HOKKAIDO UNIVERSITY

Title	Income Expectations in Japan
Author(s)	KATO, Akira
Citation	HOKUDAI ECONOMIC PAPERS, 15, 149-174
Issue Date	1985
Doc URL	https://hdl.handle.net/2115/30724
Type	departmental bulletin paper
File Information	15_P149-174.pdf

Hokkaido University Collection of Scholarly and Academic Papers : HUSCAP

Income Expectations in Japan *

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1. INTRODUCTION

The aim of this study is to statistically test how expectations of income are formed according to the different ways in which hypotheses are formed. Expectations of average real disposable income growth rates for individual household in Japan were examined. Tests were conducted over a seven year period from 1977-1984. This includes the stagflation period from 1978-1981.

Extensive testing has been conducted on expected inflation rates by many researchers. However, testing on expected income has never been conducted before.

It has been impossible to test the ways in which hypotheses of expected income have been formed because the variable of expected income is unobservable. This also applies to the variable of expected inflation rates. However, I feel that this is important and, therefore, have included testing on expected income in this paper.

In this study we utilized survey data, which can be divided into two categories. Using inflation rates as an example, one category in quantitative survey data. This

*I would like to express my gratitude to Professor Kobayashi and Assistant Professor Nagata for guiding this study. I am also grateful to Assistant Professor Imaizumi for his suggestions. Of course, I am wholly responsible for any posible errors.
This paper has been translated from Japanese into English. The original version is entitled "Kitaishotoku to sono keiseikasetsu no kentei," *Economic Studies* 34 (December, 1984):374-385.

asks people to answer questions regarding the level of future inflation rates. The second category is qualitative survey data. People are asked whether they anticipate future inflation rates to rise, fall or remain unchanged.

Turnovsky (3) tested the ways in which hypotheses were formed on expected inflation rates in the United States from quantitative survey data. Carlson and Parkin (1) tested it in the United Kingdom by converting qualitative survey data into quantitative survey data. In Japan, Toyoda (4) tested the ways in which hypotheses were formed by converting data using Carlson and Parkin's method. The articles mentioned above were used as the asis for Toyoda's study.

We have taken these studies into consideration and tested how expectations of income for individual household were formed. This was done by converting qualitative survey data[1] into quantitative survey data according to Carlson and Parkin's method.

For this purpose, we used *The Household Consumption Movements* published by the inquiry section of the Japanese Economic Planning Agency as survey data. It researched 27 million households in Japan, excluding single member households and foreign households. From 499 unit divisions of 309 cities, towns, and villages, which were selected by three stage sampling (cities, towns and villages, unit divisions, and households), 5,837 households were sampled.

In section 2 of this report, expectations of income have been obtained by using Carlson and Parkin's method. In section 3, we have tried to conduct F tests on the representative ways in which hypotheses were formed. Two types of adaptive expectation hypotheses, which include

1) The inquiry section of the Japanese Economic Planning Agency, ed., *The Household Consumption Movements*, March, 1983.

income trends are proposed in section 3. By utilizing the results of tests conducted, we have concluded, according to how hypotheses are formed, how expectations of individual household are formed. This is the subject of section 4.

The estimation period is for seven years, or 28 quarters. It begins in the 3rd quarter of 1977 and ends in the 2nd quarter of 1984.

2. EXPECTED INCOME

For data we utilized a section of the book, *The Household Consumption Movements* entitled, "Consumer Consciousness." This survey includes qualitative data in which households are asked to respond to the following question: "Do you think that the conditions of your household will improve over the period of one future year?" In particular, households were asked whether they expect their household conditions to rise, fall, or remain unchanged.[2] The survey was conducted four times a year on the last day of March, June, September, and December. The households surveyed were broken into the following categories: farm households, part-time farm households, working households, households employed by private enterprises, and all other households. However, for this paper we did not distinguish between categories, but rather used the total figure for all of these households.

We have interpreted the term "conditions" to imply "household income" which we define as: average real disposable income growth rates over the period of one future year. We consider the growth rates as the average growth rates over the period of one future year, not as the annual growth rates. This is because the survey

2) See the inquiry section of the Japanese Economic Planning Agency, ed., *The Economic White Paper*, September, 1981, p.395.

questioned households regarding their expectations of household conditions over the period of one future year. Households were not surveyed on their current expectations of household conditions for exactly one year in the future, i.e., what their expectations of their household conditions will be at exactly one year in the future.

We converted the previously metnioned qualitative survey data into quantitative survey data. This was done according to Carlson and Parkin's method.

We assumed that the i-th household possesses the subjective probability distribution, f_t^i , of real disposable income average growth rates over the period of one future year (x_t^i). Each household anticipated whether x_t^i would change in comparison to the current real disposable income growth rates ($\dot{y}_t$). We assume that the "difference liemen" exists and is constant. We have termed it the variable "δ" for every quarter and every household. The results of the survey indicate that household conditions will improve when the subjective probability that the real disposable income average growth rates over the period of one future year (x_t^i) are greater than the "difference liemen" (δ) plus the current real disposable income growth rates ($\dot{y}_t$) is greater than 50 percent. Similarly, when the subjective probability that the real disposable income average growth rates over the period of one future year (x_t^i) are less than the "difference liemen" (δ) minus the current real disposable income growth rates ($\dot{y}_t$) is greater than 50 percent, household responded that conditions would fall. Households responded that income will remain unchanged when it was anticipated that the real disposable income average growth rates for the period of one future year (x_t^i) are the same as the current real disposable income growth rates ($\dot{y}_t$), or in the case that the variance of the subjective probability distribution is large. This analysis is relatively simple. It involves comparing the

size difference between the subjective probability distribution medium, m_t^i, and the quantity $\dot{y}_t - \delta$ or $\dot{y}_t + \delta$. m_t^i is defined as the point at which the probability is 50% that x_t^i is greater than m_t^i and less than m_t^i.[3)]

m_t^i will differ between households because the subjective probability distribution for each household is different. We assume that i=1, 2, 3,..., N, and regard $\{m_t^i\}$ as N samples from a normal distribution which possesses the expected value, ${}_{t+4}\dot{y}_t^e$, and the variance, σ_t^2. We have termed this random variable, m_t.

When the ratio of the number of households that answered that the real disposable income average growth rates would rise (A_t), fall (B_t), and remain unchanged (C_t) is compared individually to the total number of households, at the t-th quater, the following is true because of the law of large numbers if $N \to \infty$:

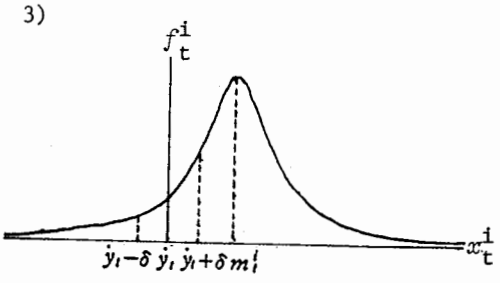
(1) $A_t = P_r(\dot{y}_t + \delta \leq m_t)$
(2) $B_t = P_r(m_t \leq \dot{y}_t - \delta)$
(3) $C_t = P_r(\dot{y}_t - \delta < m_t < \dot{y}_t + \delta)$

"P_r" indicates the probability of each event. If we normalize m_t, $\dot{y}_t + \delta$, and $\dot{y}_t - \delta$ then:

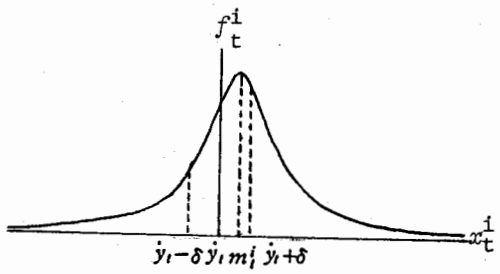
$$(4)\quad Z_t = \frac{m_t - {}_{t+4}\dot{y}_t^e}{\sigma_t}$$

$$(5)\quad a_t = \frac{(\dot{y}_t + \delta) - {}_{t+4}\dot{y}_t}{\sigma_t}$$

3)



"improve"



"remain unchanged"

$$(6)\quad b_t = \frac{(\dot{y}_t - \delta) - {}_{t+4}\dot{y}_t}{\sigma_t}$$

(1) and (2) are indicated as follows:

$$(7)\quad A_t = P_r\,(a_t \leq z_t)$$
$$(8)\quad B_t = P_r\,(z_t \leq b_t)$$

By assumption, the probability distribution of z_t is a standard normal distribution N(0, 1). a_t and b_t were obtained in the survey and can be found in the numerical value table. The reason we use equation (1) and equation (2), and do not use equation (3), is because the summation on both sides of equations (1), (2), and (3) together equal one. In addition, the equations are not independent of each other. Therefore equation (3) is redundant.

If we eliminate the variable, σ_t, from equations (5), and (6) and resolve the equation using ${}_{t+4}\dot{y}^e_t$, then we can obtain the following:

$$(9)\quad {}_{t+4}\dot{y}^e_t = \dot{y}_t - \delta\,\frac{(a_t + b_t)}{(a_t - b_t)}$$

We assume about δ that the expected value of ${}_{t+4}\dot{y}^e_t$ in the estimation period (t=1, ..., T) is equal to the expected value of the average growth rates of real disposable income for the period of one future year in the estimation period.

$$(10)\quad \sum_{t=1}^{T} {}_{t+4}\dot{y}^e_t = \frac{\sum_{t=1}^{T}(\dot{y}_{t+1} + \dot{y}_{t+2} + \dot{y}_{t+3} + \dot{y}_{t+4})}{4}$$

The scale parameter, δ, is calculated by using equations (9) and (10) as follows:

$$(11)\quad \delta = \frac{4\dot{y}_1 + 3\dot{y}_2 + 2\dot{y}_3 + \dot{y}_4 - 4\dot{y}_{r+1} - 3\dot{y}_{r+2} - 2\dot{y}_{r+3} - \dot{y}_{r+4}}{4\sum_{t=1}^{T}\frac{a_t + b_t}{a_t - b_t}}$$

The value of δ for all households was 0.00587. If we substitute this value into equation (9) for δ then we can calculate the value of ${}_{t+4}\dot{y}^e_t$ through a_t, b_t, any $\dot{y}_t$. In other words, the $\{a_t, b_t\}$ series can be obtained through

the $\{A_t, B_t\}$ series, and we can obtain ${}_{t+4}\dot{y}_t^e$ by combining it with the $\{\dot{y}_t\}$ series. Therefore, by using this equation we can define ${}_{t+4}\dot{y}_t^e$ as an individual household's real disposable income average growth rates for the period of one future year (the annual rates). We term, ${}_{t+4}\dot{y}_t^e$, the expected income of a household at t period.

Figure 1 is a plotted graph that shows ${}_{t+4}\dot{y}_t^e$ and the average growth rates of real disposable income during the previous year $\dot{Y}_t$ ($\dot{Y}_t$ is defined as $(\dot{y}_t + \dot{y}_{t-1} + \dot{y}_{t-2} + \dot{y}_{t-3})/4$). We understand that, of course, a time difference exists between the expected value and the actual value for real disposable income. The chart results have taken this time lag into consideration.

The value for real disposable income was obtained by dividing disposable income by the Japanese consumer price index for all commodities. Both disposable income and the consumer price index were obtained from 8 quater moving averages and were adjusted seasonally and quarterly.[4)]

3. TESTS OF THE EXPECTATION HYPOTHESES

I. The Extrapolative Expectation Hypothesis (i)

Expected income of a household at period t, which is formed according to the extrapolative expectation hypothesis, is given in equation (12). We assume that equation (13) is an alternative hypothesis for equation (12).

$$(12)\quad {}_{t+4}\dot{y}_t^e = \dot{Y}_t + \lambda(\dot{Y}_t - \dot{Y}_{t-4}) + \varepsilon_t$$

$$(13)\quad {}_{t+4}\dot{y}_t^e = \alpha_0 + \alpha_1\dot{Y}_t + \alpha_2(\dot{Y}_t - \dot{Y}_{t-4}) + \varepsilon_t'$$

Equation (12) is the estimation equation and ε_t is the

4) The Economic Research Institute of the Japanese Economic Planning Agency, ed., *Annual Report on Natinal Accounts*, March, 1983. The inquiry section of the Japanese Economic Planning Agency, *Annual Report on Business Cycle Indicator*, July, 1981.

error term when constraints exist. When there are not any constraints, equation (13) is the estimation equation and ε_t' is the error term. In other words, we believe that expected income is calculated by using the actual result value, $\dot{Y}_t$, which is modified by its trend in the extrapolative expectation hypothesis (i). This is true even though expected income is linearly calculated by using the actual result value and its trend in the alternative hypothesis. Therefore the null hypothesis, H_0, becomes the following:

$$(14)\quad H_0 : \alpha_0 = 0, \qquad \alpha_1 = 1$$

Although the null hypothesis is tested by the F test, the F test statistics are indicated as follows:

$$F = \frac{(SSR - SSR')/r}{SSR'/f}$$

We assume that SSR indicates the sum of the square residual when there are constraints and that SSR' indicates the sum of the square residual when there are not any constraints. r indicates the number constraints, and f indicates the degree of freedom when there are not any constraints.

The following tests are mostly estimated according to the ordinary least square method (OLS). In the case when the null hypothesis, in which the serial correlation is zero, is rejected by the Durbin and Watson statistics (DW), we obtained the estimated value of the serial correlation by using the Cochrane and Orcutt's iteration method. We did this by assuming that the first order antoregressive process (markov process) is in the error term. But in this case the F test may not be valid. Although the serial correlation coefficient of the estimation for obtaining SSR, ρ, must be equal to the serial correlation coefficient of the estimation equation for obtaining SSR', ρ', this is not generally satisfied.

In that case we must take into consideration the estimated value and the standard error of each serial correlation coefficient. If the estimated values of the serial correlation coefficients are almost equivalent, then the hypothesis is tested as it is, assuming that the theoretical values have already been obtained. On the other hand, if the serial correlation coefficients are vastly different, the hypothesis is tested as it is assuming that the asymptotic F test is used for the F test. In the third case, the hypothesis is reestimated and tested by assuming that the mean of the estimated values of each serial correlation coefficient is equivalent to the theoretical values of both serial correlation coefficients. When the lst cse and the 3rd case are compared, it is easy to see that the validity of the asymptotic F test, used in the second case, is inferior. The equation that constains the constant term is estimated. This equation obtains DW in the case when the constant term is not possessed. In this situation we obtain the alternative R^2. It is indicated as follows:

$$\text{alternative } R^2 = 1 - \frac{{}_{t}\hat{\varepsilon}_t \, \hat{\varepsilon}_t}{{}_{t+4}\dot{y}^{e}_{t} \quad {}_{t+4}\dot{y}^{e}_{t}}$$

where $\hat{\varepsilon}_t$ indicates the residual.

The estimated results of the extrapolative expectation hypothesis (i) can be seen in table 1. DW is equivalent to 0.375 when there are constraints. DW is equivalent to 0.411 when there are not any constraints. $\rho, \rho'=0$ was rejected at the 1% level of significance by the OLS method. As a third case, we have reestimated and tested the hypothesis assuming that $\rho, \rho'=0.759$. This was done because $\hat{\rho}=0.816$ and its standard error was 0.109, $\hat{\rho}'=0.702$ and its standard error was 0.135 according to the iteration. The mark "$\hat{}$" indicates the value has been estimated. According to the estimated results, the F test

statistics were 1.48, the null hypothesis, H, was accepted at the 5% level of significance, and R^2 was good. Therefore we can conclude that the extrapolative expectation formation hypothesis (i) exists.

II. The Extrapolative Expectation Hypothesis (ii)

A second extrapolative expectation hypothesis and its alternative hypothesis are indicated as follows:

$$(15)\quad {}_{t+4}\dot{y}^{e}_{t} = \dot{Y}_t + \lambda_1(\dot{y}_t - \dot{y}_{t-1}) + \lambda_2(\dot{y}_{t-1} - \dot{y}_{t-2}) + \lambda_3(\dot{y}_{t-2} - \dot{y}_{t-3}) + \lambda_4(\dot{y}_{t-3} - \dot{y}_{t-4}) + \varepsilon_t$$

$$(16)\quad {}_{t+4}\dot{y}^{e}_{t} = \beta_0 + \beta_1\dot{Y}_t + \beta_2(\dot{y}_t + \dot{y}_{t-1}) + \beta_3(\dot{y}_{t-1} - \dot{y}_{t-2}) + \beta_4(\dot{y}_{t-2} - \dot{y}_{t-3}) + \beta_5(\dot{y}_{t-3} - \dot{y}_{t-4}) + \varepsilon_t$$

Expectated income is formed by modifying the results of the actual value by the trends from $\dot{y}_t$ to $\dot{y}_{t-3}$ in the extrapolative expectation hypothesis (ii). This is done even though expected income is explained by the actual result value and the linear trends from $\dot{y}_t$ to $\dot{y}_{t+3}$. The null hypothesis becomes the following:

$$(17)\quad H_0: \beta_0 = 0, \qquad \beta_1 = 1$$

DW is equivalent to 0.644 when there are constraints. DW is equivalent to 0.774 when there are not any constraints. $\rho, \rho' = 0$ was rejected at the 1 percent level of significance by the OLS method. We tested the hypothesis as it was, using the asymptotic F test, because $\hat{\rho}$ was equal to 0.991 and its standard error was 0.0251, $\hat{\rho}'$ was equal to 0.668 and its standard error was 0.141 according to the iteration. Consequently the F test statistics were equivalent to 1.66, the null hypothesis, H_0, was accepted at the 5 percent level of significance, and R^2 was very good. ρ_{-1} was equivalent to zero, accepted at the 5 percent level of significance, and the trends from y_t to y_{t-2} were significant at the 1 percent level of significance.

Therefore we can conclude that the extrapolative expectation hypothesis (ii) also exists.

III. THE KOYCK TYPE DISTRIBUTION LAG MODEL

The Koyck type distribution lag model, which is the most representative distribution lag model, is given in the following equation:

$$(18)\quad {}_{t+4}\dot{y}^{e}_{t} = W(L)\dot{Y}_t + U_t$$

$$W(L) = \frac{\lambda}{1 - \{(1 - \lambda)\, L^4\}}$$

$$U_t = \frac{1}{1 - \{(1 - \lambda)L^4\}}\ \varepsilon_t$$

$$0<\lambda<2$$

L represents the lag operator and W(L) represents the lag generating function. Equation (18) can be rewritten as equation (19) by using the Koyck transformation. Inversely, equation (19) is easy rewritten as equation (18) under the assumption that $0<\lambda<2$. Therefore the Koyck type distribution lag model can be expressed by equation (19). We assume that equation (20) is the alternative hypthesis of equation (19).

$$(19)\quad {}_{t+4}\dot{y}^{e}_{t} = {}_{t}\dot{y}^{e}_{t-4} + \lambda(\dot{Y}_t - {}_{t}\dot{y}^{e}_{t-4}) + \varepsilon_t$$

$$0<\lambda<2$$

$$(20)\quad {}_{t+4}\dot{y}^{e}_{t} = \alpha_0 + \alpha_1\, {}_{t}\dot{y}^{e}_{t-4} + \alpha_2\dot{Y}_t + \varepsilon'_t$$

The null hypothesis becomes:

$$(21)\quad H_0:\ \alpha_0 = 0, \qquad \alpha_1 + \alpha_2 = 1$$

Equation (19) is converged under the condition that $0<\lambda<2$. When $0<\lambda<1$ is true, the adaptive expectation hypothesis is widely accepted as the best representation

of the expectation hypothesis. When $\lambda=1$ is true, the Koyck type distribution lag model is called the static expectation hypothesis, and when $1<\lambda<2$ is true, it is called the overreactionary expectation hypothesis.[5] Equation (19) can be rewritten as follows:

$$(22)\quad {}_{t+4}\dot{y}^{e}_{t} = \sum_{i=0}^{\infty}\left[\lambda(1-\lambda)^{i}L^{4i}\dot{Y}_{t}+(1-\lambda)^{i}L^{4i}\varepsilon_{t}\right] \qquad 0<\lambda<2$$

In the case of the adaptive expectation hypothesis, the weight of the non-stochastic part, monotonously and geometrically, converges. In the static expectation hypothesis, the weight of the present period is equal to one and the weights of the past periods are also equal to zero. In the overreactionary expectation hypothesis, $\lambda(1-\lambda)^{i}<0$ is true when i is an old number, $\lambda(1-\lambda)^{i}>0$ is true when i is an even number, and the weight of the non-stochastic part oscillatoryly converges positive and negative.[6]

DW is equal to 0.570 when there are constraints. DW is equal to 0.718 when there are not any constraints. ρ, $\rho'=0$ was rejected at the 5% level of significance by the OLS method.[7] As a second case we tested the hypothesis as it was because $\hat{\rho}$ was equal to 0.784 and its standard error

5) It is written that this naming owes to Prof. L. R. Klien being based on Toyoda (4).

6) The convergence condition of the geometrical series of the non-stochastic part, $\sum_{i=0}^{\infty}\lambda(1-\lambda)^{i}$, becomes $\lambda=0$ or $|(1-\lambda)|<1$, that is, $0\leqq\lambda<2$ ($\sum_{i=0}^{\infty}\lambda(1-\lambda)^{i}=1$) and the convergence condition of the geometrical series of the stochastic part, $\sum_{i=0}^{\infty}(1-\lambda)^{i}$, becomes $|(1-\lambda)|<1$, that is, $0<\lambda<2$. Therefore the convergence condition of the nonstochastic part and the stochastic part becomes $0<\lambda<2$. The convergence condition of the geometrical progression of the nonstochastic part, $\{\lambda(1-\lambda)^{i}\}$ $(\lambda\neq0)$, becomes $-1<(1-\lambda)\leqq 1$, that is, $0<\lambda<2$ and $\lim_{i\to\infty}\lambda(1-\lambda)^{i}=0$ exists. The convergence condition of the geometrical progression of the stochastic part, $\{(1-\lambda)^{i}\}$, becomes $-1<(1-\lambda)\leqq1$, that is, $0\leqq\lambda<2$ and $\lim_{i\to\infty}(1-\lambda)^{i}=1(\lambda=0)$, $\lim_{i\to\infty}(1-\lambda)^{i}=0$ $(0<\lambda<2)$.

7) It is well known that we must utilize Durbin h statistics in the case when the estimated equation possesses one period lag of the dependent variable. But we utilize DW because this study possesses four or five period lag in it.

was 0.117, $\hat{\rho}'$ was equal to 0.520 and its standing error statistics were 1.42, the null hypothesis was accepted at the 5% level of significance, and R^2 was very good.

The estimated value of adjustment coefficient λ was equal to 1.39. If we set the null hypothesis equal to $\lambda=1$, and the alternative hypothesis equal to $\lambda>1$, then the value of t is equal to 3.61 and $\lambda=1$ was rejected at the 5% level of significance by the one tail test. Therefore the overreactionary expectation hypothesis existed and the adaptive expectation hypothesis did not exist. The lag structure of equation (19) oscillatoryly converged positive and negative, but in my opinion this is not a natural occurrence. Therefore we propose two adaptive expectation hypothesis, which includes the trends in this paper.

IV. THE SECOND ORDERED ADAPTIVE EXPECTATION HYPOTHESIS

The second ordered adaptive expectation hypothesis and its alternative hypothesis are given as follows:

$$(23)\quad {}_{t+4}\dot{y}^e_t = {}_t\dot{y}^e_{t-4} + \lambda_1(\dot{Y}_t - {}_t\dot{y}^e_{t-4}) + \lambda_2(\dot{Y}_{t-1} - {}_{t-1}\dot{y}^e_{t-5}) + \varepsilon_t$$

$$(24)\quad {}_{t+4}\dot{y}^e_t = \beta_0 + \beta_1\, {}_t\dot{y}^e_{t-4} + \beta_2\, {}_{t-1}\dot{y}^e_{t-5} + \beta_3\dot{Y}_t + \beta_4\dot{Y}_{t-1} + \varepsilon'_t$$

In the second ordered adaptive expectation hypothesis, we assumed that expected income is modified by the discrepancy of the actual result value in the current period and the actual result value in one minus the current period. Therefore the null hypothesis becomes the following:

$$(25)\quad H_0:\ \beta_0=0, \qquad \beta_1+\beta_3=1, \qquad \beta_2+\beta_4=0$$

DW was equal to 1.48 when there were constraints. DW was equal to 1.69 when there were not any constraints. $\rho, \rho'=0$ fell in the gray region at the 1% level of significance by

the OLS method. As a second case, we tested the hypothesis because $\hat{\rho}$ was equal to 0.77 and its standard error was 0.119. $\hat{\rho}'$ was equal to 0.163 and its standard error was 0.186 according to the iteration. Consequently the F test statistics were equal to 814, and the null hypothesis H was rejected at the 1% level of significance. Therefore we can conclude that the second ordered adpative expectation hypothesis does not exist, even though R^2 was very good.

V. THE RATIONAL EXPECTATION HYPOTHESIS

The rational expectation hypothesis is one of the best representations of the expectation hypotheses. It is indicated as follows:

$$(26)\quad {}_{t+4}\dot{y}_t^e = E(\dot{Y}_{t+4} \mid I_t)$$

$E(\cdot \mid I_t)$ represents the conditional expected value of the Information Set, I_t, at the t period. We assume that ε_t is equal to white noise. The rational expectation hypothesis can be expressed by equation (27). We assume that equation (28) is an alternative hypothesis.

$$(27)\quad \dot{Y}_{t+4} = {}_{t+4}\dot{y}_t^e + \varepsilon_{t+4}$$

$$(28)\quad \dot{Y}_{t+4} = \alpha_0 + \alpha_1\, {}_{t+4}\dot{y}_t^e + \varepsilon'_{t+4}$$

Therefore the null hypothesis becomes the following:

$$(29)\quad H_0: \alpha_0 = 0, \qquad \alpha_1 = 1$$

DW was equal to 0.391 where there were not any constraints. $\rho'=0$ was rejected at the 1% level of significance by the OLS method. As a second case we tested the hypothesis as it was because according to the iteration $\hat{\rho}'$ was equal to 0.713 and its standard error was 0.133 and ε_t was equal to white noise. According to the estimated results, the F test statistics were equal to

56.3 and the null hypothesis H_0 was rejected at the 1% level of significance. Therefore we can conclude that the rational expectation hypothesis does not exist.[8)]

VI. THE ADAPTIVE EXPECTATION HYPOTHESIS, WHICH INCLUDES THE TRENDS (i)[9)]

The overreactionary expectation hypothesis existed and the adaptive expectation hypothesis did not exist. But we must ask whether the lag structure corresponding to equation (19) oscillatoryly converges positive and negative. We assume that expected income is modified not only by the discrepancy between it and the actual result, but that it is also modified by the actual result value trend or the trends from $\dot{y}_t$ to $\dot{y}_{t-3}$.

$$ {}_{t+4}\dot{y}^e_t = {}_t\dot{y}^e_{t-4} + \lambda_1(\dot{Y}_t - {}_t\dot{y}^e_{t-4}) + f(\dot{Y}_t - \dot{Y}_{t-4}) + \varepsilon_t $$

$$ {}_{t+4}\dot{y}^e_t = {}_t\dot{y}^e_{t-4} + \lambda_1(\dot{Y}_t - {}_t\dot{y}^e_{t-4}) + f_1(\dot{y}_t - \dot{y}_{t-1}) + f_2(\dot{y}_{t-1} - \dot{y}_{t-2}) $$

$$ + f_3(\dot{y}_{t-2} - \dot{y}_{t-3}) + f_4(\dot{y}_{t-3} - \dot{y}_{t-4}) + \varepsilon_t $$

Although f or f_1 to f_4 is the general function, we can obtain equation (30) or equation (33) by linearly approximating them.

We propose two adaptive expectation hypothesis, which include the trends presented in this section and in the next section. Equation (30) and its alternative hypothesis are given as follows:

$$ (30) \quad {}_{t+4}\dot{y}^e_t = c + {}_t\dot{y}^e_{t-4} + \lambda_1(\dot{Y}_t - {}_t\dot{y}^e_{t-4}) + \lambda_2(\dot{Y}_t - \dot{Y}^e_{t-4}) + \varepsilon_t $$

$$ (31) \quad {}_{t+4}\dot{y}^e_t = \alpha_0 + \alpha_{1t}\dot{y}^e_{t-4} + \alpha_2\dot{Y}_t + \alpha_3(\dot{Y}_t - \dot{Y}_{t-4}) + \varepsilon'_t $$

Therefore the null hypothesis is as follows:

8) Pesando (2) tested the rational expectation hypothesis about the expected inflation rates by the Chow test.

9) In the followings, I much owed to Assistant Professor Nagata's suggestion.

(32) $H_0 : \alpha_1 + \alpha_2 = 1$

DW is equal to 0.898 where there are constraints. DW is equal to 0.993 where there are not any constraints. ρ, $\rho' = 0$ was rejected at the 1% level of significance by the OLS method. As a third case, we reestimated and tested the hypothesis assuming that ρ, ρ' was equal to 0.489 because $\hat{\rho}$ was equal to 0.558 and its standard error was 0.157. $\hat{\rho}'$ was equal to 0.420 and its standard error was 0.171 according to the interation. The F test statistics were equal to 1.64, the null hypothesis was accepted at the 5% level of significance, and R^2 was very good.

The estimated value of the adjustment coefficient, λ_1, was equal to 1.86. If we set the null hypothesis equal to $\lambda_1 = 1$, and the alternative bypothesis equal to $\lambda_1 > 1$, then the value of t was equal to 6.06 and $\lambda_1 = 1$ was rejected at the 5% level of significance, according to the one tail test. Therefore although the lag structure, which excludes the trend, oscillatoryly converged positive and negative, it was also not a natural occurrence.

VII. THE ADAPTIVE EXPECTATION HYPOTHESIS, WHICH INCLUDES THE TRENDS (ii)

Equation (33) and its alternative hypothesis are given as follows:

$$(33)\quad {}_{t+4}\dot{y}_t^e = c + {}_t\dot{y}_{t-4}^e + \lambda_1(\dot{Y}_t - \dot{y}_{t-4}^e) + \lambda_2(\dot{y}_t - \dot{y}_{t-1}) + \lambda_3(\dot{y}_{t-1} - \dot{y}_{t-2}) + \lambda_4(\dot{y}_{t-2} - \dot{y}_{t-3}) + \lambda_5(\dot{y}_{t-3} - \dot{y}_{t-4}) + \varepsilon_t$$

$$(34)\quad {}_{t+4}\dot{y}_t^e = \beta_0 + \beta_1\, {}_t\dot{y}_{t-4}^e + \beta_2\dot{Y}_t + \beta_3(\dot{y}_t - \dot{y}_{t-1}) + \beta_4(\dot{y}_{t-1} - \dot{y}_{t-2}) + \beta_5(\dot{y}_{t-2} - \dot{y}_{t-3}) + \beta_6(\dot{y}_{t-3} - \dot{y}_{t-4}) + \varepsilon_t'$$

Therefore the null hypothesis becomes as follows:

(35) $H_0 : \beta_1 + \beta_2 = 1$

DW was equal to 0.872 by the OLS method when there were constraints. DW was equal to 1.32 by the OLS method when there were not any constraints. Using the asymptotic F test, we tested the hypothesis as it was because $\hat{\rho}$ was equal to 0.692 and its standard error was 0.136, $\hat{\rho}'$ was equal to 0.388 and its standard error was 1.74 according to the iteration. Consequently the F test statistics were equal to 6.30, the null hypothesis, H_0, was accepted at the 1% level of significance, and R^2 was very good.

The estimated value of the adjustment coefficient, λ_1, was equal to 0.478, and $\lambda_1=1$ was rejected at the 5% level of significance by the one tail test. This is true because if we set the null hypothesis equal to $\lambda_1=1$, and the alternative hypothesis equal to $\lambda_1<1$, then the value of t was equal -3.02. Therefore we obtained a satisfactory conclusion. The lag structure, which excludes trends, was monotonously and geometrically converged.

$\rho_{-1}=0$ was accepted at the 5% level of significance and the values for t of the parameters were all significant at the 1% level of significance. Therefore, we can conclude that the adaptive expectation hypothesis, which includes the trends (ii), exists.

The estimated results of the expectation hypotheses

I. the extrapolative expectation hypothesis (i)

$$(12') \quad {}_{t+4}\dot{y}_t^e = \underset{(0.992)}{\dot{Y}_t + 0.111(\dot{Y}_t - \dot{Y}_{t-4})}$$

alternative $R^2=0.731$ $\quad=0.759$

$DW=0.938$ $\quad SSR=0.00437$

$$(13') \quad {}_{t+4}\dot{y}_t^e = \underset{(1.33)}{0.0215} + \underset{(3.61)}{0.678}\dot{Y}_t + \underset{(1.86)}{0.266}(\dot{Y}_t - \dot{Y}_{t-4})$$

$R^2=0.728$ $\rho'=0.759$
DW=1.11 SSR'=0.00391

II. the extrapolative expectation hypothesis (ii)

$$(15')\quad {}_{t+4}\dot{y}^e_t=\dot{Y}_t+\underset{(51.7)}{0.754}(\dot{y}_t-\dot{y}_{t-1})+\underset{(38.6)}{0.528}(\dot{y}_{t-1}-\dot{y}_{t-2})+\underset{(19.9)}{0.269}(\dot{y}_{t-2}-\dot{y}_{t-3})-\underset{(-0.459)}{0.00648}(\dot{y}_{t-3}-\dot{y}_{t-4})$$

alternative $R^2=0.998$ $\hat{\rho}=0.991(0.0251)$
DW=1.94 SSR=0.0000254

$$(16')\quad {}_{t+4}\dot{y}^e_t=\underset{(-3.31)}{-0.00276}+\underset{(95.8)}{0.987}\dot{Y}_t+\underset{(47.1)}{0.754}(\dot{y}_t-\dot{y}_{t-1})+\underset{(38.1)}{0.536}(\dot{y}_{t-1}-\dot{y}_{t-2})+\underset{(19.5)}{0.276}(\dot{y}_{t-2}-\dot{y}_{t-3})+\underset{(0.391)}{0.00663}(\dot{y}_{t-3}-\dot{y}_{t-4})$$

$R^2=0.998$ $\hat{\rho}'=0.668(0.141)$
DW=1.89 SSR'=0.0000220

III. the Koyck type distribution lag model

$$(19')\quad {}_{t+4}\dot{y}^e_t={}_t\dot{y}^e_{t-4}+\underset{(12.9)}{1.39}(\dot{Y}_t-{}_t\dot{y}^e_{t-4})$$

alternative $R^2=0.965$ $\hat{\rho}=0.784(0.117)$
DW=1.17 SSR=0.00299

$$(20')\quad {}_{t+4}\dot{y}^e_t=\underset{(1.21)}{0.00785}-\underset{(-5.98)}{0.545}\,{}_t\dot{y}^e_{t-4}+\underset{(13.2)}{1.34}\dot{Y}_t$$

$R^2=0.894$ $\hat{\rho}'=0.520(0.161)$
DW=1.25 SSR'=0.00269

IV. the second ordered adaptive expectation hypothesis

$$(23')\quad {}_{t+4}\dot{y}^e_t={}_t\dot{y}^e_{t-4}+\underset{(12.9)}{1.59}(\dot{Y}_t-{}_t\dot{y}^e_{t-4})-\underset{(-2.62)}{0.307}(\dot{Y}_{t-1}-{}_{t-1}\dot{y}^e_{t-5})$$

Alternative $R^2=0.972$ $\hat{\rho}=0.777(0.119)$
DW=1.78 SSR=0.00237

$$(24')\quad {}_{t+4}\dot{y}^e_t=0.00210+1.06\,{}_t\dot{y}^e_{t-4}+0.00145\,{}_{t-1}\dot{y}^e_{t-5}+4.14\dot{Y}_t-4.22\dot{Y}_{t-1}$$
$$(5.15)\quad (25.1)\quad (0.0992)\quad (81.6)\quad (-52.7)$$

$R^2=0.999$ $\hat{\rho}'=0.163(0.186)$
DW=1.85 SSR'=0.0000221

V. the rational expectation hypothesis

(27) SSR=0.0240

$$(28)\quad \dot{Y}_{t+4}=0.0235+0.532\,{}_{t+4}\dot{y}^e_t$$
$$(2.10)\quad (4.47)$$

$R^2=0.614$ $\hat{\rho}'=0.713(0.133)$
DW=0.854 SSR'=0.00451

VI. the adaptive expectation hypothesis, which includes the trends (i)

$$(30)\quad {}_{t+4}\dot{y}^e_t=-0.00871+{}_t\dot{y}^e_{t-4}+1.86(\dot{Y}_t-{}_t\dot{y}^e_{t-4})-0.382(\dot{Y}_t-\dot{Y}_{t-4})$$
$$(-2.43)\quad (13.1)\quad (-3.34)$$

$R^2=0.930$ $\rho=0.489$
DW=1.34 SSR=0.00240

$$(31)\quad {}_{t+4}\dot{y}^e_t=-0.000707-0.810\,{}_t\dot{y}^e_{t-4}+1.70\dot{Y}_t-0.298(\dot{Y}_t-\dot{Y}_{t-4})$$
$$(-0.0984)\quad (-5.62)\quad (9.17)\quad (-2.29)$$

$R^2=0.917$ $\rho'=0.489$
DW=1.43 SSR'=0.00224

VII. the adaptive expectation hypothesis, which includes the trends (ii)

$$(33)\quad {}_{t+4}\dot{y}^e_t=-0.00161+{}_t\dot{y}^e_{t-4}+0.478(\dot{Y}_t-{}_t\dot{y}^e_{t-4})+0.902(\dot{y}_t-\dot{y}_{t-1})$$
$$(-2.08)\quad (2.77)\quad (18.8)$$

$$+0.804(\dot{y}_{t-1}-\dot{y}_{t-2})+0.652(\dot{y}_{t-2}-\dot{y}_{t-3})+0.509(\dot{y}_{t-3}-\dot{y}_{t-4})$$
$$(8.96)\quad (5.19)\quad (2.99)$$

$R^2=0.999$ $\hat{\rho}=0.692(0.136)$
DW=1.94 SSR=0.0000172

$$(34)\quad {}_{t+4}\dot{y}^e_t = \underset{(0.365)}{0.000294} + \underset{(4.53)}{0.659}\,{}_t\dot{y}^e_{t-4} + \underset{(2.19)}{0.321}\dot{Y}_t + \underset{(22.9)}{0.928}(\dot{y}_t - \dot{y}_{t-1}) + \underset{(11.6)}{0.877}(\dot{y}_{t-1}-\dot{y}_{t-2}) + \underset{(7.11)}{0.755}(\dot{y}_{t-2}-\dot{y}_{t-3}) + \underset{(4.61)}{0.660}(\dot{y}_{t-3}-\dot{y}_{t-4})$$

$R^2=0.999$ $\hat{\rho}'=0.388(1.74)$
DW=1.90 SSR'=0.0000132

The numbers inside parenthesis indicates the value of t, R^2 represents the coefficients of determination, alternative R^2 represents the alternative coefficients of determination, $\hat{\rho}$ represents the estimated value when there are constraints, $\hat{\rho}'$ represents the estimated value when there are not any constraints, the numbers inside parenthesis of $\hat{\rho}$ indicates the standard error of $\hat{\rho}$, the numbers inside parenthesis of $\hat{\rho}'$ indicates the standard error of $\hat{\rho}'$, DW represents the Durbin and Watson statistics, SSR represents the sum of the square residual when there are constraints, and SSR' represents the sum of the square residual when there are not any constraints.

4. CONCLUSION

The expectation hypotheses which were accepted by the F test were: the extrapolative expectation hypothesis, the overreactionary expectation hypothesis, and the adaptive expectation hypothesis, which includes the trends.

The adaptive expectation hypothesis, which includes the trend (i), is the nested hypothesis of the extrapolative expectation hypothesis (i) and the over reactionary expectation hypothesis. The adaptive expectation hypothesis, which includes the trends (ii), is the nested hypothesis of the extrapolative expectation

hypothesis (ii). If we assume that the adaptive expectation hypothesis, which includes the trend (i), is the alternative hypothesis of the extrapolative expectation hypothesis (i), then the null hypothesis H_0 becomes $H_0: c=0,\ \lambda_1=1$. According to the estimated results, the F test statistics were equal to 10.3 and the null hypothesis H_0 was rejected at the 1% level of significance. Therefore, we can conclude that the extrapolative expectation hypothesis (i) does not exist. If we assume that the adaptive expectation hypothesis, which includes the trends (ii), is the alternative hypothesis of the extrapolative expectation hypothesis (ii), then the null hypothesis H_0 becomes $H_0: c=0,\ \lambda_1=1$. Consequently, the F test statistics were equal to 5.24 and the null hypothesis was rejected at the 5% level of significance. Therefore, we can conclude that the extrapolative expectation hypothesis (ii) also does not exist. However the F test statistics were equal to 3.07 and the null hypothesis, H_0, was accepted at the 5% level of significance. This was true even though we assumed that the adaptive expectation hypothesis, which includes the trends (i), was the alternative hypothesis of the overreactionary expectation hypothesis. The null hypothesis, H_0, confirms that $c=0$ and $\lambda_2=0$. Therefore, the overreactionary expectation hypothesis still exists. However the lag structure in equation (19) oscillatoryly converges positive and negative. The lag structure, which excludes the trend in equation (30), also oscillatoryly converges positive and negative in adaptive expectation hypothesis (i). The convergion of positive and negative in these situations is not natural because the lag structure monotonously converges. Therefore we have rejected the two expectation hypotheses.

The adaptive expectation hypothesis, which includes the trends (ii), can be rewritten as follows:

$$(36)\quad {}_{t+4}\dot{y}^{e}_{t}=(\frac{\lambda_1}{4}+\lambda_2)y_t+\sum_{i=0}^{\infty}(1-\lambda_1)^i\,[c+(\frac{\lambda_1}{4}-\lambda_2+\lambda_3)L^{1+4i}\dot{y}_t$$
$$+(\frac{\lambda_1}{4}-\lambda_3+\lambda_4)L^{2+4i}\,\dot{y}_t+(\frac{\lambda_1}{4}-\lambda_4+\lambda_5)L^{3+4i}\,\dot{y}_t$$
$$+\{(1-\lambda_1)(\frac{\lambda_1}{4}+\lambda_2)-\lambda_5\}\,L^{4(1+i)}\,\dot{y}_t+\varepsilon_t]$$

L represents the lag operator. If we substitute the estimated values of λ_1 to λ_5 in equation (36), then the weights of the nonstochastic terms, which exclude the constant term, as as follows:

i=0	1.02	i=1	0.0215
i=2	-0.0325	i=3	-0.0235
i=4	0.0242	i=5	-0.0112
i=6	-0.0170	i=7	-0.0123 ...

That is, the estimated values of the weight, which includes the trends in equation (33), is almost equal to 1 in the present period and almost equal to 0 in the past. This is true even though the lag structure, which excludes these trends, monotonously converges.

It is very interesting to derive the true lag structure by estimating the general distribution lag model. However, it is difficult to estimate it by a strong multicolinearity that is peculiar to the time series data. As a second best alternative, we have estimated an Almon type distribution lag model, which possesses a smooth lag structure (the weight is represented by a polynomial equation of comparatively low order about the lag period). We used the Cochrane and Orcutt's iteration method because in case one DW was equal to 1.68 and in case two DW was equal to 1.77 according to the OLS method. The lag period in each case was 21 quarters and 13 quarters respectively.

The estimated results made clear that the value for t of the weight of the current period was very significant in case 1. It was even more significant in case 2 at the

1% level of significance. It also became clear that the estimated value of the weight of the current period was almost equal to 1, and that the estimated value of the weight of the past was almost equal to 0 in both cases.

Therefore it is evident that the lag structure of the Almon type distribution lag model was almost identical as the adaptive expectation hypothesis, which includes the trend(ii).

Therefore, taking into consideration the values for t of the parameters and R^2, we can conclude that the adaptive expectation hypothesis, which includes the trends (ii), is the most valid.

Finally, we can consider the relation between permanent income and expected income as an unsolved problem. It is a task for the future.

Table 2 The estimated results of the Almon type distribution lag model

1. Case 1

The estimation period: from the third quarter in '77 to the second quarter in '84

The lag period: 21 quarters

The constraint: six ordered polynomial

$$\dot{y}^e_{t+4} = \sum_{i=0}^{20} \alpha_i \dot{y}_{t-i} + \varepsilon_t$$

R^2=0.999 $\hat{\rho}$ =0.147 DW=1.84

α_0=0.839(34.5)	α_{11}=-0.0228(-2.01)
α_1=0.248(26.1)	α_{12}=-0.0203(-1.31)
α_2=-0.00441(-0.342)	α_{13}=-0.00810(-0.416)
α_3=-0.0720(-9.08)	α_{14}=0.00771(0.322)
α_4=-0.0554(-12.1)	α_{15}=0.0185(0.621)
α_5=-0.0160(-2.50)	α_{16}=0.0162(0.441)
α_6=0.0148(2.31)	α_{17}=-0.00216(-0.0497)
α_7=0.0260(7.28)	α_{18}=-0.0278(-0.547)

α_8 =0.0191(5.82) α_{19} =-0.0339(-0.547)
α_9 =0.00251(0.521) α_{20} =0.357(0.527)
α_{10} =-0.0140(-1.90)

2. Case 2

The estimation period: from the third quarter in '77 to the second quarter in '84

The lag period: 13 quarters

The constraint: six ordered polynomial

$$\dot{y}^e_{t+4} = \sum_{i=0}^{12} \beta_i \dot{y}_{t-i} + \mu_t$$

R^2=0.999 ρ =0.329 DW=1.85
β_0=0.980(52.0) β_7=-0.0232(-1.26)
β_1=0.0952(4.98) β_8=-0.00458(-0.182)
β_2=-0.0731(-7.59) β_9=0.0200(0.608)
β_3=-0.0274(-2.97) β_{10}=0.0134(0.321)
β_4=0.0172(2.56) β_{11}=-0.0302(-0.648)
β_5=0.0128(2.18) β_{12}=-0.00942(-0.182)
β_6=-0.0133(-1.22)

The figures inside the parenthesis indicate the value for t of the parameter.

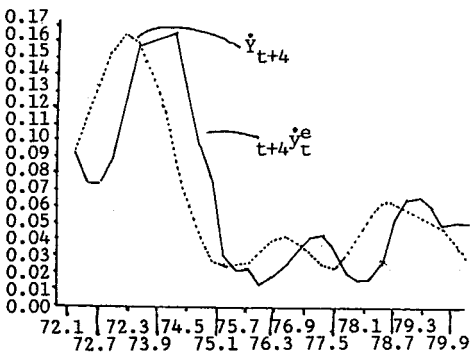


Figure 1 $_{t+4}\dot{y}^e_t$ and $\dot{y}_{t+4}$

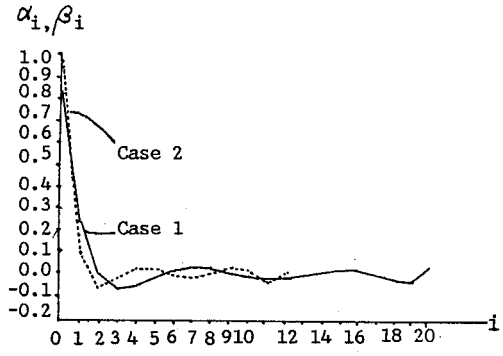


Figure 2 The lag structure of the Almon type distribution lag model

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