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MEASUREMENT OF CAPITAL STOCK IN SRI LANKA
1958 – 78*

by

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The purpose of this study is to measure the capital stock in the Sri Lankan economy for the period of 1958-78.

A great deal of literature and empirical studies is available on the capital stocks in developed countries, but there is a dearth of such material in the case of developing countries. In developed countries two parts of real capital stock namely the human capital and non-human capital have been measured. This study measures only the non-human capital which is relatively less complicated. In this study the total non-human capital is obtained by aggregating five subgroups of capital stocks namely, land, buildings, constructions, transport, and machinery. This type of capital stock data series have been measured by researchers and research institutes in a few countries such as Canada, U.S.A., Japan, Australia, Denmark, Germany, Greece, Ireland, Italy, Sweden, and U K.[1]

Capital stock is an important factor for both theoretical and empirical analysis of production, consumption and investment functions and the demand for money.[2] Capital stock is also considered to be of basic and primary importance in economic growth.

Although the importance of the measurement of capital stock has been widely accepted it has been subjected to some criticisms. The well known "capital controversy" highlights the problem of aggregating different types of capital goods which are heterogenous with divergent characters and differences in longevity, impermanence and productivity qualities. Counter arguments to this have been brought forward by many authors (Usher and Nadiri (1970)). One may almost say that if one were to accept the argument against aggregating capital goods, one would have to stop the common practice of aggregating labour and output, since the problems of aggregation are equally applicable to these cases as well.

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1 For further details of these see Ward Michael *The Measurement of Capital Stock.* Organization for Economic Co-operation and Development. Paris. 1976).

2. An excellent exposition of the purpose of capital stock estimates can be found in Usher. *The Measurement of Capital, Studies in Income and Wealth.* (Chicago: The University of Chicago Press, V. 45, 1980.)

As the important uses of capital stocks estimates have been presented in various studies (see Barna (1959); Usher, D. (1980), Ward M. (1976)) this study will not give a detailed discussion of this issue.

Section II of this study is an exposition of the techniques used in the measurement of capital stock. In section III methodology for measuring the capital stock for Sri Lanka is discussed. The resulting estimates of capital stock are presented in section IV. The basic investment data used and their sources are shown in section V.

SECTION II

Measurement of Capital Stock

Several methods of measuring capital stock have been proposed in various studies. These alternative methods can be categorized as follows :

(i) Survey of Physical Assets

(ii) Survey of Book Values

(iii) Survey of Insured Values

(iv) Perpetual Inventory Model (PIM)

(i) Survey of Physical Assets

The direct method of collecting data for the specific purpose of measuring capital is seldom used. Among the countries that measure the capital stock, Russia and Japan have carried out a comprehensive census of physical assets (Ward, M (1976)). Besides its high cost involvement and comprehensiveness, there are other difficulties such as, inconsistent data due to the different methods of evaluating replacement cost, and problems in obtaining comparable historical data for each year. However, the infrequent use of this method is mainly due to its high comprehensiveness and, in turn, the heavy consumption of time and money.

(ii) Survey of Book Values

Due to its conflict in purposes, use of the book values in measurement of capital stock has been somewhat restricted. The book values do not provide consistent data for the whole period due to different depreciation methods even in the similar assets. Also, sometimes in the case of assets such as structure, which may not be depreciated at all, book values will provide an overestimation of the capital stock.

(iii) Survey of Insured Values

Insured values also are seldom used for the specific purpose of the measurement of capital stock. Practically, insured values often do not represent the whole value of the physical asset, but only the more important parts of the assets. Also, it is difficult to find similar evaluation methods among firms or industries. The given values for insurance purposes are very often affected by inflation expectations, as well as by the exposure to risk.[3]

(iv) Perpetual Inventory Method

A perpetual inventory estimate of capital stock is a weighted sum of past gross investment flows. The basic information needed for calculating the capital stock according to PIM is :

(a) Time series of gross investment in each capital good in current prices.

(b) Time series of prices of capital goods.

(c) The rate of depreciation of each capital good.

(d) A benchmark estimate of the capital good.

The equation for calculating the capital stock forward from the benchmark year is as follows :

$$K_t = K_{t-1} - dK_{t-1} + GI_t \quad \ldots\ldots\ldots\ldots (1)$$

Where, K_t —is the capital stock in year t at constant prices.

K_{t-1} —is the capital stock in year t-1 at constant prices.

d —is the average rate of depreciation of relevant capital goods which is equal to 2/le when le is the assumed life span of the capital good.

GI_t —is the gross investments of relevant capital good in the t-th year at constant prices (deflated by the appropriate price deflator).

To obtain an estimate of a benchmark year capital stock, one sums up the weighted figure of gross investments; i.e. :

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3. For details see Goldsmith R. and Saunders C. (eds). *The Measurement of National Wealth.* London: Bowes and Bowes, 1959, pp. 46-47.

$$K_t = GI_t + \frac{le-1}{le} \cdot GI_{t-1} + \frac{le-2}{le} \cdot GIt\text{-}2 + \\ + \frac{2}{le} \cdot GI_{t-le+2} \cdot GI_{t-le+1} \quad \ldots\ldots\ldots\ldots \quad (2)$$

We, therefore, assume that at the end of its life span the value of capital goods is equal to zero. This reveals that in order to undertake the PIM, we need time series data of gross investments at least to cover the period of the life span of the relevant capital goods.

To build capital stock data backward, from a benchmark year we get the following equation by manipulating equation (1) :

$$K_{t-1} = \frac{kt - GI_t}{(1-d)} \quad \ldots\ldots\ldots\ldots \quad (3)$$

Advantages of PIM

Based upon this method, some of the basic advantages of the PIM can be cited: (a) since we have investment data and benchmark year capital stock we can go backward and forward in building capital stock data for each year without interruption, (b) PIM is a convenient method as it uses already available national data, (c) also, capital stock can be estimated for shorter periods than one year, depending upon the availability of investment data for the short periods, and (d) resulting capital stock data can be checked with other benchmark data if it is necessary in correcting or in identifying possible errors.

Limitations of PIM

Due to the difficulty of obtaining perfect information, any estimation method which uses already available data is subject to some drawbacks. PIM is not an exception. PIM departs somewhat from accurate practical estimation of capital stocks partly because of the difficulty of obtaining more accurately defined and/or valued data.

This method is subject to the drawbacks of price indices. Possible drawbacks of PIM (Ward, M. (1976)) in this case are that price indices seldom measure accurately the changes in prices of heterogenous groups of goods and services because of a changing composition of the group even if the quality stays the same. Under this method, the scrap value is taken as zero, but in reality it might also be negative.

Fixed assets are considered to have their original output generating capacity over their lifetime and this might lead to an overestimation of capital

stock data if some of the fixed assets suffer output, and/ or input decay, (for greater detail see Ward, M. (1976)). Although drawbacks can be seen, compared to other methods, this method has great advantages. International economic organizations such as the organization for Economic Cooperation and Development (OECD) with the cooperation of relative governments (Ward, M. (1976)) as well as various governmental agencies and individuals (such as the Bureau of Economic Analysis, U.S. Department of Commerce; Mukherjee, M. (1959)[4]; Goldsmith, R. (1959)) have measured capital stock in various countries using the PIM.

SECTION III

Methodology Used in Measuring Capital Stock in Sri Lanka

Although in his study Rajapaksa, J. (1976) recognized the importance of measurement of capital stock for Sri Lanka and tried to measure the capital stock, he failed to use an appropriate method in finding a figure for a benchmark year capital stock (which in his case, was 1962 capital stock).

Although the PIM is subject to some common limitations such as those caused by the depreciation method used and the price indexing system, it is considered one of the best alternative methods. This study uses PIM in measuring capital stock in Sri Lanka. The time period of study is determined by the availability of consistent and continuous data on investment and the period covers most of the "modern" Sri Lankan economy.

All the capital stock and investment expenditure data given in this study is in millions of 1963 rupees. Five groups of capital stocks, namely land, buildings (residential buildings and non-residential buildings) constructions, transport and machinery are considered. According to the United Nations' *Yearbook of National Accounts Statistics*, the five groups of investment which are consistent with the five groups of capital are as follows :

(a) Land

Net expenditures, including legal and other transfer fees, connected with the acquisition of land. Land is here defined as including land, waters and natural subsoil deposits but as excluding buildings on sites. Land reclamation is included if it represents an addition to total land availability.

(b) Dwelling

Includes expenditures on new construction and major alterations to residential buildings, including the value of the change in work in progress

4. See Goldsmith R. and Saunders C. (1959).

but excluding the value of the land before improvement. Expenditure on all permanent fixtures such as furnaces, fixed stoves, central heating and water supply installations is also included.

(c) Non-Residential Buildings

All buildings other than dwellings. It includes industrial buildings warehouses, office buildings, stores, restaurants, hotels, farm buildings and buildings for religious, educational and similar purposes. Major alterations and work in progress are included. Movable equipment which is not an integral part of the structure is not included.

(d) Other Constructions and Works

New constructions and major alterations and repairs are those such as : permanent ways of railroads, subways and tunnels, marine constructions, piers and other habour facilities, car parking facilities, airports, athletic fields, roads, streets, and sewers, electricity transmission lines, gas mains and pipes, and communication systems such as telephone and telegraph lines, etc. Large expenditures by farmers for irrigation projects, flood control, forest clearance, land reclamation resulting from flood, etc., should be included.

(e) Transport Equipment

Ships, motor cars and aircraft for commercial use, trucks and commercial vehicles, tractors for road haulage, vehicles used for public transport systems, railway and tramways rolling stock, carts, and wagons are included.

(f) Machinery and Other Equipment

All capital expenditure not included in the above groups is included in this one. It includes power generating machinery, agricultural machinery and implements, tractors (other than for road haulage), office machinery and furniture, metalworking machinery, mining, construction and other industrial machinery and equipment and instruments used by professional persons.[5]

The capital stock data of each group is based on these investment groups. Total capital stock is estimated by summing up all these five categories of capital goods.

SECTION IV

Estimates of Capital Stock in Sri Lanka in 1958-78

Table 1, presents the estimates of various types of capital stock for the period of 1958-78 in Sri Lanka in millions of 1963 rupees.

5. United Nations *Yearbook of National Accounts Statistics*. 1969. v. 1. p. xxiii - xxiv.

In Table 2, the real capital, real output, and capital/output ratio in Sri Lanka 1958-78 in millions of 1963 rupees are presented.

Table 3, presents the investment expenditure in Sri Lanka from 1958-78 in millions of 1963 rupees. These figures are the bases for Table 1.

SECTION V

Capital and Investment Data

A. Land

The total acreage of land is taken from Richards, P and Stoutjesdijk, E. (1970). Total land is divided into 7 main categories in this study in order to find a better general evaluation for land. These categories are: tea, rubber, coconut, paddy, sugar, other cultivations and with forest, grass and other lands grouped together. The acreage of land groups are shown in Table 4. The sources of data for each group for the year 1977 which is considered as the benchmark year, is given below :

Tea, rubber, coconut and paddy acreage were taken from the Central Bank of Ceylon (1977) *Review of the Economy*, Table 12. Sugar acreage of 1977 is abstracted from *Economic and Social Statistics of Sri Lanka* (1978) Table 5.7. (This figure is the sugar harvested area). The other cultivations such as cocoa, cinnamon, cardomons, citronella, pepper, manioc, maize, chillies, onions, etc. is taken from Table 4.4 and Table 4.7 of *Economic and Social Statistics of Sri Lanka* (ibid.). Except for cocoa, cinnamon, cardomons, citronella and pepper the other acreages are taken from the 1976/77 figures. The item of forest grass and other land are taken as the residual.

The rupee value of each category of land is calculated by multiplying the acreage of each category by its average price per acre using 1977 market prices and then adjusting that figure into 1963 prices by using the land price index. (This index is taken from the UN *Yearbook of National Accounts Statistics.*)

The investment on land is taken from the *Yearbook of National Accounts and Statistics* (1967, 1972, 1977 and 1979) for the periods of 1958-66, 1967-71, 1972-75 and 1976-78, respectively. In this calculation the average rate of depreciation is considered zero and the equations become :

$$(a) \quad K_t = K_{t-1} + GI_t$$

for the capital stock for land after 1977 carried forward.

$$(b) \quad K_{t-1} = K_t - GI_t$$

for the capital stock of land before 1977 carried backward.

B. Buildings

As the investment data is not available for the full 80 years which is the assumed life span of the buildings the following technique is used to estimate a benchmark year capital stock :

$$\beta = \frac{K_2}{Y_2} = \frac{\Delta K_2}{\Delta Y_2}$$

where K_2 = capital stock of buildings

Y_2 = income of buildings (in this case rent)

where β stands for both marginal and average ratios.
by definition :

$$\Delta K_2 = I_2 + dK_2$$

where ΔK = the change in capital stock of buildings. I_2 is the investment of buildings, and d is the depreciation rate. By manipulating the figures we obtain :

$$\beta = \frac{g_2}{g_2 + d \quad \Delta \frac{I_2}{Y_2}}$$

where $g_2 = \frac{\Delta Y_2}{Y_2}$ (in this case the growth rate of rent).

Therefore, if I and Y series are available, based on this formula, we can obtain the capital output ratio. Due to the absence of data on income (rent) for total investment in buildings (including both non-residential and residential), the value for residential dwellings can only be estimated.

In estimating the total capital stock of dwelling it is considered that 77.6% of total buildings are residential buildings and 22.4% are non-residential (see UN *Statistical Yearbook*, p. 263). Although the life span of non-residential buildings is considered shorter than for residential buildings, the same life span is assumed for non-residential buildings in this study. The justification for this is that the high percentage of non-residential buildings are hospitals, institutions and office buildings (see Department of Census and Statistics, *National Accounts of Sri Lanka*, 1970-77, Table 15).

The investment data of buildings at 1963 prices are found in the United Nations *Yearbook of National Accounts* 1968 v. 1, 1977, v.l and 1979 v. 1 for the periods 1958-67, 1968-76 and for 1976-78, respectively.

The income from residential dwellings has been taken from the Department of Census and Statistics, *National Accounts of Sri Lanka* (1963-68) for the period 1963-68. Using the GNP at 1963 prices the income of residential dwellings before 1958 is extrapolated. For the sources of GNP prior to 1958 see details of construction. The extrapolated values of income of residential dwellings can be justified by comparing the income of residential dwellings after 1963 which are shown in *National Accounts of Sri Lanka* (1963-68) with the income of residential dwellings which has been extrapolated by using the GNP at 1963 prices. Both figures were equal.

Assuming an 80 year life span, d is equal to .025. We thus (by using the investment of residential dwelling at 1963 prices and the income of residential dwellings at 1963 prices) obtain the benchmark year (1958) capital stock of residential buildings, namely 1470.16 (millions of 1963 rupees). The total capital stock of buildings, both residential and non-residential buildings in 1958 was found to be 1909.3 (in millions of 1963 rupees). Here, the percentage of residential dwellings of the total dwelling is assumed as 77.6% (see *National Accounts of Sri Lanka* 1970-77, Table 15).

C. Construction

The assumed average life-span for construction is 40 years and d is equal to 0.5. The difficulty of gathering investment data of construction for over 40 years is solved as follows: since the ratio of real investment of construction to constant GNP stayed approximately .02 over 27 years (from 1950-77) when using this ratio the real investment for construction for the period of 1939-50 are extrapolated in order to compile the capital stock of construction for the benchmark year 1978. The real gross national product for the period 1937-50 are found from Rasaputram, W. (1964), p. 99, the nominal GNP data for the periods 1933-38 is found in Rasaputram, W. (1964) and for the periods 1944, 1947, 1950-55 and 1956-57 nominal were found in *Statistical Yearbook* (1951, 1957 & 1960) respectively. For the remaining years the data was extrapolated. The investment data for the period 1950-51 were taken from the *Yearbook of National Accounts and Statistics* (1957) and for the period 1952-57 were from the same source (1959). The investment data for the period 1958-78 were taken from the *Yearbook of National Accounts and Statistics* v. 1 (1968, 1977 and 1979), respectively. The benchmark year is found as 1978 and the relevant capital stock is found as 4120.6 millions of 1963 rupees.

D. Transport

The assumed life-span for transport is 15 years and d (as average rate of depreciation) is found to be .13. Basic investment data at 1963 prices are taken from the same sources in the category of buildings for the period 1958-78. Thus the relevant capital stock of the benchmark year (1978) equaled 2422.1 (in millions of 1963 rupees).

E. Machinery

The life-span is assumed as 20 years and the relevant d can be equal to .1. The source of investment expenditure data and the price deflator are the same as in the category of buildings for the period 1958-78. The benchmark year (1978) capital stock of machinery is 4704.9 (in millions of rupees).

TABLE I

Estimates of Capital Stocks in Sri Lanka (1958-1978)
(in millions of 1963 rupees)

Year	K_1 *Land*	K_2 *Buildings*	K_3 *Constructions*	K_4 *Transport*	K_5 *Machinery*
1958	8569.2	1909.3	2720.1	4100.8	5469.7
1959	8641.5	2291.9	2752.5	3706.6	5133.8
1960	8715.7	2694.9	2793.5	334.1	4804.9
1961	8789.5	3058.3	2835.2	2970.2	4538.2
1962	8867.5	3418.9	2880.9	2669.9	4321.4
1963	8943.5	3761.9	2941.9	2416.2	4178.3
1964	9026.7	4111.7	2972.8	2184.3	4048.3
1965	9105.8	4420.0	3017.3	1989.1	3871.0
1966	9179.2	4788.7	3047.6	1825.0	3690.7
1967	9252.3	5153.7	3108.4	1690.3	3555.0
1968	9386.3	5639.6	3184.4	1538.3	3474.4
1969	9518.3	6237.4	3275.0	1563.3	3589.3
1970	9671.3	6923.7	3355.8	1507.6	3644.1
1971	9842.3	7700.6	3330.2	1444.4	3669.1
1972	9977.3	8505.2	3348.8	1434.9	3656.1
1973	10148.3	9123.5	3509.5	1459.3	3564.5
1974	10296.3	9667.7	3639.6	1571.8	3598.7
1975	10480.3	10100.3	3764.4	1697.7	3778.9
1976	10676.3	10534.2	3904.3	1870.7	3986.8
1977	10919.7	11056.2	4001.0	2027.8	4218.1
1978	11145.5	11611.5	4120.6	2422.1	4704.9

Note : The estimates of benchmark year capital stock and the sources of real investment series and the depreciation rate for each capital good are discussed earlier in this section.

TABLE 2

Total Real Capital, Real Output and Capital Output Ratio in Sri Lanka (1958-78)

(in millions of 1963 rupees)

Year	*K* *Total Capital*	*Y* *Output*	*K/Y* *Capital Output Ratio*
1958	22769.1	5900.7	3.858
1959	22526.3	6213.8	3.625
1960	22343.1	6554.1	3.409
1961	22191.4	6672.9	3.325
1962	22158.6	6822.1	3.248
1963	22241.8	7295.2	3.049
1964	22343.8	7529.9	2.967
1965	22403.2	7725.3	2.900
1966	22531.2	8070.3	2.792
1967	22759.7	8517.2	2.672
1968	23223.0	8817.8	2.633
1969	24183.3	9135.2	2.647
1970	25102.5	9507.9	2.640
1971	25986.6	9550.9	2.721
1972	26922.3	9856.3	2.731
1973	27805.1	10227.8	2.718
1974	28774.1	10623.4	2.708
1975	29821.6	10918.6	2.731
1976	30972.3	11256.0	2.751
1977	32222.8	11738.1	2.745
1978	34004.6	14939.6	2.276

Note : $K = K_1 + K_2 + K_3 + K_4 + K_5$

Source : Real GNP is taken from *Statistical Yearbook for Asia and the Far East* (1968) and Central Bank of Ceylon *Annual Report* (1977) and (1978). For others see Table A-III-1 and Table A-III-3.

TABLE 3

Investment Expenditure in Sri Lanka for 1958-78

(in millions of 1963 rupees)

Year	*Land*	*Buildings*	*Construcion*	*Transport*	*Machinery*
1958	72.30	383.9	181.7	150.0	216.6
1959	74.22	430.4	168.4	138.9	210.9
1960	73.81	460.3	178.6	109.4	184.6
1961	78.14	430.8	181.4	69.5	213.8
1962	76.02	437.0	187.4	85.8	237.8
1963	83.20	428.5	205.0	93.4	289.0
1964	79.12	443.8	178.0	82.2	287.9
1965	73.43	411.1	193.1	88.8	227.4
1966	73.11	479.2	181.2	94.5	206.8
1967	134.0	484.6	213.2	102.6	233.4
1968	132.0	614.8	231.7	67.8	274.9
1969	153.0	738.8	249.5	225.0	462.3
1970	171.0	842.2	244.5	147.6	413.7
1971	135.0	950.0	142.2	132.8	390.4
1972	171.0	997.1	185.1	178.3	353.3
1973	148.0	831.0	328.1	210.9	274.0
1974	184.0	772.2	305.5	302.2	390.6
1975	196.0	674.3	306.8	330.3	540.1
1976	243.4	686.4	328.1	393.7	585.8
1977	186.7	785.4	291.9	400.3	630.0
1978	225.8	831.7	319.7	657.9	908.7

Source : *Yearbook of National Accounts Statistics* (1968, v. 1; 1977- v. 1, 1979- v. 1).

TABLE 4

Land Use in Sri Lanka (1977)

Plantation Crops	
Tea	598,000
Rubber	559,850
Coconut	1,152,418
Sugar	11,326
Peasant Crops	
Paddy	2,046,000
Other	746,687
Forest Grass and Other	10,883,719
Total Land Area	15,998,000

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