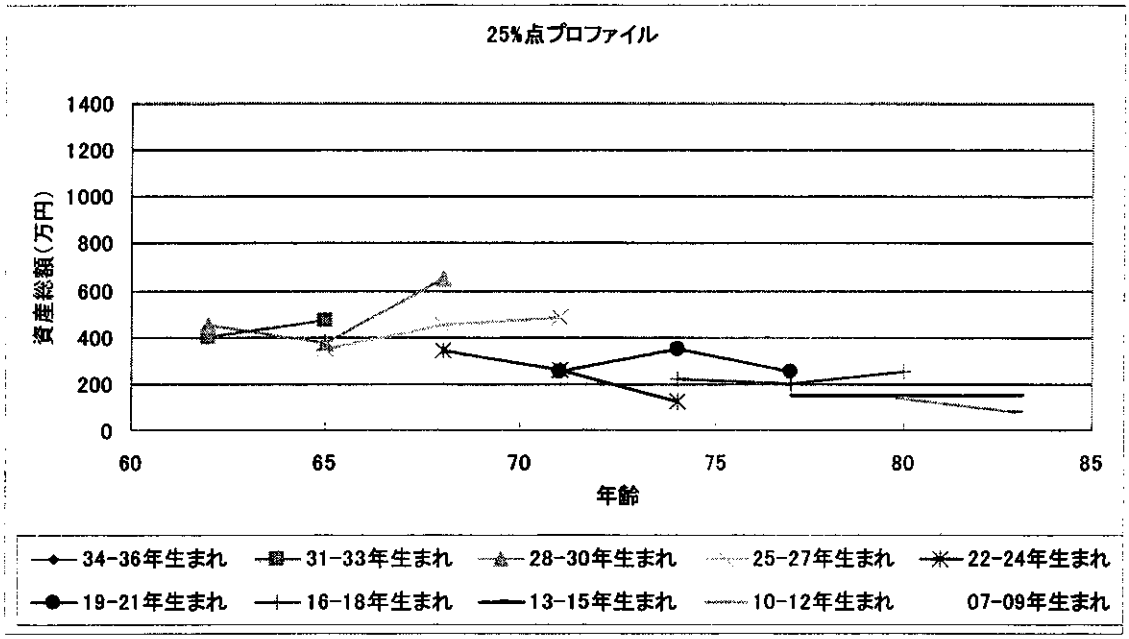

図 7-6　高齢単身女性世帯の金融資産保有額プロファイル　1992-1998

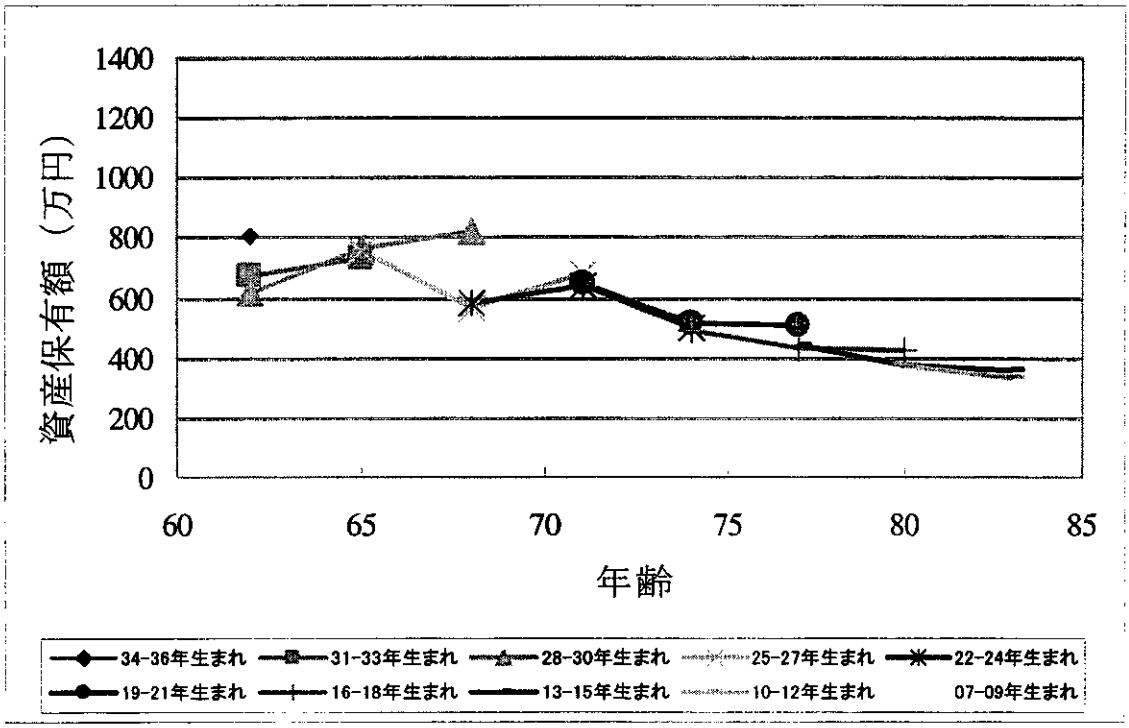

図 8-1　子供の数・年齢別　子供の費用

単位(月額/万円)

	子供の数			
	夫婦世帯	夫婦と子供一人	夫婦と子供二人	夫婦と子供三人
必要生計費	21.1	27.1	30.4	36.7
追加的費用		6.0	3.3	6.3

単位(月額/万円)

	子供の年齢				
	0-3	4-6	7-12	13-18	19-22
必要生計費	27.1	33.6	36.3	42.5	53.8
0-3才児費用との差額		6.6	9.2	15.4	20.2

表 2-1　先行文献における主要な結果

わが国のデータを用いた先行研究									推定された等価尺度				
研究名	国名	データ名	データ期間	推定方法	夫婦世帯	一人	二人	三人	単身世帯	二人世帯	三人世帯	四人世帯	五人世帯
武藤(1992)	日本	全国消費実態調査	1984, 1989	Engel法			0.128-0.173(1984)[1)]						
							0.127-0.143 (1989)						
駿河（1995)	日本	全国消費実態調査	1984	Prais-Houthakker法	1	0.156-0.243							
				Engel法	1	0.354	0.834						
				Rothbarth法	1	0.15	0.322						
八木・橘木(1996)	日本	全国消費実態調査	1984						1	1.533	1.685	1.741	1.99
駿河・西本(2001)	日本	消費生活に関するパネル調査	1993-1996	Rothbarth法	1	0.313	0.221[1)]						

農村高齢者の経営継承形態別生活状況の分析

時子山由紀[1]・金子能宏[2]

A. 研究目的

農業生産力の相対的な低下とそれに伴う農業者の高齢化により農村及び農家の構造は大きく変化している。これらの変化に対応するために、農業政策の大きな転換がおこなわれた。平成12年度に制定された食料・農業・農村基本法では、特に農業の中心的担い手を政策対象に据え、中心的担い手への一層の経営の集中を促すことを目的としている。しかしながら、こうした産業政策の目的に沿うように策定されてきた農業者に対する社会保障政策、特に農業者年金制度は、農村の高齢化と過疎化を背景に、成熟度が220%を超え、平成14年度に抜本的な制度改定が行われた。

こうした産業構造、社会保障制度の過渡期にあって、社会保障制度の対象としてだけでなく、実質的な産業の担い手である、わが国の農家世帯の高齢者の経済状態を分析することは先に挙げた制度面における変更を評価する上で重要であると考える。本研究では農村高齢者の生活状況について経営継承形態別に経済的側面の分析を行うことで、産業政策および社会保障政策の変更が農村高齢者の生活に与える影響について考察する。

B. 研究方法

『国民生活基礎調査』の平成元年から10年度データに含まれる個人のうち農業所得が正であると回答したサンプルを農業者とみなしている。さらに農業者のうち年齢が60歳以上の者を農村高齢者として定義した。次に農村高齢者のいる世帯を経営の継承形態別に、経営継承された親子同居世帯三グループ（親子とも農業に従事している世帯、子世代のみが農業に専従している世帯、子世代が農業を副業にしている世帯）と経営継承ていない世帯二グループ（同居世帯でありかつ高齢者である世帯員のみ農業に従事している世帯、高齢者のみ世帯で農家世帯）の合計五グループにわけそれぞれの世帯について消費・所得・資産保有高、労働供給等の経済状態及び介護者の有無やストレスの有無といった生活状況別に分析した。

C. 研究結果

平成元年から10年にかけて農業就業人口の高齢化が観察された。農業就業者の年齢が上昇し、また農業所得の高齢者層への分配率も上昇した。経営継承形態別に見た場合経済的に見て比較的豊かである世帯は子世代が農業を副業にしている世帯であった。また、高齢者のみの農家世帯では経済水準が低く特に現金収入が低い傾向が観察された。また、農村地域では従来、公的サービスよりも親族や近隣の住人による私的なネットワークによる助け合いが重要であると指摘されてきたが、要介護者の有無、入院者の状況等を見る限りこの傾向は現在では比較的薄いようである。

[1] 日本経済研究センター特別研究員
[2] 国立社会保障・人口問題研究所 社会保障応用分析研究部室長

D.　　考察

以上のように経営継承形態別に農村高齢者の生活水準が異なることが観察された。具体的には、子世代が農業を副業として経営継承した世帯では、子世代の安定した農外所得とともに、経営継承したことによる農業経営上の特典、親世代が農業者年金制度上の恩恵を受け比較的裕福な状態にあること、また、経営継承されずに高齢夫婦のみから構成された農家では、生活水準が低いことが観察された。もし、経営継承者の有無が高齢者にとって外性であるとするならば、経営継承形形態に依存する産業政策や社会保障制度は高齢農業者間に不公平を生じさせていると考えられる。

Decomposition of Income Inequality both by Professions and by Income Sources

Takeshi Mori and Toshiaki Tachibanaki
Kyoto University

Abstract

The purpose of this paper is to decompose income inequality based on two different dimensions in nature. One is sample's personal characteristics, and the other is income sources. Empirical investigation is attempted to data in Japan. Although there are several studies which attempted decomposing income inequality either based on personal characteristics including several different personal characteristics, or based on income sources in Japan, this is the first attempt at least in Japan, which decomposed income inequality by combining the different dimensions in nature. We find based on this rigorous estimation method that several personal characteristics and/or particular income sources work as either equalizing factors for total income inequality or inequalizing factors.

Address for communication:
Toshiaki Tachibanaki, Institute of Economic Research,
Kyoto University, Sakyo-ku, Kyoto, Japan 606-8501.

＊ 本稿における実証分析は、金子能宏が分担研究者として参加した厚生科学研究費補助金（政策科学推進研究事業）「社会保障の改革動向に関するの国際共同研究」平成１３年度総合研究報告書の分冊『「国民生活基礎調査」再集計結果・付属統計表』に基づくものである。再集計作業は国立社会保障・人口問題研究所の研究者が担当した.

1. *Introduction*

There are basically two approaches to investigate empirical decomposition of income inequality. The first is to decompose samples into several sub-samples based on various demographic categories or qualifications such as age, profession, sex, etc., and estimate the relative contribution of decomposed inequality by categories or qualifications to total inequality measure. The second is to decompose total income into various sources such as wages, interest incomes, transfer incomes etc., and to estimate the relative contribution of decomposed inequality by sources. The second one pays attention to the fact that the sum of various source incomes is equal to total income. Takayama(1976), and Toyoda and Wago(1977) are the examples of the first approach, and Atoda and Tachibanaki(1985) is the example of the second approach in Japan.

The purpose of this study is to combine the first and the second approaches, and thus to decompose the total income inequality measure by both the first and the second criteria, i.e., by categories and sources. We use the method which was developed by Shorrocks(1999) for our purpose, and applies it for the following three measures; the relative variance, the Gini, and the Theil measures.

2. *Estimation Method*

2.1 *Data*

It is necessary to use income data which contain two information, as explained previously. The first is various demographic characteristics of samples, and the second is not only total income but also income sources such as wages, interest incomes, etc. We use the 「National Living Standard Survey」 by the former Ministry of Welfare(currently the Ministry of Welfare and Labor). The 1998 data are used mainly, while the 1992 data are used supplementarily in order to commit to a time-series comparison.

The data describe the following demographic information: age, profession, family size, number of income earnings. We use here the criterion of profession, and its criterion divides samples into five sub-samples, regular employees, employees with limited duration of contract or working hours, daily employees, self-employed, and others. Also they provide the following six income sources; earnings(i.e., wages), enterprise incomes, farmer incomes, interest incomes, transfer incomes by social security system, and other sources.

2.2 Three Inequality Measures

It is well-known that a particular inequality measure has merits and demerits to show the true story of income inequality. We apply the following three measures; (1)Relative Variance, (2)Gini coefficients, (3)Theil measure. It is expected that the result based on these three measures can show the stable, balanced and reliable story of empirical measures of income inequality fairly well.

3. Decomposition of the Shapley Value

Shorrocks(1999) proposed a decomposition method which can decompose income inequality by both demographic characteristics and income sources, based on the Shapley value(1953). Since it is not easy to understand for non-specialists why the Shapley value is useful to decompose inequality by two different criteria, we describe a brief explanation by applying the concept of coalition game theory and/or of albeit game theory. We owe coalition game and/or albeit game to Okada(1996).

3.1 Shapley Value

The example below will be useful to understand why the Shapley value is useful to interpret the decomposition method adopted here.

Suppose there are three persons called A,B,C, who plan to work individually and/or jointly. We know the following initial conditions,

(1) Each person(i.e., persons A,B,C, respectively) can earn A:60(thousands yen), B:40, and C:20, when each person works separately and independently.

(2) Two persons earn the following if they work together. A and B: 200, A and C: 150, and B and C: 100.

(3) Three persons earn(i.e., A, B, and C) 240 if they work together.

The Shapley value determines the way, "who works together or separately?, and how total earnings should be allocated to each person?"

For simplicity we write each coalition(i.e., a combination of who works together) in the following manner.

(1) one person coalition: {A},{B},{C}

(2) two persons coalition: {A,B},{A,C},{B,C}

(3) three persons coalition: {A,B,C}

Total earnings are described below for each coalition. v is called characteristic function at the game theory.

v(A)=60, v(B)=40, v(C)=20
v(A,B)=200, v(A,C)=150, v(B,C)=100
v(A,B,C)=240

The Shapley value can be obtained in the following way. First, we calculate the marginal contribution of each person. For example, the marginal contribution of person A to three persons coalition is equal to 140(i.e., 240-100).

If three persons form three persons coalition under the order of A, B, and C, the marginal contribution of each person is written as follows,

v(A)−0=60
v(A,B)−v(A)=200−60=140
v(A,B,C)−v(A,B)=240−200=40

Table 1 shows various marginal contributions for all possible orders. Since it is impossible to commit to any order under uncertainty, we regard the average of each player's marginal contribution as a prior evaluation, which is called the Shapley value. It is easy to show the following Shapley value(ϕ) under this example.

ϕ_A=115, ϕ_B=80, ϕ_C=45

This suggests that each person's earning is 115 for person A, 80 for person B, and 45 for person C.

The Shapley value is the expected value of each person's marginal contribution in the framework of coalition game. Let us define the Shapley value formally. We consider a coalition game (N, v) with N players(or participants) and v(i.e., marginal contribution).

$$\phi_i(v) = \sum_{i \in S \subset N} \frac{(S-1)!(n-S)!}{n!} \cdot \{v(S)-v(S-\{i\})\}$$

where $\phi_i(v)$ is the ith person's (i= A, B, C) Shapley value.

3.2 Data Analysis by Shapley value

After understanding the essence of the Shapley value, the next step is to show that it is useful and applicable for two dimension's decomposition of income inequality. We use again an example for this purpose.

Table 2 is prepared for the illustrative purpose, which consists of 20 person's income figures, and of their three different income sources (i.e., y^1, y^2, y^3). Needless to say, total income y is equal to (y^1+ y^2+y^3). Also we consider a hypothetical classification, say criterion X_1, for demographic characteristics. It can be age or profession. There are three different groups for this criterion.

First, we evaluate decomposition by income sources, i.e., y^i (i=1, 2, 3) . The relative variance is used for the illustrative purpose as an inequality measure. Table 2 shows that the relative variance for total income y is 0.113, and 0.123 for income source y^1. The next step is to take the sum of two income sources, i.e., y^1+y^2, y^1+y^3, y^2+y^3, and calculate respective relative variance. Then, we consider all orders regarding y^i, i.e., $y^1 \rightarrow y^2 \rightarrow y^3$, $y^1 \rightarrow y^3 \rightarrow y^2$, etc. This enables us to calculate the marginal contribution of each y^i, and to obtain the Shapley value for each y^i. The result shows that $\phi(y^1) = -2.130$, $\phi(y^2) = 1.629$, and $\phi(y^3) = 0.614$. Since the sum of the above three is equal to 0.113, which is equivalent to the original relative variance, we find that the decomposition here is right.

Second, we are now concerned with decomposition by demographic characteristics. Our example due to a hypothetical criterion X_1 can indicate the estimation procedure in the simplest way. Table 3 shows the Shapley values only for samples which have qualifications X_1=1. Based on the same method, Tables 4 and 5 present the Shapley values for X_1=2, and X_1=3, respectively.

It is necessary to calculate the Shapley values for all combinations such as (1, 2), (1, 3), (2, 3), and (1, 2, 3) for X_1. This enables us to calculate the marginal contribution of each characteristic, and to obtain the average of the marginal contributions. Table 6 is the estimated relative variances for all combinations, and Table 7 is the result of the Shapley values based on Table 6.

Table 8 is the final result in the case in which the decomposition by both income sources and demographic classification is made. The table suggests that X_1=2 is the largest, while X_1=1 is the negative value, implying that samples which belong to X_1=2 have the largest inequality, while samples which belong to X_1=1 have the lowest inequality. The result based on income sources suggests that y^2 is the source which gives the largest inequality, while y^1 is the source of the lowest inequality. It is noted that the largest source y^2 again shows the largest inequality

for samples in X_1=2.

4. Empirical Results for Decompositions by Two Dimensions, Profession and Income source

Table 9, 10 and 11 show the estimated results based on the three measures, i.e., relative variance, Gini coefficient, and Theil measure. It is quite impressive to notice that three different measures do not produce any significantly different result regarding the implication of decompositions of total income inequality. Thus, we interpret our result based only on the estimated by relative variance.

Figures, which can indicate the essence of our study more intuitively, are presented. Figure 1 shows the relative contribution by age class.

This figure suggests that income inequality is fairly stable for samples whose ages are between 20 and 40 years old. It increases, however, fairly rapidly at the age 40s, and its increase continues with high speed at the age 50s until the age 70s. This implies that the degree of income inequality for younger and middle age generations is not so large, while the one for older generations is quite large.

There has been a dispute over empirical observations on income distribution in Japan regarding its time-series change over the past 30 years. One school proposes, for example Tachibanaki(1998), that the degree of income inequality has been increasing, and that it reaches a fairly high level. The other school does not accept this proposition. One of the disputes is concerned with the cause of a widening trend in income differentials; the aging trend in population age structure facing in Japan is likely to be one of the main causes.

The empirical result in this paper clearly supports this cause because an increasing share of aged people in the total population, which is a symbol of the aging trend, reinforces an increasing trend in income inequality considerably in view of the very wide income differentials among older generations. Thus, this study sheds light on the issue of income distribution in Japan.

An interesting subject related to this is the reason why income differentials among older generations are so wide. Three possible candidates can be suggested. One is the institutional feature of industrial relations in Japan; the seniority system, implying that wage payments increase with employees' age with a considerably sharp degree. Older generations can receive considerably high wages based on this system. Second, the nature of the life-cycle saving hypothesis, which is one of the most plausible hypothesis for the very high saving rate in Japan, supports high wealth holdings among older generations. Third, it is possible to

raise another reason which is related to the second reason; since older generations fear their future public pension benefits in view of the anticipated financial difficulty in the system caused by the aging trend, they tend to save a lot from their incomes. A high degree of propensity to bequeath to next generations is another cause related to this.

One important reason for wider income differentials among older generations is its statistical feature; part of older generations do not have any wage earnings because they have already retired, while part of them continue to receive wage earnings from working activity. We show later that some older generations receive extremely high incomes from their executive positions at enterprises, as seen in Figure 2. This distribution between non-working and working can explain one of the causes of wider income differentials among older generations. A future work, which separates samples between non-working and working would be desirable to confirm this explanation.

The second concern is decomposition of total income inequality by professions. Figure 2 presents such results. We can see the following observations. First, the most apparent profession, which can contribute to the largest income difference, is self-employed workers. Daily workers follow it.

It is quite natural that income levels are so different among self-employed workers because very successful self-employed workers can receive extremely high earnings for various reasons. Venture entrepreneurs, successful medical doctors, writers, professional sport players, etc. are examples. Unsuccessful self-employed workers such as small shops, retail traders, farmers, however, cannot earn high incomes, as we know them in the real world. Since economic activity of self-employed requires risky tasks and at the same time is determined by luck, it is natural to see the fact that income differentials among self-employed are quite large.

The traditional self-employed workers in Japan were dominated by farmers, retail traders, etc. Income levels of these professions were relatively low on average, although there were a small number of rich farmers and retail traders. The share of these occupations within self-employed category has been in a decreasing trend. Thus, the story for ambitious venture entrepreneurs, successful various professions such as sport players, writers, musicians, etc. rather than for farmers and retail traders is now crucial for the determination of income levels of self-employed workers.

Second, the relative contribution of being employees to the total income

inequality is minor except for samples whose ages are older than 70 years. The minor role of employees for income inequality is not surprising in view of the Japanese way of wage determination because fairly higher equality among employees was regarded as a principal rule, although its feature is losing popularity currently. It was believed in the past that equal treatment for employees concerning their wages and promotion possibilities at Japanese firms was useful to draw the highest work motivation and incentive from nearly all employees. It is obvious that such a principle contributed to narrowing wage differentials among employees.

This feature, i.e., equal treatment, however, is moving towards emphasis on merit system. This system recommends that employees' wages and promotion possibilities should be determined by their productivity and thus contributions to the firm. The difference in wages among employees shows a widening trend currently because the system is dominant in many firms.

The exception for employees whose ages are older than 70 years comes from the fact that some employees in this group receive very high earnings, possibly because they are executives (i.e., top managers) at firms. This is one of the causes of the very wide income differentials among older employees, as described previously.

Third, we examine decomposition by income sources, whose result is shown in Figure 3. There are several interesting observations which can be derived from this figure.

First, the influence of both enterprise incomes and property incomes(i.e., interest incomes) is quite large to determine the degree of total income inequality. In particular, the role of property incomes such as interests, dividends, rents, etc. is the largest for nearly all age classes for 60s and 70s. Households, who have high asset values such as financial assets and real assets, are quite advantageous in receiving higher incomes because they can receive interests, dividends, rents, etc.

Atoda and Tachibanaki (1991) also obtained the similar result based on the different estimation method, proposing that the influence of property incomes is very large. Atoda and Tachibanaki speculated that wealth tax might be necessary to reduce the role of property incomes in the determination of total income inequality. Since we have to take into account various factors and effects of this tax based on both efficiency and equity grounds, we do not discuss this issue further.

Second, the relative contribution of wage incomes is negative for all age

classes except for extremely older observations (i.e., over 70 years old). This is related to the previous finding such that wages are distributed fairly equally. Wage incomes act as an income source which contributes to reducing the degree of total income inequality in Japan. This is an important fact finding.

Third, a more impressive result appears in the role of transfer incomes such as public pensions, medical insurance payments, unemployment compensations, supplementary benefits, etc. because its sign is negative for older samples. Naturally, older people receive these payments much more frequently and with considerably higher amounts than younger and middle age people. Social security system in Japan works as a system which contributes to reducing the degree of total income inequality. We are able to confirm that social security system in Japan works quite fairly and appropriately.

Fourth, we performed the similar decomposition analysis for 1992 data as 1998 data which were discussed with great length in this paper. Since the result for 1992 data is not so different from the one for 1998 data regarding the effect of decomposition by both profession and income sources. Thus, we do not provide any explanation.

One supplemental result is shown by Table 12 to investigate a time-series change in total income inequality from 1992 to 1998. It indicates that three measures, namely relative variance, Gini and Theil, describe a very minor increase in the degree of total income inequality. Income distribution in Japan in the 1990s was moving towards more inequality, although its degree towards inequality was very minor or nearly negligible.

5. Concluding Remarks

The paper presented theoretical implications of the decomposition analysis developed by Shorrocks(1999), and an empirical analysis based on hypothetical data for the illustrative purpose. We hope that readers find the first part useful to understand decomposition method considered here.

The second part presented empirical evidence in Japan. This is the first attempt in Japan, which decomposed total income inequality based on two dimensions, namely profession (or occupation) and income source.

Several worth-while findings in Japan may be summarized as follows. First, the degree of total income inequality is unchanged for younger and middle age populations, while it increases fairly drastically for older generations.

Second, income differentials by self-employed and daily workers are quite large, while the ones by employees are fairly small. These findings regarding the difference in professions are consistent with the common knowledge in Japan.

Third, the role of enterprise incomes and property incomes is fairly large to determine total income inequality. The role of wage earnings is negative for all samples except for over 70 years old samples, and also the one of transfer incomes is negative for older generations. The latter finding regarding wage earnings and transfer incomes is impressive because these two income sources play an important role in reducing the degree of total income inequality.

Reference

Atoda, N. and T. Tachibanaki (1985), "Decomposition of Income Inequality based on Income Sources, " *Quarterly Journal of Social Security*, vol.20, No.4, pp.330-340.

Okada, A. (1996), *Game Theory*, Yuhikaku.

Takayama, N.(1976), "Inequality in Income and Monetary Asset Distribution and Its Causes," *Keizai-Bunseki*, vol.27, pp.134-142.

Toyoda, K. and H. Wago (1977), "Income Inequality based on professions in 40s and its measurements," *Kokumin-Keizai*, No.137, pp.41-60.

Shapley, L. (1953), "A value for n-person games, " in : H. W. Kuhn and A. W. Tucker, eds., Contributions to the Theory of Games, Vol.2(Princeton University Press).

Shorrocks,A.F.(1999) , "Decomposition Procedures for Distributional Analysis: A Unified Framework Based on the Shapley Value, " University of Essex and Institute for Physical Studies.

Table 1. Marginal Contributions for Albeit Game

Possible order	A	B	C
A B C	6	14	4
A C B	6	9	9
B A C	16	4	4
B C A	14	4	6
C A B	13	9	2
C B A	14	8	2

Table 2. Shapley Decomposition by Income Sources for Hypothetical Data

Original data

	total income				characteristics1
	y	y^1	y^2	y^3	X_1
person1	180	160	20	0	1
person2	200	200	0	0	1
person3	161	130	0	31	2
person4	216	216	0	0	1
person5	196	170	0	26	3
person6	211	200	11	0	1
person7	140	140	0	0	2
person8	184	184	0	0	1
person9	240	200	0	40	3
person10	96	96	0	0	1
person11	28	28	0	0	2
person12	200	200	0	0	1
person13	300	300	0	0	3
person14	266	260	6	0	2
person15	162	162	0	0	1
person16	130	130	0	0	1
person17	200	150	25	25	2
person18	140	140	0	0	1
person19	130	110	0	20	1
person20	182	182	0	0	1
mean μ	178.1	167.9	3.1	7.1	
variance V(y)	3584.305	3461.67	52.095	171.25	
relative variance	0.113	0.12280	5.4209	3.3972	

Calculated data

	y^1y^2	y^1y^3	y^2y^3
person1	180	160	20
person2	200	200	0
person3	130	161	31
person4	216	216	0
person5	170	196	26
person6	211	200	11
person7	140	140	0
person8	184	184	0
person9	200	240	40
person10	96	96	0
person11	28	28	0
person12	200	200	0
person13	300	300	0
person14	266	260	6
person15	162	162	0
person16	130	130	0
person17	175	175	50
person18	140	140	0
person19	110	130	20
person20	182	182	0
mean μ	171	175	10.2
variance V(y)	3545.37	3481.16	242.8
relative variance	0.12125	0.11367	2.33372

Result

	y^1	y^2	y^3
$y^1y^2y^3$	0.122796	−0.00155	−0.00825
$y^1y^3y^2$	0.122796	−0.00067	−0.00913
$y^2y^1y^3$	−5.29964	5.420888	−0.00825
$y^2y^3y^1$	−2.22072	5.420888	−3.08717
$y^3y^1y^2$	−3.28353	−0.00067	3.397196
$y^3y^2y^1$	−2.22072	−1.06348	3.397196
Shapley value	−2.12984	1.629235	0.6136

Table 4. Shapley Decomposition by Income Sources based on Characteristics 1 (X_1=2) for Hypothetical Data

X_1=2	total income				characteristics1
	y	y^1	y^2	y^3	X_1
person3	161	130	0	31	2
person7	140	140	0	0	2
person11	28	28	0	0	2
person14	266	260	6	0	2
person17	200	150	25	25	2
mean μ	159	141.6	6.2	11.2	
variance V(y)	7664	6782.8	117.2	239.7	
relative variance	0.303153	0.338285	3.048907	1.910874	

Result

	y^1	y^2	y^3
$y^1y^2y^3$	0.338285	-0.00135	-0.03378
$y^1y^3y^2$	0.338285	0.005579	-0.04071
$y^2y^1y^3$	-2.71198	3.048907	-0.03378
$y^2y^3y^1$	-1.33445	3.048907	-1.41131
$y^3y^1y^2$	-1.6133	0.005579	1.910874
$y^3y^2y^1$	-1.33445	-0.27327	1.910874
Shapley value	-1.05293	0.972391	0.383696

Table 5. Shapley Decomposition by Income Sources based on Characteristics 1 (X_1=3) for Hypothetical Data

X_1=3	total income				characteristics1
	y	y^1	y^2	y^3	X_1
person5	196	170	0	26	3
person9	240	200	0	40	3
person13	300	300	0	0	3
mean μ	245.3333	223.3333	0	22	
variance V(y)	2725.333	4633.333	0	412	
relative variance	0.04528	0.092894	0	0.85124	

Result

	y^1	y^2	y^3
$y^1y^2y^3$	0.092894	0	-0.04761
$y^1y^3y^2$	0.092894	0	-0.04761
$y^2y^1y^3$	0.092894	0	-0.04761
$y^2y^3y^1$	-0.80596	0	0.85124
$y^3y^1y^2$	-0.80596	0	0.85124
$y^3y^2y^1$	-0.80596	0	0.85124
Shapley value	-0.35653	0	0.401813

Table 3. Shapley Decomposition by Income Sources based on Characteristics 1 (X_1=1) for Hypothetical Data

X_1=1	total income				characteristics 1
	y	y^1	y^2	y^3	X_1
person1	180	160	20	0	1
person2	200	200	0	0	1
person4	216	216	0	0	1
person6	211	200	11	0	1
person8	184	184	0	0	1
person10	96	96	0	0	1
person12	200	200	0	0	1
person15	162	162	0	0	1
person16	130	130	0	0	1
person18	140	140	0	0	1
person19	130	110	0	20	1
person20	182	182	0	0	1
mean μ	169.25	165	2.583333	1.666667	
variance V(y)	1424.568	1508.727	40.08333	33.33333	
relative variance	0.049731	0.055417	6.006243	12	

Result

	y^1	y^2	y^3
$y^1y^2y^3$	0.055417	0.001577	-0.00726
$y^1y^3y^2$	0.055417	0.001417	-0.0071
$y^2y^1y^3$	-5.94925	6.006243	-0.00726
$y^2y^3y^1$	-3.49478	6.006243	-2.46173
$y^3y^1y^2$	-11.9517	0.001417	12
$y^3y^2y^1$	-3.49478	-8.45549	12
Shapley value	-4.12994	0.593568	3.586106