfect substitution is the so-called Armington assumption (Armington 1969). Under the Armington assumption, goods in the same industry classification produced in the different countries are viewed as imperfect substitutes by demanders[3]. Shoven and Whalley (1984) point out two possible advantages of the Armington assumption. First, it is consistent with "cross-hauling" observed in trade data, which some of the early trade modelers encountered with difficulties. If a modeler assumes complete specialization of homogeneous goods, the policy change overestimates its effect on the economy due to too strong specialization assumptions. A whole economy tends to move from one extreme specialization to another. Second, the model can utilize econometrically-estimated import- and export-demand elasticities. In the homogeneous goods model,

[2] For detailed model descriptions, contact to the author. The original model is adapted from Winters, P., de Janvry, A., Sadoulet, E., and Stamoulis, K. (1997). "The Role of Agriculture in Economic Development: Visible and Invisible Surplus Transfers." *Working Paper No. 814 Department of Agricultural and Resource Economic, University of California at Berkeley*., and extended by the author.

[3] See Stern, D. a. (1986). *The Michigan Model of World Production and Trade Theory and Applications*, The MIT Press, Cambridge, Massachusetts. for the survey. Deardorff, A. V. (1984). "Testing Trade

there is no substitution between domestic and foreign produced goods, which is unrealistic for trade data.

In this study we utilize the LA/AIDS model for consumption function. The origin of the AIDS model derived from the preference specification called Price Independent Generalized Logarithmic Class of Preference (PIGLOG). (See Muellbauer (1976) for PIGLOG class of preference. Muellbauer's PIGLOG class is further investigated by Deaton and Muellbauer (Deaton and Muellbauer 1980a; Deaton and Muellbauer 1980b).

The AIDS cost function in logarithmic form can be expressed as follows:

$$\log C(U, p) = (1-U)\log[a(p)] + U \log[b(p)]$$

where $C(U, p)$ is a cost function, p is a vector of prices, and U is the utility level.

Following Banks et al (1997) notation, *a(p)* and *b(p)* can be expressed as follows:

$$\ln a(p) = a_0 + \sum_{i=1}^{n} a_i \ln p_i + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} g_{ij} \ln p_i \ln p_j \text{ , and}$$

$$b(p) = \prod_{i=1}^{n} p_i^{b_i}$$

where i and j denote the commodity, and other Greek letters are the coefficients estimated from AIDS model.

As Hoffman and Johnson (1999) put, the base-weighted true cost of living index from the cost function presented above can be written as follows:

$$\log P(p^0, p^1, U^0) = (1-U^0)\log[\frac{a(p^1)}{a(p^0)}] + U^0 \log[\frac{b(p^1)}{b(p^0)}],$$

where U^0 is the base utility level, and p^0 and p^1 are the price vectors before and after the change, respectively. For the base utility level, we use as follows:

Theories and Predicting Trade Flows." Handbook of International Economics, R. W. Jones and P. B.

$$U^0 = \frac{\log[\frac{X}{a(p^0)}]}{\log[\frac{b(p^0)}{a(p^0)}]},$$

where X is the total expenditure on commodities.

With the AIDS coefficient estimation and CGE simulation, the compensating variation in cost function, $CV = C(p^1, U^0) - C(p^0, U^0)$, for a representative household can be simulated.

IV Empirical Results

In the next WTO negotiation round, the reduction of tariff rate will be the main focus. In this counterfactual simulation, we set the base-line ad-varlorem tariff of rice and processed rice at 300%, and gradually reduce to zero percent.

Figure 2 shows the overall price and quantity according to the tariff level. Increase in the import of rice and processed rice reduces the overall domestic price. This is due to the supply effect. In natural resource sector, meat sector, and food away from home (FAFH) sector show the slight increase in price. **Figure 3** shows the quantity level increase in all agriculture and food sectors. The highest increase is processed rice sector, and then raw rice sector follows. Other sector follows; however the level of increase in quantity is negligible level. In sum, the over all effect on a whole economy is very small, except the rice sectors by themselves.

Figure 4 shows the change in c.i.f. import price and the import. At zero tariff, import price goes down by 74.26% compared to base-line. In quantity base, the processed rice increases by approximately 2867%. Since the base-line quantity of import is under the prohibitively high tariff; hence this ratio is not unexpected. **Figure 5** shows

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Kenen, eds., Elsevier Science, 467-517. shows the application for international trade theory.

the change in imports and the ratio of domestic to foreign rice. This ratio represents the self-sufficiency level. Self-sufficiency level drops to 65%. Considering that current self-sufficiency rate for rice is 100%, this decrease in self-sufficiency rate would be felt strongly by policy makers as well as consumers.

Figure 6 shows the change in employment. The impact of trade liberalization is minimal; employment in rice and non-crop sector shows the slight decline, while crop and natural resource sector shows the slight increase[4]. **Figure 7** shows the change in income. Non-farm household shows the slight increase in the income due to the lower price of rice; however, the increase is merely around 1.5% at zero tariffs compared to 300% tariff level. The biggest and negative impact hits full-time farm household: 6.28% of income reduction due to the trade liberalization. These full-time farmers are the victims of the trade liberalization; the government needs to consider lump-sum income transfer to compensate for the trade liberalization.

Figure 8 shows the change in welfare. Non-farm household as well as farm households show the welfare gain; this gain is due to the reduction of rice. Trade liberalization is welfare enhancing even for Japanese farmers.

V Conclusion

Food Basic Law in Japan was established in the early 60's. Until now, the base concept of the law has been the same: income parity of farm and non-farm household and self-sufficiency of food supply. The environment of agriculture domestically as well as internationally has changed. Income level of farm household exceeds the one of urban household due to part-time farming. Migration to the urban area accelerates the aging

population of agricultural sector. International wave of trade liberalization hit Japan in 1995; since then Japan gradually changes its domestic policy, and in 1999 Japan accepted the tariffication of rice.

This study simulates the direction and magnitude of trade liberalization of rice. The results show that the impact of trade liberalization is minimal: full trade liberalization is welfare enhancing for non-farm as well as farm households at any tariff rate, primarily through lower consumer prices. Full-time farm household income declines by only 6.3 per cent at the zero tariff, but is more than compensated by falling prices at the consumer side. Regarding national self-sufficiency, the ratio of domestic to imported rice in the market becomes seven to three. These simulation results apparently undermine the government's argument against trade liberalization.

The average age of farmers keeps increasing. If this trend continues, sooner or later, Japanese agriculture would loose its competitiveness completely, since there is no successors. Whenever possible, the market should be opened; trade liberalization is welfare enhancing and cost reducing. Japanese consumer's welfare increases, and the rice exporters gain the share of its benefit.

Reference:

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[4] In this simulation, the model is closed in a way that agricultural workers are not allowed to "migrate" in non-agricultural sectors according to the tariff rate. Hence, the total amount of four agricultural sectors

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keeps constant.

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Figure 1: **Overview of Japanese CGE model**

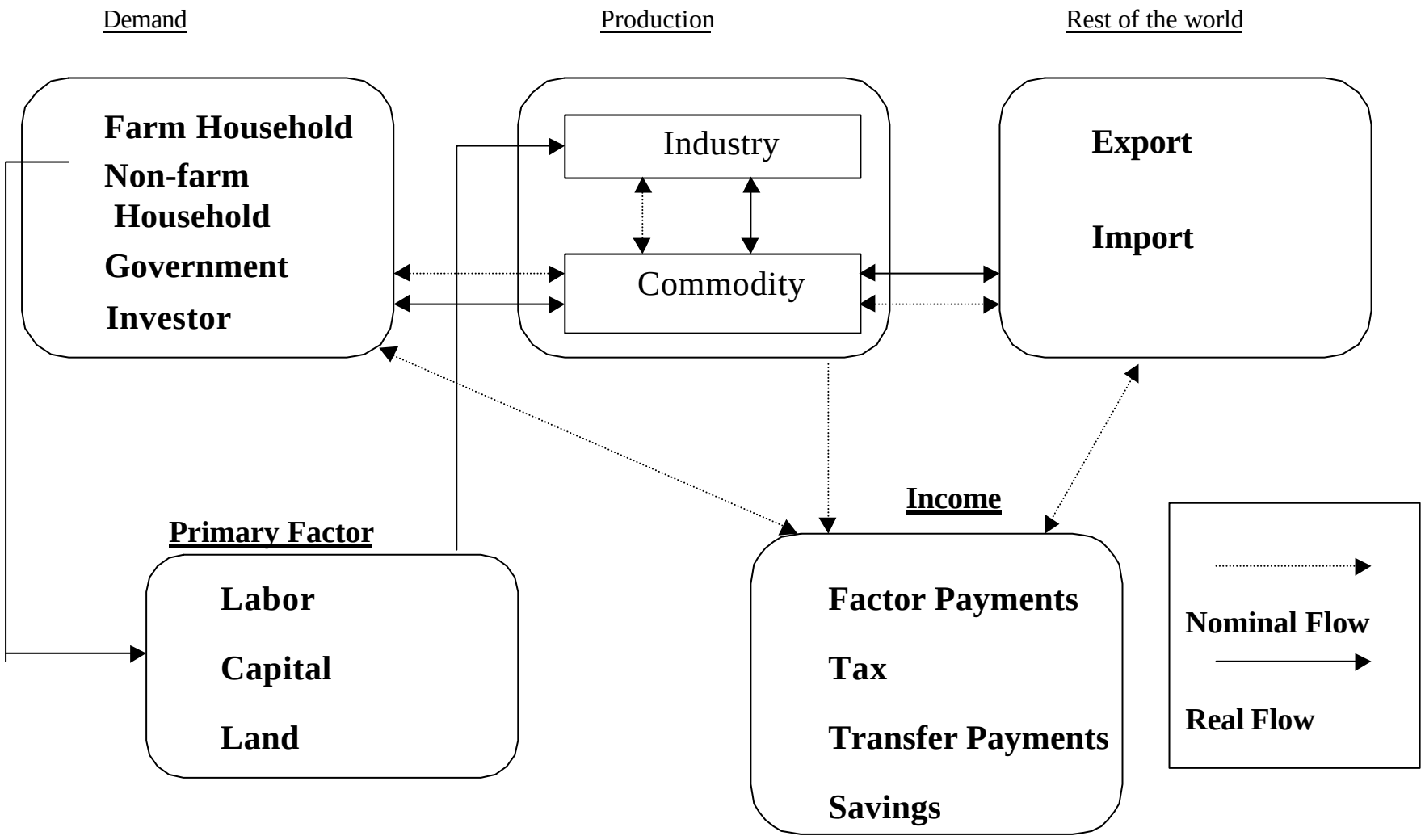


Table 1

Schematic Social Accounting Matrix

Expenditures		Activities	Labor	Institutions					Capital Account		Rest of World	Row Total
Receipts		AC	LB	HH	FH	AFM	IFM	GV	PRI	PUB	WT	TOT
1. Activities	**AC**	Intermediate Demand							Investment	investment	Export	Total sales
2. Labor	**LB**	Wage to labor										Labor Income
3. Institutions	**HH**	Rent to Capital	Labor Income				Capital Income	Transfer				Household Income
	FH		Labor Income			Capital Income		Transfer				Farm Household Income
	AFM	Rent to Capital		Direct Tax	Direct Tax							Ag Firm Income
	IFM	Rent to Capital										Firm Income
	GV	Indirect Tax										Government Income
4. Capital Account	**PRI**			Household Saving	Farmhouseh old Saving	Saving	Saving				Foreign Remittances	Total Savings
	PUB							Gov't savings				
5. REST OF WORLD	**WT**	Import							Net Capital Inflow			Foreign Income
6. Column Total	**TOT**	Total Costs	Employee Compen-sation	Farm Household Expenditure	Household Expenditure	Government Expenditure	Firm Expenditure	Ag Firm Expenditure	Total Investment		Foreign Expenditure	

Table 2

Algebraic Social Accounting Matrix

Expenditures		Activities	Labor	Institutions					Capital Account		Rest of World
Receipts		AC	LB	HH	FH	AFM	IFM	GV	PRI	PUB	WT
1. Activities	AC	$p_i \times io_{ij} \times xd_i$		$hhcons_{i,h}$				$gdtot \times gd \times p_i$	$p_i \times imat_{i,inv} \times inv$		$e_i \times pwe_i \times er$
2. Labor	LB	$factl_{h,l} \times linc_l$									
3. Institutions	HH		$factl_{h,lb} \times linc_{lb}$			$hicoef_{h,f} \times ydispi$		$pindex \times gtranph_h \times gtrant$			
	FH	$factk_{h,i} \times kva_i$	$factl_{h,ag} \times linc_{ag}$								
	AFM	$factinst_{f,i} \times kva_i$									
	IFM	$factinst_{f,i} \times kva_i$									
	GV	$itax_i \times pd_i \times xxd_i$		$htax_h \times yh_h$							$gfbor \times er$
4. Capital Account	PRI			$mps_h \times ydishph_h$		$mpsi_f \times ydishpi_f$					
	PUB							$\sum p \times imat \times pubinv$			
5. REST OF WORLD	WT	$m_i \times pwm_i \times er$						$p_i \times imat_i \times pubinv$			

Table 3

Unit: Billion Yuan

	Rice	Crop Agri	Non Crop	Natural	Meat fish	Rice Proc	Other Food	FAFH	Chemical	Manu	Const	Service	Ag labor	Labor	HH	BFH	SeBFH	SiBFH	Ag firm	Ind firm	Govt	Private	Public	ROW	TOTAL
Rice	5	1	15	0		3099	47		5	19	0	1										22		0	3213
Crop Agri		101	210		258	94	987	570	488	96	184	327			2881	48	48	89				49		14	6444
Non Crop	137	119	352	2	2117		81	131	21	44		79			272	5	5	9				143		1	3516
Natural		1		296	1503		18	333	3864	3840	1075	1423			959	16	16	29				388		44	12206
Meat fish				68	1354		710	2348	169	26		593			12583	210	209	387				15		91	18733
Rice Proc			0	3	683	102	321	355	25	1		168			2255	38	38	71				30		8	4100
Other Food			7	24	897		897	3398	223	23		697			10237	162	161	299			117	-50		48	17949
FAFH															21966	234	234	433				1397		192	24455
Chemical	212	471	865	217	554	127	658	221	14513	10749	2985	22159			13533	220	219	406			7	108		4133	72368
Manu	22	196	64	164	495	90	1216	436	2853	88244	25773	14640			28414	467	465	862				34479	3436	32567	226825
Const	7	12	13	16	45	30	43	81	294	1130	256	6741										45925	33179	2292	89966
Service	228	319	408	1084	2062	785	2255	4573	12898	39879	10110	143671			123919	2041	2034	3767			18453	94745	17896	7327	496864
Ag labor	485	1835	610	1007																					4338
Labor					2193	184	1856	5223	7336	38179	24322	171747													251629
HH														241621						39241	88551				361413
BFH	897	1810	403	941									1895	362					291		522				6324
SeBFH	535	602	241	561									1227	2599					384		687				6839
SiBFH	350	394	159	366									1218	7848					1037		1857				12428
Ag firm					1295	1366	1503	4230																	8394
Ind firm									7457	18789	11573	88392													126611
Govt Subs	-25	-142	-175	-92	-212	-1961	-63	-2	-67	-178	-429	-8274													-11619
Tax/trans	228	398	263	342	791	140	5257	1268	16869	10998	5710	44480			68095	1240	1597	2642						2441	161976
Tariffs	7	111	12	1423	1081	9	522	0	1155	2814	0	4													6338
Private															76298	1643	1813	3415	6682	87371					177222
Public																					54503				54503
ROW	121	1057	60	5384	3207	35	730	1290	5264	21779		9618													49088
TOTAL	3213	6444	3516	12206	18733	4100	17049	24455	72368	226825	89966	496864	4338	251629	361413	6324	6839	12428	8394	126611	156086	177222	54503	49088	

Source: Author

Table 4

Sector	Abbreviation	Main Products
Rice (Husked)	rice	Husked rice
Crop Agriculture exc.. Rice	crop	Wheat, Potatoes, Beans, Vegetables, Fruits
Non Crop Agriculture	ncrop	Live Stock, Forestry, Fisheries
Natural Resource	nat	Mining, Coal, Oil
Meat and Fish	meat	Meat and Fish Products
Milled Rice	ricepr	Milled Rice
Food	other	Other Food Products, Beverage, Tobacco
Food Away From Home (FAFH)	fafh	Food Away From Home (Eating Out service)
Chemistry	chem	Chemistry and its products
Manufacturing and Machinery	manu	Manufacturing and Machinery
Construction	const	Construction
Service	serv	Public and Private Services

Figure 2

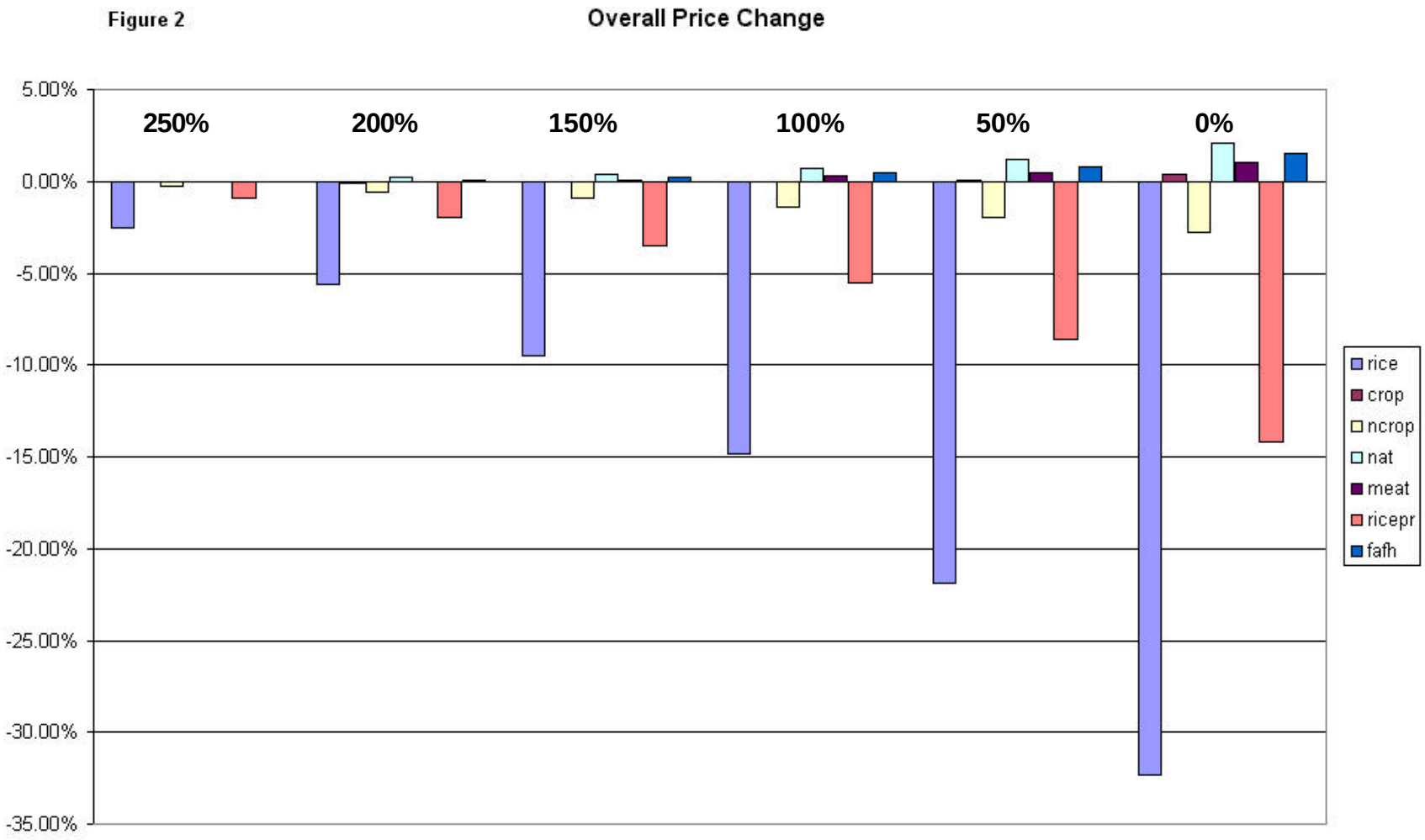

Overall Price Change
250%
200%
150%
100%
50%
0%
5.00%
0.00%
-5.00%
-10.00%
-15.00%
-20.00%
-25.00%
-30.00%
-35.00%
rice
crop
ncrop
nat
meat
ricepr
fafh

Figure 3

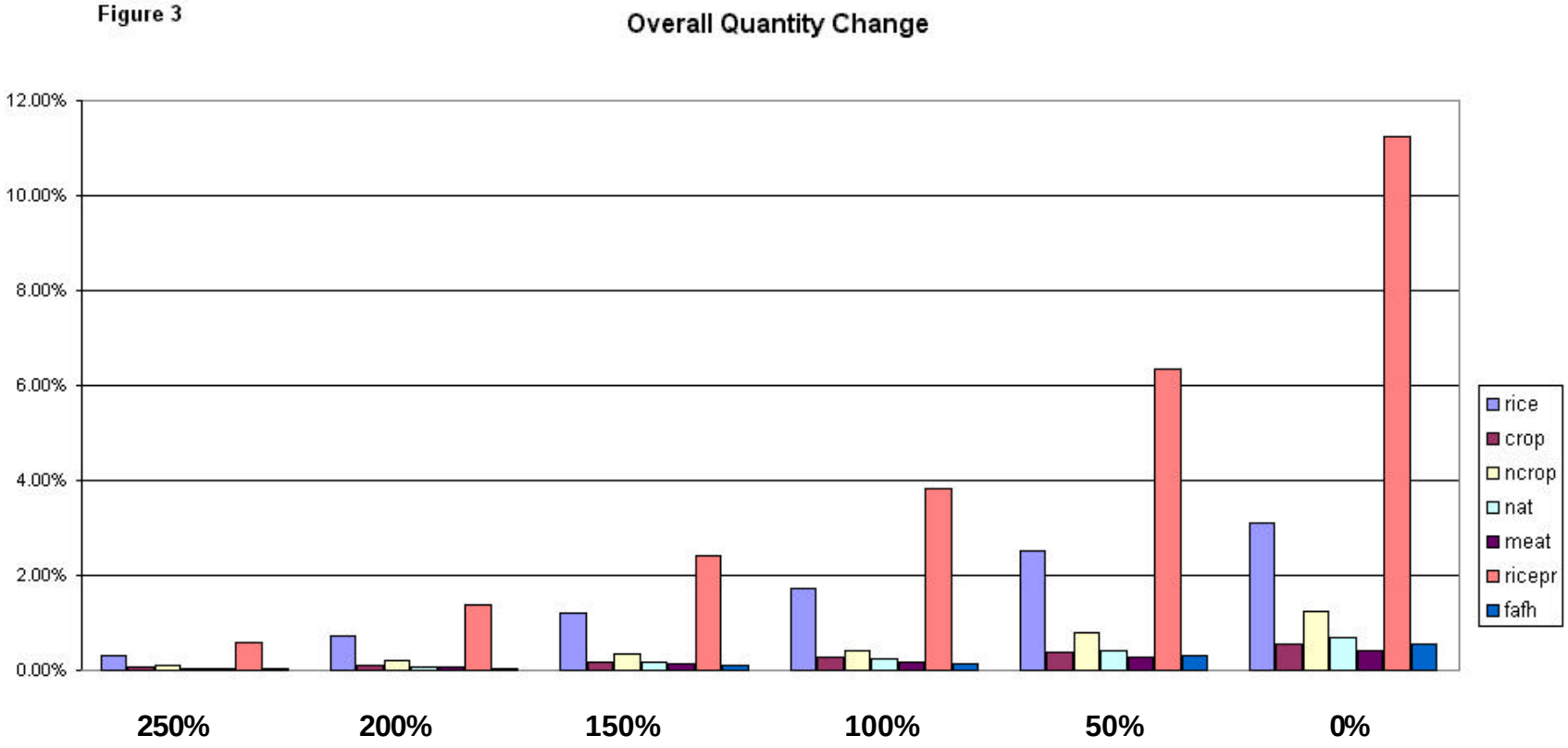

Overall Quantity Change
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
250%
200%
150%
100%
50%
0%
rice
crop
ncrop
nat
meat
ricepr
fafh

Figure 4

Change in Import Price and Quantity

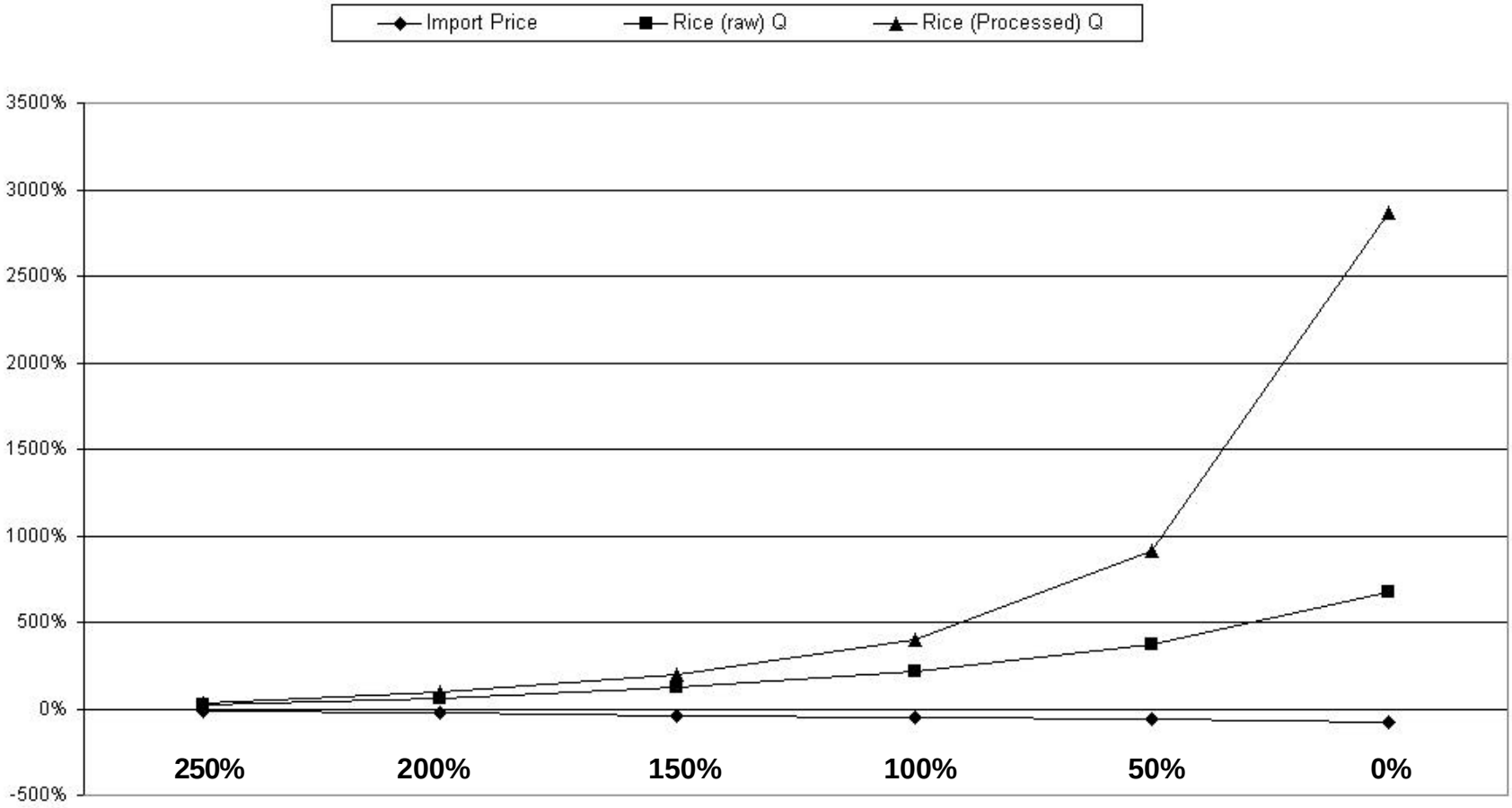


Figure 5

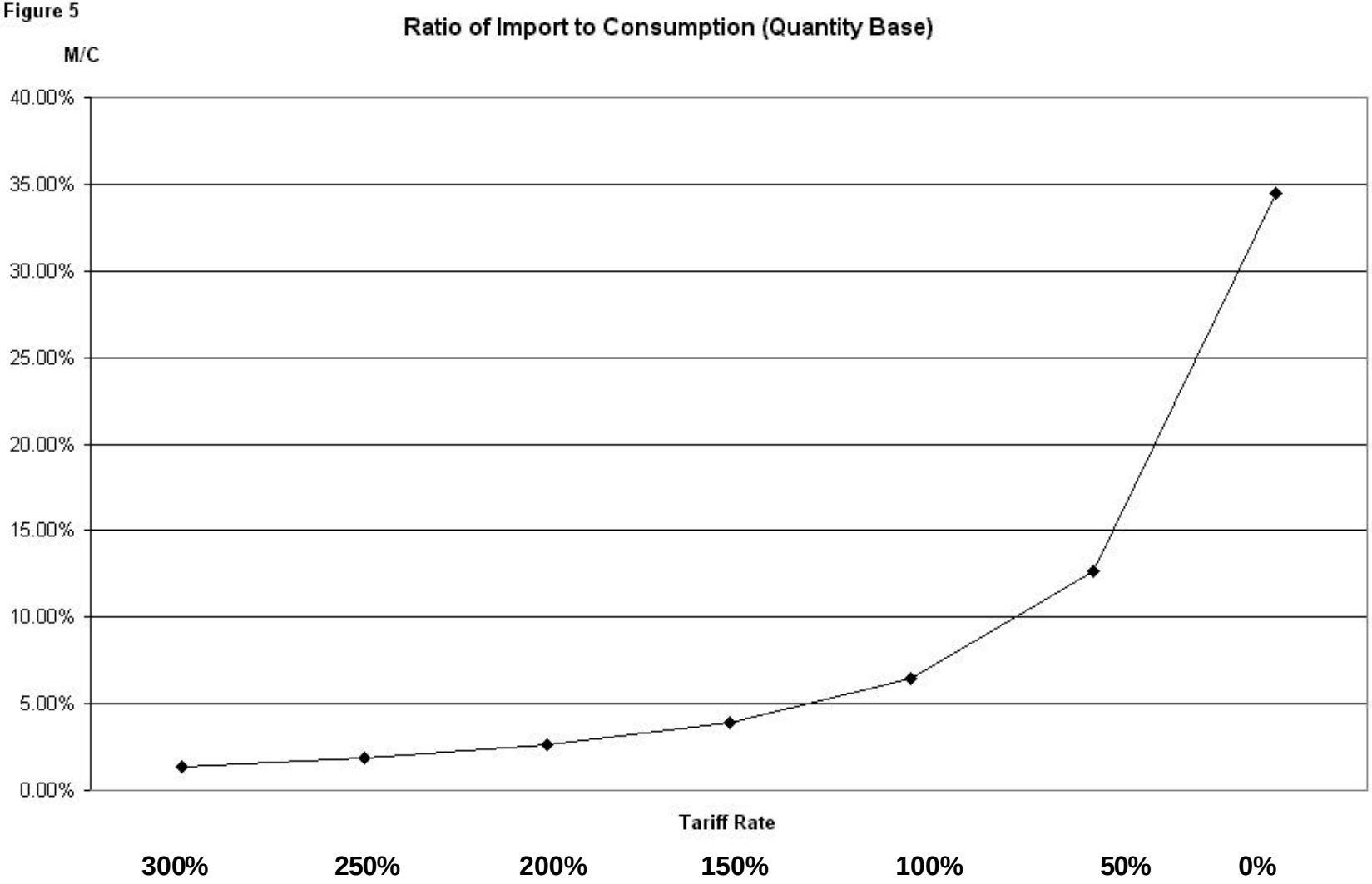

Ratio of Import to Consumption (Quantity Base)
M/C
40.00%
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
Tariff Rate
300%
250%
200%
150%
100%
50%
0%

Figure 6

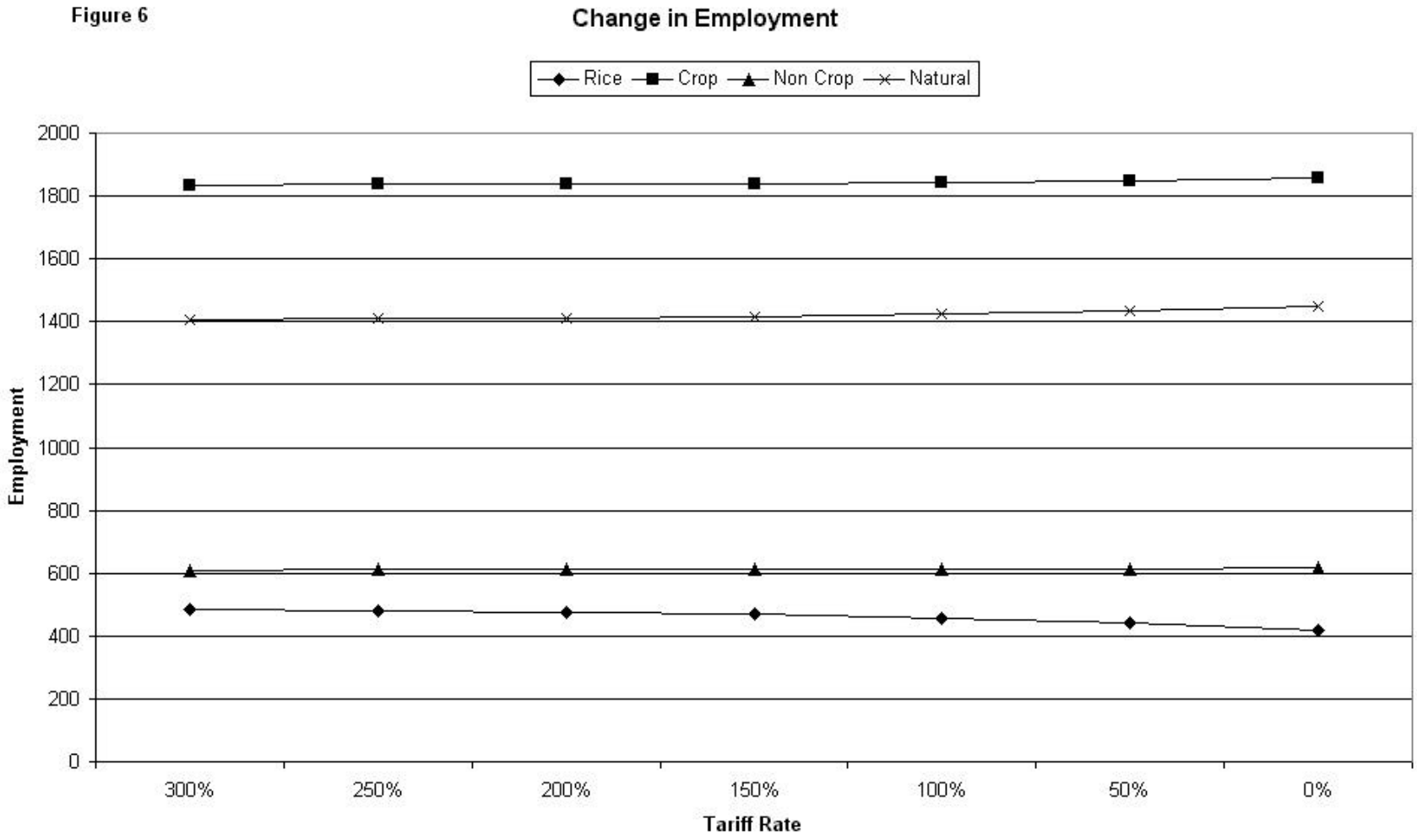

Change in Employment
Rice
Crop
Non Crop
Natural
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Employment
300%
250%
200%
150%
100%
50%
0%
Tariff Rate

Figure 7

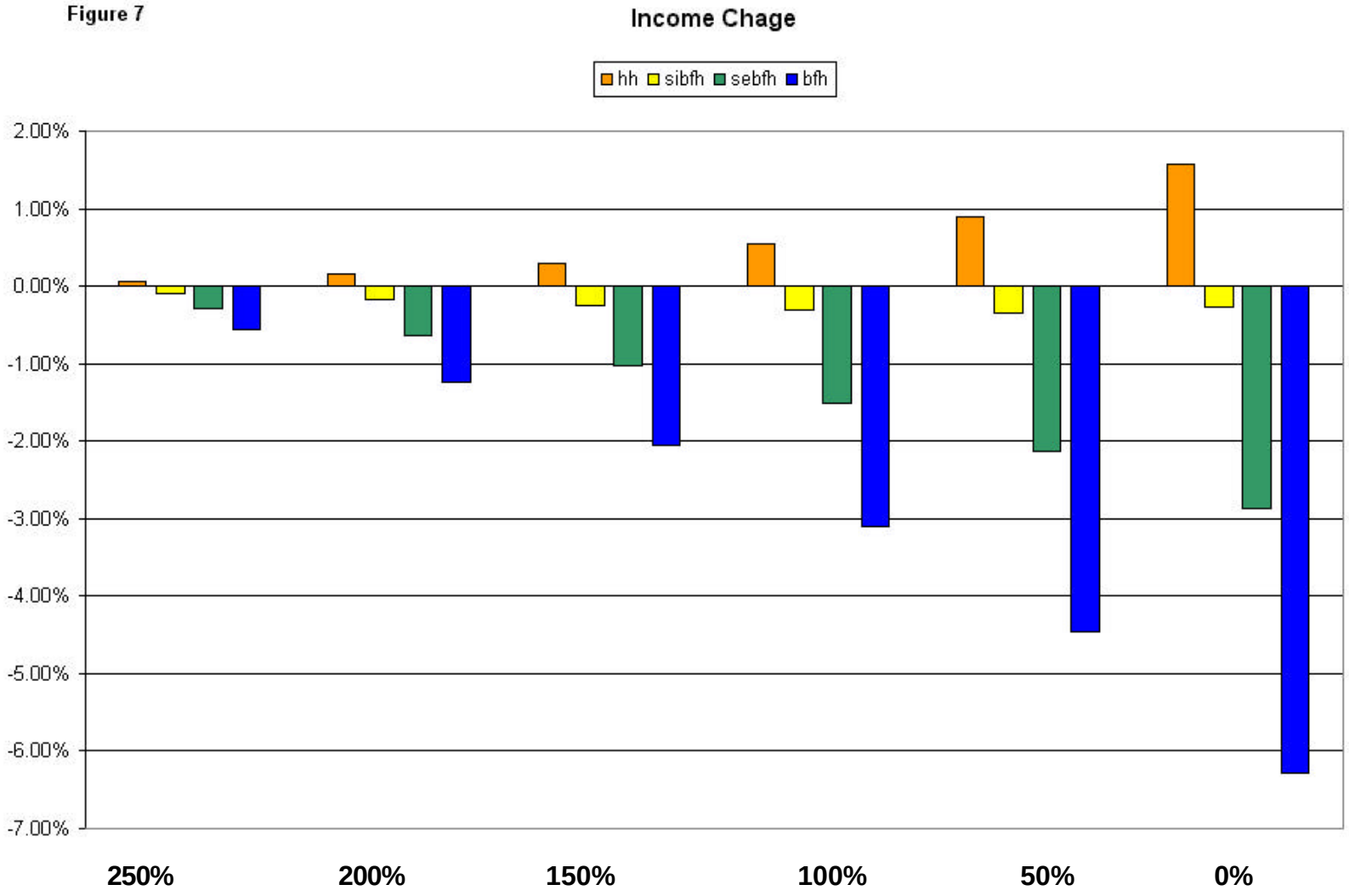
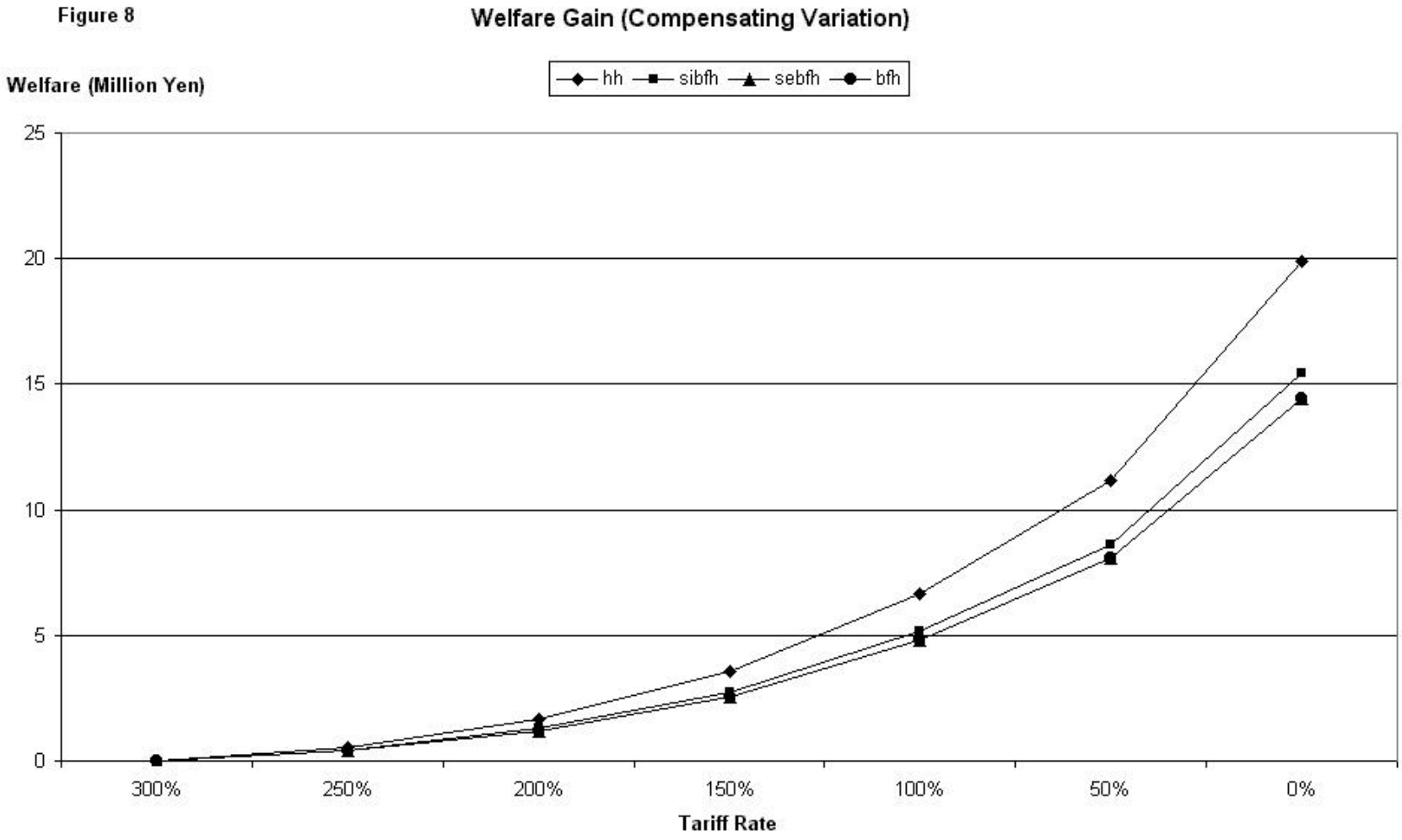

Income Chage
hh
sibfh
sebfh
bfh
2.00%
1.00%
0.00%
-1.00%
-2.00%
-3.00%
-4.00%
-5.00%
-6.00%
-7.00%
250%
200%
150%
100%
50%
0%

Figure 8


Welfare Gain (Compensating Variation)
hh
sibfh
sebfh
bfh
Welfare (Million Yen)
25
20
15
10
5
0
300%
250%
200%
150%
100%
50%
0%
Tariff Rate