Household Income Based on a Broad View of Production: The Contribution of Women

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Paper prepared for the 37th IARIW General Conference

August 22-26, 2022

Session 2B-2, Measuring Comprehensive Consumption and Implications for Equivalence Scales, National Accounts, Poverty, and Inequality II

Time: Tuesday, August 23, 2022 [16:00-17:30 CEST]

37th IARIW General Conference, Luxembourg

August 23 (Tuesday), 2022

Session: 2B-2 Measuring Comprehensive Consumption and Implications for Equivalence Scales, National Accounts, Poverty, and Inequality II (16:00-17:30)

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By Mitsuhiko Iyoda

[Abstract]

This is an updated and expanded version of Iyoda (2016) that includes the most recent data (DNA (RSAS), 2018) based on 2016 GDP. Using this more recent data, we confirm substantial wage-earning differences between the sexes and between full- and part-time workers, as well as a large work-hour difference between the sexes. The current paper articulates more clearly the effects of considering broad household production to assess spousal contributions to household income. The value of unpaid work, which is generally understated using opportunity cost, is addressed with the introduction of adjustment indices to account for wage-earning and work-hour differentials. The effects of using market income, broad income, and adjusted income to establish the distribution of income and to measure the contributions of women to household income are examined, providing very different perspectives on equality and the contributions of married women to family income. The disproportionate burden placed on women is highlighted.

I Introduction

The concept of broad household production was explored in a previous paper (Iyoda 2016) and in a subsequent version of the paper (Iyoda 2021). There it was shown that broad income analysis produces a very different picture of the household income distribution and of spousal contributions to household income. Using the same methods and framework, this current paper deals with the most recent estimates based on 2016 GDP data and considers additional issues (differential adjustments and comparisons).

Building on the finding of Hamada (2006) that the pseudo-Gini coefficient for unpaid household value is very low, we confirm our previous results showing the presence of substantial wage-earning differences between the sexes and between full- and part-time workers, and a large total work-hour difference between female spouses and the male head of household (HoH), with a far heavier burden imposed on working wives. To better accommodate a welfare point of view, we propose a way to effectively adjust for these differences.

Since estimates based on opportunity cost tend to understate the estimated value of unpaid work, we construct indices that will allow us to make differential adjustments for both wage-earning and work-hour differentials. We then compare the effects of using three different concepts of income—market income, broad income, and adjusted income—on the income distribution and on spousal contributions to household income.

As a result of our treatment, the real value of unpaid work is clearly explained. From a welfare perspective, considering household production has a powerful effect during the child rearing stage, not only on the income distribution but also on the contribution of the female spouse to household income (from an equality perspective). The true burden placed on married women is effectively established.

Macroeconomic Background: Stiglitz, Sen and Fitoussi (2009, p. 36) reported that household production in the U.S. amounted to 30% of conventionally measured GDP (1995-2006 average). Since personal consumption was 67% of GDP (2004), household production can be considered roughly equivalent to 45% of personal consumption. The Genuine Progress Indicator (GPI)[1] considers personal consumption expenditures as a key driver. According to Talberth, Cobb and Slattery (2007, p. 9), "The value of housekeeping and parenting was roughly 33% of personal consumption expenditures in 2004; in 1950 it was 58%." In our calculation, the figure is closer to 65% (calculated from Table 1). Household production is thus a core part of GPI, second only to personal consumption expenditures.

While this macroeconomic background establishes the importance of household production, the inherent vagaries of the measurements make it difficult to assess the real value of such production. To make precise comparisons, we need to consider the nature of the unpaid work covered and the method used in the valuation. Below, we note the available methods for estimating the value of unpaid work and propose an analytical framework for analysis.

II Methodology

Broad household production: Generally speaking, three methods are available to estimate the monetary value of unpaid work[2]:

(1) the opportunity cost method
(2) the replacement cost method (specialist approach)
(3) the replacement cost method (generalist approach)

Here, we take the opportunity cost approach, where unpaid work is estimated by considering the benefits that could have been obtained by choosing the best alternative opportunity. In this approach, the monetary value of unpaid work directly reflects not the content of the unpaid work but rather who does it and, importantly, at what age[3].

Framework by household stage: The alternatives for classifying household production include:

(1) Couples with children, with stages I, II, III distinguished by the age of the married woman.

[1] GPI is constructed by incorporating various aspects of economic wellbeing that are either ignored or treated incorrectly in GDP forecasts (Talberth, Cobb and Slattery, 2007, p.3). See also Redefining Progress (2016) and Wikipedia (2019) for GPI.

[2] Regarding unpaid work in household production, Vanoli (2017) mentions "a general agreement" that the value in these activities "is in principle for inclusion in the SNA General Framework GDP", but "is conventionally excluded for practical reasons"; he recommends that "these activities should be measured … in a satellite account, every five or ten years or so" (p. 261). UNECE (20137) is the guide for national statistical offices "on selecting and applying for valuing own-use production work of services," and "on compiling Household Satellite Accounts" (p. iii, Preface). See also DNA (RSAS) 2018 for a brief explanation of methodology.

[3] We deal with opportunity cost estimates based on Precode method for time use in DNA (RSAS) (2018).

(2) Income by type of work by men and women (full-time, part-time, and housekeeping).
(3) Household income by work type combining men and women (both full-time, full-time & part-time, full-time & housekeeping).

Dealing with households by life stage is an important aspect, as unpaid housework differs greatly by life stage and type of work. This approach has better interpretative value than analyses based on averages for an entire society as it can (1) show a more welfare-oriented view of income and its distribution, (2) identify substantial wage differences between the sexes and between work types, and (3) reveal the reality of the work-hours distribution and the relative burden placed on the sexes during the various age-related life stages.

III Facts: A Broad View of Household Production (Equality and Inequality)

Iyoda (2016) estimated broad household production from a welfare perspective, suggesting innovative ways to look at the distribution of income (identifying income equality in households or among persons and highlighting wage rate inequalities) and poverty. In our current study, we examined the case of Japan[4], with the following results:

(1) Welfare viewpoint: The pseudo-Gini coefficient for unpaid household value is very low. Estimates of broad income indicate that the distribution of income is more equal than is shown in the current measurement. Hamada (2006) dealt with the monetary value of unpaid work as separate income and compared it with conventional household income. He found that the unpaid values were similar among conventional household income brackets. As a result, the pseudo-Gini coefficients for the unpaid household values (in 2001) were very low—0.1064 (0.3578) for all households and 0.0096 (0.3050) for households with two or more members. (The numbers in parentheses here are the Gini coefficients of annual household income as derived from values published by the Statistics Bureau of the Ministry of Public Management, Home Affairs, Post and Telecommunications (SB of MPHPT, 2001; 2002).) The value of unpaid work for conventional household income was 0.452 for all households and 0.479 for households with two or more members (Tables 4(1), 6(1), and 6(2) based on opportunity cost). See Iyoda (2016, fn.14).

(2) Inequality: Wage rate differentials are substantial between the sexes and between full- and part-time workers. Table 1 indicates two cases of wage rate differences by sex and type of work based on Wage Census (Basic Survey on Wage Structure) data. The first case (a) is the conventional measurement and is calculated as the "hourly scheduled cash earnings rate." The second case (b) is calculated as "hourly scheduled cash earnings rate with annual special cash earnings included." The latter includes bonuses, etc., but excludes overtime. This wage rate ratio is close to the hourly actual cash earnings differences between males and females. In the case of part-time employment, the annual special cash earnings are small and less important. Our previous estimates (Iyoda, 2016) correspond to the second case for full-time employment and the first case for part-time employment. The wage rate differences in case (b) are larger than those in case (a) by some 3 percentage points for the female/male wage ratios (full-time) and 10 percentage points for the part-/full-time wage ratios for both men and women. These differences mainly reflect the Japanese bonus system and fringe benefits.

[4] Iyoda (2016) is based on the government estimate of unpaid work in National Accounts 2011. Our related work in the research mostly corresponds to this base year. Reflecting the recent labour shortage, wage differentials are becoming smaller. The most recent estimate of unpaid work is based on National Accounts 2016, released in Dec. 2018 (corrected on 17 June 2019). Our estimate depends on this most recent estimate except for (1) below.

As shown, differences in the full-time wages of men and women are substantial and grow wider in the later household stages. In case (b), for example, women earn 83.6% of what men earn in Stage I, 71.8% in Stage II, and just 61.4% in Stage III. On the other hand, differences in the part-time wages of men and women are relatively small. More importantly, however, although these are only rough estimates, the part-/full-time wage ratios for men and women appear to be very different in all stages. For men, part-time wages are initially 55.4% of full-time wages in Stage I; the percentage then falls to 45.2% in Stage II and to 36.6% in Stage III. For women, the respective percentages are 63.7%, 56.3%, and 53.5%. This pattern reflects the Japanese seniority-based wage system, where wages increase with age until one's 50s.

Table 1

Wage Rate Differences by Sex and Type of Work (2016) *Unit: Yen*

Household		*Hourly Wage Rate*						*Part-/Full-time*	
		Full-time		Ratio %	Part-time		Ratio %	Wage Ratio %	
Stage	Age	Male	Female	F/M	Male	Female	F/M	Male	Female
	(a) Hourly scheduled cash earnings[1)]								
I	30-34	1741	1506	86.5	1182	1115	94.3	67.9	74.0
II	40-44	2176	1622	74.5	1224	1074	87.7	56.3	66.2
III	50-54	2582	1672	64.8	1187	1061	89.4	46.0	63.5
All	covered[3)]	2035	1506	74.0	1134	1054	92.9	55.7	70.0
	(b) Hourly scheduled cash earnings including hourly special cash earnings[2)]								
I	30-34	2183	1826	83.6	1210	1164	96.2	55.4	63.7
II	40-44	2770	1988	71.8	1252	1120	89.5	45.2	56.3
III	50-54	3344	2054	61.4	1225	1099	89.7	36.6	53.5
All	covered[3)]	2563	1820	71.0	1171	1091	93.2	45.7	59.9

Notes. [1)]: Hourly wage rates for (a) are calculated as "scheduled cash earnings divided by actual number of scheduled work hours"; [2)]: Hourly wage rates for (b) are calculated as "(scheduled cash earnings x 12 + annual special cash earnings) divided by (actual number of scheduled work hours x 12)"; [3)]: All ages are covered (i.e., 15 and over).

Sources. SID of MHLW (2017), Vol. 1, Table 1 for full-time; Vol. 3, Table 13 for part-time. (Data are whole—private and public enterprises—industries excluding agriculture, fishing, and forestry; cash earnings establishments with 10 employees or more).

(3) Total work hours of male HoH and female spouse: The total work hours of women exceeded those of men by a considerable margin, which would indicate, in general, a much heavier burden on women. Table 2 shows that, if unpaid work hours are included, women worked more hours than men in all three household stages except for non-working women in Stage III. Indeed, the work hours of full-time working women exceeded three thousand total hours per year in every stage, as was the case for non-working homemakers in Stage I. Women working part-time also exceeded three thousand hours in household Stages I and II. In these cases, the work-hour differences between men and women are notably large.

Table 2

Summary of Annual Work Hours of HoHs and Spouses by Work Type (2016)

Case[1]	**Stage I:** 2(1.48)[2], 30-34		**Stage II:** 2(1.78), 40-44		**Stage III:** 2(1.86), 50-54	
	Paid hours(Unpaid hours)[3]		Paid hours (Unpaid hours)		Paid hours (Unpaid hours)	
	HoH[4]	Spouse	HoH	Spouse	HoH	Spouse
(a) Scheduled hours						
A	1980	1944	1992	1944	1980	1944
B	1980	1149	1992	1115	1980	1140
C	1980	0	1992	0	1980	0
(b) Total Hours						
A	2232(415)	2064(1594)	2196(251)	2052(1503)	2124(182)	2028(1148)
B	2231(415)	1149(2049)	2196(251)	1115(2002)	2124(182)	1140(1474)
C	2232(415)	0(3201)	2196(251)	0(2852)	2124(182)	0(2233)

Case[1]	**All:** covered		**Child-rearing:** 2(1.64),25-54[5]	
	Paid hours (Unpaid hours)		Paid hours (Unpaid hours)	
	HoH	Spouse	HoH	Spouse
(a) Scheduled hours				
A	1980	1956	1980	1956
B	1980	1056	1980	1127
C	1980	0	1980	0
(b) Total Hours				
A	2172(248)	2050(1050)	2172(300)	2050(1422)
B	2172(248)	1056(1365)	2172(300)	1127(1847)
C	2172(248)	0(2100)	2172(300)	0(2844)

Notes. [1]: Case A: HoH (full-time), Working spouse (full-time); Case B: HoH (full-time), Working spouse (part-time); Case C: HoH (full-time), Spouse (Non-working house maker). [2]: Married couple and number of children in parentheses in each stage. [3]: Unpaid work hours are in parentheses. [4]: HoH denotes head of household. [5]: Ages are covered for 25-54 from the viewpoint of child rearing households.

Sources. (1) Annual work hours for full-time and part-time are obtained from the respective sources of Table 1. (2) Unpaid hours for HoH and Non-working spouse are obtained from DNA (RSAS) (2018, revised), Figure-Table 10; those of working spouses (full-time and part-time) are from Iyoda (2016), Table A5. (3) For child rearing stage, work hours are calculated by the simple average of six 5-year age brackets in DNA (RSAS) (2018), Figure-Table 10. Unpaid hours are calculated by assuming 50% of non-working housemaker (for full-time) and 65% of non-working housemaker (for part time), respectively. (See Table 7).

The approach taken here includes both work value and the physical hours of work, giving us the ability to better understand work value and appreciate the full reality of actual working hours (working sometimes in toil). This is an important aspect of our analysis. Currently, unpaid work is assigned a low value, as reflected in the large wage differences between the sexes and between full- and part-time workers. In fact, the ratio of the value of unpaid work to GDP in 2016 was estimated to be 26.6% using the opportunity cost method[5]. Recognizing these realities is critical to understanding the real meaning of the welfare contribution of women and their overall circumstances and raises the question of fairness. What is fairness? The question itself raises a few delicate practical issues.

(4) Methodology: Both a macro-economic analysis and a stage analysis are important to understanding the situation. Macro-economic averages give a sense of the economy as a whole

[5] DNA (RSAS) (2018) made three kinds of estimates, the other of which was 20.8% (specialist approach); 18.8% (generalist approach) (Chart-Table 1). This paper dealt with the estimate based on the opportunity cost method. We can apply the similar analysis to the other approaches.

but do not necessarily shed light on detailed constituent characteristics. Tables 1 and 2 include averaged totals for reference (stage "All"). Our household stage analysis reveals useful structural characteristics such as those described in points (2) and (3) above.

In Japan, the declining birth rate, nursery care for the aged, the inequalities of life between the sexes, and the future of house production are among the more prominent fairness-related issues of the day. From an international perspective, the specific issues are likely to reflect the situation in each individual country, including its social traditions, social and political systems, local property ownership, religion, and stage of economic development.

Section III is almost the reproduction of section "A Broad View of Household Production (Equality and Inequality)" in Iyoda (2021a, pp. 34-38). Based on these facts, we conduct further analysis. Firstly, we construct wage-earning differential and work-hour differential index, respectively. Then, we compare the outcomes associated with the three different conceptualizations of National Income. Lastly, we show adjustment indices for macroeconomics.

IV Differential Adjustments (Wages and Work Hours)

As noted earlier, the pseudo-Gini coefficient of unpaid household value is very low, indicating a high degree of equality. In our study, we found (1) large wage-earning differences between the sexes and between full- and part-time workers, and (2) large work-hour differences between the sexes and by type of work. Unpaid work values are estimated using wages with substantial differentials, which would seem to produce underestimates from a welfare point of view. Simply adding the long work hours of the spouse, including unpaid work hours, does not adequately express the true spousal contribution to the household. In our approach, we construct indices (wage-earning and work-hour differential coefficients) in order to better capture and interpret the actual situation and to make adjustments to the estimated values.

Constructing the Wage-Earning (E_d) Index

Calculating the E_d coefficient: We identified three types of wage-earning differentials (see Section III or Table 3):

Earnings ratio of full-time women to full-time men ($E_{(fw/fm)}$),
Earnings ratio of part-time women to full-time women ($E_{(pw/fw)}$), and
Earnings ratio of part-time men to full-time men ($E_{(pm/fm)}$).

The unpaid work values are calculated using opportunity costs based on the large wage-earning differential between the sexes and between part-time and full-time workers.

Calculating the E_d index: Using the E_d coefficient allows us to make a further adjustment to broad income, which includes estimated unpaid work values. Table 3 shows the development of the index values used for the adjustments. Because the wage-earning differentials are very large, we chose to apply a conservative half-ratio adjustment rather than using the full ratio. For example, for Stage I (A) full-time women, the index is calculated as

$$(1 - E_{(fw/fm)}) * (1/2) = (1 - 0.836) * (1/2) = 0.082,$$

indicating an 8.2% increase in the broad income of Stage I (A) full-time women. The same approach is applied to Stage I (B) part-time women. For Stage I (C) house-k women, the same

wage-earning differential that we applied to Stage I (A) full-time woman is used. (As noted previously, our estimates of unpaid work values are based on opportunity cost.)

While the earnings ratio $E_{(pm/fm)}$ is low (indicating a large differential), we do not consider this adjustment. The percentage of part-time workers in the total number of employed men is 17.3% (2016), among which one third (32.7%) are in the 25-59 years of age group and the percentage distribution over five-year age brackets for this age range averages out at 4.7% (2016). Then, we have 0.81% (= 0.173 x 0.047) of part-time employed men in these five-year age brackets (during the child-rearing stage)[6].

Constructing the Work-hour (H_d) Index

Calculating the H_d coefficient: The H_d index includes three types of work-hour differentials (see Table 3). We use the average work hours (including unpaid work hours) of full-time men as the basis for our numerical comparisons.

Table 3 Constructing the Indices: Wage-Earning and Work-Hour Differentials (2016)

Household	*E_d(wage-earning dif.) %*			*E_d(by stage)*[2)]		*Total work hours*[3)]		*H_d(by stage)*[4)]
	Women (spouse)		Men(HoH)	based on half ratio				index
Stage(type)	fw/fm[1)]	pw/fw	pm/fm	Spouse	HoH	Spouse	HoH	Spouse/HoH
I(A)	83.6			1.082	1.000	3,658	2,647	1.382
I(B)		63.7	55.4	1.182	1.000	3,198	2,647	1.208
I(C)	83.6			1.082	1.000	3,201	2,647	1.209
II(A)	71.8			1.141	1.000	3,555	2,447	1.453
II(B)		56.3	45.2	1.219	1.000	3,117	2,447	1.274
II(C)	71.8			1.141	1.000	2,852	2,447	1.166
III(A)	61.4			1.193	1.000	3,176	2,306	1.377
III(B)		53.5	36.6	1.233	1.000	2,614	2,306	1.134
III(C)	61.4			1.193	1.000	2,233	2,306	0.968
All(A)	71.0			1.145	1.000	3,100	2,420	1.281
All(B)		59.9	45.7	1.201	1.000	2,495	2,420	1.031
All(C)	71.0			1.145	1.000	2,100	2,420	0.868

Notes:
[1)] We assume that the wage-earning of house-k w (women) is equivalent to market income of full-time women.
[2)] Wage-earning differentials are large; half-ratios are used to construct the index. We do not consider HoH $E_{(pm/fm)}$ adjustment.
[3)] Total work hours (per capita) include unpaid work hours from Table 2.
[4)] H_d (stage) expresses work-hour differences in the respective Stages (I, II, III, and All).

Sources: Tables 1 and 2.

[6] Part-time employee ratio of men 17.3% from Nijuichi Seiki Gundan (2019), Attached Table 81; average percentage distribution 4.7% calculated from SB of MIAC (2017), Table 1-A-5. (Data are whole industries excluding agriculture and forestry.)

Table 4	Household Income by Sex (Market, Broad-based and Adjusted, 2016)										
								Unit: Million Yen except for (5) - (7)			
Household	*Market income*		*Unpaid work values*		*E_d(by stage)* [1]		*H_d*	*Market*	*Broad income* [3]		
	Female	Male	Female	Male	based on half ratio		(by stage)[2]	income	Female(spouse)		Male(HoH)
Stage(case)	Spouse	HoH	Spouse	HoH	Spouse	HoH	W/M	Non-adj.	Non-adj.	Ed adj.	Non-adj.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
I(A)	3.81	4.67	2.39	0.72	1.082	1.000	1.382	8.48	6.20	6.71	5.39
I(B)	1.03	4.87	3.08	0.72	1.182	1.000	1.208	5.90	4.11	4.86	5.59
I(C)	0.00	4.87	4.81	0.72	1.082	1.000	1.209	4.87	4.81	5.20	5.59
II(A)	4.10	5.81	2.43	0.55	1.141	1.000	1.453	9.91	6.53	7.45	6.36
II(B)	1.03	6.01	3.23	0.55	1.219	1.000	1.274	7.04	4.26	5.19	6.56
II(C)	0.00	6.01	4.6	0.55	1.141	1.000	1.166	6.01	4.60	5.25	6.56
III(A)	4.20	6.80	1.9	0.47	1.193	1.000	1.377	11.00	6.10	7.28	7.27
III(B)	1.03	7.00	2.44	0.47	1.233	1.000	1.134	8.03	3.47	4.28	7.47
III(C)	0.00	7.00	3.69	0.47	1.193	1.000	0.968	7.00	3.69	4.40	7.47
All(A)	3.78	5.31	1.59	0.50	1.145	1.000	1.281	9.09	5.37	6.15	5.81
All(B)	1.03	5.51	2.09	0.50	1.201	1.000	1.031	6.54	3.12	3.75	6.01
All(C)	0.00	5.51	3.05	0.50	1.145	1.000	0.868	5.51	3.05	3.49	6.01
Notes:	[1] Wage-earning differentials are large; half-ratios used to construct the index.										
	[2] H_d (stage) expresses work-hour differences for the respective Stages (I, II, III, and All).										
	[3] Broad income includes the value of unpaid work.										
Sources:	For (1) and (2), total cash earnings of establishments, with 10 employees or more are calculated as "contracted cash earnings x 12 + annual										
	special cash earnings" (Vol. 1,Table 1, SID of MHLW 2017). Data are for all industries (private and public enterprises) excluding										
	agriculture, fishing and forestry. The same age bracket for spouse is applied to HoH: For family type A, 200 thousand yen deducted;										
	for B, C, no deduction (spouse's fringe benefits are included). Part-timer income is approx. 1.03 million yen, due to tax exemption in Japan.										
	(3) and (4) are from DNA "Money Value of Unpaid Labour" Figure-Table 12. (https: //www.esri.cao.go.jp/sna/sonota/satellite/roudou/										
	contents/pdf/190617_kajikatsudoutou.pdf). Unpaid work values by work type are from Table 7.										
	(5), (6) and (7) are from Table 3.										
	(8) = (1) + (2); (9) = (1) + (3); (10) = (9) x (5); (11) = (2) + (4).										
	(As the data for working women include both full-timers and part-timers, it was necessary to decompose the data, distinguishing between										
	the two groups. In our previous paper we accomplished this by using NHK Data. The values in Table 7 result from this decomposition.)										

The work-hour differences between married women and full-time men by family (work) type are treated as follows:

For Stage I (A), work-hour ratio of full-time women to full-time men ($H_{(fw/fm)}$)
For Stage I (B), work-hour ratio of part-time women to full-time men ($H_{(pw/fm)}$),
For Stage I (C), work-hour ratio of housekeeping women to full-time men ($H_{(hw/fm)}$).
The same approach is applied to Stage II (A, B, and C), Stage III (A, B, and C), and All (A, B, and C).

Calculating the H_d index: The H_d values are calculated by work type. For example, the index for Stage I (A) full-time women is constructed as

total work hours of full-time women / total work hours of full-time men = 3,658 / 2,647 ≈ 1.382.

The result here indicates that the total work hours of full-time women exceed those of full-time men by 38.2%.

V Comparing Household Income by Sex and Family Type

Household Income by Sex: Among the core questions of interest is whether reducing the wage inequality of women relative to men and/or reducing the wage inequality of part-timers relative to full-timers would improve welfare and elevate satisfaction levels. Moreover, what would be the effect of reducing the large gap in work hours between women and men? Table 4, Household Income by Sex (market, broad-based and adjusted, 2016), shows the income and adjusted data used as the basis for the analyses. H_d indicates the excessive work hours of full-time, part-time, and housekeeping women relative to full-time men, respectively. From the H_d values shown in the table in all cases (except for III(C), homemaker), women bear a heavy burden (full-timers, part-timers, and housekeeping homemakers).

Table 5 Spouse Contribution to Household Income (by Family Type)

Unit: %

	Household Equality			**Spouse Contrib. to Household**						**Spouse Contrib. by Work Type**	
Household	*Market*	*Broad income* [1)]		*Income ratio (%): Spouse/HoH; (with a) Spouse/Household*						*(Spouse unpaid work values/*	
Income	income			Market income		Broad income				*House-k woman income) ratio (%)*	
Stage		Non-adj.	E_d adj.	Market		Non-adj.		E_d adj.		Non-adj.	E_d adj.
(family type)	[1]	[2]	[3]	[4]	[4a]	[5]	[5a]	[6]	[6a]	[7]	[8]
I(A) (full-time)	174.1	111.4	112.1	81.6	44.9	115.0	53.5	124.5	64.2	49.5	49.5
I(B)(part-tme)	121.1	93.3	96.8	21.1	17.5	73.5	42.4	86.9	46.5	64.0	70.0
I(C)(house-k)	100.0	100.0	100.0	0.0	0.0	86.0	46.3	93.1	48.2	100.0	100.0
II(A) (full-time)	164.9	115.5	117.0	70.6	41.4	102.7	50.7	117.1	54.0	52.8	52.8
II(B)(part-tme)	117.1	97.0	99.5	17.1	14.6	64.9	39.4	79.2	44.2	70.2	75.0
II(C)(house-k)	100.0	100.0	100.0	0.0	0.0	70.1	39.7	80.0	44.5	100.0	100.0
III(A) (full-time)	157.1	119.8	122.5	61.8	38.2	83.9	45.6	100.1	50.0	51.5	51.5
III(B)(part-tme)	114.7	98.0	99.0	14.7	14.7	46.5	31.7	57.3	36.4	66.1	68.3
III(C)(house-k)	100.0	100.0	100.0	0.0	0.0	49.4	33.1	58.9	37.1	100.0	100.0
All(A) (full-time)	165.0	123.4	125.9	71.2	41.6	92.4	48.0	105.8	51.4	52.1	52.1
All(B)(part-tme)	118.7	100.8	102.7	18.7	15.7	51.9	34.2	62.3	38.4	68.5	71.9
All(C)(house-k)	100.0	100.0	100.0	0.0	0.0	50.7	33.7	58.1	36.7	100.0	100.0

Note: [1)] Broad income includes the value of unpaid work.

Notes: Table 5 is calculated from Table 4. Numbers in parentheses refer to columns in Table 4.

[1]: For I(A), A(8)/C(8); for I(B), B(8)/C(8); for I(C), C(8)/C(8). Stages II, III, and All follow in the same way.

[2]: For I(A), A((9)+(11))/C((9)+(11)); for I(B), B((9)+(11))/C((9)+(11)); for IC, C((9)+(11))/C((9)+(11)). Do.

[3]: For I(A), A((10)+(11))/C((10)+(11)); for I(B), B((10)+(11))/C((10)+(11)); for I(C), C((10)+(11))/C((10)+(11)). Do.

[4]: For I(A), A(1)/A(2); for I(B), B(1)/B(2); for I(C), C(1)/C(2). Do.

[4a]: For I(A), A(1)/A((1)+(2)); for I(B), B(1)/B((1)+(2)); for I(C), C(1)/C((1)+(2)). Do.

[5]: For I(A), A(9)/A(11); for I(B), B(9)/B(11); for I(C), C(9)/C(11). D0.

[5a]: For I(A), A(9)/A((9)+(11)); for I(B), B(9)/B((9)+(11)); for I(C), C(9)/C((9)+(11)). D0.

[6]: For I(A), A(10)/A(11); for I(B), B(10)/B(11); for I(C), C(10)/C(11). Do.

[6a]: For I(A), A(10)/A((10)+(11)); for I(B), B(10)/B((10)+(11)); for I(C), C(10)/C((10)+(11)). Do.

[7]: For I(A), A(3)/C(3); for I(B), B(3)/C(3); for I(C), C(3)/C(3). Do.

[8]: For I(A), A((3)x(5))/C((3)x(5)); for I(B), B((3)x(5))/C((3)x(5)); for I(C), C((3)x(5))/C((3)x(5)). Do.

Since we assumed A(5) = C(5), we have

[8] For I(A), A(3)/C(3); for I(B), B((3)x(5))/C((3)x(5)); for I(C), 1. Do.

Therefore, from a welfare perspective, we propose adjustments to the calculation of broad income based on the E_d index (the half ratio of the wage-earning differential) and the H_d index for the work-hour differential. We can consider using these for adjusting unpaid values. For example, extra pay might be given for longer work hours, like overtime pay.

Contributions of Spouse to Household Income by Family Type: Table 5 shows the contributions of the spouse to household income by family type, expressed in three different ways. Comparing the outcomes associated with the three different conceptualizations of National Income (market income, broad–based income and the adjusted income), we found several noteworthy results. Market income is a currently used GDP concept. Broad income includes an estimated value of unpaid work in market income. E_d adj. is adjusted income using E_d index. Table 6a shows the rough values about the household equality and woman (spouse) contributions to household income. For more precise values, we need to control these values by the respective factor weight.

Table 6a Household Equality and Woman Contriburitions to Household (Calculated from Table 5)

	Household Equality			**Spouse Contrib. to Household**		
	(Max/Min Income Ratio) [1)]			*Income ratio (%): (with a) Spouse/Household* [2)]		
Case	*Market Income*	*Broad Income*		*Market Income*	*Broad Income*	
Stage	[1] Market	[2] non-adj.	[3] E_d adj.	[4a] Market	[5a] non-adj.	[6a] E_d adj.
Stage I	1.741	1.194	1.158	20.8	47.0	53
Stage II	1.649	1.191	1.176	18.7	43.3	47.6
Stage III	1.571	1.222	1.237	17.6	36.8	41.2
Ref. (All)	1.650	1.234	1.259	19.1	38.6	42.2

Notes: [1)] Max/Min income ratio, calculated from the column in each stage of Table 5. The smaller the ratio, th larger the equality.

For column [1] market, the respective Stage value is calculated by (A/C), because Max = A and Min = C.

For columns [2] non-adj. and [3] E_d adj. follow the same way.

[2)] [4a) market, [5a] non-adj. and [6a] E_d adj. are simple averages, calculated from respective percents by stage in Table 5.

These values roughly show the spouse contributions to household income.

Firstly, from Columns [1], [2] and [3] in Table 5, we see increased equality in households differentiated by work type. While market income shows large differentials in each stage; as the stage advances, market income equality increases, but the results in [2] and [3] are not. Adversely their inequality is slightly increasing (see Table 6a). This is partly caused by the Japanese seniority wage system. As the stage advances full-time men's wages regularly increase, but women's are not always. Women are various consisted of full-time, part-time, and housekeeping women (See Table 4, Columns (1) and (2)).

Broad income, which includes the value of unpaid work, shows greater equality by family (work) type. Further adjustment shows delicate results in Column [3]. Comparing with the results in Column [2], household income equality in [3] increases in Stages I and II, but slightly deteriorates in III (see Table 6a, III 1.222 for [2] non-adj.; III 1.237 for [3] H_d adj.). The Japanese wage system is affecting in the background.

In addition, this is also caused by the large decrease of spouse/HoH work-hour ratio in Stage III (C) (see Table 4, Columns (3) and (7)). For III (C), spouse work hours largely decrease due to children living more independently from their parents or leaving hometown for study or work. So, housekeeping work of (50-54) age spouses become less than younger bracket ages. On the other hand, HoH's work hour in Stage III slightly decreases. This decreasing spouse

work also reflects part-time and full-time married women's work hours, because unpaid work hours of housekeeping women are treated as benchmark.

Secondly, from Columns [4], [4a], [5], [5a], [6] and [6a] in Tables 5 and 6a, we see that the spousal contribution, as expressed by the spouse/HoH income ratio, to household income increases. Using broad income greatly increases the spouse-to-HoH income ratio. E_d adj. further enhances the contribution of spouse (married women) to household income; however, looking at percent in Tables 5 and 6a, the spouse contribution to household income decreases as the stage advances (for example, [5a] I (47.0), II (43.3) and III (36.8)). This is the result by the opportunity cost estimate based on large earning differentials between the sexes. Seniority wage system is affecting in the background and for III decreasing unpaid work-hours of house-k women is affecting.

Thirdly, we can consider the contribution of spouses by work type in terms of unpaid work values. In the non-adjusted case in Column [7], the unpaid work values of full-time working spouses are approximately half those of house-k women; for part-timer spouses the values vary from 64% to 70.2%. (See Table 7). After adjustment, the Column [8] values are like those in the non-adjusted case, which depends on assumptions of E_d construction; however, the part-timer's percentages increase slightly. Women are overburdened, which are shown by work type in Columns [7] and [8].

Facing Two Important Questions

For further interpretation, we face two important questions. (1) Broad income by family type in [2] shows greater equality; however, further adjustment using E_d index brings to delicate results in [3]. Table 6b shows in column (adjusted income), for example, Min, Max, and Average values all increase, but the equality does not always increase. *We need to decide the priority between these.* We see technical expressions for this purpose.

[Technical Expressions]: Table 6b shows comparative results during the child-rearing stage in terms of *dispersion*. In statistics, dispersion indicates the extent to which a distribution of values is stretched or squeezed, essentially measuring the spread in the data. Common measures of structural dispersion include variance (σ^2), standard deviation (σ), and the coefficient of variation (CV)[7]. Such measures can be used as indicators of the degree of "equality" in a data set—the lower the value, the greater the equality.

Based on the values in Tables 6a and 6b, the following observations can be made: The equality effect of using broad income (column [2]) is substantial, not only in each stage but throughout the stages. However, in the adjusted income case (column [3]), the additional equality effects gradually decrease from stage I to stage II, while in stage III, equality is adversely affected. As can be seen, there is a slight deterioration throughout the stages. This is caused not only by the Japanese seniority wage system but also by the decreased unpaid work hours of housekeeping woman in Stage III.

We can trace these effects using CV. For example, for market income, the CV is 24.7%; for broad income, it is 9.6%, and for adjusted income, the CV is 10.2%. For the adjusted case,

[7] The technical expressions for these statistics are as follows: variance (σ^2) is a measure of the degree of dispersion of n values around the mean $\bar{x}$, expressed as $\Sigma(x_i - \bar{x})^2/n$; standard deviation ($\sigma$) is the square root of variance, expressed as $\sqrt{\Sigma(x_i - \bar{x})^2 / n}$; the coefficient of variation (CV) is the standard deviation divided by the mean, expressed as $100\sigma/\bar{x}$.

although the CVs are slightly higher, average household income as well as the maximum and minimum values are all higher than their equivalents in the broad income case. We can use these observations as one of the bases for making useful judgements.

Technical expressions totally show the degree of income equality[8]; however, it is difficult to suggest well balanced decision between these [2] and [3]. People perhaps select a higher level of income under at a certain equality condition (if equality deterioration is slight). Many policy makers would select E_d adj. case (adjusted income) rather than (the case of broad income) in Table 6b. They consider not only relative values (equality) but also absolute (or level) values. As a result, here, some value judgment needed for deciding. Above case, two causes were explained. If the reason is a due course, leaving the results would be allowed. Otherwise, compensating for deteriorating income distribution should be provided.

Table 6b Household Income by Family Type (Equality)

Unit: Million Yen for income

	Household Income (equality)[1)]					
Income	*Market income*		*Broad inocme*		*Adjusted income*	
Stage(case)	`(8)	$\sum (x_i - \bar{x})^2$	(9)+(11)	$\sum (x_i - \bar{x})^2$	(10)+(11)	$\sum (x_i - \bar{x})^2$
I(A)	8.48	0.81	11.59	0.06	12.10	0.00
I(B)	5.90	2.82	9.70	2.69	10.45	2.72
I(C)	4.87	7.34	10.40	0.88	10.79	1.72
II(A)	9.91	5.43	12.89	2.40	13.81	2.92
II(B)	7.04	0.29	10.82	0.27	11.75	0.12
II(C)	6.01	2.46	11.16	0.03	11.81	0.08
III(A)	11.00	11.70	13.37	4.12	14.55	6.00
III(B)	8.03	0.20	10.94	0.16	11.75	0.12
III(C)	7.00	0.34	11.16	0.03	11.87	0.05
All(A)	9.09		11.18		11.96	
All(B)	6.54		9.13		9.76	
All(C)	5.51		9.06		9.50	
Sum (I, II, III)	68.24	31.40	102.03	10.65	108.88	13.75
Average (I,II,III) $\bar{x}$	7.58		11.34		12.10	
Max	11.00		13.37		14.55	
Min	4.87		9.70		10.45	
Vriance [2)] σ^2		3.49		1.18		1.53
Standard dev. σ		1.87		1.09		1.24
Coefficient of variation (CV)		24.7		9.6		10.2

Notes: [1)] Numbers in parentheses indicate the column in Table 4 .

[2)] Variance (σ^2) = $\Sigma(x_i - \bar{x})^2/n$, where x_i = sample value, $\bar{x}$ = sample average, n = sample size, and coeficient of variation (CV) = 100 $\sigma/\bar{x}$.

[8] A certain equality condition coexists with various levels of income. Equality is, in principle, a concept of relative values among persons but living standards or satisfactions are related to both relative and absolute values. For example, Lorentz curve, Gini coefficient are centred on the relative value, being more or less independent from absolute values.

Married women's unpaid work hours are decreasing from age 50, which may be reasonable (please see the reason later in the *data set selection*). The discussion about seniority wage system would be divided between the stages; (merits) as the stage advances, their family needs increase where the wage system meets the demand; (demerits) the wage system is against the principle that the same work should be paid by the same wage.

(2) E_d adj. is a trial example, showing adjustment procedures. Our example assumes current wage-earning and work-hour differentials, and a half ratio adjustment (in 2016). We can also apply other ratios and see the results. E_d adj. is an added broad income to household, and an estimated value itself is something like a cake in the picture. How to get reducing these differences is a serious question. To actualize this needs some ingenuities (social policies, the change in work rules, etc.) for reducing wage-earning and work-hour differentials. Adjusted results are not simple, reflected from the stage structure. We expect our procedure would be useful for setting policy target on this matter. Here, we do not take up the equivalence-based household income but see Appendix (Table 6c) for this.

Data Set Needed for Constructing the Adjustment Index

Broadening the data: We use employee data from the *Labour Force Survey* and broaden the data to include house-k women in the estimates. Current labour force statistics exclude house-k women from the working labour force; however, from a welfare perspective, housekeeping is critically important. We thus consider the category of "broad working women" to include housekeeping women.

Data set selection: Given our goal of establishing the real situation of women during the child-rearing stages, stage data are clearly essential. A comprehensive data set covering ages 15 to over 85 would not be particularly useful. In fact, analytical results based on such "all covered" data would be biased due largely to the effects of including after-retirement ages and the increasing number of single women (living single, living with child (ren) or with parent(s)). The work hours of housekeeping married women decrease from age 50, as their children leave home or require less care. Additionally, after the retirement of the HoH, there is an increase in shared housekeeping. Up to 29 years age, the per capita unpaid work hours of unmarried women are less than 10% of those of married women; this percentage increases as the per capita unpaid work hours of unmarried women gradually increase up to 59 years of age but remain less than 50% of the hours of housekeeping married women. See DNA (RSAS) (2018), Figure-Table 10. Our data set is differentiated by stage (stages I, II, III, and "All").

Unavailable data: While per capita unpaid work-hour data are available for 2011 and 2016, we needed to calculate the figures for other years by using related data. Although DNA (2013) and DNA (RSAS) (2018) show unpaid work hours for "working women," they do not decompose the data to distinguish between full-time and part-time working women. For our desired decomposition, *Time Use of Japanese 1990*, published by NHK (1992), gives useful, albeit insufficient, datasets (Figure-Tables III-13 and III-14). Using these figures as a basis, we proceeded to decompose the data for 2016 and 2011. According to our estimates, the unpaid work hours of full-time and part-time women in stage II (40-44) are approximately 52.7% and

70.2% of the work hours of housekeeping women, respectively. Although these are admittedly rough estimates, we have not found any other relevant datasets. (See Table 7[9]).

Table 7 Unpaid Work-hour Ratio of Women to Housekeeping (homemaker) by Work Type in 1990

Stage / *Unpaid Workhour Ratio*	*Stage I (30-34)*	*Stage II (40-44)*	*Stage III (50-54)*	*All(15 and over)*
Full-timer / House-k	0.498	0.527	0.514	0.523
Part-timer / House-k	0.640	0.702	0.660	0.685
House-k (homemaker)	1.000	1.000	1.000	1.000

Sources: Estimated from DPOS (NHK, 1992), Chart-tables III-13 and III-14.

VI Adjustment Index for Macroeconomics

Inequality Adjustments for Personal Consumption: GPI starts from personal consumption expenditures as a key driver. It uses the Income Distribution Index (IDI) as an inequality adjustment for personal consumption expenditures, producing weighted personal consumption. The IDI measures the relative change in the Gini index (published regularly by the US Census Bureau). The base year is 1968 in the US, corresponding to the year of the lowest Gini index value (Talberth et al., 2007, p. 9).

Further Adjustments for Broad Income: Unpaid work values are the second largest addition to GPI. While our analysis focuses on life stages, particularly the child-rearing stage, it provides a basis for constructing adjustment indices by connecting the "All" stage data in Table 3 with the broad working women rate. An illustrative application of the E_d and H_d adjustments is shown below:

According to our broad working women estimate (2016)[10], regular working women constitute 25.0% of the total, while house-k women comprise 33.1%, non-regular working women comprise 31.8% and self-employed related women[11] comprise 10.1%. We consider the first two together (58.1% in total) and the last two together (41.9% in total).

We can construct our macroeconomic adjustment index using E_d (based on the half ratio of wage-earning differentials) in Table 3 as follows:

For All (A, C) as $(1/2)\ (1 - E_{(fw/fm)}) * 0.581 = 0.145 * 0.581 \fallingdotseq 0.084$, and

for All (B, S) as $(1/2)\ (1 - E_{(pw/fm)}) * 0.419 = 0.201 * 0.419 \fallingdotseq 0.084$.

We then have, for All (A, B, C, and S), a value of 1.168 (= 1 + 0.084 + 0.084).

[9] We considered stage II (40-44) as a representative set. Then decomposition of unpaid workhour of working women between full-timer and part-timer are carried out by the above percentages. Looking at Table 7, their percentages are different in stages. Therefore, general percentages for decomposition might be about 50 and 65, respectively.

[10] Broad working w (women) is defined as "working w + housekeeping w." Weights in number by work type of women are calculated by using the following data. Labour force, working w, and non-working w are obtained from Nijuichiseiki Shokugyo Zaidan (2019), Chart-Table (CT) 1; House-k from CT 7; Regular working w, non-regular working w (part, others) from CT 21-1.

[11] Self-employed related women are delicate situation. Most of them are family workers and small numbers are the self-employed. In constructing an index, we assume they are like part-time women of both wage-earning and workhours rather than regular work and house-k women.

From a welfare perspective, we can use this index to make the adjustment "(wage-earnings of women + unpaid work values of women)[12] x 1.168." As a result, GPI consumption expenditures increase where reduced ratios of E_d are important. When the reduced ratios in percentage are 10, for example, the multiplier becomes 1.0336 (= 1 + (0.168/5)). Since 0.168 is a wage-earning gap based on half ratio (1/2), dividing further by 5 makes (1/10) ratio. Considering the long work hours of women, it would be possible to construct H_d indices to make further adjustments.

Here, we consider the half ratio of H_d and construct the index. For example,

for All (A) as (1/2) $(H_{(fw/fm)} - 1) * 0.25 = 0.141 * 0.25 \fallingdotseq 0.035$,

for All (B, S) as (1/2) $(H_{(pw/fm)} - 1) * 0.419 = 0.016 * 0.419 \fallingdotseq 0.007$, and

for All (C), since $H_{(hw/fm)} < 1$, as (1/2) $(H_{(hw/fm)} - 1) * 0.331 = -0.066 * 0.331 \fallingdotseq -0.022$.

We have, then, for All (A, B, C, and S), the multiplier 1.020 (= 0.035 + 0.007 – 0.022).

To interpret these results, one should keep in mind that two types of work-hour differences are included in stage "All" (see Data Set Selection in Section V). In the above adjustment, if we consider that excessively long work hours may decrease the welfare level, we can use the H_d index as a "deduction" adjustment for consumption.

VII Conclusion

This study uses the same methods and framework that were used in our previous paper (Iyoda 2016) but includes the newest estimated DNA (RSAS) (2018) data for 2016. We found similar patterns of large differentials in both wage earning and work hours and proposed a method for constructing appropriate adjustment indices.

For the wage-earning index, full-time wage-earning serves as the numerical basis; for the work-hour index, the basis is the full-time work hours of men. Although the differences were large, we chose to use a modest half-rate adjustment. If desired, rates other than this half-rate may be similarly applied and assess the results.

The results of our comparative analysis using market income, broad income, and adjusted income are revealing. Firstly, in terms of welfare importance, housekeeping women are unrepresented in the market income approach based on current GDP. But as the stage advances, household equality increases due to seniority wage system. Secondly, introducing unpaid work provides a much different view of income equality and highlights the large contributions of the female spouse to household income. These are caused by the addition of unpaid work values and spouse overburdened work hours. Even our rather modest E_d adjustment amplifies the spouse's contributions to household income but deteriorate in Stage III; however, spouse weight in the household income decreases as the stage advances, which is reflected by the opportunity cost estimate based on large earning differentials between the sexes. Seniority wage system is affecting in the background and Stage III is affected by the large decrease of spouse work hours.

[12] For Japan, total amount of women, 189,705 billion yen (the same money unit below), multiplied by 1.168 makes 221,575. Women's paid earnings (78,500) obtained from DNA (RSAS) 2018, Figure-Table 17 and women's unpaid work values (111,205) from *op. cit.* Figure –Table 11 (women 15 years and over).

Thirdly women are overburdened. According to our rough estimate, unpaid workhours of the full-time working spouses are about half of house-k women; for part-time working spouses are about 65-70 % of those of house-k women. It was also noted that data differentiating unpaid work by full-time versus part-time workers are lacking, as their work intentions are quite different in Japan.

Finally, our trial indices address two substantial data gaps: the large difference in the unpaid work values and unpaid work hours of married and single women and the differences between women during the child-rearing stage and women after this stage. In this regard, our "All" stage analysis may serve as a useful, if limited, reference, accepting that more work in this area needs to be done.

This research has several significant policy implications:

(1) Our analytical results (income distribution, women's contributions, etc.) have an important relation to the questions of low birth rate, work/life balance, and living standards.
(2) The household production that is replaced as an economy develops and more women go to work may increase income under the current GDP concept; however, this trend will not necessarily continue, as various factors such as the wage system, the social and family system, religion, and the level of economic development are involved.
(3) To explore these issues, macroeconomic analyses based on averages are generally insufficient. The methodology and framework proposed in our work offers a promising alternative.

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Appendix: Table 6c

Table 6c is the equivalence-based household incomes. Comparing with Table 6b in the text, equality levels are higher in all three concepts and equality trends are similar.

Table 6c Equivalence-Based Household Income by Family Type (Equality)

Unit: Million Yen for income

			Equivqlence-based Household Income[1)]				
Stage (case)	*Square root of*	*Market income*		*Broad inocme*		*Adjusted income*	
no. of children	*household size*	*`(8)*	$\Sigma(x_i - \bar{x})^2$	*(9)+(11)*	$\Sigma(x_i - \bar{x})^2$	*(10)+(11)*	$\Sigma(x_i - \bar{x})^2$
I(A) (1.48)	1.87	4.55	0.38	6.21	0.11	6.49	0.04
I(B) (1.48)	1.87	3.16	0.59	5.20	0.47	5.60	0.46
I(C) (1.48)	1.87	2.61	1.74	5.58	0.10	5.79	0.25
II(A) (1.78)	1.94	5.10	1.36	6.63	0.55	7.10	0.68
II(B) (1.78)	1.94	3.62	0.10	5.57	0.10	6.04	0.06
II(C) (1.78)	1.94	3.09	0.70	5.74	0.02	6.08	0.04
III(A) (1.86)	1.97	5.60	2.78	6.80	0.84	7.40	1.07
III(B) (1.86)	1.97	4.09	0.02	5.57	0.10	5.98	0.09
III(C) (1.86)	1.97	3.56	0.14	5.68	0.04	6.04	0.06
Sum (I, II, III)		35.38	7.81	52.98	2.34	56.52	2.74
Average (I,II,III) $\bar{x}$		3.93		5.89		6.28	
Max		5.60		6.80		7.40	
Min		2.61		5.20		5.60	
Vriance[2)]	σ^2		0.87		0.26		0.30
Standard dev. σ			0.93		0.51		0.55
Coefficient of variation (CV)			23.71		8.66		8.79

Notes:

[1)] Numbers in parentheses indicate the column in Table 4 .

[2)] Variance (σ^2) = $\Sigma(x_i - \bar{x})^2/n$, where x_i = sample value, $\bar{x}$ = sample average, n = sample size, and coeficient of variation (CV) = 100 $\sigma/\bar{x}$.