CAPITAL STOCK IN JAPAN, 1878–1940*

By Shigeru Ishiwata

Introduction

The main purpose of this paper is to discuss the method of estimation of capital stock. The full utilization of the results of estimation for further extended analyses should be done in another paper. Among various economic series, capital stock series is one of the most difficult ones to be obtained in many countries. The difficulties are derived from many unsolved problems in measuring capital stock: such as, (i) what kind of valuation method is to be taken; (ii) what kind of depreciation method is to be assumed; (iii) how to deal with natural disaster reconstruction, major and minor alterations, additions, or repairs; (iv) what is capital consumption and how to measure it; and so on. Therefore, our estimates are one of many possibilities.

The limitations of available basic data have hindered our usage of consistent method of estimation, such as Perpetual Inventory Method firstly advocated by Goldsmith. The lack of enough information on capital in Japan during and soon after World War II has made measurment of capital stock, both in the pre-and post-war periods, with consistent methods impossible. Inventories are

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excluded from our estimation only due to the lack of informations. Sectoral sub-division of capital stock is also a problem for future attempts.

Our analysis attempted here is done primarily for the purpose of fact finding. We have no space to discuss Fei=Ranis' estimates of capital stock in Japan and their thesis of "capital shallowing."[1] but our findings denote that Japan had never experienced so called "capital shallowing" either in the pre-war period or in the post-war period[2].

In Section I, our findings on trends of total capital stock itself and on the relationship of capital stock to output and labor are summerized. Sections II and III are devoted to the explanation of the methods of estimation of capital stock. Section II presents a brief outline of the methods and their related problems. In Section III the estimation methods by type of capital goods are discussed in great detail.

I. Trends in Capital Stock, 1880~1939

A. Trends in Total Capital Stock

(1) Rate of Growth in Gross and Net Capital Stocks.

This section deals with the long-term trends in total capital stock. The relevant date are show in Table 1. The averages in Table 1 are geometric means. The problem of inclusion or exclusion of livestock & poultry and trees is debatable, so we shall discess the two cases here.

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(1) Cf., John C.H. Fei and Gustav Ranis, "Innovation Capital Accumulation and Economic Development,"*American Economic Review*, June 1963, LIII (3), 284—313; E. P. Reubens, "Capital-Labor Ratios in Theory and History: Comment," *American Economic Review*, December 1964, LIV (6), 1052—62; and John C.H.Fei and Gustav Ranis' "Reply" to Reubens, "Capital-Labor Ratios in Theory and in History: Comment," "*American Economic Review*, December 1964, LIV (6), 1063—68.

(2) In the dissertation, sectoral sub-division of capital stock was done on the basis of less reliable informations. The Economic Planning Agency's estimates in the post-war period showed an accelerated capital-deepening tendency.

Table 1

Rate of Growth of Gross and Net Capital Stock in Japan, in 1930 Prices, 1880—1939

(Amounts in million yers, in yearly averages)

Period	Gross Capital Stock			Net Capital Stock		
	Sectoral Total (1)	Roads Harbors Riparians (2)	Total (3)	Sectoral Total (4)	Roads Harbors Riparians (5)	Total (6)
Volumes						
Total						
1. 1880—1899	11,646	1,104	12,750			
2. 1900—1919	15,578	2,172	17,750			
3. 1920—1939	29,746	4,635	34,381			
Total, excluding livestock & poultry and trees						
4. 1880—1899	5,284	1,104	6,388	3,729	680	4,409
5. 1900—1919	9,670	2,172	11,842	6,703	1,358	8,151
6. 1920—1939	23,400	4,635	28,035	15,392	3,076	18,468
Percentage Rate of Growth, Total Period						
Total						
7. Line 1 to line 3	2.37	3.65	2.51			
Total, excluding livestock & poultry and trees						
8. Line 4 to line 6	3.79	3.65	3.77	3.61	3.85	3.65
Percentage Rate of Growth, Subperiods						
Total						
9. Line 1 to line 2	1.46	3.44	1.67			
10. Line 2 to line 3	3.29	3.86	3.36			
Total, excluding livestock & poultry and trees						
11. Line 4 to line 5	3.07	3.44	3.13	3.04	3.52	3.12
12. Line 5 to line 6	4.52	3.86	4.40	4.18	4.17	4.18

The findings fromTable 1 can be summarized as follows:

(i) The annual volume of capital stock increased remarkably. From 1880—1899 to 1920—1939, it rose by about 2.5 times in gross capital stock including livestock & poultry and trees; it rose by more than 3.3 times in gross and net capital stocks excluding the above two items.

(ii) Comparing Lines 9 with 10, we notice that the rate of growth of capital stock excluding the two items was more than twice as high as the one including them, while the rate of growth of roads, harbors and riparians was almost the same between the two subperiods. This finding denotes that the share of livestock & poultry and trees in the total capital stock was less dominant in the latter subperiod (1920—1939) than in the former (1880—1899). This shows that livestock & poultry and trees had a low rate of secular growth.

(iii) In the case of total capital stock excluding the two items, the discrepancy of the growth rates between the two subperiods was rather small.

(2) Relation of Capital Stock to Output and Labor

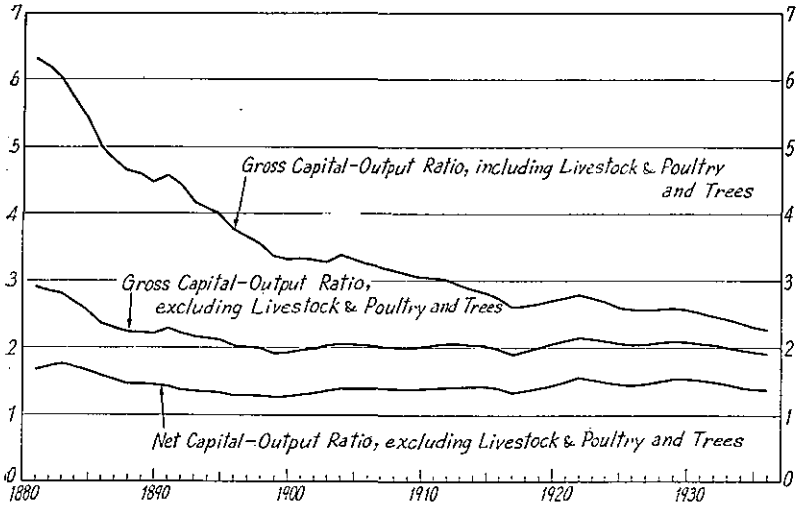
In growth economics, capital-output ratios and capital-labor ratios play important roles as strategic variables for economic growth. They are sometimes counted among the"great ratios"of economics(1).

First, we will discuss the capital-output ratio. The relevant data of the ratio are presented in Chart 1. Three kinds of ratio are shown gross capital-output ratio including livestock & poultry and trees, gross and net capital-output ratios excluding the two items. The former one and the latter two have different secular trends. A decreasing trend can be seen in the gross capital-output ratio including livestock & poultry and trees, while the gross and net capital-output ratios excluding the two items remain on the

(1) Cf., L.R. Klein and R.F. Kosobud, "Some Econometrics of Growth: Great Ratios of Economics," *Quarterly Journal of Ecomics*, May 1961, LXXV (2), 173—198.

CHART 1.

Gross and Net Averagc Capitsl-Output Ratios, in 1930 Prices, 1881~1936.



same level except for the period before 1890. The levels of the two ratios are 2.0 in gross terms and 1.5 in net terms, which are rather low as compared with the ratios of other countries. For the Unieed States, Kuznets' data show that the ratio has a significant downward trend from 3.99 in 1900 to 3.31 in 1939 in net terms; for Norway, Aukrust and Bjerke's data show that the ratio also has a downward trend from 4,07 in 1900 to 3,53 in 1939 in net terms. In gross terms Kuznets calculated the ratios 5.3 for 1869~1878 and 5.4 for 1939—1948 under the U. S. Department of Commerce's concept of national product(1). Leaving data problems aside, the low levels of capital-output ratios, both in gross and in

(1) Annual caluation of capital-output ratio in U. S. is in L.R. Klein and R.F. Kosobud, *op.cit.*, 179—180. For Norway, see Odd Aukrust and Juul Bjerke, "Real Capital and Ecomic Growth in Norway 1900—56," *The Measurement of National Wealth*, Income and Wealth Series VIII, London: Bowes & Bowes, 1959.80—118. For Kuznets' calculation, see, S. Kuznets, *Capital in the American Economy: Its Formation and Financing:* National Bureau of Economic Research Princeton University Press, 1961. 80—81.

net terms, in the Japanese economy before World War II need further explanations before they can be fully accepted.

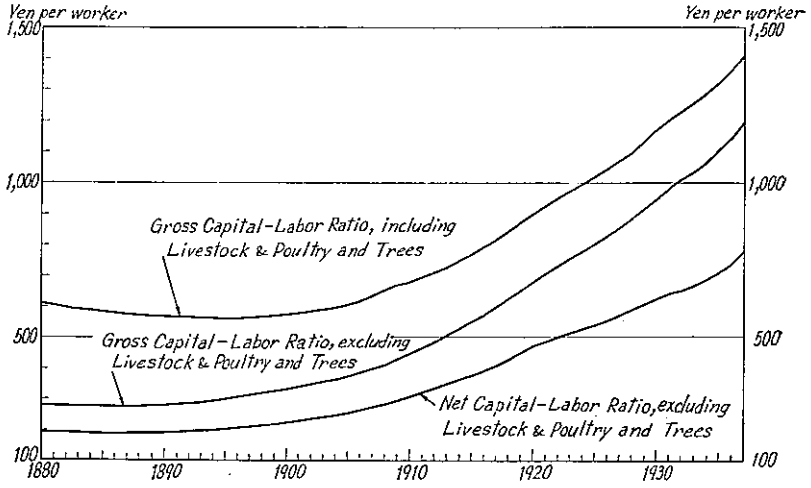
Second, capital-labor ratios presented in Chart 2 also have three kinds. In this case, the three ratios showed almost the same upward trends from the turn of the century. Before 1900, the curves of the ratios were almost herizontal except a little declining trend in gross capital-labor ratio including livestock & poultry and trees. From our data no capital shallowing could be found in the pre-war Japan(1)

B. Trends in Structure of Capital Stock, By Types of Capital Goods.

In the preceding section, we discussed capital stock as a total. Much information can be derived by distinguishing the types of capital goods, such as producers' durables, public works, railways, public utilities non-residential buildings, and livestock & poutry

CHART 2

Gross and Net Capital-Labor Ratios, in 1930 Prices, 1880~1937.



(1) From the writer's calculation, capital-labor ratio in secondary industry showed the greatest upward trend from the turn of the century. See S. Ishiwata, *op.cit.*

is excluded.

Table 2 gives us the relevant date for discussion here. The shares of each component in percentage terms are calculated for every five years, from 1880 to 1935. In the case of gross capital stock including livestock & poultry and trees, the table may suggest such findings as follows:

(i) In 1880 the order of items in accordance with their share was livestock & poultry and trees (58.5%), non-residential buildings (32.0%), public works (8.0%), producers' durables (1.5%) and railways (0.2%). Public utilities appeared since 1905.

(ii) In 1910 the order changed very much: non-residential buildings got the first position in place of livestock & poultry and trees, and producers' durables occupied the third place instead of public works. The share of public utilities was only 0.4% in 1910.

(iii) The share of producers' durables was 29.3% and ocupied the first place in 1925, and it became 30.8% in 1935. In 1935 the second place was occupied by non-residential buildings, and the third place by both livestock & poultry and trees and public works. Then railways and public utilities followed.

A remark should be added that all machinery in railways and public utilities, such as rolling stocks in railways and electric generators or transformers in public utilities, were included in producers' durables.

In the case of gross capital stock excluding livestock & poultry and trees, the share of non-residential buildings moved very differently from the above case. It remained almost at the same level from 1885 to 1910, while it decreased very rapidly from 78.0 % in 1885 to 51.5% in 1910 in this case. In the former case the decrease in the share of non-residential buildings might have been cancelled out by the decrease of livestock & poultry and trees which had the largest share in all items.

In the case of net capital stock excluding livestock & poultry and trees, a distinguishing point is that the share of non-reside-

ntial buildings maintained the first place throughout the period. The share of producers' durables occupied the third place in 1880 and the second in 1910 replacing that of public works, and it kept

TABLE 2

Structure of Capital Stock, By Types of Capital Goods

(in percentages)

Period	Producers' Durable Equipment (1)	Public Works (2)	Railways (3)	Public Utilities (4)	Non-residential Buildings (5)	Livestock Poultry Trees (6)
Gross, including livestock & poultry and trees						
1880	1.5	7.9	0.2		31.9	58.5
1885	1.8	8.8	0.5		36.7	52.9
1890	2.6	8.8	1.7		36.2	50.7
1895	3.8	9.8	2.4		36.9	47.1
1900	6.4	11.1	3.7		36.6	42.2
1905	9.3	12.1	4.6	0.1	35.6	38.3
1910	13.3	12.8	5.5	0.4	33.9	34.1
1915	17.7	13.8	6.4	0.9	32.7	28.5
1920	25.9	13.1	6.2	1.3	29.3	24.2
1925	28.7	13.4	6.5	2.5	27.6	21.3
1930	29.3	14.6	6.6	3.6	27.1	18.8
1935	30.8	16.4	6.2	4.3	25.9	16.4
Gross, excluding livestock & poultry and trees						
1880	3.6	19.0	0.4		77.0	
1885	3.8	17.2	1.0		78.0	
1890	5.3	17.9	3.4		73.4	
1895	7.2	18.5	4.6		69.7	
1900	11.1	19.2	6.4		63.3	
1905	15.1	19.7	7.4	0.2	57.6	
1910	20.3	19.4	8.3	0.5	51.5	
1915	24.7	19.3	8.9	1.3	45.8	
1920	34.2	17.3	8.1	1.8	38.6	
1925	36.5	17.0	8.3	3.1	35.1	
1930	36.0	18.0	8.1	4.5	33.4	
1935	36.9	19.6	2.5	5.2	30.8	
Net, excluding livstock & poultry and trees						
1880	3.4	13.8	0.4		82.4	
1885	4.2	15.1	1.2		79.5	
1890	5.5	15.7	3.5		75.3	
1895	7.3	16.3	4.7		71.7	
1900	10.7	17.0	7.2		65.1	
1905	14.4	17.7	8.4	0.2	59.3	
1910	19.0	17.6	9.9	0.6	52.9	
1915	22.8	17.9	10.6	1.5	47.2	
1920	33.0	16.1	9.2	2.1	39.6	
1925	33.0	16.6	9.7	3.7	37.0	
1930	30.5	18.5	9.4	5.5	36.1	
1935	30.2	21.0	8.3	6.5	34.0	

and tress. In the governmen sector, capital stock for military use the same position until 1935. This may be mainly due to the fact that the average lifetime of producers' durables is seventeen years, while the average lifetime of non-residential buildings is fifty years. This means that the annual depreciation rate of producers' durables is higher than that of non-residential buildings.

II Definition and Estimation Problems

A. Definition and Scope

The concept of capital stock in our measurement can be difined as reproducible tangible assets which contribute to production of goods and services directly or indirectly. Items included in our measurement are listed below following the classification of *the National Wealth Survey in* 1930:

Buildings (excluding Residential Buildings)
Railways and Streetways
Bridges
Harbors
Water Supply Installation*
Telegraph and Telephone Installation*
Electricity and Gass Supply Installation*
Industrial Machinery and Equipment*
Vehicles and Airplanes*
Ships*

In our measurement, all items denoted by the sign "*" except constructions in Water, Electricity and Gass Supply Installation, are included in Producers' Durable Equipmet (PDE).

Items excluded in our measurement are Land and Deposits in Mining Industries which are considered as irreproducible assets; Consumers' Holdings of Durable Commodities, Works of Art and Other Collectors' Items, and Coins and Gold and Silver Bullion which are considered as assets not for production; and International Balance which is as intangible asset. All inventories are

also excluded due to the lack of basic data.

In accordance with Kuznets, there are two concepts of capital: peace-time concept and war-time concept. Our measurement is in priciple based on the former one. We said "in principle," because in our measurement, for exampie, the military assets in PDE cannot be fully excluded due to the lack of the appropriate data.

B. Estimation Period

The estimation period of each item is not the same due to the differences in the availability of basic data. In relation to other economic series, such as GDP and labor force, our estimation period is confined to 1878—1940, although some items can be traced back before 1878 while some other items cannot even be obtained after the century. Our measurement is divided into two periods: before 1907 and after 1908. After 1908 all items which we tried to estimate in our measurement are included, but before 1907 some items are excluded due to lack of basic data and some other are simply estimated with relations to other series.

C. Valuation Problems

On valuation problems, there are many discussions such as prospective vs. retrospective methods, productivity vs. cost principles, forward looking vs. backward looking measurements, gross vs. net terms and so on. However, both in theory and in measurement these discussions do not give any final answer. We can only say that there are many valuation criteria, and the choice of measurement entirely depends on the analytical viewpoint of the use of capital formation or capital stock.

Our measurement is made from the point of view of production approach, in which the prospective method or the productivity principle and gross term basis might be better for the valuation of capital formation and capital stock. But as Denison pointed out, the prospective method or the productivity principle cannot be applicable to the measurement of capital formation, and this

is also inappropriate for measuring capital stock(1). With the matter of gross term basis, there is no definite reason which satisfies everyone. We might say not that any asset were to reduce its phisical productivity in accordance with straight-line or declining balance method of depreciation allowance principle which is highly based upon accounting practices, but that any asset could keep the same physical prodictivity through the period of the expected lifetime, if it were cared properly with current expenditures.

All assets are to be measured at the end of each year, but capital expenditures in terms of fiscal year such as Public Works by the central and local governments are not adjusted in terms of calendar year.

D. Three Main Methods of Estimation.

Three methods are used in the estimation of capital stock adopted in our measurement. The first one is the"physical stock valuation method" (we shall call it "PSV" Method below), which was adopted in the case of agriculture where capital stock is derived from physical capital stock series multiplied by the base year unit prices. The second one is "Perpetual Inventory Method" (we shall call it "P I" Method below), which was advocated by Goldsmithl as mentioned earlier. The third one is the "Benchmark Year Method," which was used, for instance, by the Economic Planning Agency of Japan and by Fei=Ranis series, where capital stock is derived from adding or subtracting capital formation series to or from capital stock in a benchmark year.

(i) Physical Stock Valuation Method

The explanation of the method can be given by using the case of buildings. Annual capital stock series in buildings is obtained by multiplying annual series of buildings in terms of physical unit

(1) See, Edward F. Denison "Theoretical Aspects of Quality Change, Capital Consumption and Net Capital Formation," in *Problems of Capital Formation, Studies in Income and Wealth*, Vol. 19, 1957

such as *tsubo* (approximately 3.3 square meter) by unit of construction cost in the base year. Although it has some defects, such as neglecting the quality changes of buildings, it is a workable method of estimation; its defects may be reduced by adopting more than one base year and by classifying buildings by types of construction and by usages.

(ii) P I Method

The principle of this method is the cumulation of depreciated cacital expenditures or supply of depreciated capital goods, adjusted for changes in costs or prices, to obtain the amount of annual capital stock. It can be expressed in the following formula, if we assume straight-line method of depreciation allowance:

$$K_t^N = K_{t-1}^N + I_t^G - \frac{1}{n}\sum_{t=t-n}^{t-1} I_t^G$$

where K_t^N, I_t^G and n denot net capital stock for t-th year, gross capital formation for t-th year and asset's useful lifetime respectively. In the same way gross capital stock can be written as

$$K_t^G = \sum_{t=t-n}^{t} I_t^G$$

where K_t^G denotes gross capital stock for t-th year. The gross capital stock, as we define here, is valued under the assumption that all assets are kept in the same physical productivity throughout their lifetime but their productivity becomes zero soon after the lifetime. The calculation of capital stock under P I Method, here attempted, neglects the possible scrap-value of assets.

(iii) Benchmark Year Method

At the beginning of our measurement, we decided to adopt this method and to take 1930 as our benchmark year, because *the National Wealth Survey* in 1930 is the latest one which gives us its method and scope rather in detail in the pre-war period, though it is generally said that the benchmark year should be a "normal

year from political and economic points of view. This method consists of three steps: determination of gross or net capital stock at a benchmark year, compilation of new or net annual capital fromation series, and addition or subtraction of the latter to or from the former. The defects of this method are the bold assumptions abopted to obtain the amounts of annual capital stoch due to in availability of informations on annual depreciation allowances, replacement costs and obsolescences.

III. Estimation Methods

A. Non-primary Sector

In this section we will discuss the basic data and the methods of estimation adopted for the measurement of (i) Producers' Durable Equipment (PED), (ii) Ships, (iii) Railways, (iv) Electricity Supply and (v) Non-residential Buildings. In addition, the limitations of the methods used will also be discussed.

(i) PDE, excluding ships

Ships are included in this category but estimated separately, because of their high share in PDE and because of the availability of basic data for independent estimation. PDE is estimated by P I Method. The methods of calculating the depreciated supply of PDE and the lifetime are discussed below.

1919—1939

Total supply of PDE is derived from non-military private domestic production plus government non-military repair with the adjustments of international net balance and freight and distribution. Inflators in *the National Wealth Survey in 1955* are used for price adjustment. Private non-military domestic production for more than five-worker factories is completely based on *Kōjō tōkei hyō* (Factory Statistics). Midget Industry production and goverement non-military repairs are derived from Rosovsky's estimates[1]. Annual series of freight and distribution adjustment

are not available and in our measurement Shinohara's esdimate (fifteen percent) is adopted for the pre-war period[2]

Before 1918

The inavailability of *Kōjō tōkei hyō* figures is the most difficult problems in this period[3] Our estimates are obtained by using Koide's Production Index for Machinery Industries with the deflated *Kōjō tōkei hyō* figures for 1930 as a benchmark. The total domestic production is the sum total of our estimates obtained above and Midget Industry prduction and government non-military repairs from Rosovsky's estimates, minus ships and private military production. International net balance and freight and distribution adjustments are calculated in the same way as in the case of 1919—1939. Basic data for international net balance adjustments are as follows:

(a) The Department of Finance (ed.), *Nihon gaikoku bōeki nenpyō* (Annual Return of the Foreign Trade of Japan):

(b) Tōyō Kezai Shinpōsha (ed.), *Nihon bōeki seiran* (Foreign Trade of Japan -A Statistical Survey-), 1935

(c) Goverment General of Chōsen (ed.), *Chōsen bōeki nenpyō* (Chōsen Table of Trade and Shipping): and.

(d) The Government of Taiwan (ed.), *Taiwan bōeki nenpyō* (Annual Return of the Trade of Taiwan (Formosa)).

Lifetime of PDE

PDE can be classified into four groups by their lifetime as follows:

1st group, 20 years

Machiery & Equipment

(1) Cf., H. Rosovsky, *Capital Formation in Japan*, 1868—1940, New York: The Free Press of Glencoe, 1961.

(2) Cf., Miyohei Shinohara, "An Estimate of Capital Formation in Japan by 'Commndity Flow'" *Annals of the Hitotsubashi Academy, V* (2) April 1955.

(3) *Kōjō tōkei hyō* in 1909 and 1914 are available although less reliable

Rolling Stock

2nd group, 15 years

Tools & Instruments and Others (The last item consists of flywheels, gears, wheels, shafts, bearings, and other parts and production of Midget Industry.)

3rd group 10 years

Finishing & Repair Fees

Government Non-military Repairs

4th group. 6 years

Automobile and Other Vehicles

Using the amount of each item as weights we can calculate the aver ge lifetime of PDE for every five years since 1909 as follows:

Year	1909	1914	1919	1924	1929	1924
Weighted Average of Lifetime	16.8	17.9	17.3	18.0	15.1	15.2

Since the arithmetic mean of these lifetime figures is 16.7 years, we decide to take 17 years as the average lifetime of PED throughout the period.

(ii) ships

The basic data are derived from:

(a) Ministry of Commerce and Industry (ed.). *Kōjō tōkei hyō* (Factory Statistics). 1909, 1914, 1919—1939

(b) Cabinet Statistical Bureau (ed.), *Nihon teikoki tōkei nenkan* (Statistical Yearbook of the Empire of Japan);

(c) Ministry of Posts and Communications (ed.), *Kaiji tōkei ruisan* (Classified Statistical Collection of Marine Affairs); and

(d) ……, *Kaiji tekiyō* (Abstract of Marine Affairs).

From these basic sources we can obtain twe kinds of series of domestic produotion; in terms of money (*yen*) and in terms of physical quantity (gross tonnage). Before 1918 only physical quantity data are available from (b) to (d). We assume that the total domestic production before 1918, which is equivalent to *Kōjō*

tōken hyō figures in nature, is the purchase of new domestic production plus exports, though it may have a little upward bias since exported ships are not always new.

The linkage of this quantity data to *Kōjō t kei hyō* figures is the most difficult task to be done, because unit prices of steam and sailing vessels might be different and the weight of the two is not stable, e.g., upward trend for that of sailing vessel if we trace backward in the time sepuence. Several attemps were made and finally we adopted the domestic production for 1915 from Bureau of Special Industry Survey (ed.), *Kikai kōgyō ni kansuru tōkei hyō* (Statistical Tables for Machinery Industries) as our benchmark. As for price adjustment, Steel Vessel Inflator in *the National Wealth Survey in 1955* is used. With the series derived above net and gross capital stock series for Ships are now available by P I Method with the assumption of 20-year lifetime.

Kōjō tōkei hyō figures for 1919 and 1920, in 1930 prices, are declining backward, while our estimates of the domestic production are sharply rising backward. This movement can be partly proved by the production of the two large shipbuilding companies, e.g., Mitsubishi Nagasaki and Kawasaki. Thus we decided to adopt these estimates in place of *Kōjō tōken hyō* figures for 1919 and 1920 as well as for 1909 and 1914.

(iii) Railways

The following basic data on railways are available :

(a) Ministry of Railroads (ed.), *Tettsdō tōkei nenpō* (Statistical Yearbook of Railroads); and

(b) Cabinet Statistical Bureau (ed.), *Nihon teikoku tōkei nenkan* (Statistical Yearbook of the Empire of Japan).

From these data two kinds of series are obtained. (a) As flow data, we have an ual capital expenditures. According to accounting terms of National Railroads, they are "Kensetsū hi (construction costs)", "Kairyō hi (major alterations)" and "Hojyu hi (additions)" (b) As stock data, we have total amounts of assets of

National Railroads as the summation of past capital expenditures and total kilo-metre of established and unestablished railroad lines as physical quantity series. In the flow data, we already have some series, such as Rosovsky series, Massaki series and EPA series. In this study, we adopted PSV Method, because the existing flow data are confined only to Natinal Railroads over their lifetime.

Rail ways consists of (a) National Railways, (b) Local Railways, and (c) Street Railways. Unit construction cost for these railways are all based on *the National Wealth Survey in 1930.* Gross capital stock series for these three types of railways are obtained by multiplying unit construction costs by total kilo-metres of established and unestablished railroad lines. Transformation of gross terms into net terms is made by using net-gross capital stock ratio of National Railroads which is calculated by P I Method with Rosovsky series of gross capital fomation and *the 1955 National Wealth Survey* Inflator for Railroad Construction.

(iv) Electricity and Gass Supply

Since Rosovsky's gross capital formation series for Gass Supply are shorter than the lifetime of capital and the amounts are negligible, our measurement is confined to Electricity Supply only. PSV Methnd is also adopted here.

The mothed of our measurement is almost the same as Rosovsky's method used in calculating capital formation. The gross capital stock series for Electricity Supply is obtained by multiplying unit construction costs by total capacity of power plants both established and unestablished. We assume a constant ratio of transformation of grors capital stock into net capital stock, basing also on *the Nationl welth survey in 1930.*

Before 1902 we have no data on total capacity of power plants. Simple backward extrapolation is made, using number of electric lamps installed.(1)

(v) Non-residentital Buildings

Non-residential Buildings consist of (a) Factory Buildings, (b) Commercial Buildings and (c) Other Buildings such as private school buildings and central and local government buildings

(a) Factory Buildings

Factory Buildings are estimated by PSV Method in the following ways. Unit construction costs are derived from Emi=Ishi's estimates[2]. Total *tsubo* of factory buildings are obtained by multyplying the numbers of factories by industries by the amount of *tsubo* of factory of the respective industries. The numbers of factories by industries since 1894 are obtained from Emi=Ishi series basing upon *Nōshōmu tōkei hyō* and *Kōjō tōkei hyō* with some adjustments of their inconsistencies. The amount of *tsubo* of factory buildings per factory by industries is based on *Kōgyō chōsa* (Industry Survey) edited by the Industry Dempart- ment of Nagoya City in 1933, with some reclassifications of industries in accordance with the industry classification of *Kōjō tōkei hyō*.

Due to inavailability of the numbers of factory by industries before 1893, simple extrapolation is made basing upon gainfully occupied population series in the secondary industry[3]. Trans- formation of gross terms into net terms is made by using a simple arithmetic mean of net-gross ratios of Public Works and Railways. The reliability of our estimates is dependent on the plausibility of *Kōgyō chōsa* as a substitute for nation wide averages.

(b) Commercial Buildings

The Benchmark Year Method is adopted in the estimation of Commercial Buildings. The gross capital stock of Commercial Buildings for 1937—40 is calculated by using the gross capital formation from Rosovsky series deflated by a simple arithmetic mean of *the 1955 National Wealth Survey* Inflators for Non- residential Buildings. Since a new capital formation ratio for Commercial Buildings is not available, the arithmetie mean of new capital formation ratios in Public Works is used in order to obtain

the gross capital stock until 1886. For data before 1885 a simple extrapolation is also made, basing upon total population of Ohkawa's series[4]. The transformation ratio of Factory Buildings is adopted here also in order to get the net capital stock series from the gross capital stock series obtained above.

As for 1930, our estimate of the Commerical Buiidings is 2.67 times larger than that of *the National Weaith Survey in 1930.* The main difference between the two is due is due to the exclusion of *heiyo jütaku* part, which is used for commercial purposes, in *the National Wealth Survey in 1930.* With the allowance of this part, the difference may become rather slight, but there may still be some discrepancy between the two.

(c) Other Buildings

As for Other Buildings the same method is used is in the case of Commercial Buildings. Rosovsky' gross capital formation series series and *the 1955 Natinal Wealth Survey* Inflator for Non-residential Buildings are also used. The ratio of our estimae to *the 1930 National Survey* figure is 0.81. This discrepancy may be due to the inclusion of military faotorics of the central government, private university buildings and so on.

B. Primary Sector

Our measurement of capital stock in Primary Sector is only confined to agriculture and forestry. The capital stock in fishery is excluded from our estimate, partly because of its comparatively

(1) C. f., R. Minami *Denki jigyō no shotoku suikei* (Estimation of Income in Electric Supply Enterprises), Preliminary Report No. D 19 Rockefeller Project, Institute of Economic Reserch, Hitotsubashi Uoiuersity, 1962.

(2) Cf., K. Emi and H. Ishi, *Minkan kenchiku tōshi no suikei, kōgyō kenchiku* (Estimation of Private Building Investment, Factory Buildings), Preliminary Report No. D 33, Rockefeller Project, Institute of Economic Researh, Hitotsubashi University, 1964.

(3) K. Ohkawa *et. al.*, *The Growth Rate of the Japanese Economy since* 1878, Tokyo: Kinokuniya, 1957, 145.

(4) K. Ohkawa *et. al.*, *op. cit.*, 140—41.

small share in Primary Sector, therefore its exclusion does not substantially affect our final conclusion(1).

Long-term estimation of capital stock in agriculture was made by Umemura and Yamada from 1876 to 1957(2). Their estimation method was based on PSV Method in our terms. Estimsted itemd were (a) Residential Buildings, (B) Other Buidings and Structure, (b) Livestock and Poultry, (d) Tree and (e) Agribultural Machinery and Tools. We adopted Umemura=Yamada's estimates of items other than Residential Buildings and Agricultural Machinery and Tools, because residential buildings in agriculture are *heiyō jūtaku* from which the exclusion of residential part is a very difficult task without assuming a certain ratio of residential part to total residential buildings, and agricultural machinery and tools are already included in Producers' Durables in the Non-primary Sector(3).

(i) Livestoc & Poultry

(a) Scope

The scope of Livestock & Poultry here include cattle, horses, domesticated pigs, sheep, goats, chickens, and ducks.

(b) Unit prices

The unit prices of the above seven items are derived from *the National Wealth Survey in 1930.* As in Umemura=Yamada's quantity data, livestock & poultry owned by central and local governments are excluded, unit prices are calculated by deviding total amount in terms of *yen* by total quantity for each item owned by private sector.

(ii) Trees

(1) Fishing boats are in Ships in Non-primary Sector.

(2) M. Umemura and S. Yamada, "Nōgyō Koteishihon no sukei(Estimation of Real Capital in Agriculture), 1876—1957," *Nōgyō sōgō kenkyū*, XVI (4), 91—147.

(3) Extclusion of agricultural machinery and tools from our estimates of PDE is one of the problems to get sectoral subdivision of capital stock.

(a) Scope

Nineteen kinds of trees are measured in Umemura=Yamada's estimates but in our measurement four out of the above nineteen are excluded due to lack of unit price information and some items are summed up into one item such as citrus fruits. They are citrusfruittrees, apple-trees, grape-vines, persimmon-trees, pear-trees, peachtrees, cherry-trees, loquat-trees, plum-trees, mulberry-trees and tea-trees.

(b) Unit prices

Unit prices of trees is also derived from *the National Wealth Survey in 1930* in the same way of calcultion as in the case of Livestock & Poultry.

(iii) Other Trees[1]

(a) Scope

Other trees, here we call, are only concerned with trees for timber and fuel and bamboos. Therefore, our measurement includes utilization forests only and excludes protection forests against wind, flood and sand.

(b) Unit prices

Unit price information in our measurement completely depends on *the National Wealth Survey in 1930*. As unit prices for central government's forests are not available, unit prices for local government's forests are used in place of the above ones

(c) Forest Area

Forest area series in our measurement is based on *Nōrinshō ruinen tokeihyō* (Accumulated Statistical Table of the Ministry of Agriculture and Forestry), 1955. Several adjustments are made due to (i) inconsistency of observation time, (ii) inconsisteney of geographical scope, and (iii) inavailability of survery years other than every third year since 1915.

(1) This item is not included in Umemura=Yamada's estimates.

Unit Prices, By Usage and By Owner

Unit : Yen/Cho (about 99 ares)

	Local Government	Private	
		Shrine & Temple	Others
Forest for Timber			
needle-leaved trees	287.44	1,005.74	390.08
broad-leaved trees	190.64		
Forest for Fuel	166.37	150.46	88.04
Forest for Timber & Fuel			
needle-leaved trees	263.23	676.28	481.21
broad-leaved trees	170.01	278.75	133.35
Bamboo Forest	733.89	1,745.46	1,368.60

(iv) Non-residential Buildings and Structure

Non-residential Buildings consist of barns, warehouses, cattle sheds and compost shods, and Structure consists of silos, underdrains, manure-sinks and cableways. We cannot obtain unit prices for these items from *the National Wealth Survey in 1930.* Hence we adopted the inflator for Non-residential Buildings in Non-primary Sector in *the National Wealth Survey in 1955* to change the base year from 1955 to 1930.

APPENDIX OF TABLES

TABLE 1

Five-Year Moving Averages of Gross Capital Stock, Gross Domestic Product, in 1930 Prices, 1880—1937

(million yens)

Year on Which Moving Average Is Cmtered	Sectoral Total		Roads	Total		Gross
	Including Livestock Poultry & Trees (1)	Excluding Livestock Poultry & Trees (2)	Harbors & Riparians (3)	Including Livestock Poultry & Trees (4)	Excluding Livestock Poultry & Trees (5)	Domestic Product (6)
1880	11,091	4,631	840	11,931	5,471	
81	11,138	4.664	863	12,001	5,527	1,905
82	11,143	4,697	888	12,031	5,585	1,951
83	11,156	4,732	914	12,070	5,646	2,001
84	11,213	4,766	939	12,152	5,705	2,141
1885	11,268	4,807	964	12,232	5,771	2,264
86	11,348	4,861	988	12,336	5,849	2,482
87	11,439	4,921	1,010	12,449	5,931	2,606
88	11,530	5,001	1,035	12,565	6,036	2,712
89	11,593	5,100	1,062	12,655	6,162	2,765
1890	11,667	5,206	1,092	12,759	6,298	2,843
91	11,722	5,319	1,124	12,846	6,443	2,815
92	11,795	5,434	1,159	12,954	6,593	2,993
93	11,871	5,543	1,196	13,067	6,739	3,130
94	11,936	5,649	1,232	13,168	6,881	3,233
1895	12,015	5,775	1,270	13,885	7,045	3,329
96	12,094	5,922	1,314	13,408	7,236	3,576
97	12,208	6,084	1,360	13,568	7,444	3,716
98	12,338	6,273	1,411	13,742	7,684	3,888
99	12,477	6,467	1,467	13,944	7,934	4,141
1900	12,618	6,654	1,526	14,144	8,180	4,267
01	12,787	6,835	1,586	14,373	8,421	4,317
02	12,942	7,031	1,648	14,590	8,679	4,402
03	13,110	7,228	1,706	14,316	8,934	4,397
04	13,338	7,456	1,761	15,099	9,217	4,466
1905	13,631	7,713	1,813	15,444	9,526	4,672
06	13,959	8,003	1,868	15,827	9,871	4,885
07	14,342	8,318	1,924	16,266	10,242	5,091

(continued)

TABLE 1 (concluded)

Year on Which Moving Average Is Centered	Sectoral Total		Roads Harbors & Riparians (3)	Total		Gross Domestic Product (6)
	Including Livestock Poultry & Trees (1)	Excluding Livestock Poultry & Trees (2)		Including Livestock Poultry & Trees (4)	Excluding Livestock Poultry & Trees (5)	
1908	14,755	8,667	1,986	16,741	10,653	5,332
09	15,136	9,037	2,060	17,196	11,097	5,555
1910	15,471	9,443	2,147	17,618	11,590	5,809
11	15,849	9,906	2,240	18,089	12,146	5,967
12	16,237	10,391	2,337	18,574	12,728	6,174
13	16,632	10,853	2,439	19,071	13,292	6,499
14	17,056	11,311	2,540	19,596	13,851	6,854
1915	17,557	11,789	2,629	20,186	14,418	7,153
16	18,118	12,312	2,708	20,826	15,020	7,615
17	18,789	12,940	2,779	21,568	15,719	8,262
18	19,584	13,717	2,843	22,427	16,560	8,529
19	20,455	14,594	2,904	23,359	17,483	8,768
1920	21,365	15,470	2,974	24,339	18,444	8,967
21	22,243	16,315	3,061	25,304	19,376	9,215
22	23,070	17,092	3,161	26,231	20,253	9,357
23	23,831	17,797	3,269	27,100	21,066	9,896
24	24,587	18,493	3,391	27,978	21,884	10,418
1925	25,350	19,207	3,528	28,878	22,735	11,052
26	26,155	19,969	3,677	29,832	23,646	11,577
27	27,003	20,778	3,839	30,842	24,617	12,023
28	27,915	21,642	4,020	31,935	25,662	12,364
29	28,890	22,466	4,224	33,024	26,690	12,720
1930	29,647	23,246	4,461	34,108	27,707	13,241
31	30,485	24,018	4,732	35,217	28,750	13,939
32	31,332	24,807	5,027	36,359	29,834	14,640
33	32,226	25,655	5,343	37,569	30,998	15,525
34	33,300	26,689	5,667	38,967	32,356	16,541
1935	34,540	27,906	5,974	40,514	33,880	17,552
36	35,930	29,286	6,253	42,183	35,539	18,597
37	37,578	30,924	6,514	44,092	37,438	

Note: Unestablished railroad lines and electric power plants are excluded here.

TABLE 2

Five-Year Moving Averages of Net Capital Stock, Net Domestic Product and Labor, in 1930 Prices 1880—1937

(million yens and thousands)

Year on Which Moving Averages Centered	Net Capital Stock			Net Domestic Product	Labor: Gainfully Occupied Population
	Sectoral Total (1)	Roads Harbors & Riparians (2)	Total (3)	(4)	(5)
1880	3,278	519	3,797		19,532
81	3,301	533	3,834	2,304	19,876
82	3,324	549	3,873	2,253	20,209
83	3,348	564	3,912	2,222	20,533
84	3,370	580	3,950	2,325	20,849
1885	3,400	595	3,995	2,427	21,157
86	3,437	609	4,046	2,562	21,457
87	3,479	623	4,102	2,699	21,748
88	3,534	638	4,172	2,871	22,032
89	3,602	654	4,256	2,913	22,305
1890	3,674	672	4,346	3,005	22,570
91	3,750	691	4,441	3,107	22,824
92	3,828	713	4,541	3,354	23,072
93	3,901	735	4,636	3,457	23,310
94	3,973	757	4,730	3,546	23,540
1895	4,061	780	4,841	3,636	23,761
96	4,168	806	4,974	3,917	23,971
97	4,284	834	5,118	4,005	24,179
98	4,419	865	5,284	4,140	24,379
99	4,562	900	5,462	4,381	24,575
1900	4,695	937	5,632	4,478	24,762
01	4,819	975	5,794	4,472	24,945
02	4,954	1,016	5,970	4,540	25,117
03	5,089	1,054	6,143	4,503	25,283
04	5,247	1,089	6,336	4,548	25,438
1905	5,430	1,124	6,554	4,771	25,584
06	5,639	1,159	6,798	4,945	25,719
07	5,871	1,196	7,067	5,102	25,849
08	6,116	1,236	7,352	5,309	25,964

(continued)

TABLE 2 (concluded)

Year on Which Moving Averages Centered	Net Capital Stock			Net Domestic Product	Labor : Gainfully Occupied Population
	Sectoral Total (1)	Roads Harbors & Riparians (2)	Total (3)	(4)	(6)
1909	6,376	1,285	7,661	5,526	26,069
1910	6,657	1,241	7,998	5,780	26,166
11	6,975	1,402	8,377	5,985	26,256
12	7,305	1,465	8,770	6,208	26,335
13	7,622	1,532	9,154	6,493	26,406
14	7,928	1,597	9,525	6,762	26,465
1915	8,242	1,656	9,898	6,981	26,514
16	8,598	1,709	10,307	7,421	26,553
17	9,041	1,756	10,797	8,178	26,583
18	9,600	1,797	11,397	8,485	26,731
19	10,214	1,837	12,051	8,665	26,919
1920	10,841	1,882	12,723	8,816	27,148
21	11,398	1,940	13,338	8,922	27,417
22	11,873	2,006	13,879	8,880	27,735
23	12,268	2,079	14,347	9,438	27,970
24	12,645	2,163	14,808	9,998	28,206
1925	13,020	2,257	15,277	10,550	28,441
26	13,419	2,361	15,780	11,024	28,677
27	13,863	2,474	16,337	11,361	28,913
28	14,352	2,601	16,953	11,473	29,149
29	14,795	2,747	17,542	11,589	29,210
1930	15,193	3,925	18,119	11,935	29,264
31	15,573	3,138	18,711	12,424	29,390
32	15,954	3,371	19,325	12,949	29,672
33	16,382	3,620	20,002	13,785	30,028
34	16,961	3,870	20,831	14,349	30,401
1935	17,703	4,096	21,799	15,872	30,798
36	18,632	4,286	22,918	16,825	31,137
37	19,878	4,451	24,329		31,334

Note: Unestablished railroad lines and electric power plants are excluded here.