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A Quantitative Factorial Component Analysis to Investigate the Recent Changes of Japan's Weight-Based Food Self-Sufficiency Ratio

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Abstract

We investigate the weight-based food self-sufficiency ratio (*WSSR*) for Japan over a 50-year period (1961-2011) by applying factorial component analysis technique in order to measure the changes of the *WSSR* quantitatively. Quantitative data analysis is employed to determine the drivers of those changes. Numerical results show that Japan experienced a drastic decline in its food self-sufficiency ratio (*FSSR*) during the above period. The factorial component analysis shows that such a decline was caused by the changes in the *FSSR* of the food groups/items, not in the quantity of the food supply. A number of characteristics of those changes are presented and a list of major food groups that have major impacts on the changes is constructed. The findings in this paper reiterate the alarming food security problem in Japan and provide clear insight into the causes of this problem. The findings in this study pick up where previous studies have left off, aid the food-related policy-making process and identify new ideas for future food research.

Keywords

Food Self-Sufficiency Ratio, Food Security, Factorial Component Analysis

1. Introduction

"Food security" is an important issue in Japan. This is partly due to the surge in world food and agricultural commodity prices in 2007, but it also reflects the food supply insufficiency the country has experienced over the

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past few decades. "Food security" is a multi-faceted and complex term, with varied applications. Indeed, among scholars and more broadly in the government, "food security" is used to refer to different concepts and contexts. The most widely used definition that was agreed upon by the Food and Agriculture Organization (FAO) of the United Nations was adopted in 1996 by representatives from over 180 countries, including Japan, with the Rome Declaration on World Food Security: "*Food security exists when all people, at all times, have access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life*"[1]. However, this definition allows for a range of interpretations and applications, depending on the purpose of the user. In developing countries, food insecurity may be a matter of life or death. In developed countries, food insecurity may create political riots and pressure national security and sovereignty. The rice replacement program in Japan in the after-war period is but one example.

Living in the world's third largest economy, Japanese enjoy a standard of living that most people in the world can only dream of. However, even though Japan is a prosperous nation, and Japanese have enough food to lead "an active and healthy life", it is widely believed in Japan that the country has a problem that is theoretically faced only by the world's poorer countries: food insecurity. Although this may sound ironic, even contradictory, some Japanese worry about an excessive nutritional intake of animal fats and unbalanced diet, many worry about Japan's future food supply as its food self-sufficiency ratio (*FSSR*) has been declining over the past half century.

The *FSSR* is used to represent the magnitude of domestic production as a proportion of domestic utilization (including consumption). It is defined as the percentage of domestic production against domestic utilization. On a calorie basis, Japan's *FSSR* has drastically dropped from 79% in 1960 to 39% in 2005, a drop of 40 percentage points in 45 years. This trend was publicly noted in 1973 and has been documented by Ogura [1], Higuchi [2] and Saeki [3], and more recently by, among others, Kako [4], Tanaka and Hosoe [5], Mashimo [6], Yoshii and Oyama [7], Trung, *et al*. [8], Hayami and Godo [9], Hayami [10], and in various reports issued by Japan's Ministry of Agriculture, Forestry and Fisheries(MAFF) (2000-2008) [11].

These studies focus on the exogenous elements that are factors of the decline of Japan's *WSSR* and economic implications both for supply and demand of food. Many have given attention to domestic and international economic policies. However, few have examined the endogenous factors that account for the downward trend in the *FSSR*. It is important, though, to investigate the drastic change in Japan's *FSSR* in more detail, from the inside out in order to gain an overall understanding of the situation. Such research would help policy makers in planning new directions for the country's future food supply and food policy.

We seek to enrich the literature by performing quantitative factorial component analysis to investigate, in detail, the endogenous elements that have affected Japan's *WSSR* over the 50 years from 1961 to 2011. In the next section the paper starts by constructing and presenting a weight-based *WSSR* for Japan. Then in Section 3 the ratio will then be decomposed into factorial components for quantitative analysis. The characteristics of the changes will be analyzed to provide insights into the most important factors that have driven down Japan's *WSSR*. The findings, which are presented in Section 4, will have implications for policy directions. Summary and conclusions are given in the final Section 5.

2. Japan's Food Self-Sufficiency Ratio and Its Past Trend

Calorie intake is often used in Japan as the basis for calculating the nation's *FSSR*. The *FSSR* on a calorie basis is defined as the percentage of the net calorie intake per capita per day supplied by domestic production over the total net calorie intake per capita per day. Japan's *FSSR* on a calorie basis drastically fell from 79% in 1960 to 39% in 2005 (Kako [4]), and has stayed around 39% thereafter until now. These figures, with minor adjustments, were widely used in academic papers and policy discussions in MAFF (various reports/papers 2007-2009), Kako [4], Tanaka and Hosoe [5], Mashimo [6], Yoshii and Oyama [7], Trung, *et al*. [8].

There are other methods to measure a country's *FSSR*. One measure using weight is called the "*WSSR* on a weight basis" (*WSSR*). Similarly, the *FSSR* measure based on money is called the "*FSSR* on a monetary basis" (*MSSR*). Japanese make little use of the *MSSR* while the *WSSR* is rarely given official attention in Japan. Japanese government, however, has announced the target for the *FSSR* on a calorie basis as 45% in 2025 even though it seems to be very difficult to be attained as the current value is still low as of 39% in 2014.

[1]FAO, "Rome Declaration on World Food Security and World Food Summit Plan of Action", World Food Summit, Rome, 13-17 November 1996.

This paper, however, opts to use a more internationally recognized approach to calculate Japan's *FSSR* so that a comparative perspective may be obtained. This paper employs FAO definitions and utilizes its Food Balance Sheets to reassess Japan's data from 1961 to 2011 so that a comprehensive picture of the country's food supply patterns during that period can be obtained. Data for those sheets were standardized and updated in December 2009. We have used the most recent data set FAO-STAT as the 2011 data is the latest one at this stage.

Using the FAO's internationally acknowledged methods of data classification for representing actual agricultural production, a measure of Japan's *FSSR* on a weighted basis (hereinafter, the "*WSSR*") is developed to estimate the magnitude of domestic production in relation to overall domestic utilization. Let N be the set of food groups/items concerned. Then Japan's *FSSR*, on a weight basis, denoted by *WSSR*, is formulated as follows:

$$WSSR = \frac{\sum_{i \in N} DP_i}{\sum_{i \in N} DP_i + \sum_{i \in N} IM_i + \sum_{i \in N} SV_i - \sum_{i \in N} EX_i} \quad (1)$$

where

DP_i	:	Domestic production of food group/item i (ton), $i \in N$;
IM_i	:	Imports of food group/item i (ton), $i \in N$;
SV_i	:	Stock variation (increase or decrease) of food group/item i (ton), $i \in N$;
EX_i	:	Exports of food group/item i (ton), $i \in N$,

While (1) is used to obtain a value for the *FSSR* of all food groups/items, the self-sufficiency ratio of each food group/item i on a weight basis (%), denoted by $WSSR_i$, can also be calculated in a similar manner.

$$WSSR_i = \frac{DP_i}{DP_i + IM_i + SV_i - EX_i}, \quad i \in N. \quad (2)$$

Likewise, a food import dependency ratio for Japan (the "*FIDR*") on a weight basis (%) is developed to assess the importance of imported food in the country. The *FIDR* expresses the magnitude of imports in relation to domestic utilization and is formulated in a similar manner to its *WSSR* counterpart except for the difference in the numerator, where domestic production is replaced by the value for import, as follows.

$$FIDR = \frac{\sum_{i \in N} IM_i}{\sum_{i \in N} DP_i + \sum_{i \in N} IM_i + \sum_{i \in N} SV_i - \sum_{i \in N} EX_i}. \quad (3)$$

The numerical results for *WSSR* and *FIDR* were derived by computing the values for (1), (2) and (3) using the FAO 2010 data for Japan's Food Balance Sheets from 1961 to 2011. The values are given in **Table 1** and graphed in **Figure 1**. Twenty major food groups (*MFG*) were used to compute the ratio. The group labeled "Miscellaneous" is omitted due to missing data throughout the reference period[2]. The use of all 20 *MFG* allows for a consistent measure of the total food supply and utilization in the country. These *MFG* and the food items included in each grouping are given in **Table 2**.

The results show that the values for both the *WSSR* and the *FIDR* changed drastically over time in ways consistent with the views of those concerned about Japan's future food supply and import dependency. It is obvious from the graph in **Figure 1** that the values for the *WSSR* fell sharply from 87% in 1961 (or an average of 80% in the 60s) to an average of 54% in the first five years of the new millennium. It is a drop of nearly 34 percentage points in 45 years, or a loss of 39% in value. The values for *FIDR* rose from just above 14% in 1961 to more than 49% in 2005. That is an increase of 35 percentage points over the same period, or a 2.5-fold gain in value. In the meantime, food supply in Calories (kcal) continued to rise as Japanese sought a higher living standard and the economy grew. The calorie intake rose from 2468 Calories per capita per day in 1961 to 2752 Calories in

[2]The major food groups were: (1) Cereals-Excluding Beer; (2) Starchy Roots; (3) Sugar Crops; (4) Sugar & Sweeteners; (5) Pulses; (6) Tree Nuts; (7) Oil Crops; (8) Vegetable Oils; (9) Vegetables; (10) Fruits-Excluding Wine; (11) Stimulants; (12) Spices; (13) Alcoholic Beverages (14) Meat; (15) Offals; (16) Animal Fats; (17) Eggs; (18) Milk-Excluding Butter; (19) Fish, Seafood; and (20) Aquatic Products, Other.

Table 1. *WSSR* and *FIDR* on a weight basis (%), and Food supply (kcal/capita/day) (kcal), Japan 1961-2011.

	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
WSSR (%)	86.4	84.8	82.2	79.9	80.0	77.5	77.7	77.2	74.7	72.3
FIDR (%)	15.0	15.9	19.2	21.6	23.2	24.6	25.5	26.1	27.4	30.4
Food supply (kcal)	2525	2572	2609	2632	2621	2643	2690	2700	2699	2738
	1971	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**
WSSR (%)	71.2	70.7	68.8	67.9	68.6	66.2	66.0	65.7	64.9	63.8
FIDR (%)	29.6	30.5	33.2	34.5	33.0	35.7	36.0	36.5	37.4	36.8
Food supply (kcal)	2729	2782	2773	2743	2717	2752	2774	2791	2808	2799
	1981	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
WSSR (%)	64.9	65.6	64.8	65.2	64.0	63.7	62.5	61.4	61.4	60.8
FIDR (%)	36.3	35.9	36.7	37.7	38.4	38.1	38.9	40.8	40.0	40.3
Food supply (kcal)	2750	2814	2829	2827	2862	2874	2896	2942	2969	2949
	1991	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
WSSR (%)	58.8	58.5	56.9	57.2	55.6	55.3	55.4	54.7	54.0	53.6
FIDR (%)	41.9	42.4	43.6	44.7	45.9	45.5	46.0	45.7	47.3	48.0
Food supply (kcal)	2934	2943	2926	2932	2921	2963	2939	2895	2898	2900
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
WSSR (%)	53.1	52.5	52.2	52.1	52.2	51.7	52.8	53.5	52.7	51.4
FIDR (%)	47.7	48.4	48.3	49.1	49.5	49.7	48.4	48.4	47.4	49.8
Food supply (kcal)	2890	2853	2842	2843	2828	2777	2816	2732	2674	2692
	2011									
WSSR (%)	51.3									
FIDR (%)	49.9									
Food supply (kcal)	2719									

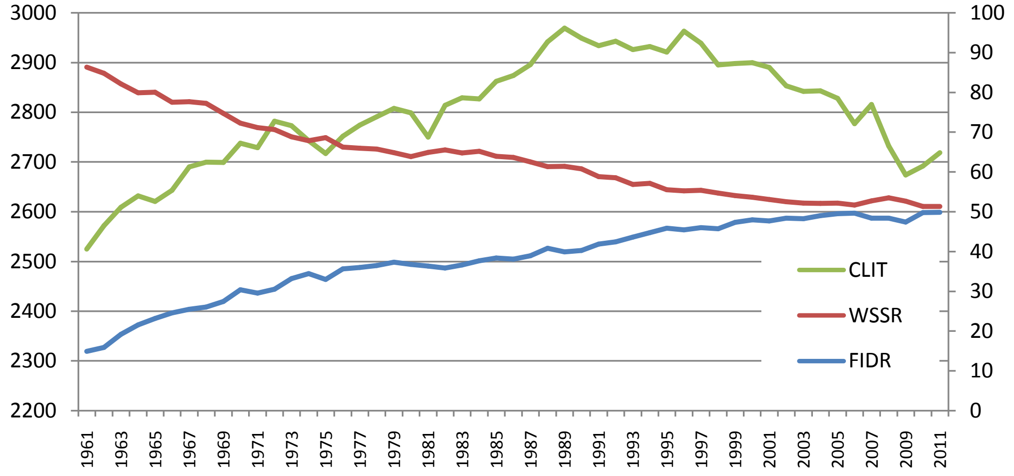

Figure 1. Japan's per capita per day calorie intake (left axes) and *WSSR*, *FIDR* (right axes).

1972, peaking at 2859 Calories in 1996 before slightly decreasing to 2743 Calories in 2005. That was a 11% increase in daily calorie intake over the last half century. Nevertheless, the 2005 level was just about that of the early 1970s, implying no net improvement in calorie intake over the 35-year period.

Taken altogether, the three trends indicate that while the quality of life is improving, Japan produces only half of its food needs and has come to depend on foreign imports for the other half. Setting aside differences in the

Table 2. 20 *MFG* and the items included.

MFG	Items included
Cereals-Excluding Beer	Wheat; Rice (Milled Equivalent); Barley; Maize; Rye; Oats; Millet; Sorghum; Cereals, Other.
Starchy Roots	Cassava; Potatoes; Sweet Potatoes; Yams; Roots, Other.
Sugar Crops	Sugar Cane; Sugar Beet.
Sugar & Sweeteners	Sugar, Non-Centrifugal; Sugar (Raw Equivalent); Sweeteners, Other; Honey.
Pulses	Beans; Peas; Pulses, Other.
Tree Nuts	
Oil Crops	Soyabeans; Groundnuts (Shelled Equation); Sunflowerseed; Rape and Mustardseed; Cottonseed; Coconuts-Incl Copra; Sesameseed; Palmkernels; Olives; Oilcrops, Other.
Vegetable Oils	Soyabean Oil; Groundnut Oil; Sunflowerseed Oil; Rape and Mustard Oil; Cottonseed Oil; Palmkernel Oil; Palm Oil; Coconut Oil; Sesameseed Oil; Olive Oil; Ricebran Oil; Maize Germ Oil; Oilcrops Oil, Other.
Vegetables	Tomatoes; Onions; Vegetables, Other.
Fruits-Excluding Wine	Oranges, Mandarines; Lemons, Limes; Grapefruit; Citrus, Other; Bananas; Plantains; Apples; Pineapples; Dates; Grapes; Fruits, Other
Stimulants	Coffee; Cocoa Beans; Tea.
Spices	Pepper; Pimento; Cloves; Spices, Other.
Alcoholic Beverages	Wine; Beer; Beverages, Fermented; Beverages, Alcoholic; Alcohol, Non-Food.
Meat	Bovine Meat; Mutton & Goat Meat; Pig Meat; Poultry Meat; Meat, Other.
Offals	
Animal Fats	Butter, Ghee; Cream; Fats, Animals, Raw; Fish, Body Oil; Fish, Liver Oil.
Eggs	
Milk-Excluding Butter	
Fish, Seafood	Freshwater Fish; Demersal Fish; Pelagic Fish; Marine Fish, Other; Crustaceans; Cephalopods; Molluscs, Other.
Aquatic Products, Other	Meat, Aquatic Mammals; Aquatic Animals, Others; Aquatic Plants.
Miscellaneous	

statistics used, the results correspond to the findings described in the MAFF papers and in the previous studies by Kako [4], Tanaka and Hosoe [5], Mashimo [6], Yoshii and Oyama [7], Trung, *et al*. [8], Hayami and Godo [9], and Hayami [10].

Whether the trends are cause for "alarm" depends on one's point of view. Many other variables also shape the political decision-making process in this globalized era. One could say that these trends might raise much concerns in both domestic and international arenas, given their impact both on Japan's food production, prices and trade, and the world's needs for overall global sufficiency.

In addition to realizing the changes in both *WSSR*, *FIDR* and calorie intake, one should also note that the pattern of food consumption in Japan has changed considerably over the past 50 years. Mashimo [6] has commented on the reasons for such changes[3], and studied three different patterns of Japanese food consumption in 2005. The first pattern was the *status quo*in 2005. The second pattern was a set of food intake and nutritional data recommended by the Ministry of Health, Welfare and Labor (MHWL). This pattern has been created as the ideal for Japanese to maintain their health, avoiding lifestyle-related sickness (MHWL pattern). And the third pattern was a set of food requirements based on the daily meal menus organized by Setsuko Shirone, an expert of sustainable food consumption and organic agriculture. Mashimo [6] called this the Chisan-chisho pattern (LP-LC pattern), after a popular movement that encouraged local production and local consumption in Japan. In 2005, according to the MHWL pattern, the ingestion of grains, potatoes and vegetables would increase, while the consumption of meat, milk products, sugar and fat would drastically decrease. This tendency was even more radical in the LP-LC pattern. The difference was the high amount of marine product intakes that was still considered to be possible. All of this, however, consisted of small fish and coastal fish, as well as the continued con-

[3]Mashimo argued that dietary changes in Japan dated back to the 1960s and 1970s with the rice diversion program and the "westernization" of the Japanese dietary habit. See Mashimo (2008) for details.

sumption of other domestically available marine species (Mashimo [6]).

3. Method and Numerical Results for Factorial Component Changes

3.1. Method for Measuring Changes

This part of the paper employs a factorial component analysis to assess the weight of endogenous factors that might account for the decline in the *WSSR*. The annual total change in the *WSSR* is broken into two major factorial components: (1) the change due to the *WSSR* change of each *MFG* component, and (2) the change due to *MFG*'s quantity supply change. These two factors are then compared to examine the irrelative impact on the *WSSR*.

Recalling the definition of food self-sufficiency ratio, *WSSR* is defined as the magnitude of domestic production in relation to overall domestic utilization. In other words, *WSSR* is the fraction of the total domestic utilization times its own self-sufficiency ratio (which equals domestic production) over the total domestic utilization. In mathematical terms, *WSSR*—hereinafter denoted by *R*—is defined as follows:

$$R = \frac{\sum_{i \in N} p_i w_i}{\sum_{i \in N} w_i} \tag{4}$$

where,

p_i	:	*MFGi*'s weight-based self-sufficiency ratio, $i \in N$;
w_i	:	*MFGi*'s quantity (weight) supply, $i \in N$,

The first derivative of (4) with respect to time shows that changes in *R* consists of both changes in p_i and w_i. In general terms, the annual change in Japan's food self-sufficiency ratio is the combination of a component change in the self-sufficiency ratios of the concerned *MFG* and a component change in the quantity of those *MFG*'s supply. Specifically, a small change in the value of *R*, denoted as ΔR, can be decomposed into two components corresponding to the SSR change and the quantity change respectively, as follows:

$$\frac{\mathrm{d}R}{\mathrm{d}t} = \sum_{i \in N} \frac{\partial R}{\partial p_i} \frac{\mathrm{d}p_i}{\mathrm{d}t} + \sum_{i \in N} \frac{\partial R}{\partial w_i} \frac{\mathrm{d}w_i}{\mathrm{d}t} \tag{5}$$

Denoting the above "annual" changes corresponding to the changes for *R*, p_i and w_i as ΔR, Δp_i and Δw_i, respectively, we can rewrite the expression in (5) as follows:

$$\Delta R = \sum_{i \in N} \frac{\partial R}{\partial p_i} \Delta p_i + \sum_{i \in N} \frac{\partial R}{\partial w_i} \Delta w_i \tag{6}$$

Let $W = \sum_{i \in N} w_i$ be the total supply for domestic utilization, then the right-hand-side (RHS) terms in (6) could be rewritten as:

$$\frac{\partial R}{\partial p_i} = \frac{w_i}{W}, \quad i \in N \tag{7}$$

$$\frac{\partial R}{\partial w_i} = \frac{1}{W}\left(p_i - \frac{\sum_{i \in N} p_i w_i}{W} \right) = \frac{\sum_{j \in N, j \neq i} \left(p_i - p_j \right) w_j}{W^2} = \frac{p_i - R}{W}, \quad i \in N \tag{8}$$

$$\Delta p_i = p_i^t - p_i^{t-1} \quad \text{and} \quad \Delta w_i = w_i^t - w_i^{t-1}, \ i \in N \tag{9}$$

Replacing (7) and (8) in (6) yields

$$\Delta R = \sum_{i \in N} \left(\frac{w_i}{W} \right) \left(p_i^t - p_i^{t-1} \right) + \sum_{i \in N} \left(\frac{p_i - R}{W} \right) \left(w_i^t - w_i^{t-1} \right) \tag{10}$$

$$\Delta R = \Delta R_p + \Delta R_w \tag{11}$$

Note that the left-hand-side (LHS) in (9) is the total annual change in Japan's food self-sufficiency ratio. The first term of the RHS in (9) is the factorial change in the major food groups' self-sufficiency ratios, and the second term is the factorial change of their supply quantities.

3.2. Numerical Results for Factorial Component Changes

The numerical results for the *WSSR* for each of the 20 *MFG*, and the values for all the terms in (6) were computed through (9) using the 2010 FAO data for Japan's Food Balance Sheets from 1961 to 2011. The results are presented in the **Table A** in the Appendix and in **Table 3** below.

Table 3. Numerical results for W, R, ΔR, ΔR_p and ΔR_w.

	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
W	495.0	515.7	537.1	541.3	548.2	563.1	577.8	599.2	593.3	601.5
R	86.4	84.8	82.2	79.9	80.0	77.5	77.7	77.2	74.7	72.3
ΔR		−1.355	−2.217	−2.161	0.710	−1.502	−0.130	−0.154	−1.486	−1.642
ΔR_p		−1.606	−2.616	−2.001	0.333	−1.604	−0.011	−0.658	−1.151	−1.432
ΔR_w		0.251	0.399	−0.160	0.377	0.102	−0.119	0.503	−0.335	−0.210

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
W	604	623.9	619.1	609.7	612.7	611.8	634	639.1	646.3	637.5
R	71.2	70.7	68.8	67.9	68.6	66.2	66.0	65.7	64.9	63.8
ΔR	−0.316	−0.083	−1.484	−0.848	0.550	−2.331	0.224	0.453	−0.237	−0.542
ΔRp	−0.864	−0.434	−1.412	−0.683	0.186	−1.976	−0.467	0.298	−0.256	−0.220
ΔR_w	0.548	0.351	−0.073	−0.165	0.363	−0.355	0.691	0.155	0.019	−0.322

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
W	627.8	642.3	643.3	636	649.9	656.8	667.3	674.3	683.3	674.1
R	64.9	65.6	64.8	65.2	64.0	63.7	62.5	61.4	61.4	60.8
ΔR	0.753	0.686	−0.544	0.068	−1.089	−0.018	−0.665	−1.690	0.001	−0.431
ΔR_p	0.707	0.414	−0.501	0.145	−1.143	−0.410	−1.055	−1.930	0.132	−0.470
ΔR_w	0.046	0.272	−0.043	−0.077	0.054	0.391	0.390	0.240	−0.131	0.039

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
W	670.4	678.9	669.5	677	679.6	677.5	670.6	652.1	658.9	655.2
R	58.8	58.5	56.9	57.2	55.6	55.3	55.4	54.7	54.0	53.6
ΔR	−1.955	−0.166	−1.230	−0.846	−1.834	−0.017	0.455	−1.200	−0.709	−0.974
ΔR_p	−1.921	−0.475	−1.076	−1.120	−1.847	0.133	0.566	−0.784	−0.640	−0.736
ΔR_w	−0.034	0.309	−0.155	0.274	0.013	−0.151	−0.110	−0.416	−0.069	−0.238

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
W	649.9	640.6	631.8	627.7	628.4	609.8	616.5	598.8	585.8	581
R	53.1	52.5	52.2	52.1	52.2	51.7	52.8	53.5	52.7	51.4
ΔR	−0.657	−0.720	−0.235	−1.089	−0.128	−0.576	0.942	0.428	−0.265	−1.649
ΔR_p	−0.263	−0.155	−0.101	−0.924	0.066	−0.513	1.085	0.388	−0.082	−1.282
ΔR_w	−0.394	−0.565	−0.134	−0.165	−0.194	−0.063	−0.142	0.040	−0.183	−0.366

	2011
W	591.7
R	51.3
ΔR	−0.727
ΔR_p	−0.877
ΔR_w	0.150

Using the breakdown in formula (6), we can map the relations between *WSSR*'s annual factorial changes, ΔR_p and ΔR_w, and the total changes ΔR. Using the computed data, the graphs in **Figure 2** show those relations and the 3-period moving average trend for ΔR.

Figure 2 shows that a strong correlation between the factorial change in *MFG*'s *WSSR* (ΔR_p) and the total change in *WSSR* (ΔR) does exist, but we cannot find a relation between the factorial change in *MFG*'s quantity supply (ΔR_w) and ΔR. The graphs show that ΔR_w fluctuated in a narrow band close to the origin0.0 and registered mostly positive values except for the period after year 1995. On the other hand, ΔR_p and ΔR took on mostly negative values and moved in close tandem with each other in a much wider fluctuation, mainly below zero. Positive values and minor adjustments or changes in *MFG*'s supply tend to stabilize and mitigate the total changes in *WSSR*. Nonetheless, changes in *MFG*'s *WSSR* diminish that effect as sharp falls tend to cause a drastic fall in the total change in *WSSR*. The 3-year moving average trend line also shows that, on average, ΔR moved in a wide band far below zero in a way that reflected the broad negative fluctuation of ΔR_p, and cancelling out the positive effect brought about by ΔR_w. The moving average stays mostly below zero, implying and verifying the fact that *WSSR* declines most of the time.

This data analysis shows that the declining trend of *WSSR* is mainly due to the declining trend of the MFG's *WSSR* rather than due to the changes in *MFG*'s quantity supply.

3.3. Trend Analysis on the Factorial Change

We analyze the time series trend of factorial component changes in order to investigate the change in the *WSSR* in more detail. We divide the whole time span of 1961-2011 into four sub-periods, trying to find the specific characteristic of the three elements concerned (ΔR, ΔR_p and ΔR_w) in each of these four sub-periods, which we denote by I, II, III, and IV, respectively.

Sub-period I (1961-1976): This is the longest sub-period, characterized by large negative values for ΔR and ΔR_p. During the sub-period the rise in the values for ΔR_w kept the values for ΔR from falling more than they did. This period corresponds to the time when many food-related policies, such as the rice diversion program, which started in 1970 to reduce the domestic rice production by 30% - 40%, thus policy changes were adopted in Japan. The period also saw the "westernization" of Japanese diets. Although agricultural production in this period performed satisfactorily, new demands created huge shortages in food items which were not produced domestically. The outcome was a sharp fall in the values of ΔR_p for many food items (*i.e.*, *MFG*) which led to the sharp fall in the values of ΔR (*i.e.*, *WSSR*). Major falls occurred in rice, grain and wheat in the "Cereals" *MFG* and in potatoes and sweet potatoes in the "Starchy Roots" *MFG*. On the other hand, weights of vegetables, fish, seafood, milk and fruits increased in a large scale, which made the values of ΔR_w rather stable.

Sub-period II (1977-1984): This is the shortest sub-period, lasting only eight years, where the fluctuations in ΔR and ΔR_p were within a narrow band. Again in this sub-period, the values for ΔR_w remained mostly highly and strongly positive. ΔR remained only slightly negative through this period, and for some years even rose into positive territory. This period came after a long period of decline in the *WSSR* that had begun to alarm Japanese in the early 1970s, following the Oil Crisis that rocked Japan's economy. A mild "return to local foodstuff" saw the *WSSR* rise somewhat. However, Japan's relatively open agricultural trade policy tended to offset the return, and the *WSSR* fluctuated during this time. Major contributors to the fluctuation were grain and wheat in the "Cereals" *MFG*. New impacts came from wine and alcoholic beverages in the "Alcoholic Beverages" *MFG*, the "Vegetables" *MFG*, and a range of foreign fruits from the "Fruits-Excluding Wine" *MFG*.

Sub-period III (1985-1996): During this period, Japan returned to the pattern that had been found for the first sub-period. It was characterized by negative values for ΔR and ΔR_p (though with slightly smaller values). The values for ΔR_w were positive from 1985-1989. Then they turned negative, which, together with ΔR_p, amplified the negative values being registered for ΔR. This period marks the beginning of Japan being the world's largest net food importer. High volumes of imports in wheat, grain in the "Cereals" *MFG*, in potatoes in "Starchy Roots", in wine and alcoholic beverages in "Alcoholic Beverages", in tomatoes, onions and other vegetables in "Vegetables", in apples, bananas, oranges, pineapples, grapes in "Fruits-Excluding Wine" contributed mostly to low negative values in ΔR_p. The new commodities were marine fish and other seafood in the "Fish, Seafood" *MFG*, and bovine meat, mutton and goat meat in the "Meat" *MFG*.

Sub-period IV (1997-2005): This was a stable, but all negative period. The values for ΔR_p and ΔR_w were negative almost all time, thereby keeping those for ΔR in the negative zone. The moving average was quite

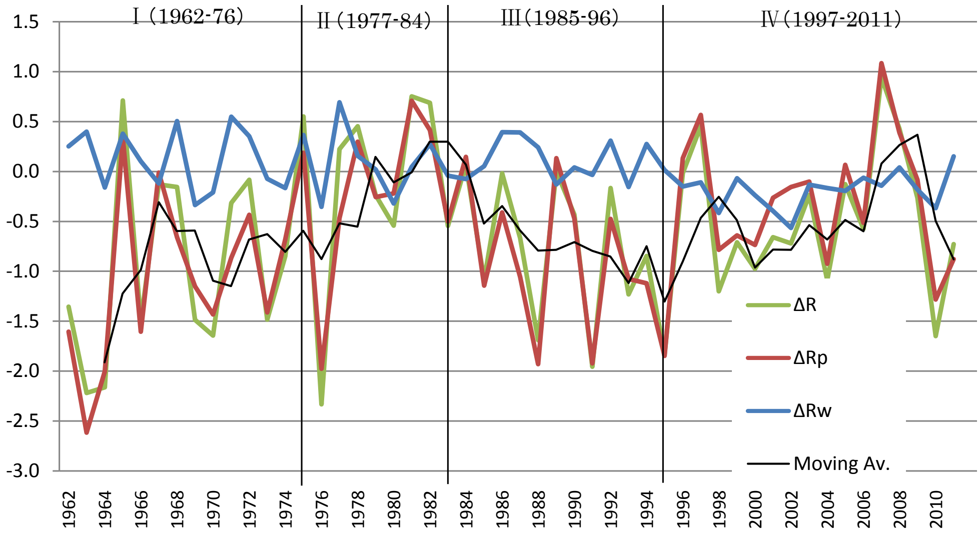

Figure 2. ΔR_p, ΔR_w, ΔR and its 3-year moving average of ΔR.

smooth and the negative scale was not that as much as that of the former three sub-groups. Thus the "stabilized period" is explainable. After three periods of sharp declines and fluctuation, the values for ΔR_p and ΔR_w seem to "adapt" themselves to the new domestic demands and dietary habits. This results in a more stable set of slightly negative values for ΔR. The commodities remain those noted above.

4. Investigation on the Relation among Factorial Component Changes

4.1. Impact of Factorial Component Changes on the Total Change

To analyze the impact of factorial component changes on the total change, the values for ΔR_p and ΔR_w are individually regressed against those for ΔR. **Figure 2** plots the two combinations (ΔR, ΔR_p) and (ΔR, ΔR_w) to represent the comparative relation between the two components and the total change. We note that, firstly, the values for the total change ΔR vary within an interval ranging from −3.0 to 1.0. Secondly, the values for the factorial component change ΔR_p range within the same interval $-3.0 < \Delta R_p < 1.0$. Thirdly, the values for the factorial component change ΔR_w range in a much narrower interval $-0.5 < \Delta R_w < 0.5$.

The graphs in **Figure 3** show that the data points for the (ΔR, ΔR_p) combinations, letting ΔR and ΔR_p expressed by x and y, respectively, are best explained by the single variable linear regression model $y = 0.874x - 0.124$ (with $R^2 = 0.897$). This means that the component change ΔR_p is generally explained by the total change ΔR with almost 90% goodness of fit. Moreover, only one-fifth (20%) of the (ΔR, ΔR_p) combinations, *i.e.*, 9 out of 50 combinations, are located in the first coordinate while almost 70%, *i.e.*, 37 out of 50 combinations, are in the third coordinate, meaning the negative change in the values for ΔR is mostly attributed to the negative change in the values for ΔR_p, not that of those for ΔR_w. In other words, the declining trend of *WSSR* is attributed to the decline in the self-sufficiency ratios of the foodstuff themselves, not that of the change in the food supply quantity.

On the other hand, the graph does not show a satisfactory correlation for the (ΔR, ΔR_w) combinations. These combinationsscatter along a narrow rectangle given by $-3.0 < \Delta R < 1.0$, and $-0.5 < \Delta R_w < 0.5$, meaning that the factorial component ΔR_w has not changed on a large scale in the past 45 years and has not contributed greatly to the total change ΔR. We also note that data points in the first coordinate (*i.e.*, positive values for both ΔR and ΔR_w) stay close to the origin, implying not much change and impact on ΔR. Positive changes in ΔR_w are mostly reflected in the increase in Calorie supply (kcal/capita/day) rather than in ΔR and *WSSR* as a whole.

4.2. Relation between Factorial Components

Table 4 presents the frequency of the values for ΔR_p and ΔR_w during the reference period. It shows how they are distributed, over 51 years as a whole (50 years of changes), and in each of the above-mentioned four sub-periods in particular. It can be seen from the table that the number of years when the values for ΔR_w are nonnegative and that when the values for ΔR_w are negative are equal as 23 and 27, respectively, thus they are not so different.

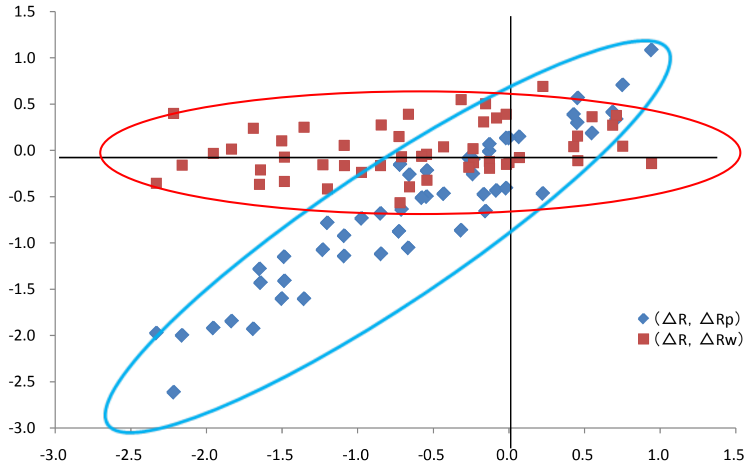

Figure 3. Plots of (ΔR, ΔR_p) and (ΔR, ΔR_w).

Table 4. ΔR_p and ΔR_w frequency.

Sub-period	ΔR_p				ΔR_w		
	$\Delta R_p < -2$	$-2 < \Delta R_p < -1$	$-1 < \Delta R_p < 0$	$0 < \Delta R_p$	$\Delta R_w < -1$	$-1 < \Delta R_w < 0$	$0 < \Delta R_w$
I (1962−1976)	2	6	5	2	0	7	8
II (1977−1984)	0	0	4	4	0	3	5
III (1985−1996)	0	7	3	2	0	4	8
IV (1997−2011)	0	1	10	4	0	13	2
Total	2	14	22	12	0	27	23

On the other hand, regarding the values of ΔR_p, they are positive only 12 years among 50 years while other 38 years show negative values.

In the sub-period I only 2 years out of 15 are in the 1st coordinate, *i.e.*, ΔR_p and ΔR_w are both positive while other 6 years are in the 2nd coordinate, *i.e.*, ΔR_p negative and ΔR_w positive, and 7 years are in the 3rd coordinate, *i.e.*, ΔR_p and ΔR_w are both negative. In the sub-period II 3 years are distributed in the 1st coordinate and 1 year is in the 4th coordinate, *i.e.*, ΔR_p positive and ΔR_w negative while 2 years are in the 2nd and 3rd coordinates, respectively. In the sub-period III 2 years out of 12 in total are in the 2nd coordinate while remaining 8 years are in the 2nd coordinate and 2 years are in the 3rd coordinate. In the sub−period IV only 1 year out of 15 in total is in the 1st coordinate while remaining 10 years are in the 3rd coordinate and only 1 year and 2 years are exceptionally in the 2nd and 4th coordinates, respectively.

Thus, we find that most sub-periods, excluding II, show dominatingly negative ΔR_p no matter how ΔR_w are valued. This trend in the sub-period I is due to the decrease (increase) in supply (import) in majorly grains. In the sub-section III similar trend comes from decreasing supply of rice, vegetables, fruits, meat and fish. Sub-period IV shows the decreasing trend of major food items excluding meat corresponds to the negative ΔR_w. Sub-period II shows that both ΔR_p and ΔR_w are close to zero.

Figure 4 graphs the time series changes in the four sub-periods, and for the 1962-2011 period as a whole, relative to a center point. We find that ΔR_p and ΔR_w follow two different paths unrelated each other. In all four sub-periods, ΔR_w tended to be stably staying around the circular line corresponding to the value zero while ΔR_p unsteadily scattered along the scale and mostly staying in the area corresponding to "negative" points. We find that the graphs reiterate ΔR_p's tendency of being mostly negative for sub-periods I and III while it is mostly close to ΔR_w's for sub-periods II and IV.

We also note that the values of the center points are all different for these figures while the scale for each sub-period is also different. This means ΔR_p and ΔR_w vary in each sub-period as we see the different shapes of

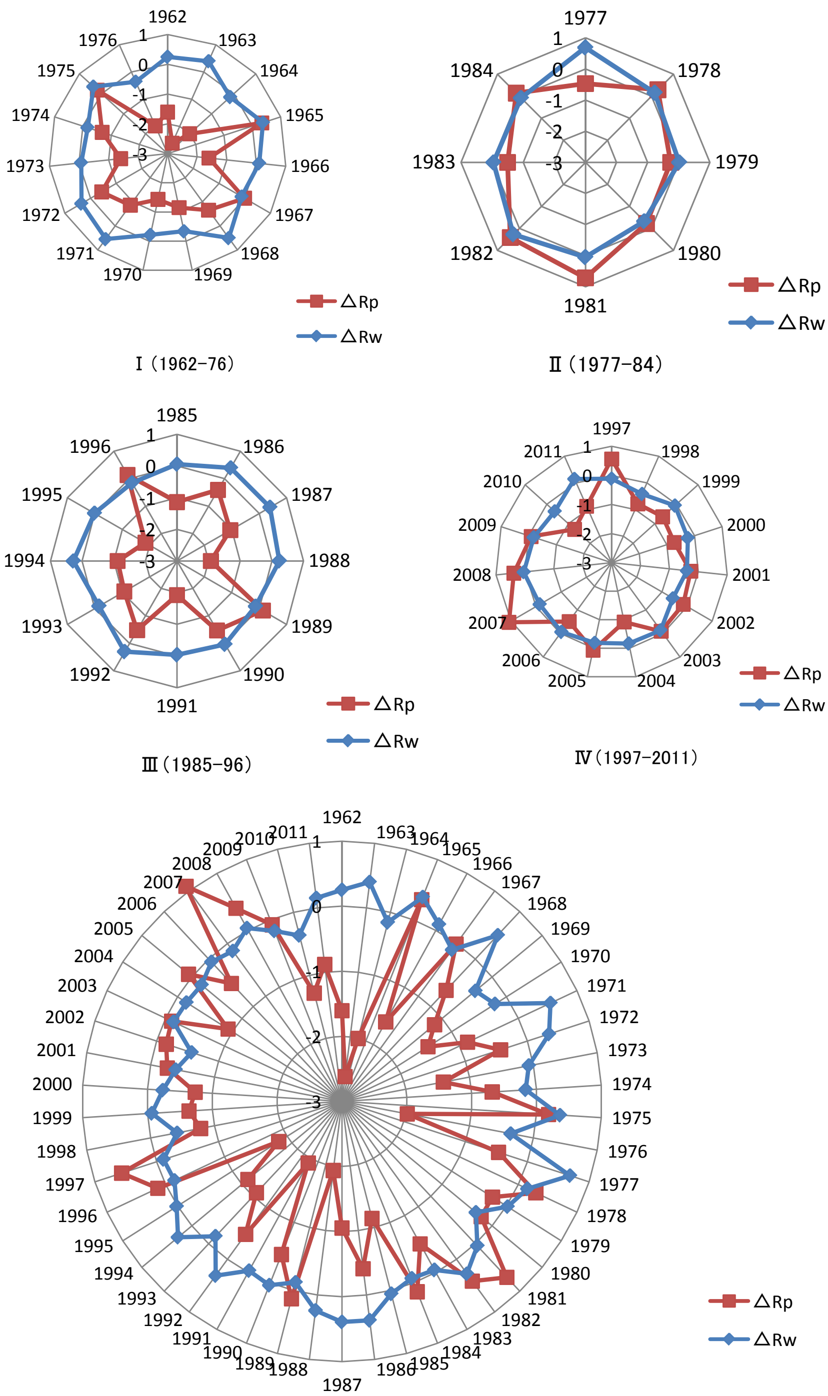

Figure 4. ΔR_p and ΔR_w in 4 sub−periods and all.

the graphs. Moreover, we learn that there were but 8 years (out of 50, or 16%) in the reference period where ΔR_p and ΔR_w took on positive values, and stayed close to each other. Those were in 1965, 1975, 1978, 1981, 1982, and 2008. It explains why the total change ΔR were mostly negative, and *WSSR* declined during the 1961-2011 period.

4.3. Impact of *MFG* on the Factorial Component Changes

Of all 20 *MFG* concerned, the impacts they have on ΔR_p and ΔR_w (and, therefore, on ΔR) are quite different. We compute minimum, median and maximum of ΔR_p and ΔR_w for all 20 *MFG* in the reference period to observe such impacts. **Table 5** presents these minimums, medians and maximum, and **Table 6** lists the top 10 *MFG* with the greatest impacts on ΔR_p and ΔR_w, respectively. The ranking is based on (1) the scale of the impact with respect to the median, and (2) the nature of *MFG*'s fluctuation pattern. These **Table 5** and **Table 6** are obtained from calculating numerical results given in **Table A** in the **Appendix**.

From **Table 5** and **Table 6** we find that regarding the median of ΔR_w, changes of supply for "Cereals", "Alcoholic Beverages", and "Fish, Seafood" give rather positive impacts while only "Starchy Roots" gives rather negative impact. Negative impact due to "Starchy Roots", even though small, may result from the fact that they are transformed into some other consuming foods rather than directly consumed in the market. Also regarding the median of ΔR_p, only "Sugar & Sweeteners" brings small positive impact while other "Cereals", "Fruits", and "Fish, Seafood" bring large negative impacts. These large negative impacts may result from the fact that we have been importing these foods such as "Cereals", "Fruits", and "Fish, Seafood" constantly and largely as major foods in Japan.

As shown in **Table 5** and **Table 6**, we see that maximum values with respect to ΔR_p are very high for "Cereals", "Starchy Roots", "Sugar & Sweeteners", "Alcoholic Beverages", and "Fish, Seafood", and their minimum values are generally very small, which implies that these foods including "Vegetables" and "Meat" have both large positive and large negative impacts on our ΔR. The "Cereals" *MFG* has the second largest and highly important impact on both ΔR_p and ΔR_w. The "Fish, Seafood" *MFG* has more impact on ΔR_p and less on ΔR_w while "Meat" and "Vegetable Oils" have almost the same importance in affecting ΔR_p and ΔR_w. The *MFG* "Cereals", "Starchy Roots", "Fish, Seafood", "Meat", "Vegetables", "Vegetable Oils", "Milk", "Alcoholic Beverages" are presented in both columns, implying their importance in Japanese diets. The missing *MFG* in the list ("Sugarcrops", "Treenuts", "Oilcrops", "Spices", "Offals", "Animal Fats", "Aquatic Products, Other") reveals that food policy-making process can target these *MFG* without much impact on *WSSR*. On the other hand, policy makers should be careful when targeting *MFG* in the Top 10 list in order to avoid an unwanted impact on ΔR_p and/or ΔR_w, and therefore on ΔR and *WSSR*.

Table 5. Impact of *MFG* on ΔR_p and ΔR_w.

MFG	ΔR_p			ΔR_w		
	Min	Median	Max	Min	Median	Max
Cereals-Excluding Beer	−1.809	−0.118	0.696	−0.233	0.040	0.312
Starchy Roots	−0.844	−0.030	0.566	−0.232	−0.019	0.136
Sugar Crops	0.000	0.000	0.000	0.000	0.000	0.000
Sugar & Sweeteners	−0.328	0.021	0.610	−0.357	0.000	0.238
Pulses	−0.140	−0.010	0.133	−0.018	0.000	0.024
Tree Nuts	−0.020	−0.003	0.012	−0.014	0.000	0.013
Oil Crops	−0.123	−0.004	0.016	−0.059	0.000	0.058
Vegetable Oils	−0.118	−0.010	0.056	−0.017	0.008	0.036
Vegetables	−0.454	−0.075	0.291	−0.266	−0.023	0.375
Fruits-Excluding Wine	−0.414	−0.115	0.323	−0.173	0.004	0.186
Stimulants	−0.036	−0.004	0.014	−0.037	−0.006	0.040
Spices	−0.012	0.000	0.030	−0.022	0.000	0.020
Alcoholic Beverages	−0.549	−0.010	0.535	−0.330	0.051	0.269
Meat	−0.438	−0.060	0.338	−0.010	0.012	0.060
Offals	−0.022	−0.002	0.059	−0.033	0.002	0.013
Animal Fats	−0.079	−0.002	0.081	−0.013	0.000	0.018
Eggs	−0.040	−0.003	0.034	−0.047	0.006	0.071
Milk-Excluding Butter	−0.793	0.009	0.561	−0.124	0.000	0.109
Fish, Seafood	−0.794	−0.183	0.613	−0.140	0.012	0.178
Aquatic Products, Other	−0.062	−0.002	0.065	−0.030	0.000	0.016

Table 6. Top 10 *MFG* affecting ΔR_p and ΔR_w.

Rank	Impact on ΔR_p	Impact on ΔR_w
1	Fish, Seafood	Alcoholic Beverages
2	Cereals-Excluding Beer	Cereals-Excluding Beer
3	Fruits-Excluding Wine	Vegetables
4	Vegetables	Starchy Roots
5	Meat	Meat
6	Starchy Roots	Milk-Excluding Butter
7	Sugar & Sweeteners	Fish, Seafood
8	Vegetable Oils	Vegetable Oils
9	Milk-Excluding Butter	Stimulants
10	Alcoholic Beverages	Eggs

5. Summary and Conclusions

It is inarguable that food self-sufficiency has become a very serious policy issue in Japan. Local scholars and bureaucrats believe the country's Food *SSR* has been as low as 40% in the recent trend from 2005 until now on a calorie basis. The results in this paper show a higher value, 53%, on a weight basis. Yet, it is still low, compared to that of 87% in 1961. It is a drop of nearly 34 percentage points in 50 years. This situation puts a pressure on the country's agriculture sector and leaves national food security and national safety vulnerable.

By breaking ΔR into two major factorial component changes, ΔR_p and ΔR_w, we were able to analyze and find that it was the change in the major food group's self-sufficiency ratio, ΔR_p, that drove the change in ΔR, not that of the change in the major food group's quantity supply, ΔR_w.

The trend analysis concludes that ΔR_p and ΔR_w, and that ΔR_p have a stronger and a greater impact on ΔR while there is no explicit relation between them. Thus we concluded that the decline of ΔR was mostly due to the decline in major food group's self-sufficiency ratio (ΔR_p). We also found that the values for ΔR_p and those for ΔR can be well explained by a linear equation, with an almost 90% goodness of fit. On the other hand, we could not find any satisfactory expression to explain the values of ΔR_w and those for ΔR.

We also divided the reference period into four sub-periods to investigate the characteristics of the changes and to explain *WSSR*'s overall declining trend. We noted the differences in the characteristics of each sub-per- iod, and found the commodities that contributed to such characteristics.

We also computed and listed the top 10 *MFG* that had the greatest impacts on both ΔR_p and ΔR_w in particular and ΔR as a whole. Among them, the "Cereals" *MFG* proved to have had the major and most highly important impact on both ΔR_p and ΔR_w. The *MFG* "Starchy Roots", "Fish, Seafood", "Meat", "Vegetables", "Vegetable Oils", "Milk", "Alcoholic Beverages" all displayed their importance in the Japanese diets. These are the *MFG* that the policy-making process needs to pay more attention to in order to avoid a negative impact on ΔR_p and/or ΔR_w, and thus on ΔR and *WSSR*.

By studying ΔR_p and ΔR_w—the endogenous factors of *WSSR*, the paper partly fills the gap in the literature on Japan's food problems. The findings in this paper lead to many suggestions and implications for both policy makers and food researchers. From both the research and policy-making points of view, one obvious question, among others, would be to what extent *WSSR* can be recovered. What would be the maximum sustainable *WSSR*? In an attempt to find the answer to such questions, a study on food network flow programming is conducted. The optimal results from such optimization model would be significant for further investigation of food security in Japan.

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Appendix

Table A. 20 Major food groups' self-sufficiency ratios, Japan 1961-2011.

	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
SSR Cereals−Excluding Beer +	70.2	67.5	60.3	55.6	55.0	50.6	53.5	52.1	46.1	39.0
SSR Starchy Roots +	99.4	97.1	101.7	99.2	99.4	99.0	97.1	97.2	97.3	97.0
SSR Sugarcrops +	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
SSR Sugar & Sweeteners +	27.7	30.6	31.2	38.8	37.0	32.8	31.9	28.5	25.7	23.5
SSR Pulses +	84.2	66.1	65.0	46.7	63.3	50.6	67.7	59.4	51.1	67.1
SSR Treenuts +	84.8	75.7	70.6	67.4	60.5	58.6	62.5	64.0	68.1	62.3
SSR Oilcrops +	28.8	24.8	−−	15.0	13.9	10.6	9.3	7.9	6.4	5.1
SSR Vegetable Oils +	100.8	98.2	95.9	95.2	97.9	97.9	96.9	96.0	94.7	96.7
SSR Vegetables +	100.0	100.2	99.8	99.7	99.8	99.7	99.5	99.4	99.7	99.3
SSR Fruits−Excluding Wine +	101.1	99.1	94.4	92.7	92.9	91.7	90.9	89.7	87.0	84.5
SSR Stimulants +	73.2	65.5	57.0	56.8	56.1	47.4	48.0	45.9	43.5	40.8
SSR Spices +	83.3	150.0	85.7	71.4	83.3	42.9	28.6	25.0	28.6	6.3
SSR Alcoholic Beverages +	100.1	100.1	100.1	100.1	100.0	100.1	100.1	100.1	100.0	99.9
SSR Meat +	94.8	95.6	91.4	91.1	93.7	88.0	88.9	87.5	84.8	88.4
SSR Offals +	100.0	100.0	98.6	97.6	98.9	99.0	99.1	96.4	96.8	98.0
SSR Animal Fats +	69.1	82.4	78.0	65.2	62.4	52.4	53.1	52.5	52.6	60.1
SSR Eggs +	100.8	100.6	100.2	100.1	99.9	99.7	99.2	98.3	98.3	97.9
SSR Milk−Excluding Butter +	85.5	82.1	78.1	77.4	80.5	79.5	74.0	80.2	83.2	84.8
SSR Fish, Seafood +	108.1	106.0	101.2	96.3	97.7	99.7	99.5	94.9	98.7	100.2
SSR Aquatic Products, Other +	88.7	90.2	88.6	84.8	86.0	77.8	84.4	85.7	82.2	82.0
	1971	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**
SSR Cereals−Excluding Beer +	34.1	33.2	31.1	31.3	33.2	28.6	29.6	28.6	26.8	22.1
SSR Starchy Roots +	96.6	103.0	96.6	88.5	84.3	93.1	92.0	90.7	92.3	92.4
SSR Sugarcrops +	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
SSR Sugar & Sweeteners +	22.0	22.9	25.5	18.9	21.0	23.3	23.2	35.3	36.3	43.9
SSR Pulses +	44.7	73.3	67.0	60.7	47.7	49.5	58.5	52.2	45.6	30.6
SSR Treenuts +	56.8	57.7	53.8	60.2	53.1	42.1	47.2	46.9	50.4	43.1
SSR Oilcrops +	4.6	4.3	3.8	4.4	4.0	3.5	3.4	4.5	4.5	4.1
SSR Vegetable Oils +	100.1	93.8	87.2	84.2	85.4	82.1	84.4	84.8	84.1	85.6
SSR Vegetables +	99.0	98.8	98.3	97.9	98.0	97.3	97.4	96.6	96.3	96.0
SSR Fruits−Excluding Wine +	83.3	82.0	83.7	84.0	83.8	82.3	83.0	80.7	82.2	81.9
SSR Stimulants +	38.3	34.7	35.2	35.1	36.1	33.4	32.3	34.2	27.0	27.6
SSR Spices +	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SSR Alcoholic Beverages +	99.4	99.3	99.2	98.4	99.0	96.3	96.4	96.0	95.5	94.9
SSR Meat +	86.5	83.1	78.4	87.4	83.9	80.1	82.4	82.9	82.5	85.3
SSR Offals +	97.6	96.8	94.4	97.2	90.6	84.7	84.0	81.5	83.4	83.5
SSR Animal Fats +	61.4	58.8	60.8	77.8	76.8	69.4	84.4	84.0	92.4	91.0
SSR Eggs +	98.1	98.1	97.8	98.1	97.9	97.7	97.6	98.1	98.1	98.4
SSR Milk − Excluding Butter +	86.9	86.1	84.9	81.0	82.4	74.0	72.8	71.3	72.8	74.9
SSR Fish, Seafood +	104.7	101.4	97.8	98.8	98.8	98.9	91.2	95.7	93.6	93.8
SSR Aquatic Products, Other +	80.4	77.0	73.3	77.5	81.1	66.6	65.3	71.5	65.6	82.8

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
SSR Cereals−Excluding Beer +	23.6	23.8	23.6	25.8	25.5	24.8	22.5	22.1	22.6	22.8
SSR Starchy Roots +	91.7	92.1	94.1	89.8	75.2	84.0	89.5	80.3	75.2	77.8
SSR Sugarcrops +	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
SSR Sugar & Sweeteners +	53.0	49.8	48.6	52.4	51.3	51.4	50.3	51.2	51.7	51.3
SSR Pulses +	31.5	51.8	33.0	59.7	47.2	40.7	42.4	41.1	43.4	48.6
SSR Treenuts +	51.3	44.8	42.5	40.3	37.8	32.3	32.4	25.4	25.2	25.8
SSR Oilcrops +	4.8	4.5	4.5	4.4	3.9	4.2	4.7	4.3	4.3	3.5
SSR Vegetable Oils +	81.7	81.6	82.7	84.3	83.8	83.2	81.4	79.8	77.7	76.7
SSR Vegetables +	95.4	96.3	95.7	94.4	95.1	94.5	93.9	91.5	91.8	91.7
SSR Fruits−Excluding Wine +	80.2	80.7	82.4	77.8	78.8	75.5	75.8	72.6	70.5	68.8
SSR Stimulants +	26.1	24.2	24.0	20.7	20.4	18.5	17.3	15.8	15.4	15.0
SSR Spices +	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0
SSR Alcoholic Beverages +	95.2	95.7	95.0	94.3	94.8	95.1	94.5	93.5	93.1	93.2
SSR Meat +	82.6	84.1	83.6	83.1	83.8	81.8	79.4	76.5	74.0	73.2
SSR Offals +	80.8	81.9	81.6	80.4	78.4	75.5	75.4	72.7	72.9	73.2
SSR Animal Fats +	99.3	104.7	110.9	121.1	113.6	110.3	101.5	122.5	101.7	106.0
SSR Eggs +	98.3	98.6	98.9	99.1	99.0	98.4	99.1	99.0	98.9	98.8
SSR Milk−Excluding Butter +	78.1	76.5	77.4	77.6	76.6	78.2	74.4	73.6	78.4	80.4
SSR Fish, Seafood +	94.6	97.2	92.4	95.1	92.9	88.8	87.1	83.7	85.3	78.2
SSR Aquatic Products, Other +	90.1	90.0	88.9	90.6	90.0	90.4	88.8	87.9	87.2	93.6
	1991	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
SSR Cereals−Excluding Beer +	20.3	22.1	20.3	24.4	22.3	21.7	21.0	19.2	19.9	21.2
SSR Starchy Roots +	77.9	76.9	75.4	78.9	82.2	79.3	81.5	80.0	78.1	76.6
SSR Sugarcrops +	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
SSR Sugar & Sweeteners +	53.9	50.8	52.3	51.3	54.7	50.6	54.0	55.2	54.1	54.0
SSR Pulses +	43.7	32.6	22.8	36.5	50.0	37.5	38.4	37.9	36.9	38.0
SSR Treenuts +	19.9	20.6	15.8	19.6	18.2	17.2	19.0	15.8	18.0	13.5
SSR Oilcrops +	3.3	3.1	1.7	1.9	2.2	2.6	2.1	2.3	2.6	3.2
SSR Vegetable Oils +	75.5	75.0	74.3	73.7	73.1	73.8	72.8	73.7	76.0	75.7
SSR Vegetables +	90.5	90.2	88.5	86.0	85.1	85.4	85.5	83.3	81.9	81.5
SSR Fruits−Excluding Wine +	65.2	65.8	62.0	57.2	55.6	54.5	58.6	55.8	55.2	51.1
SSR Stimulants +	14.1	15.1	14.9	13.3	13.8	13.0	13.5	12.9	12.8	11.6
SSR Spices +	22.3	27.3	26.4	24.1	17.9	22.0	19.9	19.6	16.1	13.7
SSR Alcoholic Beverages +	93.4	93.6	93.3	90.9	90.5	91.6	91.1	89.8	91.5	90.1
SSR Meat +	71.0	67.9	66.3	63.3	56.5	54.3	56.8	56.2	53.8	51.6
SSR Offals +	70.9	69.0	71.9	70.8	67.1	66.5	68.7	67.8	67.5	65.4
SSR Animal Fats +	92.3	84.8	83.9	79.6	67.7	63.2	66.5	75.5	74.8	69.6
SSR Eggs +	98.3	98.9	98.8	98.7	98.5	98.4	98.4	98.7	98.6	98.4
SSR Milk−Excluding Butter +	77.2	78.8	80.4	78.9	77.0	79.8	79.7	80.4	80.0	79.3
SSR Fish, Seafood +	73.1	67.5	65.8	60.7	53.3	56.4	56.2	57.9	54.8	54.0
SSR Aquatic Products, Other +	92.6	92.6	90.9	86.5	85.9	83.9	83.9	84.7	82.4	83.0

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
SSR Cereals−Excluding Beer +	20.7	20.5	18.7	21.0	21.7	20.5	21.1	21.9	19.9	20.0
SSR Starchy Roots +	76.4	78.0	76.9	74.5	76.2	73.7	75.0	74.5	73.3	72.8
SSR Sugarcrops +	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
SSR Sugar & Sweeteners +	55.7	56.2	57.1	57.5	57.6	58.8	56.5	58.9	60.1	58.5
SSR Pulses +	34.7	36.2	30.0	44.6	40.8	32.8	34.8	36.5	28.1	32.6
SSR Treenuts +	13.4	13.2	11.8	10.8	10.0	10.6	10.6	13.2	11.1	10.9
SSR Oilcrops +	3.9	3.6	3.1	2.4	3.4	3.5	3.5	4.1	3.9	3.7
SSR Vegetable Oils +	75.0	74.7	73.4	68.8	65.8	65.8	66.3	63.2	62.1	61.8
SSR Vegetables +	80.8	82.2	81.0	79.1	78.5	79.5	81.2	82.7	83.2	80.5
SSR Fruits−Excluding Wine +	52.2	47.5	46.2	41.9	42.9	40.7	41.8	43.3	44.6	40.8
SSR Stimulants +	11.6	11.5	12.4	12.7	12.5	11.3	11.8	13.3	11.7	11.3
SSR Spices +	13.2	19.6	17.8	21.8	23.6	23.5	26.4	28.4	34.0	34.6
SSR Alcoholic Beverages +	94.4	93.8	93.4	93.2	93.2	85.9	93.4	85.5	83.6	81.7
SSR Meat +	50.7	52.5	52.0	53.0	50.2	52.6	52.3	52.2	54.7	52.3
SSR Offals +	66.6	72.8	70.3	86.4	85.0	85.3	84.0	84.3	83.9	82.5
SSR Animal Fats +	65.0	71.9	71.6	72.3	70.7	72.3	74.0	70.6	79.2	76.2
SSR Eggs +	98.4	98.2	98.4	98.3	97.0	98.1	98.5	98.5	98.7	98.7
SSR Milk−Excluding Butter +	79.6	80.6	81.1	80.2	80.8	81.3	79.8	82.0	81.8	81.2
SSR Fish, Seafood +	49.1	46.2	52.1	47.9	49.1	49.9	52.7	53.9	54.6	54.6
SSR Aquatic Products, Other +	84.2	84.7	83.1	80.6	82.2	81.7	86.1	85.7	86.8	86.8
	2011									
SSR Cereals−Excluding Beer +	20.9									
SSR Starchy Roots +	71.2									
SSR Sugarcrops +	100.0									
SSR Sugar & Sweeteners +	53.7									
SSR Pulses +	29.2									
SSR Treenuts +	8.6									
SSR Oilcrops +	3.9									
SSR Vegetable Oils +	60.6									
SSR Vegetables +	79.3									
SSR Fruits−Excluding Wine +	40.1									
SSR Stimulants +	10.6									
SSR Spices +	34.2									
SSR Alcoholic Beverages +	80.9									
SSR Meat +	49.9									
SSR Offals +	80.5									
SSR Animal Fats +	75.3									
SSR Eggs +	98.1									
SSR Milk−Excluding Butter +	80.1									
SSR Fish, Seafood +	54.6									
SSR Aquatic Products, Other +	86.8									