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A GUIDE TO JAPANESE DATA FOR INVESTMENT BEHAVIOR ANALYSIS—WITH PRELIMINARY RESULTS FOR THE CHEMICAL INDUSTRY

BY CHARLES TAIT RATCLIFFE

1. INTRODUCTION

Data for the study of investment behavior in postwar Japan are available from a relatively large number of sources, by industry, scale and asset. The major sources of data on investment and related economic variables, as well as information on its content, strengths and weaknesses have not been made available to economists outside of Japan. In this paper we hope to make up for this neglect of the Japanese data by first presenting a test of the Jorgenson investment function using Japanese data for the Chemical industry, and then presenting a discussion of the basic data sources available for the study of investment.

2. THE NEO-CLASSICAL INVESTMENT FUNCTION

Until recently, studies of investment behavior in Japan had been confined to studies of the largest corporations, or to aggregate data for all sectors of the economy.(1) Recent studies of U.S. investment behavior indicate the superiority of analyzing investment behavior using disaggregated data by industry.(2) As a first step in this direction, we have applied Japanese data for the Chemical industry to the Jorgenson neo-classical investment function.

The Jorgenson investment function has appeared in the investment literature, so we need only present a brief outline of the theory here.(3) Reduced to essentials the theory maintains (1) that net investment is a distributed lag function of past changes in the level of optimal capital stock, and (2) that replacement investment is a constant fraction of actual capital stock at the end of the previous period. Stating this in symbols,

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(1) See for example, Hamada Fumimasa, "A Study of Investment Behavior by Industry", Management and Labor Studies, Keio University, August 1964.

(2) Jorgenson, D. W. and Stephenson, J. A., "Investment Behavior in U.S. Manufacturing, 1947–1960. Econometrica, April, 1967, p. 212–215.

(3) For a more detailed account see Jorgenson, D. W. "Anticipations and Investment Behavior", *The Brookings Econometric Model of the United States*, Rand McNally and Co., 1965.

$$IN_t = \sum_{i=1}^{T} \mu_i \Delta K_{t-i}^{+}$$

$$IR_t = \delta K_{t-1}$$

Where IR is replacement investment and IN is net investment. Since gross investment equals net investment plus replacement, we may write,

$$GI_t = \sum_{i=1}^{T} \mu_i \Delta K_{t-i}^{+} + \delta K_{t-1}$$

The level of optimal capital stock is obtained by equating the marginal productivity condition for capital input, where profit is maximized subject to a production function,

$$\frac{\partial Q}{\partial K} = \frac{c}{p}$$

to the partial derivative of the Cobb-Douglas production function, with respect to capital,

$$\frac{\partial Q}{\partial K} = \alpha \frac{Q}{K} = \frac{c}{p}$$

Rewriting the above equation yields,

$$K^{+} = \alpha \frac{pQ}{c}$$

The variable K^{+} is the optimal level of capital stock, and the first difference of the time series K_t^{+} represents the optimal level of investment. The implicit rental of capital services, c, is obtained from the definition for the valuation of capital services. This definition is,

$$q(t) = \int_t^{\infty} e^{-r(s-t)} [(1 - u)c(s)e^{-(s-t)} + uq(t)D(s)]\, ds$$

where u is the rate of taxation, D is the value of depreciation writeoffs, r is the cost of capital and δ is the constant rate of replacement. The term q is the investment goods price index, which measures the after-tax value of return on investment, $(1 - u)c$, discounted at the cost of capital rate, r, and discounted as well at the rate δ, the rate of replacement. The value of investment is fully defined when an adjustment term is added to account for the value of depreciation writeoffs.

Differentiating q with respect to time of acquisition t, and solving for c, we obtain:

$$c = \{q(r + \delta) - \dot{q}\} \left\{ \frac{1 - uz}{1 - u} \right\}$$

Where z is the present value of depreciation writeoffs, defined thus,

$$z = \int_0^{T} D(s)e^{-rs} ds$$

The complete investment function may be stated thus,

$$GI_t = \sum_{i=1}^{T} \mu_i \Delta K^{+}_{t-i} + \delta K_{t-1}$$

This specification requires a large number of lagged values of the change in optimal capital stock to estimate the lag structure in full, therefore in estimation it is more convenient to employ the General Pascal specification Under this specification the coefficients representing the lag structure are assumed to be a rational power series. The series μ_i can then be estimated as the quotient of two other power series, and can be written as,

$$\mu(\theta) = \frac{\gamma(\theta)}{\omega(\theta)} .$$

The expression $\mu(\theta)$ is equal to $\mu_0 + \mu_1\theta + \mu_2\theta^2 + \ldots . + \mu_n\theta^n$ and similarly, $\gamma(\theta) = \gamma_0 + \gamma_1\theta + \gamma_2\theta^2 + \ldots . + \gamma_n\theta^n$

with $$\theta x_t = x_{t-1}$$

The investment function can then be rewritten in the following form:

$$GI_t = \gamma(\theta)\Delta K^{+}_{t-1} - \omega_1 NI_{t-1} - \omega_2 NI_{t-2} - \ldots - \omega_n NI_{t-n} + \delta K_{t-1}$$

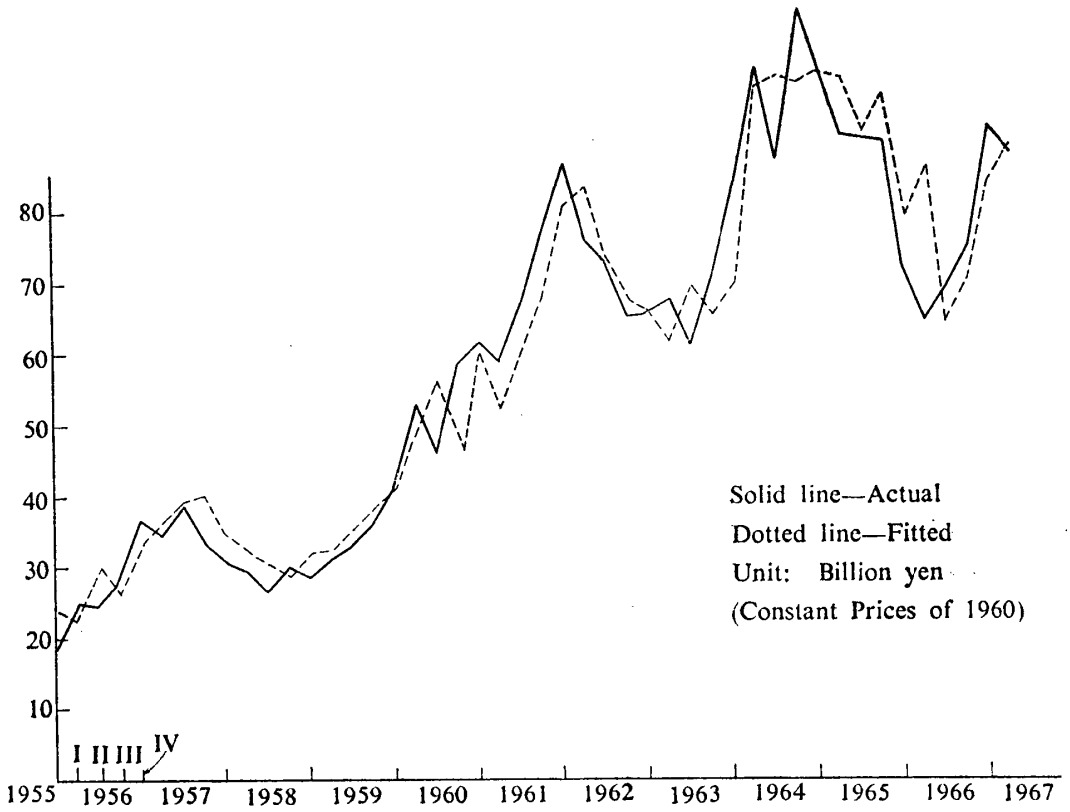
The appropriate set of lagged values of net investment and changes in the optimal level of capital stock was chosen in the following results for the Chemical industry in Japan, by first running a regression with eight lagged values of changes in optimal capital stock and a two-period lag in net investment. Coefficients of lagged terms less than their standard errors were then eliminated and another regression run for the industry.(4)

4. EMPIRICAL RESULTS

In estimating the regression function for the Chemical Industry in Japan, we have made the simplifying assumption that the cost of capital is constant at .03, as a quarterly rate. The tax rate u has been calculated as the ratio of national and local taxes on profits, to profits before taxes. The value of z, the present value of depreciation deductions, has been calculated as a weighted average of ordinary and accelerated depreciation schemes. The average useful lifetimes of equipment were calculated from the *National Wealth Survey of* **1960**. The data on investment, output and other variables covers incorporated enterprises of two million yen ($ 5556 U.S.) or more in invested capital. The smallest incorporated enterprises and unincorporated enterprises are not included in the data.

These preliminary results for the Chemical Industry are favorable to the hypotheses implicit in the Jorgenson investment function. The regression results, along with a graph of the level of actual and fitted investment are given below.

(4) An alternative method would be to try combinations of lagged values of optimal capital stock and pick the regression with the lowest standard error. This method has been employed by Jorgenson-Stephenson.



$$GI_t = \underset{(.00320)}{.00459}\left[\Delta\frac{pQ}{c}\right]_{t-1} + \underset{(.00376)}{.00381}\left[\Delta\frac{pQ}{c}\right]_{t-2} + \underset{(.00377)}{.01214}\left[\Delta\frac{pQ}{c}\right]_{t-3} + \underset{(.09176)}{.73734}NI_{t-1} + \underset{(.00345)}{.03917}K_{t-1}$$

$$R^2 = .9185 \qquad d = 1.93$$

Fig. 1

The quality of the results for the U.S., obtained by Jorgenson and Stephenson, for this industry is almost the same. The U.S. results yield $\bar{R}^2$ of .8930 and Durbin-Watson statistic of 1.96. The high level of significance of the regression parameters strongly supports the two hypotheses concerning the nature of the investment process upon which the investment function is based. First, the theory of net investment as a distributed lag function of past changes in optimal capital stock appears to give a valid account of the determination of net investment and secondly, the coefficient of lagged capital stock is highly significant and does not differ significantly from the independent estimate of the same parameter, thus lending support to the hypothesis that the rate of replacement is a constant fraction of capital stock.(5)

Using the estimated coefficients to calculate the lag pattern in gross and net investment, we find that the response of Japanese firms in the Chemical Industry to investment stimuli is significantly faster than in the United States. For example,

(5) The value of the rate of replacement estimated from capital stock benchmarks is .0423.

the average lag from stimulus to investment completion in the U.S. for this industry is 11.29 quarters, or about two and one-half years. However, in Japan the lag is only slightly more than half that, 6.02 quarters, or one and one-half years. The estimate of the average lag made from the investment function compares well with a survey of completion times made by the Economic Planning Agency for the annual publication, "The Report on Investment by Incorporated Enterprises" in 1959. According to the EPA estimates, the lag to completion is 7.33 quarters.[6]

The lag pattern or time form of lagged response in gross investment is plotted in the following graph. The corresponding pattern for the U.S. Chemical Industry is superimposed on the lag pattern for Japanese industry. As the above observations on the lag to completion suggested, the response to investment stimuli in Japan is much faster than in the U.S. By the time the peak response has been felt in Japan, in the fourth quarter after a change in the desired level of capital services, the U.S. Chemical Industry is only beginning to respond to the investment stimulus.

These results and others indicate that greater rapidity of response to investment stimuli may characterize much of Japanese industry, when compared to the United States.[7] This faster speed of response may be related to the fact that less basic research is necessary in Japan before an investment project can be brought to life. Technologically, Japan is a follower nation, having access to a wide range of production techniques developed elsewhere. Consequently significantly less time and money must be spent upon research. For this reason Japanese firms may be able to set up somewhat longer-range investment plans, with a greater certainty

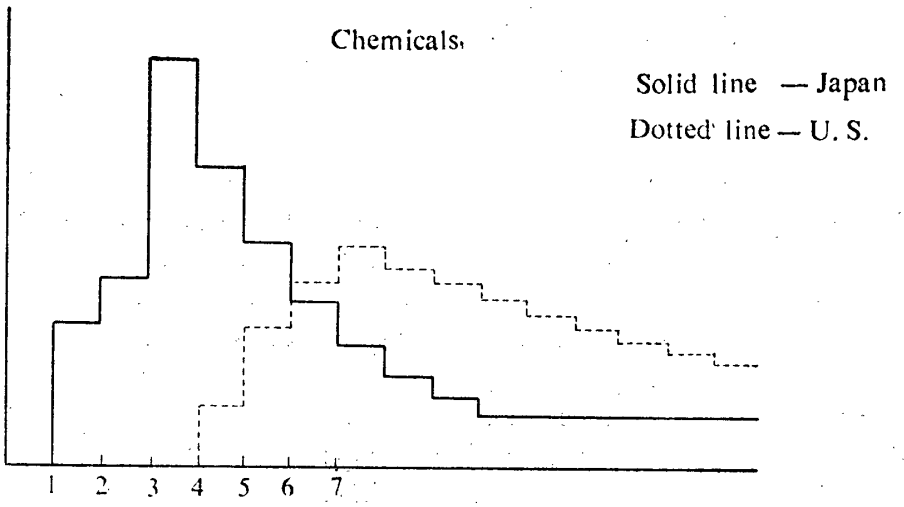


Fig. 2

(6) See Jorgenson and Stephenson, "The Time Structure of Investment Behavior in United States Manufacturing, 1947–1960", The Review of Economics and Statistics, February 1967. See also, Economic Planning Agency, "The Report on Investment by Incorporated Enterprises" (*Hojin Kigyo Toshi Jisseki Chosa Hokoku*), 1959. (1955 to the present)

(7) Preliminary results for other industries indicate most other industries show a significantly faster response speed.

about their profit-making potential, since the same techniques and products have been tried and tested in other countries.[8]

4. MAJOR DATA SOURCES

Having presented a preliminary result using Japanese data, we turn to the task of introducing the major data sources useful in the analysis of investment behavior.

A. Quarterly Data by Industry

The two major sources of aggregate data for incorporated enterprises are "Quarterly Data on Incorporated Enterprises" (*Hojin Kigyo Tokei Kiho*)[9] and "Annual Data on Incorporated Enterprises" (*Hojin Kigyo Tokei Nempo*),[10] both published by the Ministry of Finance. Quarterly data covers incorporated enterprises of more than two million yen in capital, while annual data covers all incorporated enterprises.

The classification by industry in quarterly data and that in annual data are not identical, but the more detailed classification used in the annual data is easily reconciled to that employed in the quarterly data. Using the quarterly and annual data together it is possible to obtain data according to the following industrial breakdown.

01 All Industries
02 Agriculture, Forestry and Fishing
03 Mining
04 Construction
05 Total Manufacturing
06 Foodstuffs
07 Textiles
08 Paper and Pulp
09 Chemical Products
10 Ferrous Metals
11 Non-Ferrous Metals
12 Metal Products
13 Machinery (Excluding Electrical Machinery)
14 Electrical Machinery
15 Transportation Equipment
16 Other Manufacturing (Including Clothing and other finished textile products, Wood Products, Furniture, Printing, Petroleum Products, Coal Products, Rubber Products, Leather Products, Medical and Scientific

(8) This explanation is by no means exhaustive. The content of investment projects, the methods of planning, the methods of financing and many other factors may play a role in bringing about a faster response to investment determinants.

(9) The Ministry of Finance, *Hojin Kigyo Tokei Kiho*, 1950 to the present, data from 1950I to 1963I is published in one volume, *Hojin Kigyo Tokei Kiho Shuran*.

(10) The Ministry of Finance, *Hojin Kigyo Tokei Nempo*, 1951 to the present.

Equipment, Optical Equipment, Clocks, Weaponry)
17 Wholesale and Retail Commerce
18 Wholesale Commerce
19 Retail Commerce
20 Real Estate
21 Public Utilities
22 Transportation and Communication
23 Electricity
24 Gas
25 Services

The above classification contains 25 categories, but only 22 of these are unique, the rest are combinations of the other sub-divisions. The category "Other Manufacturing" is actually one of the largest so far as investment and sales are concerned, due to the inclusion of petroleum products. In this sense the Ministry of Finance classification has suffered from severe growing pains, since it has not been updated to changes in the structure of production in Japan. Separate data on Petroleum Products should have been made available as soon as sales in this industry reached the level prevailing in the Non-Ferrous Metals industry.

The majority of the following data series become available for most of the above classifications, beginning in the first quarter of 1950. All the required series for investment studies become available by the first quarter of 1953 for nearly all the industries listed. The data classification is the following:

Number of Companies

Assets

Cash and Savings
Accounts Receivable (Including Promissory Notes Received)
Inventories
  Finished Goods
  Goods in Process
  Raw Materials
Other Liquid Assets
Total Liquid Assets
Land
Other Tangible Fixed Assets
Construction Account (Construction in Progress)
Intangible Fixed Assets
Investments in Securities
Total Fixed Assets
Deferred Account (Items belonging properly to Assets and Liabilities in other periods)
Total Assets (Including Deferred Account)

Liabilities

Accounts Payable (Including Promissory Notes)

Short-term Loans from Financial Institutions
Other Short-term Liabilities
Total Short-term Liabilities
Bonds
Long-term Loans from Financial Institutions
Other Long-term Liabilities
Total Long-term Liabilities
Total Liabilities

Capital Account

Invested Capital
Revaluation Reserve
Other Reserves
Undisposed Profits from Previous Periods
Profits This Period (Before Taxes)
Total Capital (Including Profits This Period)
Total Capital and Liabilities
Discounted Remainder of Promissory Notes

Profit-Loss

Sales
Manufacturing Costs
Management and Selling Costs
Operating Profits
Non-Operating Revenues
Interest and Discounts Paid
Other Non-Operating Expenses
Net Profit this Period Before Taxes
(Identically the same as "Profits This Period" under Capital Account)

Additions to Capital Stock

Expenditure for New Equipment
Construction Payments
Depreciation
(Note: Construction Payments and Depreciation are both included in Expenditure for New Equipment. If investment in used equipment is zero Expenditure for New Equipment corresponds exactly to Gross Investment. Expenditure for land is included in New Equipment.)

Wages, etc. Wages and Salaries
Payments to Management
Payments to Other Employees
Welfare Expenses
Number of Employees
Management
Other Employees

The Ministry of Finance quarterly data has been criticized for two reasons.

First, the number of companies in the estimation universe has undergone rapid change during the postwar period. However, the quarterly data is prepared under the assumption that the number of companies is fixed during the course of each year. The number of companies in the estimation universe is changed for the April-June quarter of each year. The effect of changing the number of companies only once per year is to produce estimates which drift from the true values during the course of the year. All the effects of growth in the number of companies are concentrated at one point, and the data series become difficult to use as time series. Secondly, Japanese firms have an accounting period of one year or six months; consequently quarterly data is not as reliable as semi-annual or yearly data.

Neither of these objections can be answered in a completely satisfactory way. Undoubtedly some error is present in the data series, due to both of these shortcomings. In the first case however, the change in the number of companies is confined to very small firms, consequently the effect on the data series is probably very small. To correct this first shortcoming, secondary estimates for stock variables are provided for the January-March quarter, based on the new universe size. Distributing the difference between estimates based on the new and the old number of companies over the previous year provides one means of adjusting stock variables. To obtain similar secondary estimates for flow variables, a related stock series is chosen and the secondary estimate for the flow series is calculated as follows:

$$\left[\begin{array}{l}\text{Secondary estimate for flow series, January-March quarter}\end{array}\right] = \left[\begin{array}{l}\text{Primary estimate (based on old number of companies) for flow series. (January-March quarter.)}\end{array}\right] \left[\begin{array}{c}\text{Secondary estimate for related stock series} \\ \hline \text{Primary estimate for related stock series}\end{array}\right]$$

The difference between the primary and secondary estimates for the flow series is then distributed over the previous year. Another method is to calculate an adjustment series from the number of companies, by interpolating the number of companies quarterly, then dividing by the number of companies assumed in the actual estimates (universe size of previous year), to obtain an index of the drift. This drift index can be used in this form, or weighted with an index always equal to one, with the weight assigned to the drift index being that also assigned to firms of, say less than 50 million yen in capital. The resulting index is then multiplied by the data series.

There is no method for correcting for error due to the accounting period of Japanese firms. However if the error is of a systematic nature, such as systematic under-estimation of profits in the third quarter, it can be reduced by seasonal adjustment. It should be noted however that the resulting estimates of "seasonal" bias would no longer indicate a purely seasonal effect, and therefore could not be used to predict the level of investment *cum* seasonal effect.

The Ministry of Finance sources cover only incorporated enterprises. To prepare agregate data including unincorporated enterprises for all the categories takes us beyond the scope of this introductory essay, however aggregate data for Manufacturing industries, Wholesale and Retail Commerce and Services can be

prepared by combining Ministry of Finance data with the "Quarterly Report on Unincorporated Commercial and Manufacturing Enterprises Survey" (*Kojin Shokogyo Keizai Chosa Kiho*)[11] published by the Prime Minister's Statistical Office. The classification by industry in this publication is more detailed than that used in Ministry of Finance quarterly data, but is readily reconcilable with it. Unfortunately the number of data items is much more limited:

Number of Proprietors
Sales
Operating Expenses
  Materials and Merchandise Purchased
  Personnel Expenses
  Other Operating Expenses
Balance Between Income and Expenses
Merchandise Inventory
Profit before Taxes
Expenditure for Equipment and Construction
Number of Employees
Side Income of Proprietors
Total Income of Proprietors

Estimates are given on a per proprietor basis. The number of proprietors has been revised recently in connection with the preparation of new national income statistics. The new estimates should be obtained from this source.

B. Data for the Largest Enterprises and for Individual Corporations

There are four sets of data which deal only with the largest corporations, defined as those companies with more than 100 million yen in capital, or in a more restricted sense as the companies listed on the first and second sections of the Tokyo Stock Exchange. The first of these is "Analysis of Financial Statements of Major Enterprises" (*Shuyo Kigyo Keiei Bunseki*)[12] prepared by the statistics department of the Bank of Japan (1950 to the present). The second source is "Analysis of Statistics on Major Japanese Firms" (*Kigyo Keiei no Bunseki*),[13] published by the Mitsubishi Economic Research Institute from 1928 to the present, omitting only the years 1943 to 1950. The third source of data on the largest corporations is "Analysis of Japanese Firms" (*Waga Kuni Kigyo no Keiei Bunseki*)[14] published by the Ministry of International Trade and Industry since 1955. These three publications give data on a semi-annual basis, according to a more detailed industry and data classification than that given above under the discussion of Ministry of Finance quarterly data. The data classifications are more than adequate for analysis of investment behavior, and the industry classifications can be adjusted to yield at least 22 of the

(11) The Prime Minister's Statistical Office, *Kojin Shokogyo Keizai Chosa Kiho*, circa 1953 to the present.

(12) The Bank of Japan, *Shuyo Kigyo Keiei Bunseki*, 1950 to the present, semi-annual.

(13) The Mitsubishi Economic Research Institute, *Kigyo Keiei no Bunseki.*

(14) The Ministry of International Trade and Industry, *Waga Kuni Kigyo no Keiei Bunseki.*

25 Ministry of Finance classifications.

In contrast to the Ministry of Finance quarterly data, the universe size has not been subject to significant variation. In addition firms have been chosen to minimize the error resulting from the practice of closing accounting periods on varying dates throughout the year. Since data is presented only on a semi-annual basis there is no problem of uncertainty about the true level of sales, profits and other variables which are surveyed.

The fourth set of data is "Corporate Security Reports" (*Yuka Shoken Hokokusho*) which are reports prepared by companies listed on the Tokyo Stock Exchange after the close of each accounting period.[15] These reports are prepared according to an almost standard format and are by far the most detailed firm data available for the Japanese economy. While using the reports can be time-consuming and expensive because of the excessive detail, the data can be compiled into any desired industrial classification and virtually any desired data classification. The Japan Development Bank has compiled most of these reports according to a standard accounting format, but much of the detail of the reports themselves has been lost in the process. This data collection has been placed on magnetic tape, but has not been made available publicly.

Data on the company level is available from the security reports mentioned above and also in the above-mentioned publication by the Mitsubishi Economic Research Institute. The latter collection contains data on more than five hundred firms since 1950. The security reports are available for over one thousand companies.

C. Investment by Type of Asset

Data on the composition of investment, depreciation and capital stock has been prepared by the Economic Planning Agency and published in "Report on Investment by Incorporated Enterprises", (*Hojin Kigyo Toshi Jisseki Tokei Chosa Hokoku*),[16] available after 1955. Investment data for corporations of more than 10 million in capital (accounting for 90 per cent of corporate investment and 70 per cent of private investment) is given according to the following classification:

C1 Buildings
C2 Residential Buildings
C3 Non-Residential Buildings
C4 Structures
C5 Machinery and Equipment
C6 Ships
C7 Metal Construction
C8 All Other Vessels
C9 Aircraft

(15) *Yuka Shoken Hokokusho*, prepared by individual companies published under supervision of the Ministry of Finance.

(16) See footnote six, entry two.

C10 Rolling Stock
C11 Tools, Fixtures, etc.
C12 Improvements to Land
C13 Other Investment

The above data is available according to two divisions by scale, for corporations of more than 10 million yen in capital, and for those with more than 100 million yen in capital. The industrial classification is more detailed than that of Ministry of Finance quarterly data, but is reconcilable to it.

D. Securities

Data series on the prices of securities, dividend rates and new capitalization by company are available in "The Annual Statistical Report" (*Tosho Tokei Nempo*)[17] of the Tokyo Stock Exchange. The industrial classification used in this annual report is somewhat more detailed than that of the Ministry of Finance quarterly data. New issues and the conditions of sale are listed by company. This publication is available from 1952; statistics prior to this data can be obtained from the monthly reports of the Tokyo Stock Exchange.[18]

E. Tax Data

Although it is possible to compute the rate of corporate taxation using the yearly data for incorporated enterprises published by the Ministry of Finance, this computation becomes inaccurate after 1961 when multiple rates were applied to different types of income and different levels of income. For this reason use of "The Annual Statistical Report of the Tax Bureau" (*Kokuzeicho Tokei Nemposho*),[19] which gives the amounts of tax paid as well as profits before taxes, is preferable. This source is also useful for checking the yearly observations for sales. The industrial classification for this data is not as complete as that of the Ministry of Finance quarterly data and is not easily reconcilable. The classification is,

Agriculture-Forestry-Fishing
Mining
Construction
Textiles
Chemical Products (Including Pulp and Paper
Petrochemicals, Rubber, Pottery)
Metal and Machinery
Other Manufacturing (Foodstuffs, Printing)
Wholesale Commerce
Retail Commerce
Real Estate
Transportation and Communication
Services

(17) Tokyo Stock Exchange, *Tosho Tokei Nempo*, 1952 to the present.
(18) Tokyo Stock Exchange, *Tosho Tokei Geppo*.
(19) The National Tax Bureau, *Kokuzeicho Tokei Nemposho*.

Restaurants and Hotels

It is impossible to divide this classification into the twenty-five classifications of Ministry of Finance quarterly data, however the quarterly data can be summed to fit the above classification. Other data included in this publication permit computation of the rate of taxation for unincorporated enterprises, and the effects of income exemptions for certain important products on the effective tax rate.

5. DATA FOR INVESTMENT ANALYSIS

Having presented an outline of the basic data sources available for the study of investment behavior in postwar Japan, we turn to a more detailed consideration of the problems involved in preparing the following data series necessary for investment behavior analysis.

Gross Investment
Capital Stock
Value of Output
The User Cost of Capital

A. Gross Investment

Quarterly data on gross investment for the twenty-five sub-divisions of the Ministry of Finance data can be obtained either directly from published data (for incorporated firms of more than 2 million yen in capital) or can be approximated using ratio-distribution or regression techniques (for all incorporated enterprises). Gross investment data is available or can be prepared according to the previously listed twenty-five sub-divisions, according to three overlapping scale classifications and according to a thirteen item division by asset. The sub-divisions by scale are:

a. The largest 500–600 firms.
b. Total incorporated enterprises.
c. Incorporated and unincorporated enterprises.

The sub-divisions by asset are those listed above under the discussion of investment by asset. This classification is probably too detailed for practical purposes. A sufficiently detailed classification for investigating the effects of depreciation policies on capital formation would be the following:

Residential Buildings
Non-Residential Buildings
Structures
Machinery and Equipment
Other Investment (including Ships, Aircraft Rolling Stock, Tools, Fixtures, Land Improvements, and Other Investment)

The basic source of gross investment data for incorporated enterprises is the Ministry of Finance quarterly data. The accounting scheme for fixed assets used in this set of data deserves comment since it is easily misinterpreted.

The scheme is,

	Land	Other Fixed Assets	Construc-tion Account	Intangible Fixed Assets	Invest-ment in Securities
1. Gross Increase[20]	a_{11}	a_{21}	a_{31}	a_{41}	a_{51}
(New Equipment)	a_{12}	a_{22}	a_{32}	—	—
(Received-Transfers)	a_{13}	a_{23}	a_{33}	a_{43}	a_{53}
2. Gross Decrease	a_{14}	a_{24}	a_{34}	a_{44}	a_{54}
(Depreciation)	a_{15}	a_{25}	a_{35}	a_{45}	a_{55}
(Sold-Losses)	a_{16}	a_{26}	a_{36}	a_{46}	a_{56}

Gross investment on a payments basis is the sum of a_{22} and a_{32}. This definition is acceptable as a general indicator of investment behavior on a payments basis, which of course is the relevant figure for investigating the effects of investment on effective demand. However, a more precise definition would include purchases of used equipment. These estimates are available for the period 1953–1964 from Economic Planning Agency data.[21]

The first step in preparing estimates for gross investment on a quarterly basis for the entire corporate sector is to prepare annual observations on investment in new equipment ($a_{22} + a_{32}$) from Ministry of Finance yearly data. Following the method used in the National Income statistics, annual observations are obtained as follows,[22]

$$I_y = I_g \frac{K_y}{K_g}$$

Where I_g = Quarterly investment summed over the year

I_y = Estimate of yearly level of investment in new equipment for all incorporated enterprises.

K_g = Book value of capital stock at the end of the fourth quarter, according to quarterly data.

K_y = Same for yearly data (Covering all incorporated enterprises).

(20) "New Equipment" is that equipment which has never appeared on the books of any firm in any industry prior to this quarter. "New Equipment" in the Construction Account means payments for construction in progress. "Received-Transfers" includes purchases of used equipment and transfers from the Construction Account, after completion. Note that the item Gross Increase viewed as a time series, involves double counting of construction, once when payment is made and once upon completion. Note also that "New Equipment" plus net purchases of used equipment is equivalent to gross investment. Because of (1) double counting of construction, (2) the writing up and down of the value of assets, and (3) an unexplained error in reporting, the net increase in capital stock, calculated as Gross Increase less Gross Decrease almost never agrees with the first difference of the individual series Land Other Fixed Assets, etc. A thorough explanation of this discrepancy should be made by the Ministry of Finance. This discrepancy does not affect the reliability of the gross investment data, defined as the text.

(21) Economic Planning Agency, *Keizai Bunseki* (Economic Analyses), Issue 17, March 1966, "The Estimation of Capital Stock—Private Enterprises, 1952–1964", p. 59–95.

(22) Economic Planning Agency, "National Income Statistics" (*Kokumin Shotoku Tokei*), 1966, Statistical Appendix.

Having obtained annual figures for the level of investment in new equipment, we then add the estimates of used equipment purchases to these figures.
Having obtained the necessary annual data, these observations can be distributed quarterly using a ratio-distribution method or regression. The yearly observations from 1953 to 1964 for gross investment prepared acccording to the above scheme are already available in the Economic Planning Agency capital stock estimates.[23]

Estimates of gross investment for the period 1953–1964 are also available for the unincorporated sector from the same source. The EPA estimates are based on the latest revised statistics prepared for the National Income Statistics. These estimates differ from those obtainable from the quarterly survey of unincorporated business because new estimates of the level of construction and the number of proprietors have been used in the latest estimates. The annual data can be distributed using the quarterly figures from the survey of unincorporated business.

Estimates of capital formation by the largest firms can be obtained from the Bank of Japan publication "Analysis of Financial Statements of Major Enterprises".[24] Having obtained investment by industry and scale, the remaining problem is to divide the investment series into investment by type of asset.

Utilizing the Economic Planning Agency data on composition of investment,[25] we can obtain estimates of investment by asset for (1) enterprises of more than 100 million yen in capital and (2) for enterprises of more than 10 million yen in capital. The first set of data can be used to obtain yearly observations on percentage composition of investment. After interpolating the yearly observations quarterly, the previously described investment series by industry and scale can be separated into investment by asset. For the largest enterprises application of (1) should give accurate estimates of investment by asset. Application of (2) to all incorporated enterprises and to incorporated and unincorporated enterprises combined involves the assumption in the first instance that the composition of the remaining 10% of corporate investment is identical with that of the firms having more than 10 million in capital. In the second instance, we must assume that the remaining 30 per cent of private investment has the same composition.

B. Capital Stock

Given data on investment, benchmarks for capital stock from the *National Wealth Survey of* **1960**[26] and estimates of the rate of replacement from the same source, we can compute a capital stock series from each of the investment series. Although there are a number of methods of calculating capital stock, the method utilized by Jorgenson and Hall appears to be the most straightforward.[27] This method consists of applying estimates of the rate of replacement (a constant) along

(23) See work cited in footnote 21, p. 80–81.
(24) See footnote 12.
(25) See footnote 6, entry 2.
(26) Economic Planning Agency, *Showa 30-Nen Kokufu Chosa.*
(27) and Hall, R. E. Jorgenson, D. W., "Tax Policy and Investment Behavior", American Economic Review, June 1967.

with investment in constant prices, and a capital stock benchmark to the following expression,

$$K_{t+1} = I_t + (1 - \delta)K_t$$

Iterative computation forward from the benchmark yields the desired capital stock series in constant prices. The resulting series by industry, scale and asset can be summed across industries by asset for the analysis of the effects of depreciation policy.

The authors of the EPA capital stock estimates have pointed out the need to convert investment on payments basis to an installment basis before estimation of capital stock.[28] The formula which they have employed for this conversion is the following,

$$I_I = I_P \times \left[1.0 - \frac{\left\{ \begin{matrix} a_{31} \\ \text{Gross Increase in Contruction Account} \end{matrix} \right\} - \left\{ \begin{matrix} \text{Gross Decrease} \\ a_{33} \end{matrix} \right\}}{\left\{ \begin{matrix} \text{Gross Investment in New Equipment} \\ a_{22}+a_{32} \end{matrix} \right\}} \right]$$

I_I Investment on an installment basis

I_P Investment on a payments basis

It is not clear that conversion to an installment basis for computation of capital stock will necessarily give better results in the study of investment behavior, however theoretically the installment basis definition is preferable, since installed capital stock is the proper value of K to use in the computation of δK, the value of actual depreciation.

C. The Value of Output

The value of Output can be measured as sales plus the change in inventories or as the sum of payments to the factors of production (gross value added at factor cosı). The latter definition is the sum of payments to labor, profits and depreciation. The saleç inventory definition is easily obtained from the data on the incorporated and unincorporated sectors which we have discussed above (Section 4-A). The gross value added measure can be obtained with out difficulty for the incorporated sector, howeve estimates of depreciation for the unincorporated sector are lacking. Data on deprecation for this sector can be computed by multiplying the proper capital stock series by rate of tax depreciation for the incorporated sector.[29]

Given estimates of depreciatio for the unincorporated sector, the necessary data for either the sales-inventory or the gross value added definitions are available by industry and scale. The choice of the appropriate definition for use in investment behavior is not an easy one, since wage payments are supplemented to an indeterminate extent by fringe benefits. For this reason we have employed the sales-

(28) See footnote 21, pp. 67–68

(29) Another possibility is to construct a capital stock series based on book value of assets and use the variable rate of depreciation calculated from corporate data on depreciation and capital stock.

inventory definition in the estimate for the Chemical.

D. The User Cost of Capital

The user cost of capital requires estimates of the following-data:

Price Index for Capital Goods
The Cost of Capital
The Rate of Replacement
The Rate of Direct Taxation
The Present Value of Depreciation Deductions

The preparation of price indices is complicated by the fact that the categorization of capital goods is not reconcilable with the classification according to which price indexes are prepared. Given the composition of the capital goods categories by commodities and by industry, weighted average price indexes could be prepared by asset category, but since this data is not available we must resort to the use of only two indexes, the price index for construction materials and the price index for all other investment goods. When estimation is made by industry, weights appropriate to the two indexes can be derived from EPA data on composition of investment ("Survey of Investment by Incorporated Enterprises").(30) When estimating investment by asset the index of construction materials is appropriate to Buildings and Structures, while the index for other capital goods is applicable to the remaining capital goods classifications. After 1957 estimates of the composition of investment for enterprises of more than 100 million yen in capital are available separately, consequently it is possible to obtain some differentiation by scale in the price indices for capital goods.

The cost of capital should be calculated as the weighted average of the rates of return on borrowed funds and equity. The rate of interest on borrowed funds, including bank loans of short and long term, corporate bonds, and discounted promissory notes is easily calculated for the corporate sector from Ministry of finance quarterly data. However since interest and discount payments are available only as a lump sum, the rates of return on these three debt instruments cannot be calculated independently. Data by industry on the cost of equity capital is available from the Annual Statistical Report of the Tokyo Stock exchange,(31) however data on dividends, profits and the face (original sale) value of stock is obtainable from Ministry of Finance quarterly data.(32) The simple stock price average is available from Tokyo stock exchange data, and has been calculated in the following way:

$$\left[\begin{array}{c}\text{Face Value}\\ \text{per Share}\end{array}\right] \times \frac{\text{Market value of shares}}{\text{Face value of shares}} = \frac{M_t N_t}{F N_t} \times F = M_t$$

In calculating this average price per share the face value is understood to be 50 yen.

(30) See footnote 6, entry two.

(31) See footnote 16.

(32) The item "Invested Capital" is equal to the number of shares times their face value. The average face value of outstanding stock (not all issues are sold at 50 yen) can be calculated from "Distribution Data on Securities" published by the Ministry of Finance, (*Kabushiki Bumpu* "Gakumen Betsu Kabusu".

Dividing this market value index again by 50 yen gives the ratio of market to face value. Multiplying this ratio by the Ministry of Finance data on the total value of equity per industry, measured at face value (Invested Capital) yields a measure of the market value of outstanding issues. Using Tokyo stock exchange data, a separate index for companies issuing new shares can also be calculated to complete the measure of the capital gains term.

The same calculation can be made for the Tokyo stock exchange alone, without including shares traded on other exchanges or unlisted shares. Such an index would be applicable to firms of 100 million yen or more in capital.

The calculation of the cost of capital for the combined corporate and non-corporate sectors involves an increase in the weight on financing instruments other than equity, since unincorporated firms do not issue stock. Very little information is available on the rate of interest charged unincorporated firms, however the annual data for the rate of interest on borrowed funds calculable from Ministry of Finance data for the smallest firms (less than five million yen in capital) should be approximately the same as that charged to unincorporated businesses. This annual rate of interest can be calculated on a quarterly basis after distribution of the denominator and numerator series using quarterly data for all incorporated enterprises. Although interest rates on borrowed funds may differ across firm sizes to some extent, due to their belonging to different risk classes, the movement of interest rates probably does not differ widely. Consequently we are justified in using the other series to distribute the annual values, since this affects only the movement of the rate of interest not its level. The proper weight for borrowed funds can be approximated roughly by calculating the weight using Bank of Japan data on total outstanding loans for the industry.(33) This approximation includes promissory notes outstanding.

The practice of requiring firms to deposit a portion of loans in time savings raises the effective interest rate. Work on the estimation of the exact proportion of loans which must be deposited in time savings is presently in progress. For large firms the proportion is thought to be between ten and twenty per cent on average. For all firms as a group the proportion may run up to twenty-five or thirty per cent. At any rate, the estimate of the portion of the nominal value of loans deposited in time savings must be subtracted from the total value of the firm's debt. Similarly the after-tax interest received on time savings must also be subtracted from interest payments to arrive at the proper measure of the cost of capital.

The rate of replacement of capital stock is identical with the rate used in the capital stock estimation. This rate can be calculated as the inverse of the average lifetime calculated from the "National Wealth Survey of 1960", by industry, by asset and by scale.

The rate of corporate taxation can be calculated from data described in Section

(33) Bank of Japan "Economic Statistics Annual", *Hompo Keizai Tokei.* "Total Outstanding Loans by Industry".

4–E. The necessary data series for the computation of the present value of depreciation deductions are the rate of discount, which we have discussed above under the cost of capital, and the average lifetimes of equipment. Average lifetimes for equipment can be computed from the *National Wealth Survey of* **1960** by asset, industry and scale. The figures calculated from this data are applicable to the period 1951–1961. In 1961 lifetimes for all assets except Buildings and Structures were shortened by 20 per cent on average. A second reduction of 15 per cent was made in 1964. Lifetimes for Buildings and Structures were shortened in 1966. The values of avarage lifetimes computed from the National Wealth Survey can be shortened accordingly, and the present value of depreciation deductions calculated using these shorter lifetimes.

6. CONCLUSION

While the data survey which we have presented is not exhaustive, analysis of the data which we have discussed would be a significant contribution to the study of investment behavior, and would most likely yield important conclusions concerning the postwar recovery of the Japanese economy.