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A COHORT ANALYSIS OF HOUSEHOLD CONSUMPTION BEHAVIOR ON LIFE CYCLE IN JAPAN*

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1. Introduction	61
2. A Structural Model of Cohort Analysis	63
3. A Decomposition: Economic Growth Effects and Age Effects	66
4. Some Results of Analysis	68
5. A Forecasting System from Cohort Analysis	72
6. Conclusions	75

1. INTRODUCTION

R. F. Harrod [1] was the first to introduce a factor of life cycle into theoretical economic analysis of consumer behavior. Unlike J. M. Keynes, who investigated the short-term economic problem, Harrod formed his theory of consumer behavior by introducing such long term factors as technological progress, an increase in population, and capital accumulation to promote the economy.

It is particularly worth noting that he kept an eye on the flow of savings in his theory. He analysed the economy dynamically from the supply side of savings. In the process, to demonstrate the propensity of individuals to save and also the different types of savings there are (to take one example: humpsaving, which equals the savings necessary to satisfy man's desires in all his life). At the same time Harrod related the life cycle of savings to that of consumption and income.

Afterwards, these theories were verified by actual data. We, however,

Acknowledgment

*) An early version of this paper was reported in the seminars held at Kokumin Seikatsu Kenkyusho-Kokumin Seikatsu Center (the Social and Economic Affairs Research Institute — the S. E. A. R. I.) during 1966-1969.

Particularly, discussions with Professors R. Ioch, K. Emi of Hitotsubashi University and Y. Kawabata and seminar participants of the S. E. A. R. I. have been of great benefit to me on an early draft forming the basis of this paper.

Professors Y. Hayakawa, T. Nagao, E. Ohya, Y. Kobayashi, H. Kashiwagi of Hokkaido University and Professor K. Takeuchi of Tohoku University have made very valuable comments on intermediate drafts.

[1] Harrod, R. F., *Towards a Dynamic Economics*, 1950.

proved in our previous thesis [2] that these old analyses still contained some unsolved problems.

It has been shown that traditional methods of life cycle analysis of consumers' behavior by cross-section and time-series analysis were defective and therefore inadequate. For that reason, the well-known demographic technique of cohort analysis was strongly recommended¹⁾. A structural model was devised to interpret the data and from this model economic growth and age effects were analysed. As the result of this analysis we have expanded the technique of forecasting.

Cohort analysis was supported by actual data from the Family Income and Expenditure Survey [F.I.E.S.] of the Bureau of Statistics of the Prime Minister of Japan. From these data, a forecasting system, that is, a system for estimating the consumption function, disposable income²⁾, and Living expenditures³⁾ of households by age groups of household heads, was formed.

But the actual data restricts analysis for several reasons. The most important of them is that this data can only be related to five year periods because it was collected for the Annual Reports of F.I.E.S. every five years. Even though the limitations of our data will somewhat change our theories, our basic premise will still be valid.

It is true, but you will find the influence of economic variables' patterns on the life cycle of households if you study the recent theories of consumers' behavior; such as the revival of new "consumers' sovereignty", the necessity of planning for decision-making, approached from the view point of life cycle based on life planning.

From this point of view, cohort analysis is required. Data is now supplied every year. Therefore, we should continue hereafter to use cohort analysis as well as to reinforce the life cycle theory in order to improve upon my previous analysis.

The purpose of this paper is to investigate the fluctuations of various

[2] The Social and Economic Affairs Research Institute (Kokumin Seikatsu Center, in Japan), Life Cycle no Kakei Cohort Bunseki, Mimeograph, 1969.

1) It is well known that the cohort approach is an alternative to the use of panels for some purposes.

Panels have important advantages which J. A. Fisher implied in [3], such as the increased analytic power which they provide. However they also have important disadvantages which J. B. Lansing and J. Sonquist state in [4], such as the difficulty and expense of following people who move.

Even though they are theoretically possible, there are no panels now in existence which provide reinterview data on consumption and income for the period since, say, 1953.

A complete review of the uses and limitations of panels is beyond the scope of this paper.

2) Disposable income=Income minus all-living expenditures.

3) Living expenditure=Food plus Housing plus Fuel and Light plus Clothing plus Miscellaneous.

coefficients (e. g. α , $Mc_a y$, $Mc_g y$) in the data which had been assumed stable in previous analyses and to analyse recent topics such as; the business cycle, the consumption of households, the fluctuations of savings and net worth and the life cycle.

2. A STRUCTURAL MODEL OF COHORT ANALYSIS

Prior to proceeding to our analysis, we would like to speak, for your information, on essential and noteworthy points of a structural model of cohort analysis.

First of all, the method of cohort analysis is supported by the following reasons: at the present historical pursuit data from each household are not enough to meet the requirement of analysis of life of households in discussing social average tendency. What we need to analyse in the life cycle patterns of households is not only data that describes individuals, but also data which is classified by type of household, and particularly data on the nuclear household.

Looking at actual statistical data from this point of view, it is only yearly average monthly receipts and disbursements per household (taken from the F.I.E.S. surveys and classified) by type of household that provide adequate social scale records for our analysis of household behavior. These data give information by type of household, and still better, by age of household head. But it is only since 1963 that income information classified by type of household has become available for all worker households and, worse still, we can only use this information when the husband is the household head.

For these reasons, it can be said that even F. I. E. S. cannot meet all requirements. But defective as the present data may be, it will still be adequate for our following analysis.

Let us assume a household head in the report on F. I. E. S., who belongs to ' t ' age group of types of households. The best way to know the changes of his income and expenditure years later, is to chart his income and expenditure which ($t+k$) age groups shows in the report of F. I. E. S., not for the same year, but k years later. This will reveal cohort patterns which we can observe. I call this "pattern of cohorts of households"

When we come to put analysis into practice, we encounter some data limitations:

[3] Fisher, J. A., "Family Life Cycle Analysis in the Study of Consumer Behavior, Lincoln H. Clark, The Life Cycle and Consumer Behavior, New York University, 1955.

[4] Lansing, J. B. and Sonquist, J., "A Cohort Analysis of Changes in the Distribution of Wealth and Income, Lee Soltow (ed.), Studies in Income and Wealth, No. 33, National Bureau of Economic Research, Inc., Columbia University Press, 1969.

1) Each age group of data in F.I.E.S. is classified at intervals of five years.

2) Information on yearly average of monthly receipts and disbursements per household by types of household is available only from 1953 to 1970. Therefore, we cannot escape using cohort analysis because of limitation (1), but because of limitation (2) we lack sufficient data to draw conclusions. Desiring the analysis by type of household, we can only wait until the necessary data is continuously available to us.

Let us consider using the data again to study cohort patterns of households with the data collected. One course is to use a "yearly average of monthly receipts and disbursements per household classified by age group of household head" table (not by type of household). This has been published on worker households since 1952 in the Annual Report on F.I.E.S.

Even if we use this data, care must be taken about the following points:

a) The age intervals for the household heads from 1952 to 1963 is different from that of 1963 onward. In the over forty-year-old household head groups, the former is at ten-year age intervals and the latter at five-year age intervals.

You will see the necessity of some connection between the two.

b) This analysis does not deal with single households.

c) Since a six-month rotation system is adopted for our investigation, we cannot accurately study the cohort pattern each.

Let us plot actual series of cohort patterns at intervals of five years based on the data since 1952 that agrees with points a, b, c above.

See the series of real disposable income in 1954-1959-1964-1969 and real living expenditure in the same years Fig. (2-1)_D, (2-1)_L. Please note that nominal disposable income and nominal expenditure are deflated by the Consumer Price Index, 1965=100. Let us explain how to look at these figures.

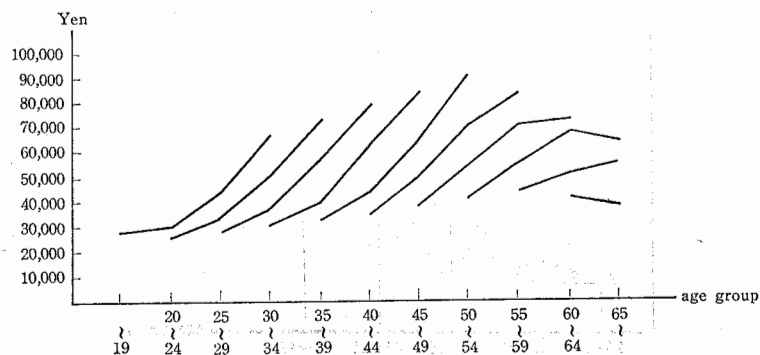


Fig. (2-1)_D Disposable income by cohort (1954-'59-'64-'69)

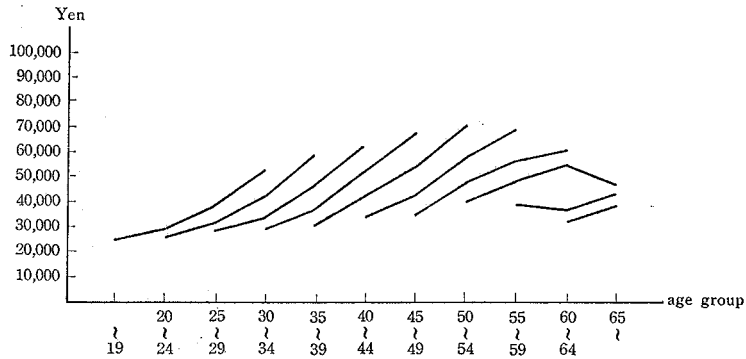


Fig. (2-1)_L Living expenditure by cohort (1954-'59-'64-'69)

For instance, in the disposable income series, we will plot the disposable income and expenditure for household heads who are certain ages in 1954. We shall call the resulting pattern of points “sequence of points of age groups starting in 1954”. For those household heads who advance five more years of age we can show a pattern of disposable income and expenditure in 1959. We shall call these points the “sequence of points in 1959”. And the income and expenditure of household heads who advance five more years to 1964 will form a pattern of points which we shall call “sequence of points in 1964”, and so forth. Consequently you will see disposable income and living expenditure related to each age point.

Fig. (2-2) helps us to understand the above analysis.

When household head's starting age is 25-29, his disposable income goes to $A \rightarrow C, \rightarrow F, \rightarrow I$. We will call this series of points the cohort pattern of a certain age group ($A \rightarrow C \rightarrow F \rightarrow I \rightarrow \dots$), or unit cohort for short. When the starting age is 30-34, unit cohort is $B \rightarrow E \rightarrow H \rightarrow K \dots$. Similarly, when starting age is 35-39, it becomes $D \rightarrow G \rightarrow J \dots$.

Thus you will see a similar folded solid line formed by each starting

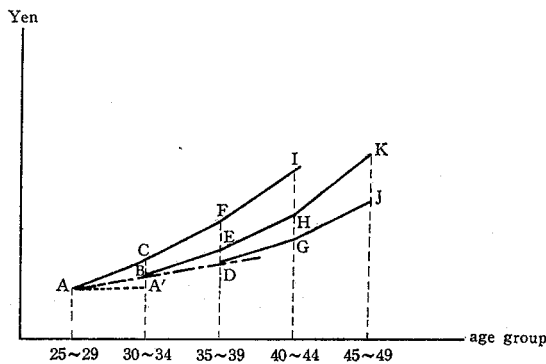


Fig. (2-2) Disposable income series

age. Together these points a figure which seems as if something made one's hair stand on end. Let us call this figure the "cohort system" in short. Namely, the whole group of unit cohorts forms the cohort system.

On the other hand, the dotted line ($\cdot-\cdot-\cdot-\cdot-\cdot$) which links the lowest points of each unit cohort (A, B, D, \dots in this case) is a sequence of points in 1954. It represents a cross-section in 1954. Similarly C, E and G represent cross-section in 1959, and F, H and J in 1964.

3. A DECOMPOSITION: ECONOMIC GROWTH EFFECTS AND AGE EFFECTS

As mentioned above, we found it possible to observe the states of households' life cycles by studying data of the F.I.E.S. according to cohorts of households. But there is still room for improvement.

H. P. Miller [5] and Y. B. Porath [6] introduced economic growth effects and age effects into the problem of estimation of income over the life span. Let us take one example: in Fig. (2-2), when household head's starting age in 1954 was 25-29, his disposable income (A) becomes (C) five years later in 1959, when the age group is 30-34. The value of (C), judging from (A), increases much more than that of (B) whose age group is 30-34 in 1954 as cross-section.

This is caused not only by a difference in a pure sense among stages of life cycles of households, but also by national economic fluctuation, or, we might say, the influence of economic growth.

The same thing can be said in the case of households' life cycle analysis.

Hence Porath modifies Miller's estimate of income over the life span based on the Census from the U.S.A. and thinks that relative changes of income in unit cohorts of starting age groups $\{A-B$ in Fig. (2-2) $\}$ can be divided into two parts: One part is related to age and the other to economic growth, Fig. (3-1).

The following formula referring to Fig. (3-1) is derived:

$$\frac{C-A'}{A} = \frac{B-A'}{A} + \frac{C-B}{A}$$

Also in Japan it will be necessary to trace cohort pattern using data published by the F. I. E. S. annually.

Having divided the increase in income ($C-A'$) into two parts, ($B-A'$) and ($C-B$), will call the former "age effects" and the latter "economic

[5] Miller, H. P., "Lifetime Income and Economic Growth", American Economic Review, Sept., 1965.

[6] Porath, Y. B., "Lifetime Income and Economic Growth: Comment", American Economic Review, Sept., 1966.

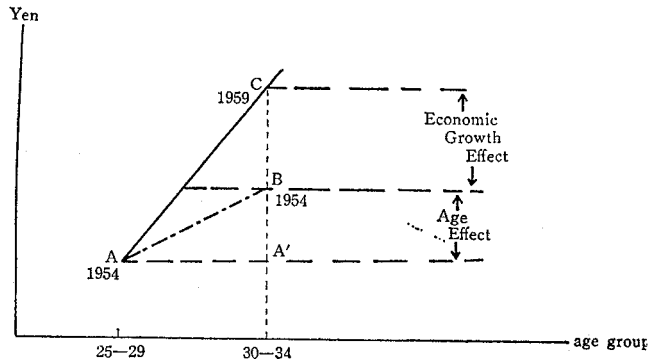


Fig. (3-1) Disposable income series

growth effects” respectively. Equally in the case of other economic variables and coefficients, we will divide each unit cohort into “age” and “economic growth” effects. After observing each variable divided, we search for rules which work among them.

To take one example of marginal propensity to consume as taking cross-section among variables, we can deduce the following formulas: if we define y , y_a and y_g respectively as follows,

y ; increase in income

y_a ; influence of age on increases in income

y_g ; influence of economic growth on increases in income

The relation among them is as follows:

$$y = y_a + y_g$$

Let us assume c and c_a as follows:

c ; increase in consumption

c_a ; influence of age on increases in consumption

c_g ; influence of economic growth on increases in consumption

Then there is a relationship among them.

$$c = c_a + c_g$$

From our definitions, the following relationships of the cross-sections are defined:

marginal propensity to consume: c/y (we express this in Mc_y)

marginal propensity to consume on age effects: c_a/y in $(Mc_a)_y$

marginal propensity to consume on economic growth effects: c_g/y
(in $Mc_g)_y$)

marginal propensity to consume concerned only with age effects:

$$c_a/y_a \ (M(cy)_a)$$

marginal propensity to consume concerned only with economic growth effects: $c_0/y_0 (M(cy)_0)$

4. SOME RESULTS OF ANALYSIS

The first thing is to observe the correspondent relations between life cycle and several economic factors, which we call, a pattern of life cycle.

In this case we must pay special attention to the following points:

① We use data on worker households of "yearly average monthly receipt and disbursements per household by age groups of household head" table in Annual Report on F. I. E. S.

② All items have been deflated by the Consumer Price Index, 1965 = 100.

③ As the interval of age groups is not always the same for this data, it must be accompanied by some assumption.

All things considered, it is still possible for us to tie four point (i. e. unit cohort) as I mentioned before. Taking these cohorts as a cohort system, we can find many patterns in it.

Thus we are able to find important patterns of meaningful variables and coefficients in these cohort systems; e. g. disposable income, consumption, saving, average propensity to consume, marginal propensity to consume etc.).

First, the real disposable income series of Fig. (2-1) forms a stable cohort pattern. The real disposable income of unit cohorts up to the starting age group 45-49 increases at a rapid rate with economic growth, while that of the older starting age groups has a tendency to decrease.

From this, we will conclude that younger age groups benefit more from economic growth than older age groups do.

Second, let us examine (a) average propensity to consume, (b) marginal propensity to consume and (c) propensity to save.

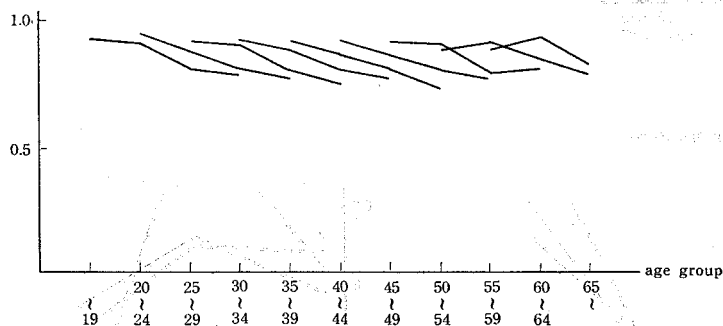


Fig. (4-1) Average propensity to consume by cohort (1955-'60-'65-'70)

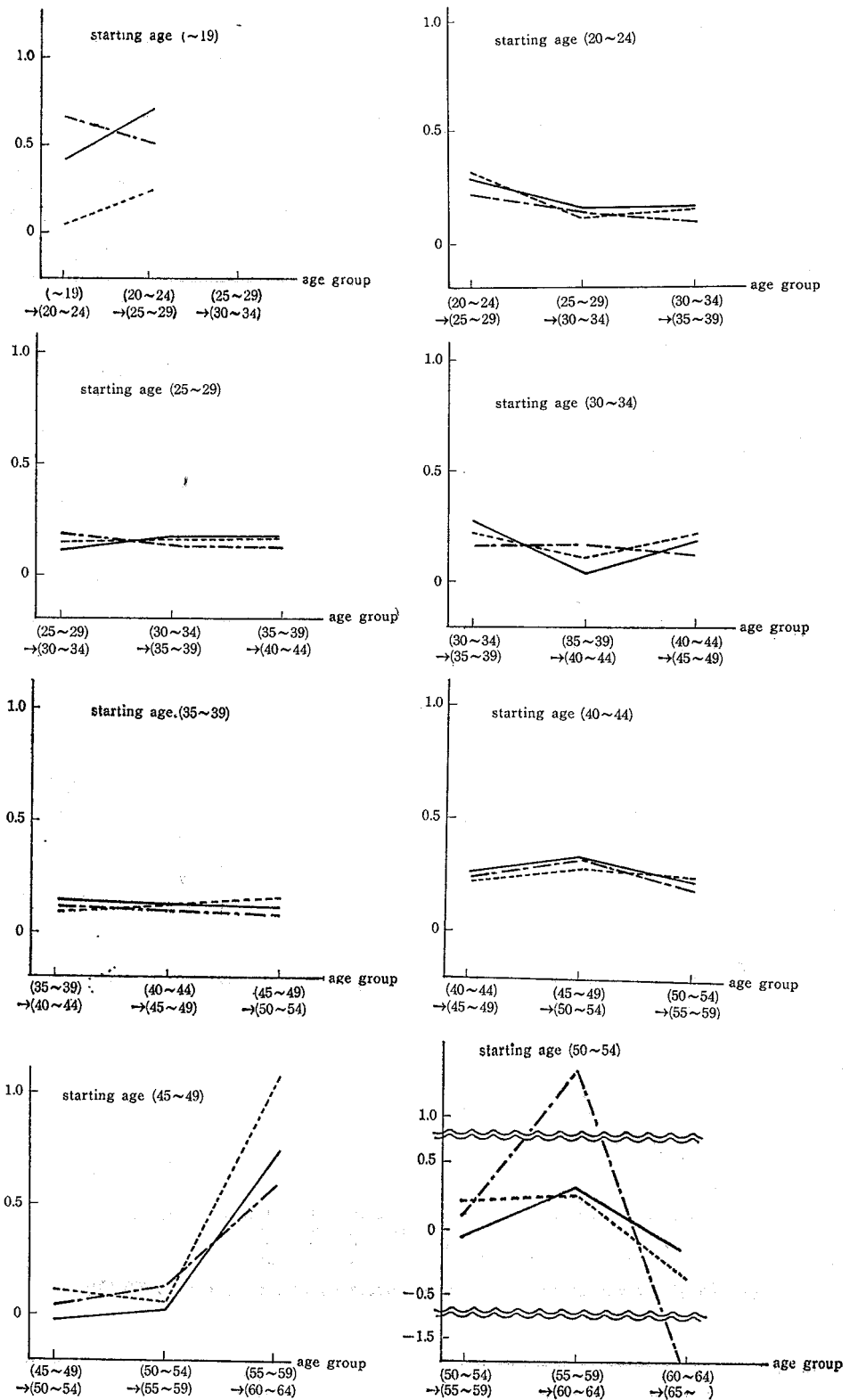


Fig. (4-2) $Mcay$ by cohort

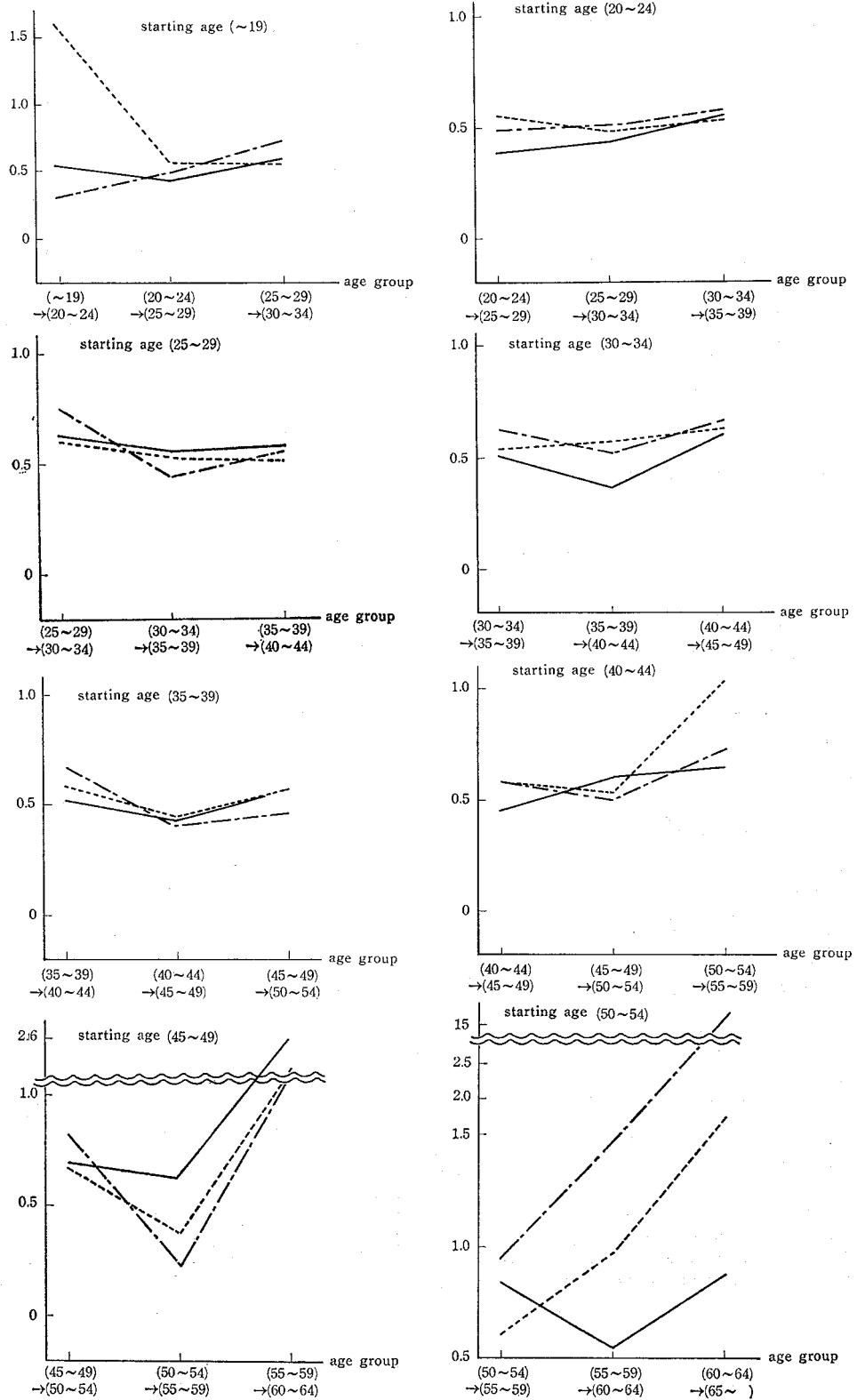


Fig. (4-3) $Mc_g y$ by cohort

- (a) Its definition is as follows :

$$\left(\frac{\text{living expenditure/disposable income}}{\tau \text{ (starting age group); } 1 \text{ (-19), } 2 \text{ (20-24), } \dots, 11 \text{ (65-)}} \right)_\tau$$

Fig. (4-1).

- (b) The definition is, in general, represented as follows :

$$\left(\frac{\text{increase in consumption/increase in income}}{\tau} \right)_\tau$$

Let us try to calculate marginal propensity to consume by starting age groups. This will show us a difference in the patterns of life cycle by age groups, as well as to apply this definition to our four continuing points.

We can derive marginal propensity to consume :

$$\left(\frac{\text{expenditure in 1960} - \text{expenditure in 1955}}{\text{disposable income in 1960} - \text{disposable income in 1955}} \right)_\tau$$

$$\left(\frac{\text{expenditure in 1965} - \text{expenditure in 1960}}{\text{disposable income in 1965} - \text{disposable income in 1960}} \right)_{\tau+5}$$

$$\left(\frac{\text{expenditure in 1970} - \text{expenditure in 1965}}{\text{disposable income in 1970} - \text{disposable income in 1965}} \right)_{\tau+10}$$

Using these definitions, we examine the series of coefficients which change as above. In addition to this method, we could make new definitions which consider both age effects and economic growth effects by means of Miller and Porath's division method that we mentioned before.

- b1. Mc_y consistently shows a stable pattern for three cohort systems.
- b2. The Mc_{ay} of the three cohort systems are not considerably different.

But if we compare the pattern of change of one starting age group to the others, important differences can be found, as shown in Fig. (4-2). These differences suggest how much each starting age group owes to economic benefits. Namely if trend has a positive tendency, the starting age group owes much to economic benefits, but if it has a negative one, it does little. This is an important fact.

- b3. Mc_y shown in Fig. (4-3) is mostly obvious in this analysis like Mc_{ay} .

- (c) average propensity to save is defined as follows :

$$\left(\frac{\text{disbursements other than expenditures}^4) - \text{receipts other than income}^5)}{\text{disposable income}} \right)_\tau$$

4) Disbursements other than expenditures-saving plus insurance premium payments plus debt payments plus installment and credit purchase payments.

5) Receipts other than income-saving deposits cashed plus insurance proceeds plus debts plus installment and credit purchases.

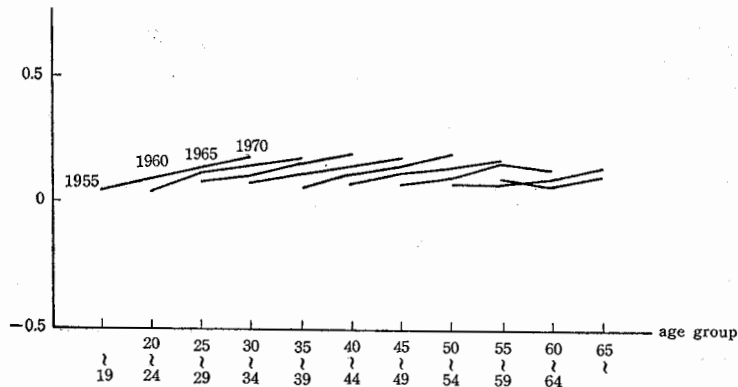


Fig. (4-4) Propensity to save by cohort (1955-'60-'65-'70)

We find that the trends of the cohorts of Fig. (4-4) are almost opposite to those of the average propensity to consume.

5. A FORECASTING SYSTEM FROM COHORT ANALYSIS

We can draw some conclusions from the above cohort analysis using "the Family Income and Expenditures Survey" in Japan.

And we can discover the following law, which will be especially important to the forecasting of disposable income and expenditure:

$$[5-1] \quad Mc_a y = (c_{at}/y_t)_t$$

This coefficient is stable among starting age groups as stated above and fixed regardless of the trade cycle (see Fig. (4-2)). By the way, in [2] we previously design a forecasting system using the laws of $Mc_a y$ and $Mc_q y$. Here $Mc_q y$ was defined as follows:

$$[5-2] \quad Mc_q y = (c_{qt}/y_t)_t$$

In this equation, expenditure of year of some starting age group plus its increase after five years c_{t+5} equals expenditure C_{t+5} five years later.

$$(C_{t+5} = c_{t+5} + C_t)$$

The same thing can also be said for disposable income.

Therefore, we have

$$[5-3] \quad C_{t+5} = c_{t+5} + C_t$$

and

$$[5-4] \quad Y_{t+5} = y_{t+5} + Y_t$$

Both [5-3] and [5-4] show a recurrent model and a forecasting system that makes it possible to estimate prospective expenditure and disposable income

TABLE 1. COEFFICIENTS FOR THE PREVIOUS ANALYSIS [2]

age group	(-19)- (20-24)	(20-24)- (25-29)	(25-29)- (30-34)	(30-34)- (35-39)	(35-39)- (40-44)	(40-44)- (45-49)	(45-49)- (50-54)	(50-54)- (55-59)	(55-59)- (60-64)	(60-64)- (65-)
α	0.24101	0.08635	0.06942	0.08603	0.15159	0.05973	0.05361	-0.07380	-0.08319	0
$Mc_{\alpha y}$	0.42136	0.18933	0.15128	0.17465	0.28276	0.14197	0.12630	-0.33209	-0.48498	0
$Mc_{\theta y}$	0.74560	0.47486	0.55205	0.51783	0.46119	0.59099	0.59812	0.98515	1.29968	0.43538

TABLE 2. INTERPOLATIONS ON EXPENDITURE BY PREVIOUS FORECASTING METHOD IN [2]

age group	(-19) -(20-24)	(20-24) -(25-29)	(25-29) -(30-34)	(30-34) -(35-39)	(35-39) -(40-44)	(40-44) -(45-49)	(45-49) -(50-54)	(50-54) -(55-59)	(55-59) -(60-64)	(60-64) -(65-)
1965 estimate based on 1955	—	39,108	42,531	46,829	54,392	58,394	63,135	60,498	53,242	—
Actual amount of 1965 expenditure	—	39,517	42,734	47,506	51,673	55,039	58,791	58,182	52,614	—

TABLE 3. COEFFICIENTS FOR THIS FORECASTING METHOD

age group	(-19) -(20-24)	(20-24) -(25-29)	(25-29) -(30-34)	(30-34) -(35-39)	(35-39) -(40-44)	(40-44) -(45-49)	(45-49) -(50-54)	(50-54) -(55-59)	(55-59) -(60-64)	(60-64) -(65-)
α	0.5803	0.0728	-0.0442	0.0704	0.0662	0.1242	0.0533	-0.0337	-0.0012	-0.0723
$Mc_{\alpha y}$	0.6470	0.2165	0.1610	0.1710	0.1589	0.2346	0.1167	-0.1251	-0.0052	0.5024
$Mc_{\theta y}$	0.2720	0.4871	0.7561	0.6245	0.6466	0.5817	0.6102	1.5151	1.0801	0.0121

TABLE 4. INTERPOLATIONS ON DISPOSABLE INCOME AND
EXPENDITURE BY THIS FORECASTING METHOD

	(-19) -(20-24)	(20-24) -(25-29)	(25-29) -(30-34)	(30-34) -(35-39)	(35-39) -(40-44)	(40-44) -(45-49)	(45-49) -(50-54)	(50-54) -(55-59)	(55-59) -(60-64)
1960 disposable income estimate based on 1955	28,484	36,933	43,153	44,927	48,092	51,642	56,732	52,626	45,411
Actual amount of 1960 disposable income	32,246	35,795	37,857	42,800	46,209	53,026	54,323	56,917	50,219
1965 disposable income estimate based on 1955	—	39,543	52,087	61,184	63,743	68,471	72,151	67,763	57,798
Actual amount of 1965 disposable income	—	47,407	51,981	58,047	62,577	65,033	71,272	72,292	60,223
1970 disposable income estimate based on 1955	—	—	56,500	73,230	85,214	89,511	94,245	85,554	74,167
Actual amount of 1970 disposable income	—	—	68,847	76,799	86,087	92,495	94,317	88,411	78,583
1960 expenditure estimate based on 1955	29,095	32,735	37,200	39,422	41,776	45,408	48,737	46,064	40,914
Actual amount of 1960 expenditure	30,015	32,154	34,918	38,666	41,648	47,611	49,776	54,105	47,795
1965 expenditure estimate based on 1955	—	36,630	43,621	50,348	52,824	57,065	59,217	57,033	49,549
Actual amount of 1965 expenditure	—	39,517	42,734	47,506	51,673	55,039	58,791	58,192	52,614
1970 expenditure estimate based on 1955	—	—	48,812	59,038	67,463	72,153	74,419	69,587	61,348
Actual amount of 1970 expenditure	—	—	56,077	61,350	66,964	74,067	72,293	70,532	64,752

by setting data in each one over and over again.

Nevertheless, another problem still remains. It is the problem of the stability of the coefficient, α . In the following paragraph, let us explain how we arrive at α . We are able to get y_{t+5} in [5-4] by the formula [5-1] (i. e. $y_{t+5} = c_{at+5}/Mc_a y$). Then we must calculate c_{t+5} in [5-3]. Here the following relation is derived from both age effects and economic growth effects :

$$[5-5] \quad c_{t+5} = c_{at+5} + c_{gt+5}$$

But c_{gt+5} can be calculated because :

$$[5-2] \quad c_{gt+5} = y_{t+5} \cdot Mc_g y$$

So we must obtain c_{at+5} . Therefore we cannot help introducing an assumption that a certain percentage of expenditure 5 years from an age point is caused by the influence of age on expenditure. This is expressed as the following relation :

$$[5-6] \quad c_{at+5} = \alpha C_t$$

The values of α were calculated from this relation but its dynamic stability was not always observed. However α of each age group was comparatively stable and their values indicated the most noticeable differences among different age groups.

Thus, if we assume that the value of α for each age group is stable, and each α of a different age group is different, then c_{at+5} for each age group can be deduced by the definition [5-6]. From these considerations we can establish a forecasting system by introducing the relations [5-1], [5-2] and [5-6] in [5-3] and [5-4]. Thus, the results of previous analysis are: the coefficients in Table 1 and the interpolations in Table 2. In calculating, we will use the average of 9's values of each coefficient observed in the same age group. Table 3.

The interpolations mean that each estimate of expenditure and disposable income in 1955, 1960, 1965 and 1970 can be compared to the actual data of the each same year in Table 4.

Judging from Table 4, there are few differences between the estimates and the actual data. Therefore, we can conclude that our forecasting system might greatly improve expenditure of disposable income.

6. CONCLUSIONS

It cannot be denied that this cohort analysis is limited, for instance, by insufficient theoretical considerations of the social and economic structures of Japan. It is further hampered by the data of F. I. E. S.

Prospective problems in forming the theory of household consumption behavior may be summarized as follows :

1. We must approach household behavior from the inter-disciplinary view as well as from the economic and sociological one.

2. How to describe households' utility is an important problem in making the pure theory, for example, aggregation of members of household, comparison among households' utility, etc.

3. Moreover, we have also the problem of how to relate economic variables which compose our definitions.

4. We must establish life stages of households in economics in addition to those in sociology as F. Modigliani and R. Brumberg say in [7].

5. The Dynamic relationship between living environment and household behavior must be clarified.

6. Increased adjustment of data and further research on the forecasting method are absolutely necessary for the analysis in future.

[7] Modigliani, F. and Brumberg, R., "Utility Analysis and the Consumption Function, An Interpretation of Cross Section Data", in K. K. Kurihara (ed.), *Post Keynesian Economics*, 1954.