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Consumer Demand for Crop and Livestock Commodities in Japan: Preliminary Estimates of the Consumption Impact of Reduced Prices

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Abstract:

Japan's 1965-1985 demand for crops and livestock is estimated. Income has positive impact on livestock and grains & oilseeds consumption; livestock price has significant own-price effect in livestock consumption and is complimentary in grains & oilseeds consumption. If Japan were to lower livestock prices, both livestock and grains & oilseeds consumption would increase.

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I. Introduction:

Japan has a longstanding and growing agricultural trade relationship with the U.S. For more than 20 years in a row, Japan has been the biggest single market for U.S. agricultural exports. In 1986, Japan accounted for about 20 percent of the $26.3 billion U.S. agricultural export value. Japan also has one of the most restrictive food import policies of any country in the world. However, economic conditions, such as being land poor and losing comparative advantage in agricultural production during industrialization, have led Japan to increase food import dependence. The U.S. agricultural export value to Japan was 12.3% in 1965, and increased to 19.5% in 1986. Japan has become the export market that food-surplus countries such as the U.S. eagerly seek.

It is important to understand Japan's domestic agricultural market in order to have gains and avoid losses through exports and trade negotiations. Here we focus on Japan's domestic demand market in order to understand the trade potential for U.S. agricultural exports. The market will be classified into two components: one is the crop sector which includes rice, wheat, corn, barley, and soybeans; the other is livestock which includes beef, pork and milk.

Rice is the major crop and major food consumption commodity in Japan. In order to achieve the goal of food self-sufficiency, the Japanese government sets a purchase price which is six times higher than the world price level to encourage rice production. In 1988, Japan produced a rice crop of 9.1 million tons. Rice is the only major commodity which is not imported. However, strong economic growth and rapid industrialization have caused consumers to alter

their diets away from traditional foods, resulting in declining rice consumption. Even though the real price of rice decreased from 449 yen/kg in 1981 to 316 yen/kg in 1986, per capita rice consumption declined from 90.45 kg in 1980 to 84.06 kg in 1985 and 79.19 kg in 1987. This trend is expected to continue.

The rapid increase in per capita income has caused the Japanese people to increasingly turn to meat products to fill their protein needs. But per capita meat and dairy consumption in Japan is still low compared to that of the U.S. The reasons have both social and religious backgrounds. Until World War II, the Japanese people were against meat-eating due to the Buddhist religion. Among the older generation, beef is still a relatively new diet. In addition, the Japanese government has set an import quota on beef and a variable levy on pork before 1950. These trade restrictions are imposed to achieve Japanese agricultural global policies --- maintaining farm income, limiting dependence on foreign sources of food and increasing domestic food self-sufficiency.

These trade restrictions have made domestic consumers pay many times higher than world price levels for livestock products and in turn consumption is discouraged. However, rising income has caused changes from the traditional diet of rice to grains and meats, and the beginnings of experiments with new foods, e.g. hamburgers. Therefore, postwar livestock product consumption in Japan has grown steadily and this growth is expected to continue.

Because of the steady growth in the livestock industry, livestock feed demand, i.e. wheat, corn and barley, in Japan has grown, too. Japan has always been heavily dependent on imported feed grains for its domestic livestock production. The government controls trade through state trading, i.e. importation by the government or by a government authorized monopoly, combined

with explicit government determined input quotas. Under these restrictions, the Japanese Food Agency sets high producer prices and low consumer prices. Both of these prices are above the world market price level.

The question raised here is how the quantity consumed of these restricted-import commodities would change if the domestic price were lowered by removing or reducing the restrictions. Based on economic theory, the quantity demanded is affected by price and income changes. The purpose of this paper is to analyze what has caused the changes in consumption that have occurred from 1965 to 1985 by estimating the demand equations for the crop and livestock sectors in Japan, and to estimate Japanese consumption levels in those sectors if Japanese prices were lowered to world price levels. These estimates provide implications for the Japanese import potential of agricultural commodities.

II. Data:

We use annual data from 1965 to 1985 in the analysis. Domestic consumption for each commodity is from PS & D. Disposable income , population and the consumer price index are from the Japan Statistical Yearbook. Due to data limitations, we use farm price, which is from Japan Agricultural Yearbook (Nihon Nogyo Nenkan), to replace retail price in each demand equation. We aggregate rice, corn, wheat, barley and soybeans into the crop sector and aggregate beef, pork and milk into the livestock sector. In order to eliminate the aggregation error by summing consumption quantities in constant prices, the Divisia indexes of consumption and price, as suggested by Solow, are used. The Divisia index uses value share as weights for each commodity. It provides consistent quantity and price indexes of bundles of commodities under the assumptions of weak separability and of a constant elasticity of substitution

relationship among the aggregated commodities. The Divisia quantity and price indexes used here are:

$$Q = \sum[Q_i*(P_i*Q_i/(\sum P_i*Q_i))]$$

$$P = \sum[Pi*(P_i*Q_{si}/(\sum P_i*Q_{si}))]$$

where Q and P are the Divisia indexes of consumption quantity and farm price, respectively. Qi, Qsi and Pi are consumption quantity, production quantity and farm price of the ith commodity within the aggregated commodities.

III. Demand for Crop and Livestock:

Per capita consumption of crops has been decreased from 95 kg in 1965 to 69kg in 1985. But per capita consumption of grains & oilseeds has increased from 33 kg in 1965 to 53 kg in 1985. This trend is also true for the per capita consumption of livestock which has been increased from 16 kg in 1965 to 27 kg in 1985 (Figure 1). The real prices of rice, grains & oilseeds and livestock in Japan have remained more stable than in the U.S. during the 1965-1985 period which reflects the greater degree of government intervention in the Japanese agricultural market (Figure 2).

The per capita consumption equations for crop and livestock are based on the conventional theoretical formulation which includes the variables of own price, substitute product price and per capita income. All equations are formulated in log linear form and estimated by OLS. The statistical results of these equations are presented in Table 1.

Equation (1) is the per capita crop consumption equation. As expected, the real price of crops is negatively related to consumption with a price elasticity of -0.11. The real price of livestock is positively related to crop consumption to exhibit the substitution effect with a cross price elasticity of 0.24. Both own price and substitute price effects are not significant at the

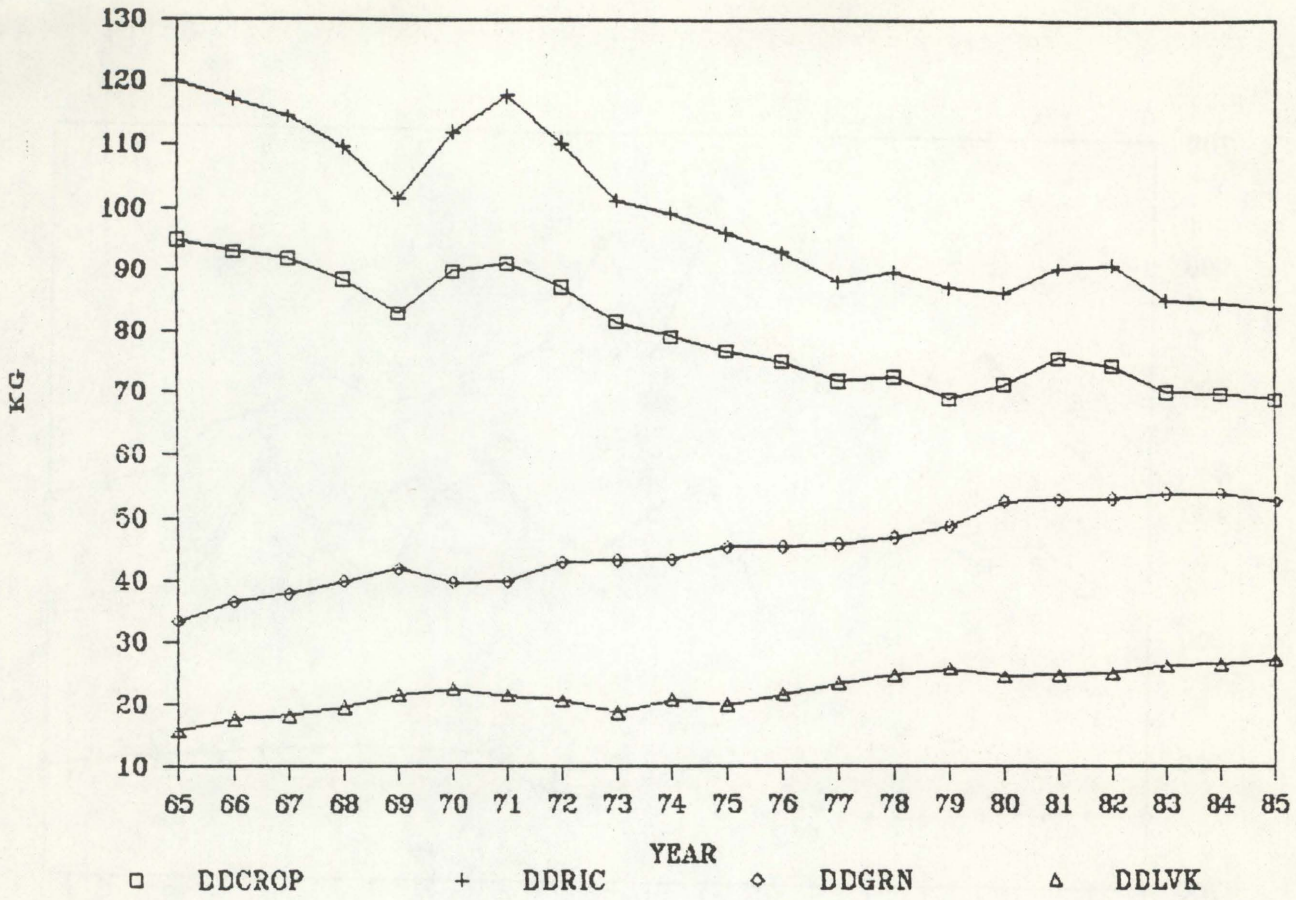

Figure 1. Per capita Consumption of Japanese Agricultural Commodities, 1965-1985.

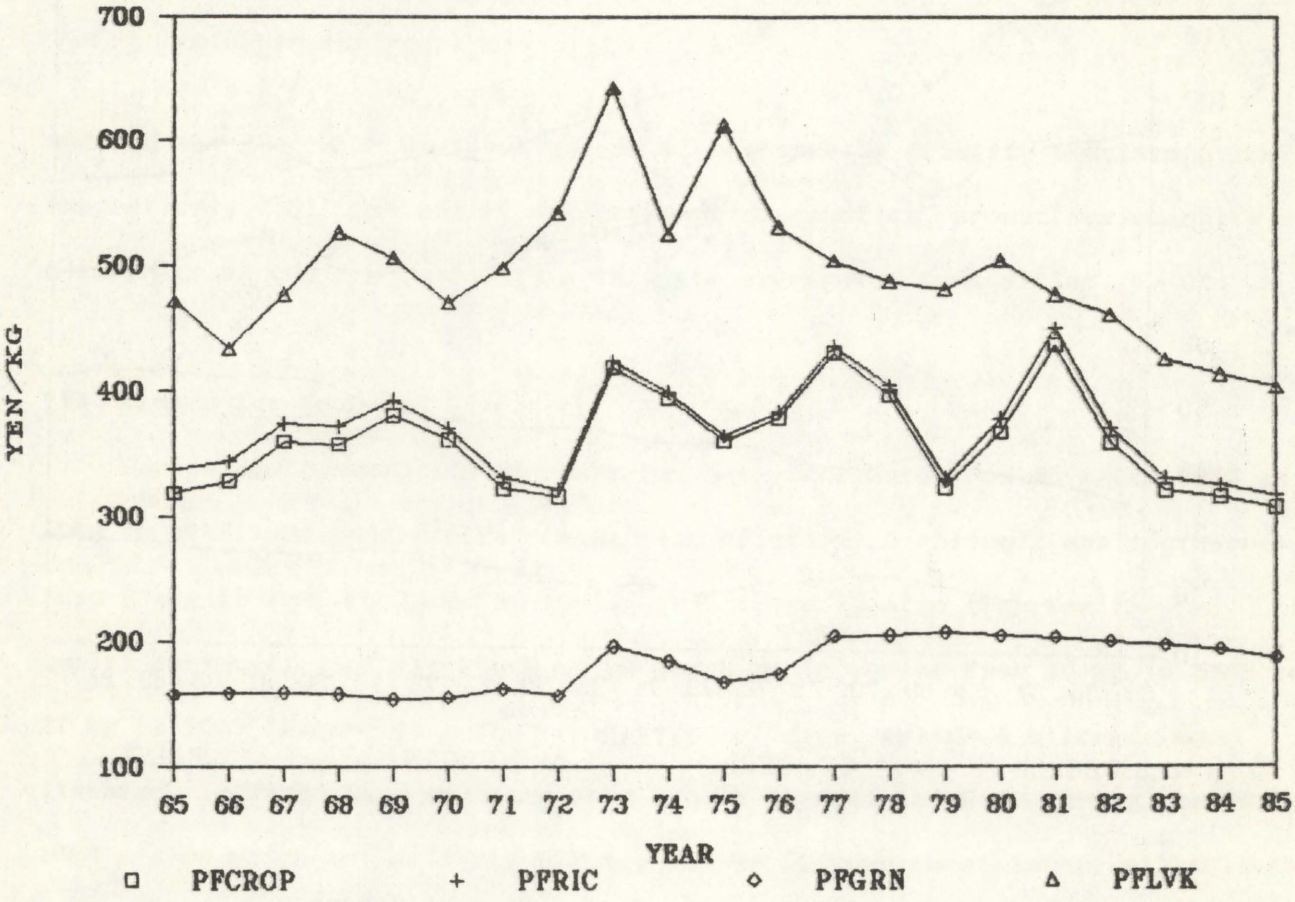

Figure 2. Real Farm Price of Japanese Agricultural Commodities, 1965-1985.

Table 1: Regression Results of Japanese Agricultural Consumption

Independent Variables	(1) DDCROP	(2) DDRIC	(3) DDGRN	(4) DDLVK
Intercept	6.51	7.42	0.41	3.27
PFCROP	-0.11			0.10
	(0.14)			(0.11)
PFRIC		-0.23		
		(0.15)		
PFGRN			0.24	
			(0.15)	
PFLVK	0.24	0.32*	-0.26*	-0.61*
	(0.13)	(0.14)	(0.10)	(0.10)
YDPOP	-0.41*	-0.45*	0.47*	0.54*
	(0.06)	(0.06)	(0.07)	(0.04)
R^2	0.74	0.75	0.88	0.91
D-W	0.89	1.01	1.36	0.81

a: All variables are in log linear form.
b: Single asterisk indicates coefficient significant at the 0.05 level.
c: Value in parentheses is standard error of the estimated coefficient of each independent variable.
d: D-W values for all equations are in the inconclusive range at 1% level.

Definitions of Variables

DDCROP	Divisia index of per capita crop consumption.
DDGRN	Divisia index of per capita grains & oilseeds consumption
DDRIC	Divisia index of per capita rice consumption.
DDLVK	Divisia index of per capita livestock consumption.
PFCROP	Divisia index of real crop farm price.
PFRIC	Divisia index of real rice farm price.
PFGRN	Divisia index of real grains & oilseeds farm price.
PFLVK	Divisia index of real livestock farm price.
YD	Real per capita disposal income.

5% level in the equation. Finally, per capita crop consumption shows a relatively large and statistically significant but negative real per capita income elasticity of -0.41.

As mentioned earlier, the Japanese have been changing their diet from traditional rice to grains and meats as per capita income has increased. Therefore, we disaggregate the crop sector into rice and grains & oilseeds products to isolate the rice income effect from the other crop income effect. Equations (2) and (3) are the per capita rice and grains & oilseeds consumption equations. We found that per capita income exhibits a statistically significant coefficient with a negative income elasticity of -0.45 in the rice equation but a positive and significant income elasticity of 0.47 in grains & oilseeds equation. This provides empirical support for the hypothesis that rice consumption has decreased and grains & oilseeds consumption has increased as a result of income increases.

The most important finding in the per capita grains & oilseeds equation is that the real grains & oilseeds price shows an insignificant but positive own price effect, and the real livestock price shows a significant but negative effect. The demand for livestock is a derived demand for feed grains and soybeans, and consumption of grains and soybeans is most of feed consumption. In 1988, 70% of grains was for feed use. The negative coefficient of livestock price in the grains & oilseeds equation indicates that when the livestock price is lowered, the quantity demand of livestock increases which in turn shifts demand for grains & oilseeds outward because of increased feed demand. The insignificant own price effect indicates that the grains & oilseeds consumption is affected primarily by real livestock price and income.

Equation (4) is the per capita livestock consumption equation. The equation shows that there is a significant own price elasticity of livestock consumption of -0.61. As compared to previous studies of the Japanese beef, pork and poultry demand elasticity, e.g. Williams (1985) provided summary of elasticities from Filippello, Kester, and Lopez, and Mount and Dyck (1988), --0.61 is at the lower bound for the range of -0.49 to -1.74 from these studies. The real price of crops is positively but not significantly related to livestock consumption with a low price elasticity of 0.10. Finally, per capita livestock consumption exhibits a relatively high and statistically significant real per capita income elasticity of 0.54. Again, this shows that the Japanese people have turned increasingly to meat and dairy consumption since World War II.

IV. Predicted Response to Reduced Trade Barriers:

Japanese domestic demand for agricultural commodities, except rice, exhibits a positive, significant and relatively high real income effect. Rice is the only food that achieves the 100% food self-sufficiency goal in Japan. As our results showed, we can expect that the demand for imports of grains, oilseeds and livestock will increase as Japanese income continues to increase. This means that, in the future, Japan will continue to be a very important market for U.S. agricultural exports. The most important finding here is that the price of livestock plays the significant role in both grains & oilseeds and livestock consumption. If the price of livestock can be lowered, the per capita consumption for both livestock and grains & oilseeds will increase. Based on our estimation results, in 1985, if the real price of livestock can be lowered from 403 yen/kg to the world price level, 225 yen/kg, which is obtained

by averaging the world price from 1983 to 1985, the per capita consumption of livestock will be increase from 28 kg to 43 kg; and the per capita consumption of grains & oilseeds will be increased from 54 kg to 62 kg. If we assume that Japan agricultural consumption pattern does not change when the livestock price is lowered, then we can translate the Divisia index of aggregate consumption to each commodity's consumption (Table 2). That represents 4.05 million tons more in the domestic demand for grains & oilseeds and 1.35 million tons more for beef and pork consumption. The real price of crops and of grains & oilseeds are not significant in either the crop or the grains & oilseeds consumption equations. The policy implication is that a lower price of livestock by removing or reducing trade restrictions will result in larger imports of agricultural commodities into Japan.

IV. Summary:

In the analysis of Japanese domestic demand for agricultural commodities, we use the Divisia index to generate consistent price and domestic quantity indexes for the crop and livestock sectors. We have a data limitation which forces us to use farm price for retail price in the per capita consumptions equations. The estimated results are very plausible. The following findings are obtained from the estimation:

(1) own price effect is not significant in crop or grains & oilseeds per capita consumption equations.

(2) livestock price is significant both in livestock consumption as own price effect and in grains & oilseeds consumption as complimentary effect.

Table 2: Predicted response of each commodity's consumption to reduced livestock price, 1985 year

unit: 1,000 tons

	1985 livestock price 403 yen/kg	1983-1985 world livestock price 225 yen/kg
(1) CORN	14,372	16,500
(2) WHEAT	6,192	7,109
(3) BARLEY	1,753	2,012
(4) SOYBEANS	5,057	5,806
(5) GRAINS & OILSEEDS =(1)+(2)+(3)+(4)	27,374	31,427
(6) BEEF	780	1,197
(7) PORK	1,750	2,687
(8) MEAT = (6)+(7)	2,530	3,884

(3) income plays a strong positive and significant role in livestock and grains & oilseeds consumption while a strong negative and significant role in rice consumption.

The findings support the conclusion that Japan will continue to be a large export market for the U.S. or the other food-surplus countries as Japanese per capita income keeps increasing. The important issue for the future is whether the price of livestock can be lowered by removing the trade restrictions, which would increase the both demand for livestock and grains & oilseeds. If Japan were to lower domestic livestock prices by 44% of the difference between 1985 world and Japanese prices, consumption of beef and pork products would increase by 54 percent or 1.35 million tons and grains & oilseeds by 15 percent or 4.05 million tons. Given production limitations in Japan, much of these increases would be imported.

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