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DERIVATION OF A TOTAL NET CAPITAL STOCK SERIES FOR MALAYSIA, 1955 – 2004

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ABSTRACT

The stock of capital provides information on the productive capacity of a country, and is used to calculate capital-output ratios and measures of profitability. Official data on capital stock for Malaysia are not available, and a number of studies have attempted to derive the series. This paper discusses the derivation of a total net capital stock series for Malaysia for the period 1955-2004. The derivation requires estimates of real gross fixed capital formation and assumptions about the depreciation rate and the starting value. Nine variants of capital stock are estimated by the perpetual inventory method, and are compared against other derived series.

Keywords: capital stock, gross fixed capital formation, perpetual inventory method.

1. INTRODUCTION

The contribution of capital to production can be measured both as a stock as well as a flow (OECD, 2001, p. 9), where the flow of services is that derived from the stock of physical assets. These services are the input into the process of production from a fixed capital asset. It is, however, difficult to quantify these services directly. Hence, it is the capital stock that is measured. The stock of capital can be used as a broad indicator of the productive capacity of a country, and is used to calculate capital-output ratios and measures of profitability such as profit rates. It is also used as a measure of input in studies of growth and investment functions, although it has been noted that in this context the flow of services from stock of physical assets would be more appropriate (OECD, 2001, p. 32).

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Estimates of capital stock are considered important enough that many countries produce such estimates officially as part of their National Accounts. Jaffey (1997) notes that the national estimates of fixed capital comprise four vital measures: investment, the most dynamic component of gross domestic product (GDP); the gross capital stock, which determines national output capacity; the net stock, the value of future capacity and a large part of measured national wealth; and capital consumption, the annual amount by which net capital stock shrinks, through wear-and-tear and obsolescence.

There are, however, a great many concerns related to measurement and estimation of capital stock for a series. A conference on this issue noted that[1], "There was a significant degree of commonality in the problems reported by countries concerning their current systems for deriving capital stock estimates. These problems included: (a) lack of empirical data directly relevant to individual countries on asset service lives for different types of assets; (b) inadequate dissection of estimates by type of equipment; (c) privatisation - difficulty of satisfactorily implementing inter-sectoral capital stock adjustments; (d) difficulties in redistributing capital stock acquired through financial leases to industry of use; (e) lack of data on second-hand transactions; and (f) inadequate treatment of extraordinary events and unforeseen obsolescence."

Official data on capital stock for Malaysia are not published as part of the National Accounts by the Department of Statistics, Malaysia (DOS). Nevertheless, capital stock has been estimated in various ways, as the need arises and in specific research contexts. More recently, the increased interest in studies of total factor productivity has led to capital stock series being constructed for a large number of countries, including Malaysia, to facilitate cross-country comparisons of growth and productivity. This paper describes the derivation of a net capital stock series for Malaysia for the period 1955 – 2004. The discussion first provides some important definitions and then describes the methodology for deriving capital stock. Previously derived series for Malaysia that have been published are then examined. The data sources are then discussed and several derived series of capital stock based on different assumptions are

[1] *Summary Record of the Conference on Capital Stock Measurement, Canberra, 10-14 March, 1997*. These issues, and others regarding measurement of capital stock in a number of countries were presented in a number of papers at the Conference. The discussions cover concepts in both economics and statistics. See
http://www.oecd.org/document/63/0,2340,en_2825_500246_1876351_1_1_1_1,00.html.
[Accessed August 15, 2005]

presented. The note concludes with an evaluation and selection of the most appropriate capital stock series.

2. CONCEPTS AND METHODOLOGY

The capital stock of a country is a measure of the value of fixed assets. It is part of the System of National Accounts (SNA) of a country. The design and structure of the SNA draw on economic theory and principles as well as business accounting practices. Basic concepts such as production, consumption and capital formation are rooted in economic theory. When business accounting practices conflict with economic principles, priority is given to the latter, as the SNA is designed primarily for economic analysis and policy-making. A number of definitions are first presented and discussed before the methodology for estimating capital stock is described.

2.1 Definitions and Concepts [2]

Gross fixed capital formation, I^G, is a measure of investment. It is the total value of a producer's acquisitions, less disposals, of fixed assets during the accounting period plus certain additions to the value of non-produced assets (such as land or subsoil assets) realized by the productive activity of institutional units.

Gross capital formation is measured by the total value of gross fixed capital formation, changes in inventories and acquisitions less disposables of valuables for a unit or sector.

Net fixed capital formation, I^N, consists of gross fixed capital formation less consumption of fixed capital.

Gross capital stock, K^G, represents accumulated investment less the accumulated value of the assets no longer in operation (that is, retired). It is measured as the value of all fixed assets still in use when a balance sheet is drawn up, at the actual or estimated current purchasers' prices for new assets of the same type, irrespective of the age of the

[2] This section is based on the description of the SNA in the data and statistics site of the World Development Indicators (WDI), http://www.worldbank.org/data/archive/wdi/tab4_1.htm, DOS (2004:, p. 139-153) and OECD (2001).

assets. Fixed assets include equipment, structures, land, and inventories. Financial capital is excluded.

Consumption of fixed capital or depreciation, D, represents the reduction in the value of the fixed assets used in production during the accounting period resulting from physical deterioration, normal obsolescence or normal accidental damage.

Net capital stock, K^N represents accumulated investment less retirements and accumulated depreciation for assets still operating (that is, gross capital stock less accumulated depreciation on assets still in operation). It is measured as the sum of the written-down values of all the fixed assets still in use when a balance sheet is drawn up. This is essentially a measure of wealth.

At a point in time, t, these quantities are related as follows:

$$K^G_t = K^G_{t-1} + I^G_t$$

$$K^N_t = K^G_t - D_t$$

$$I^N_t = I^G_t - D_t$$

$$K^N_t = K^N_{t-1} + I^G_t - D_t \qquad (1)$$

Capital assets can be valued at three types of prices, historic prices, current prices and constant prices. Historic prices mean that the assets are valued at the prices at which the assets were originally acquired. This is the usual procedure in company accounts. In contrast, for national accounting, the current or constant prices are relevant. Current prices mean that the assets are valued at the prices of the current year, while constant prices mean that the assets are valued at the prices of a selected year.

It is important to understand the distinction between gross and net capital stock. Gross capital stock encompasses the current or constant value of all produced physical fixed assets that are available and used for productive purposes. When a particular asset is eliminated because of sudden destruction, obsolescence or economic inefficiency, the gross capital stock is reduced by this particular asset. Furthermore, not all gross fixed capital formation results in an increase in fixed assets. Major improvements to non-produced assets, such as land improvements, once made, are deemed to be an inseparable part of the value of the land. Since it is capital stock for fixed assets, and not all assets that are being measured, the measurement of capital stock of fixed assets does not include the value of land improvements. Thus, the gross capital stock reflects the maximum available production capacity of fixed assets at a particular point in time.

Net capital stock, on the other hand, provides an estimate of the capacity to produce in the future. It is based on the assumption that new capital goods contain a capacity to produce that will diminish successively through usage, with the reduction appearing as economic depreciation. The estimates of net stocks are then derived from gross stock by making yearly deductions for depreciation.

The measurement of depreciation requires assumptions on asset life, the pattern of retirement and loss of efficiency of the fixed asset over its life. Asset life is determined for each type of asset. The retirement pattern generally follows an assumed functional form. For example, the simultaneous exit mortality function assumes that all assets are retired from the capital stock at the moment they reach the average service life for the type of asset concerned. The loss of efficiency measures the decline in the ability of the fixed asset to provide capital services as it ages, and again a functional form can be determined for each type of asset. However, in practice, the efficiency of the capital asset is assumed to be the same over its service life. Depreciation is also more conveniently estimated as a function of stock using an assumed form of depreciation. Straight-line depreciation is a depreciation profile based on a constant annual amount of capital consumption over the life of the asset, while geometric depreciation is a depreciation profile based on a constant annual rate of capital consumption over the life of the asset.

2.2 A Method for Estimating Capital Stock

There are a number of ways of estimating capital stock (see, for example, OECD, 2001, p. 39) and the level of detail used in the calculation depends on a number of factors such as whether the estimates are being prepared by an official agency or by a researcher in the course of a study, and importantly, what data are available.

Gross capital stock is commonly calculated using the perpetual inventory method.[3] This method produces an estimate of the stock of fixed assets in existence and in the hands of producers by estimating how much of the fixed assets installed because of gross fixed capital formation undertaken in previous years have survived to the current period. That is, it takes into account the continual additions to and subtractions from the stock of capital as new investment and retirement of old capital take place. Both capital formation and discards of assets ("scrapping") are revalued either to the prices of the current year (current prices) or to the prices of a specific year (constant prices).

Net capital stock is usually derived from the gross capital stock by deducting accumulated consumption of fixed capital. Consumption of fixed capital is obtained using a depreciation function such as straight-line or geometric depreciation. The perpetual inventory method requires assumptions on retirement patterns, depreciation and average service lives. The assumptions of simultaneous retirement pattern, straight-line depreciation and average service lives which are fixed over time lead to the usual procedure to estimate the gross capital stock, where depreciation or the consumption of fixed capital is assumed to be a function of previous net capital stock function:

$$D_t = \delta K^N_{t-1}$$

δ is known as the depreciation rate. Then, from equation (1), net capital stock is obtained by subtracting accumulated capital consumption from the gross capital stock:

$$K^N_t = I^G_t + K^N_{t-1} - \delta K^N_{t-1} \qquad (2)$$

For a given type of fixed asset, the use of this expression to derive net capital stock requires data on investment. Usually, I^G_t is taken to be gross fixed capital formation at time t. Selection of the value for δ is determined by the assumed lifetime of the asset as well as the method of depreciation adopted. The application of the method also requires the specification of a starting value for capital stock, K^N_0. Total capital stock is

[3] Jaffey (1997) argues for a reform of this method of estimation since it leads to estimates of investment that "are less inaccurate and informative than they could be". Its greatest advantage is the ease with which capital stock estimates can be derived, in particular in the absence of appropriate data, and at a macro-level.

then the sum of capital stock built up by type of asset. Calculating capital stock by type ensures that the differing lifetimes for services of different fixed assets are taken into account.

A number of alternative ways have been used to estimate initial capital stock, K^N_0:

- The series on investment is carried back long enough to cover the lifetime of all the assets prior to year 0
- K^N_0 is obtained from earlier studies or surveys
- K^N_0 is approximated as a product of the gross domestic product (GDP) for Year 0 and a presumed value (from other studies or information) of the capital-output ratio, since a longer series on GDP are generally available
- K^N_0 is estimated from a version of Harberger's (1978) formula:

$$K^N_0=I_1/(g+\delta) \qquad (3)$$

where I_1 is investment in period 1, g is the growth rate of investment over the subsequent period and δ is the depreciation rate.

The different methods could lead to quite different values of initial capital stock. However, the initial value has a declining influence on the later values of capital stock the longer the calculated series.

The value of δ differs according to the assumed years of life and the growth rate of investment. It affects the estimation of capital stock in that a lower value leads to increased size of the gross capital stock and reduces consumption of fixed capital. It has also been noted that a smaller value has an unpredictable effect on the growth rate and reduces the volatility over time in the growth of stocks (OECD, 2001, p. 52). For equation (3), for a given depreciation rate, the greater the growth of investment, g, the greater the percentage in the denominator, and the smaller the initial value of capital stock for a given initial value of investment. Table 1 from Feu (2004) shows how different lives and growth rates lead to different δ. For example, for any given life, if there were no investment growth, the rate of depreciation would refer only to the initial investment, whereas if there were investment growth, the depreciation rate would be lower reflecting the presence of younger investment in the stock. Very high growth rates of an asset that has a long life, say in construction, imply very low depreciation rates.

Table 1. Equivalent Depreciation Rates for Selected Lives and Investment Growth Rates

Life in Years	Investment Growth Rates					
	0%	1%	2%	3%	4%	7%
10	18,18%	17,91%	17,66%	17,41%	17,17%	16,52%
19	10,00%	9,71%	9,44%	9,19%	8,96%	8,35%
20	9,52%	9,23%	8,96%	8,71%	8,48%	7,88%
40	4,88%	4,58%	4,33%	4,11%	3,92%	3,50%
48	4,08%	3,79%	3,54%	3,33%	3,16%	2,80%
50	3,92%	3,63%	3,38%	3,18%	3,01%	2,67%

Source: Table A2.2, Annex 2, Feu (2004).

3. DERIVING ESTIMATES OF NET CAPITAL STOCK FOR MALAYSIA

The estimation of net capital stock requires data on real gross fixed capital formation by type, and assumptions for a depreciation rate as well as an initial value for capital stock. The distinction between gross and net capital stock is important in that the latter takes into account depreciation, and is therefore an appropriate measure of the productive capacity of an economy. However, in many publications, generally this distinction is not made, and the term “capital stock” is used to refer to “net capital stock.” For the discussion in this section, we follow this practice. It is useful to begin with a discussion of previous published estimates of capital stock for Malaysia and to ascertain the depreciation rates and initial values used in these studies. The data, assumptions about the depreciation rate, and the estimate of initial capital stock used in this study are described next. The section concludes with a discussion of the resulting nine variants of capital stock estimates.

3.1 Previous Estimates of Capital Stock

An early estimate of capital stock by the Department of Statistics, Federation of Malaya, placed the value of capital stock at the end of 1954 in Malaya between six and seven million Malayan dollars (DOS, 1965). No explanation was provided as to how this estimate was derived. Subsequently, various estimates were published during the course of research into growth and investment, all using the perpetual inventory method, but to varying degree of detail in asset structure, different depreciation rates and different initial values for capital stock[4]:

- Snodgrass (1966) used figures on investment, a 3 per cent depreciation rate and the official estimate in 1954 (two values, M$6000 and M$7000 million) to obtain two series on capital stock for Malaya in current prices from 1955-1963.

- Abraham and Gill (1969) built up capital stock in constant 1964 prices by type, building and construction, machinery and equipment and perennial crops with average lives of 40 years, 10 years and 45 years, respectively, producing two series for Peninsular Malaysia (then West Malaysia) from 1959-1966 that differed in the assumptions of growth rates used to carry back the investment series to 1920.

- Nagaraj (1972) obtained estimates in constant 1964 prices by ownership (private, public) and for the same category of investment, building and construction, machinery and equipment and perennial crops with average lives of 50 years, 10 years and 25 years, respectively, producing two series from 1955-1970 for Peninsular Malaysia (then West Malaysia) that differed in the value of initial capital stock.

- Halipah Esa (1990) obtained in a consistent and in-depth fashion series in constant 1978 prices for both Peninsular Malaysia and Malaysia by type and ownership and for differing average lives of perennial crops and buildings.

- Nehru and Dhareshwar (1995) derived capital stock for Malaysia as part of a new database of physical capital stock estimates for a group of 92 developing and industrial countries from 1955 to 1990. Investment series from 1950 onward were

[4] A number of publications (for example, Cheong and Tillman (1976), Tham (1998), Gan and Soon (1998) and Abdul Wahab (2004)) related to studies on the Malaysian economy allude to the use of derived capital stock series. However, at best, the starting values and depreciation rate used are noted; the series are not published, and so are not included here.

obtained for as many countries as possible and these were then aggregated according to the perpetual inventory method. The modified Harberger approach was used to estimate initiate capital stock. Nehru and Dhareshwar calculated net values using a geometric pattern of decay, which has the advantage of giving both survival and depreciation weights at the same time.

- Marquetti (2005) derived capital stock for Malaysia as part of the Penn World Data Set of 152 countries. The series were obtained using the investment series computed from real investment share of GDP. The series includes gross residential capital formation as well as change in stocks, and the assumed asset life is 14 years. Geometric depreciation is assumed, where δ= R/T and R is the factor that defines the degree of declining balance due to depreciation, and T is the average asset life. R was taken to be 1.05 giving a depreciation rate of 7.5 per cent.

3.2 The Data, Depreciation Rate and Initial Capital Stock

Investment

To obtain capital stock series from 1955, it was necessary to carry back the investment series to cover the assumed lifetime of assets. Data on gross fixed capital formation (GFCF) in Malaysia is available in current prices from 1947 in *Malaysia – Economic Time Series 2002* (DOS, 2003). However, data are not available by type for the whole period. Given this constraint, capital stock is estimated as a whole and not built up by type. Prior to 1970, the data refer to gross capital formation, which is GFCF plus change in stocks. Since change in inventories is likely to be small compared to GFCF[5], no adjustment is made either. However, data from 1949-1953 refer to both the Federation of Malaya and Singapore, while data from 1955 – 1962 refer to the Federation of Malaya, and an adjustment was made for this.[6]

Since capital stock refers to a physical quantity, it is important to obtain data on real investment. Real GFCF is available only for selected years from the National

[5] For the period 1971-1978, changes in stocks were 2.8% of GFCF; data from Table 1.2, Dos (2004).

[6] This was about 0.12 in the early 1960s, based on current GDP at market prices, (Table 2-4, *First Malaysia Plan, 1971-1975*, p.25).

Accounts. For the other years, the figures are obtained from the annual *Economic Report* and for the early years from Rao (1976). For the very early years, only current values are available. The various sources of data were matched and a consistent series obtained. These details are summarised in Table 2.

Table 2. Data on Gross Fixed Capital Formation: Source and Units of Measurement

Period	Unit	Source
1947 - 1959	Current prices	DOS (2003)
1960 - 1970	Real 1970 prices	Rao (1976), Table C
1971 - 1981	Real 1970 prices	DOS (1978), DOS (1984)
1981 - 1986	Real 1978 prices	Economic Reports
1987 - 2004	Real 1987 prices	DOS (2004)

To obtain a single GFCF series in 1987 prices, the following steps were taken:

1. Values for 1982-1986 which were in 1978 prices were adjusted to 1987 prices using the ratio of the values between 1987 and 1991 in 1987 prices to these quantities in 1978 prices;
2. Values for 1971-1981 which were in 1970 prices were adjusted to 1987 prices using the ratio of the value of 1981 in 1987 prices to that in 1970 prices.
3. Values for 1960-1981 which were in 1970 prices were adjusted to 1987 prices using the ratio of the value of 1981 in 1987 prices to that in 1970 prices.
4. Values for 1955-1959, which were in current prices, were adjusted using an estimated investment deflator for the period. First, the investment deflator for 1960 was obtained as the ratio of GFCF in 1987 prices to that in current prices. Then assuming that annual changes in the investment deflator between 1955 and 1960 matched those for the implicit GDP

deflator for the same set of years[7], the investment deflator for these years was obtained.

5. Finally, values from 1955 to 1970, which were for Peninsular Malaysia, were adjusted to reflect Malaysia figures, based on ratio of GDP for Sabah and Sarawak to that for Malaysia[8].

To obtain the implicit GDP deflator referred to in step 4 above, real and current values of GDP in purchasers' prices were obtained. GDP in current purchasers' prices is available from the *Malaysia Economic Statistics - Time Series 2002* for the years 1955 – 2002. Data for real GDP is available from various official publications on the National Accounts. Table 3 shows the details. The implicit deflator was obtained as the ratio of the current GDP to real GDP. The 1964, 1970, and 1978 values were brought up to 1987 prices using the overlapping values. The overlap years 1987-1997 also provided information on an adjustment factor that was applied since the values for the two series were slightly different.

Table 3. Data on Real GDP in Purchasers' Prices: Sources and Units of Measurement

Period	Unit	Source
1947 - 1959	Current prices	DOS (2004)
1955 - 1972	Real 1960 prices	Tan (1976), Table A
1970 - 1978	Real 1970 prices	National Accounts
1978 - 1997	Real 1978 prices	National Accounts
1987 - 2004	Real 1987 prices	National Accounts

Figure 1 shows the implicit GDP and GFCF deflators from 1955 – 2004. The two deflators follow together closely for the period 1970 to 1990, but before 1970 and after

[7] The investment deflator can be quite different from the implicit GDP deflator. Hence, there is a need to use constant values of GFCF from the National Accounts rather than deflate the current GFCF series with the implicit GDP deflator. Here we have assumed that *changes* in the two series are the same. Given that it affects only a few values at the beginning of the series, this assumption is not likely to have a large impact.

[8] This ranged from 0.12 in the early 1960s to 0.15 in 1970, based on current GDP at market prices (Table 2-4, *First Malaysia Plan, 1971-1975*, p.25). The values from 1955-1963 were adjusted upward by 0.12, and then an increasing adjustment factor was used for the rest of the data to reach 0.15 in 1970.

1990 the GDP deflator (a measure of overall price for the economy) lies above the investment deflator. This suggests that since the 1990s, investment price has been declining.[9]

Figure 1. Implicit GDP and Investment (INV) Deflators, 1955-2004
Base Year: 1987

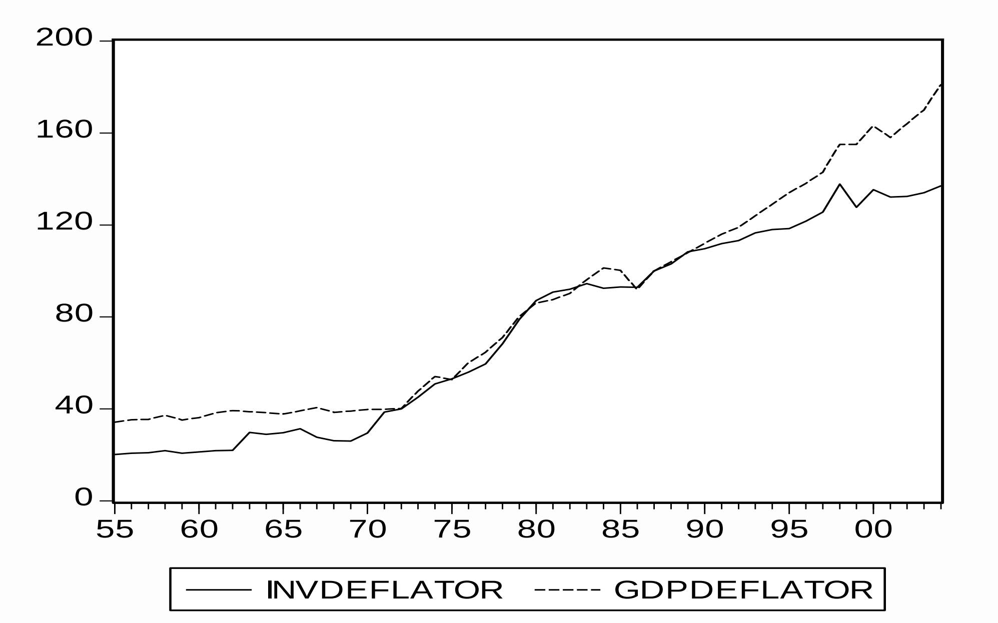
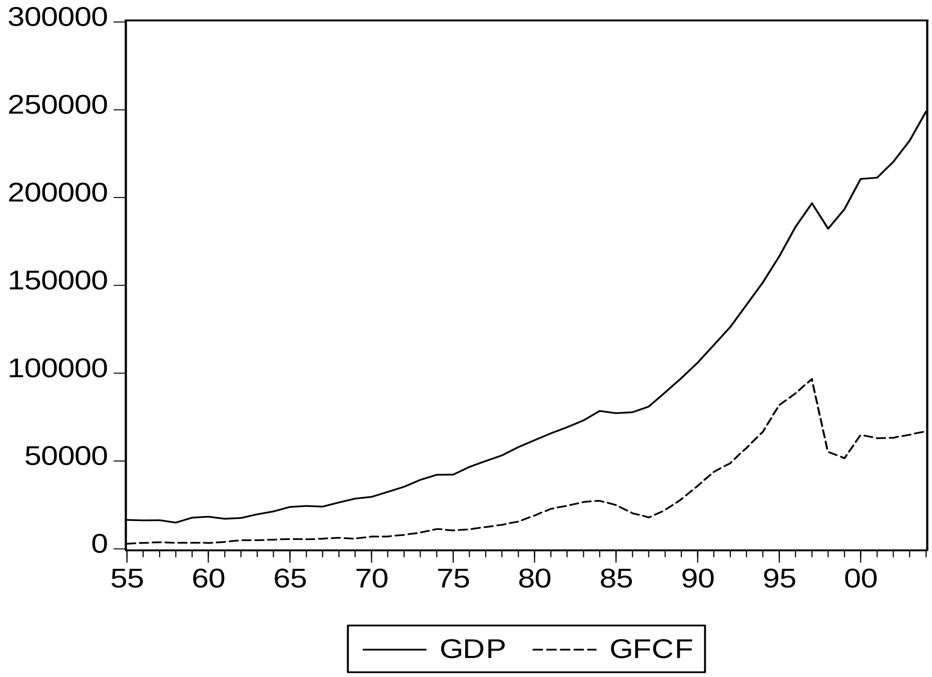


Figure 2 shows real GFCF against real GDP for the same period. Real GFCF follows a more gradual path that appears somewhat similar to that observed for real GDP until 1997. Real GFCF declined sharply in 1998 and since then has seen only a slow increase, leading to apparent divergence between growth and investment.

[9] Investment prices can be obtained as the ratio of the investment deflator to the GDP deflator. See, for example, Servén (1998).

Figure 2. Real GDP in Purchasers' Prices and Real GFCF, 1956-2003, Base Year: 1987

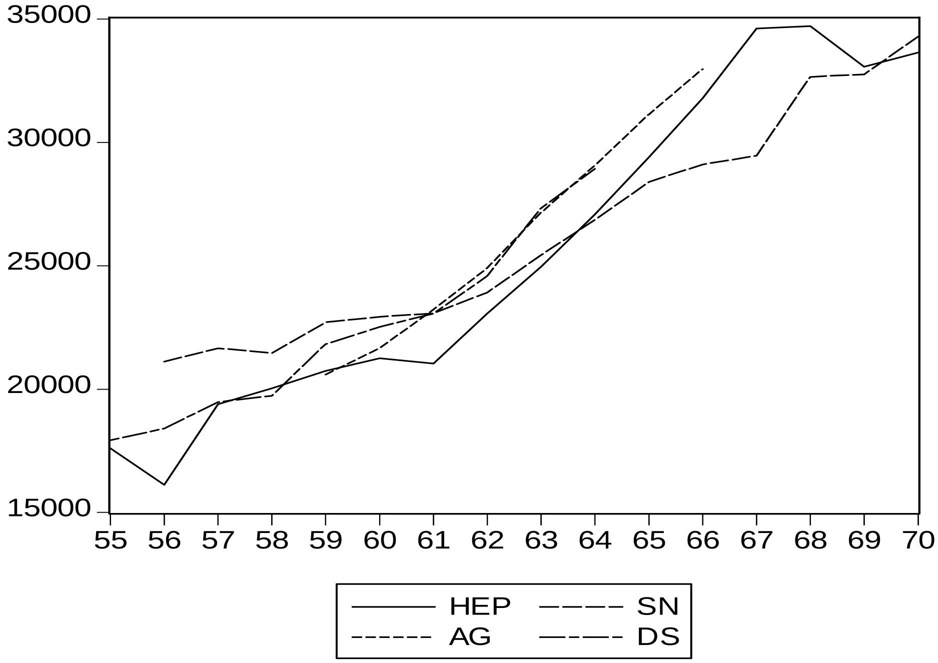


Depreciation Rate

The depreciation method used in this study is straight-line depreciation, which is a depreciation profile based on a constant annual amount of capital consumption over the life of the asset. A simultaneous retirement pattern is assumed for all assets that have served out their lifetimes. In the absence of data broken down by type of assets, one value is used for the depreciation rate, δ, in relation to the whole capital stock. This is then effectively an average of the depreciation rates by type of assets weighted by their proportion in the composition of capital stock.

To decide on an appropriate depreciation rate for the entire capital stock, it is useful to first examine the values used in the earlier estimates of capital stock of various authors as discussed in Section 3.1 above. Figure 3 compares the capital stock series for Peninsular Malaysia derived by Snodgrass (1966) (DS), Abraham and Gill (1969) (AG), Nagaraj (1972) (SN) and Halipah (1990) (HEP). The data were all converted to a common constant price series with base year 1987, by first converting the real series to current series (using deflators provided in the respective papers) and then deflating by the implicit GDP deflator with 1987=100. It is important to remember that aside from Snodgrass, these other series were built up by type of assets. All four series show rapid growth, but the Snodgrass and Abraham and Gill series show more rapid increase than the other two.

Figure 3. A Comparison of Estimated Capital Stock Series, Peninsular Malaysia*, 1955-1970 (1987 RM Million), Various Authors



* Historically West Malaysia or Malaya.

DS. Series from Snodgrass (1966), Table 1, Variant 1, current values deflated by the 1987 implicit GDP deflator.

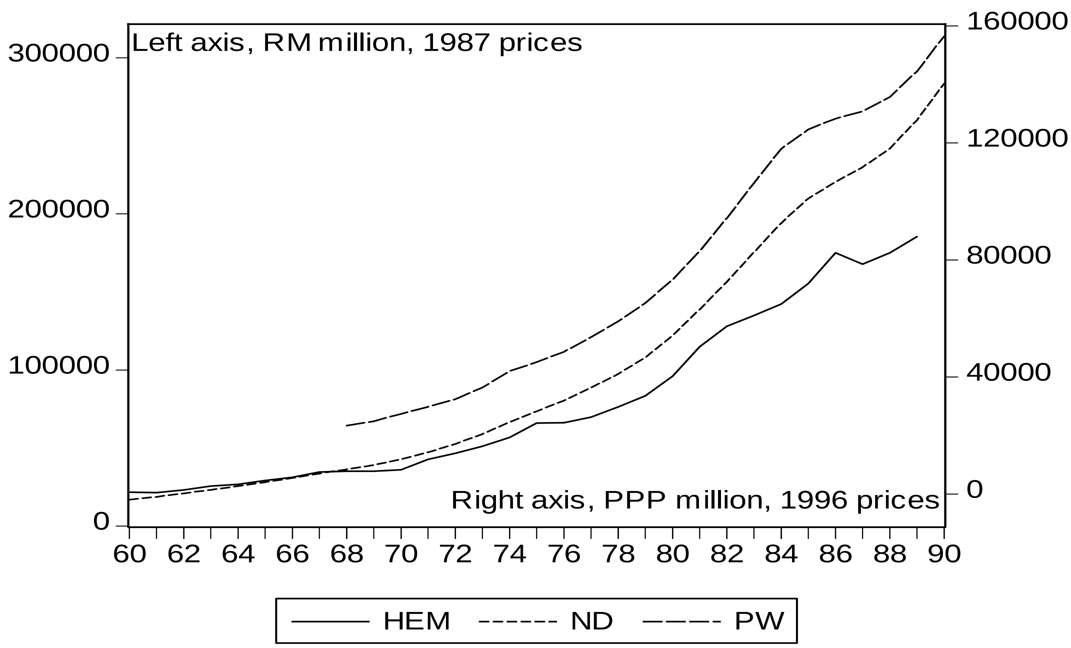
AG. Series from Abraham & Gill (1969), Variant I, converted to current values using 1964 deflator reported in Nagaraj (1972), then deflated by 1987 implicit GDP deflator.

SN. Series from Nagaraj (1972), Variant II, converted to current values using reported deflator, adding starting value from Snodgrass (1966) then deflated by 1987 implicit GDP deflator.

HEP. Series from Halipah (1990), Variant I, converted to current values using reported deflator, then deflated by 1987 implicit GDP deflator.

Figure 4 compares the series derived for Malaysia by Halipah (1990) (HEM), Nehru and Dhareshwar (1995) (ND) and Marquetti (2005) (PW). The ND series are in 1987 Ringgit Malaysia, while Halipah's series have been converted to 1987 prices. Marquetti's series which are in 1996 purchasing power parity (PPP) values are on the secondary axis. Only Halipah's (1990) series were built up by type. The rapid rise in the ND series suggests that the depreciation rate used by Nehru and Dhareshwar is much lower than that used by Halipah. The Nehru and Dhareshwar and the Marquetti series grow at about the same pace.

Figure 4. A Comparison of Estimated Capital Stock Series, Malaysia 1960-1990 (1987/ 1996 prices), Various Authors

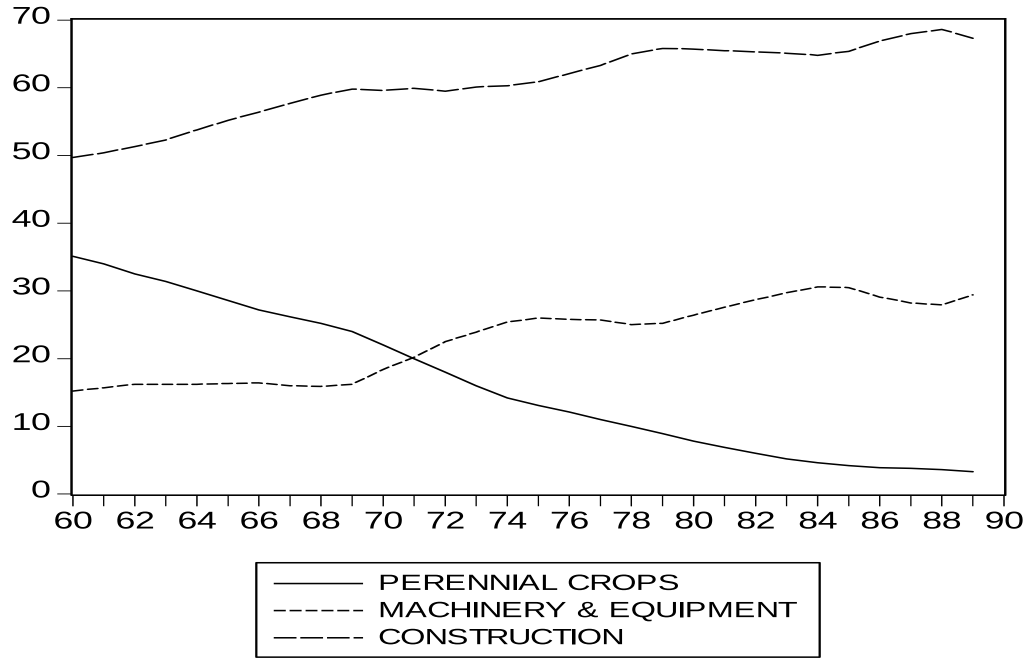


HEM. Series from Halipah (1990), Variant I, converted to current values using reported deflator, then deflated by 1987 implicit GDP deflator.
ND. Series from Nehru and Dhareshwar (1993), valued in 1987 RM.
PW. Series from Penn World Data Set, Marquetti (2005), valued in 1996 PPP.

As seen in Figures 3 and 4, the depreciation rate has a considerable effect on the growth and level of the capital stock series. The series estimated by type of asset used (AG, SN, HEP and HEM) are based on approximation of lives as supported by evidence from surveys and studies. For machinery and equipment, Abraham and Gill and Nagaraj both assumed a life of 10 years, while Halipah tried both 8 and 10 years. For construction, Abraham and Gill used 40 years and Nagaraj 50 years, while Halipah tried both values. For perennial crops, Abraham and Gill used 45, Nagaraj used 25 (based on replanting practices) while Halipah tried both values as well as 33 years.

It is quite likely that overall depreciation rates over time have increased, given the increase in investment in machinery and equipment (shorter assets lives) and the decrease in investment in perennial crops (longer asset lives). Figure 5 shows the share in capital stock of the three types of assets, machinery and equipment, construction and perennial crops from Halipah's (1990) work. The decline of the share of perennial crops is substantial. And thus, it is to be expected that the depreciation for the whole capital stock would be largely based on the rate used for construction and for machinery and equipment, both of which show an increasing trend in share over time. Indeed over the period of the series of Nagaraj (1972), the implied depreciation rate for the entire capital stock went up from about 4.5 per cent in 1957 to 6 per cent in 1970, while that for the series of Halipah (1990) (assuming 10 years for machinery and equipment, 50 years for construction and 25 years for perennial crops) went up from 3.8 per cent in 1955 to 6.8 per cent in 1989. Both figures for the latter period are close to the 5.6 per cent suggested by the estimates of Cheong and Tillman (1976, p. 17) for the investment function based on quarterly data for 1967 to 1974.

Figure 5. Composition of Capital Stock, Malaysia, 1955-1989



Source: Data from Halipah (1990).

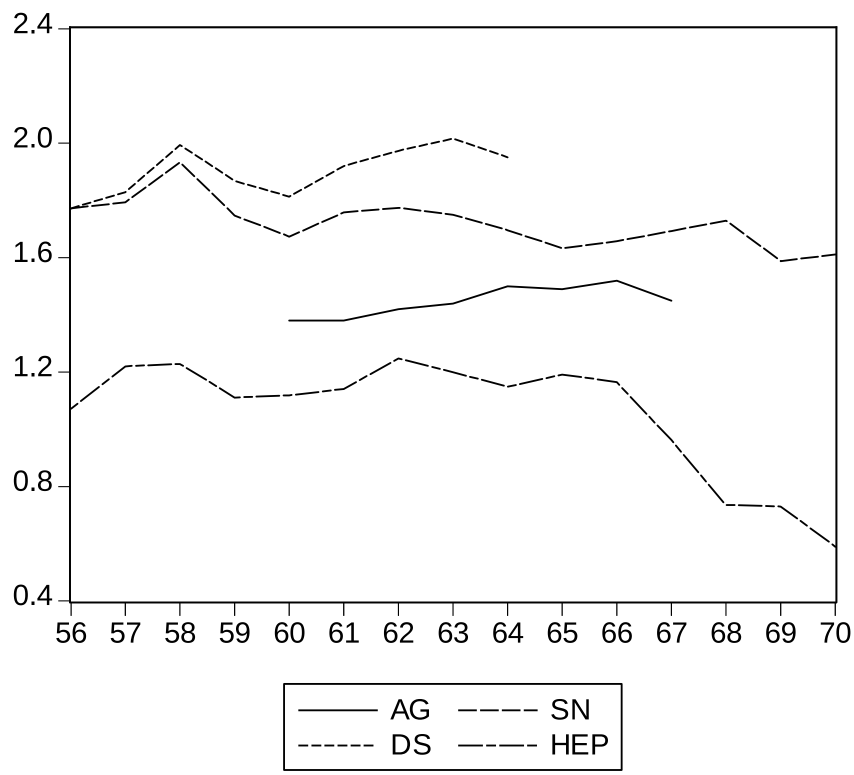
Based on the discussion above, it is expected that 7 per cent would be an appropriate depreciation rate. However, in the derivation of capital stock, three values are compared: 6 per cent, 7 per cent and 8 per cent.

Initial Value of Capital Stock

The initial value of capital stock can be obtained in various ways as noted earlier in Section 2.2. To summarise, we can use an extended series on investment that covers the lifetime of all assets; a previously known value; obtain an estimate from a known capital-output ratio; or use the modified Harberger formula. Since obtaining reliable information on investment extended back in time was not expected to be easy, only the other three approaches were used.

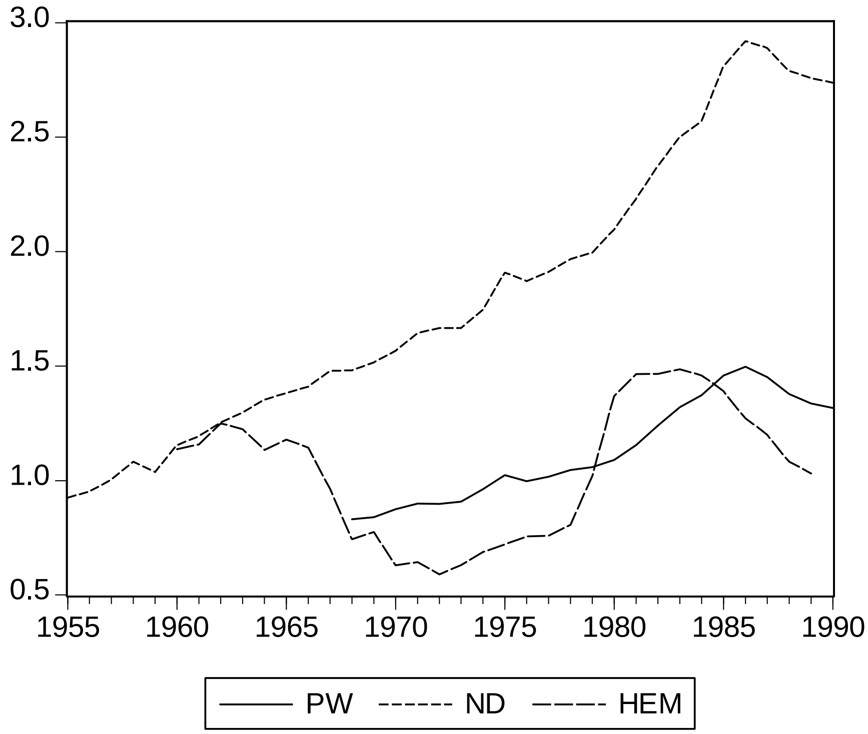
Figure 6 and 7 show the capital-output ratios for the capital stock series described in Figures 3 and 4 above. These are the original values if reported, and where not reported, they have been calculated from GDP values provided in the reports to ensure consistency in the calculation using the data set as available at the time of the original study. The capital-output ratios estimated for the Peninsular Malaysia data are not too different across authors in terms of size, although differences in evolution may be observed. On the other hand, the ND and PW series show a marked increase especially from the 1970s. The values in these two series are also quite different from the ones obtained for Malaysia by Halipah (HEM). Table 4 shows the values of capital stock and capital-output ratio obtained by various authors. Based on the values shown here, a value of 1.5 was chosen for the capital-output ratio in 1955.

Figure 6. Capital-Output Ratios, Peninsular Malaysia* 1955-1970, Various Authors



*Historically West Malaysia or Malaya.
DS. Series from Snodgrass (1966).Table 1, based on Capital Stock Variant 1.
AG. Series from Abraham & Gill (1969), Table 5.
SN. Series from Nagaraj (1972)
HEP. Calculated from values of capital stock Variant I (Halipah, 1990).

Figure 7 Capital-Output Ratios, Malaysia, 1955-2000, Various Authors



HEM. Capital Series from Halipah (1990), Variant I for capital stock, GDP factor cost, this study

ND. Computed from capiatl stock and output from Nehru and Dhareshwar (1993).

PW. Computed from capiatl stock and output from Penn World Data Set, Marquetti (2005).

The known previous value was taken to be an average of the values estimated by various authors for 1995, adjusted to 1987 prices. These are shown in the fourth column of Table 4.

To apply the modified version of the Harberger formula, the growth rate for investment for the period from 1955-2004 was estimated by regressing the natural log of real gross fixed capital formation on time. This yielded an estimate of 8.1 per cent.

Table 4. Capital Stock Estimates for Peninsular Malaysia (1987 RM million) and Capital-Output Ratios, Various Authors, Years

Author	Year^	Value* (RM million, 1987=100)	Capital-Output Ratio
Nagaraj (1972)	1956	RM21,113	1.14
Halipah (1990)	1960	RM17, 604	1.77
Snodgrass (1966)	1955	RM17, 647	1.73
Abraham and Gill (1969)	1959	RM20, 594	1.58

*Original values converted to current values using author's implicit GDP deflator, and then converted to 1987 prices using the deflator derived in this study
^For first year available in study closest to 1955.

3.3 Estimates of Capital Stock

Estimates of capital stock were derived using equation (2) for each of the three different methods for initial capital stock and for each of the three depreciation rates. The specific values are noted in Table 5. This yielded nine different series of capital stock series from 1955 (1956 for the series using the Harberger method for initial capital stock). These are:

- Variant A, obtained using an average of previous estimates as initial value and each of the three depreciation rates, A6, A7, A8, respectively;
- Variant B, obtained using an estimate for initial value based on the capital-output ratio and each of the three depreciation rates, B6, B7, B8, respectively; and
- Variant C, obtained using an estimate for initial value based on a modified version of the Harberger's formula and each of the three depreciation rates, C6, C7, C8, respectively.

Table 5. Assumed Values and Methods for Estimation of Capital Stock for Malaysia

Variant Name	Method	Assumed Values	Data*	Capital Stock in 1955/1956 (RM million in 1987 prices)	Depreciation Rate
A6	Previous Studies		Based on average in column 3 of Table 4	21,548	6%
A7	Previous Studies		Based on average in column 3 of Table 4	21,548	7%
A8	Previous Studies		Based on average in column 3 of Table 4	21,548	8%
B6	Based on Capital-Output Ratio	Capital-Output Ratio = 1.5	GDP in 1987 prices, RM million: 13696 in 1955	20,544	6%
B7	Based on Capital-Output Ratio	Capital-Output Ratio = 1.5	GDP in 1987 prices, RM million: 13696 in 1955	20,544	7%
B8	Based on Capital-Output Ratio	Capital-Output Ratio = 1.5	GDP in 1987 prices, RM million: 13696 in 1955	20,544	8%
C6	Equation (3)	$g = 0.08$ $\delta = 0.06$	GFCF 1987 prices, RM million in 1955: 2938	20,840	6%
C7	Equation (3)	$g = 0.08$ $\delta = 0.07$	GFCF 1987 prices, RM million in 1955: 2938	19,460	7%
C8	Equation (3)	$g = 0.08$ $\delta = 0.08$	GFCF 1987 prices, RM million in 1955: 2938	18,251	8%

*Values for Peninsular Malaysia adjusted upwards to Malaysia by a factor of 1.12

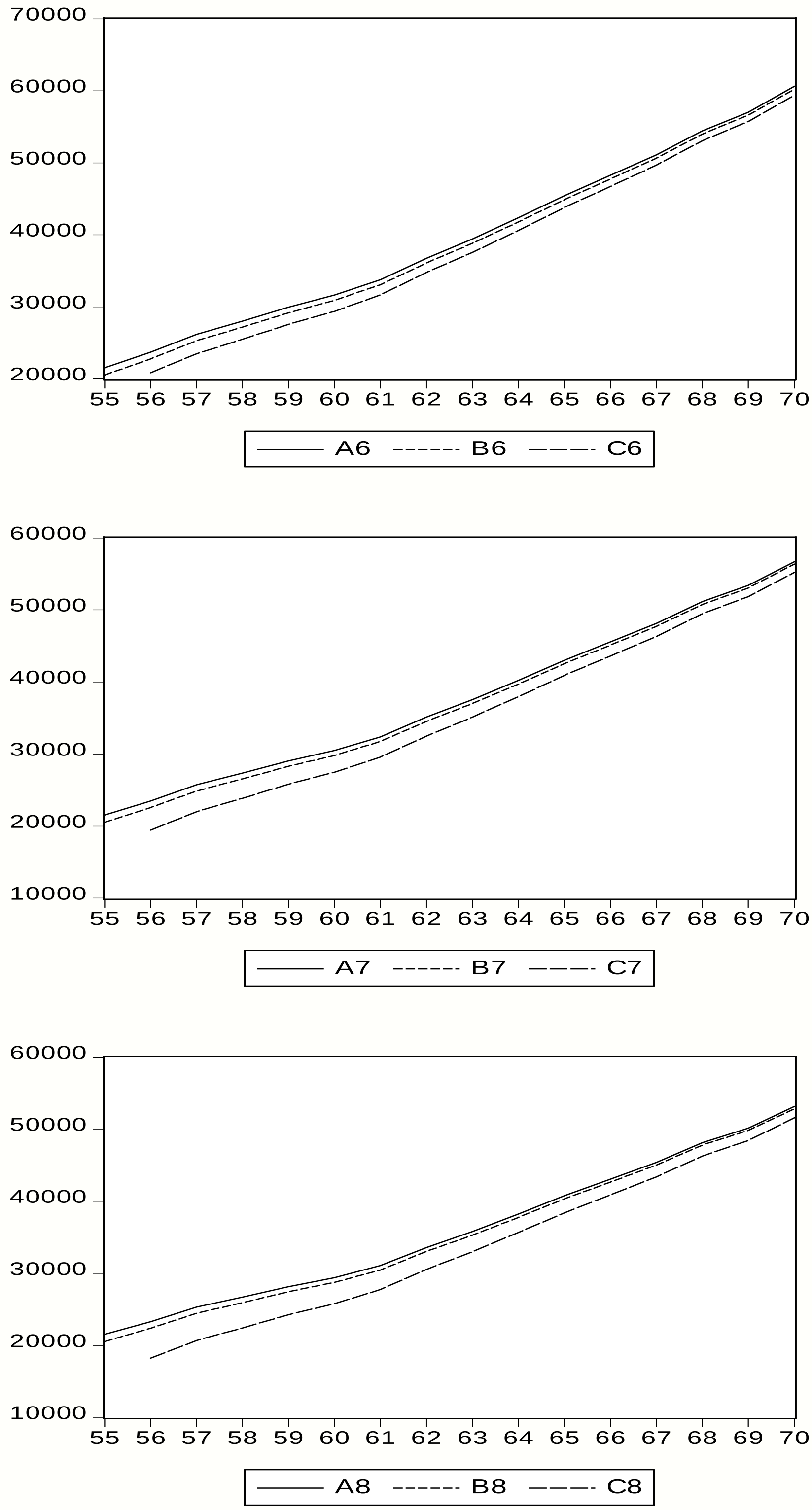
Initial values of capital stock in 1955/1956 vary between 18.3 and 21.5 million Ringgit Malaysia in 1987 prices. The initial values estimates compare well with the 1955 estimate of initial capital stock by DOS for 1954 as noted in Section 3.1. The DOS estimate for Peninsular Malaysia inflated upwards by 12 per cent to Malaysia, and converted to 1987 prices using the implicit GDP deflator derived in this study, is between 19.6 and 22.8 million Ringgit.

Variant A provides the highest value of initial capital stock, while Variant C provides the lowest values. Among the initial values in Variant C, for given g, a higher depreciation rate leads a lower starting value. It is useful to note that the initial values from Variants B and C for the depreciation rate of 6 per cent are not too different.

Figure 8 shows the effect of the starting values for each of the three depreciation rates. Since the effect of the starting value is negligible after 1970, the estimated capital stock series are displayed only from 1955 till 1965 in order to see the effect of the starting value clearly. The differences in the initial values are more apparent at the higher depreciation rates. This can also be seen in the quicker convergence of the three series for the lower depreciation rates.

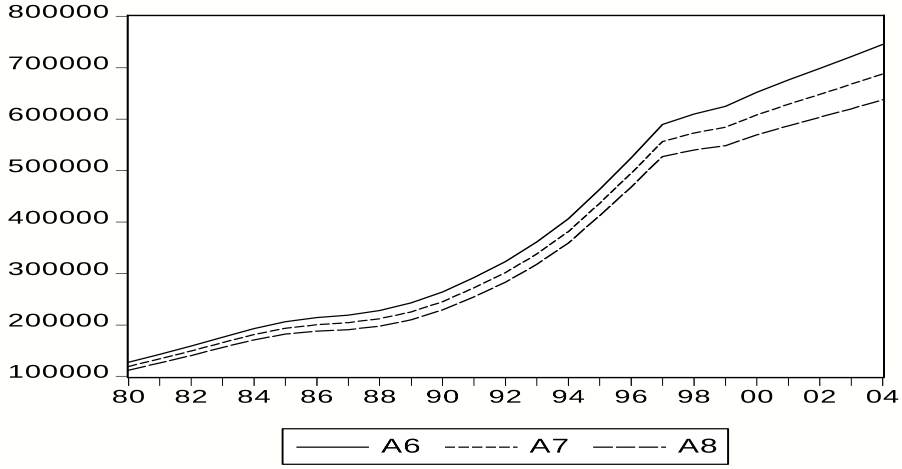
Figure 9 shows the effect of the depreciation rates for each of the three variants. The plots are shown only for the years 1980-2004, where the effect is apparent. For each set of series, clearly the larger values of depreciation lead to lower values of capital stock, and the difference is more marked, the longer the time from the initial year.

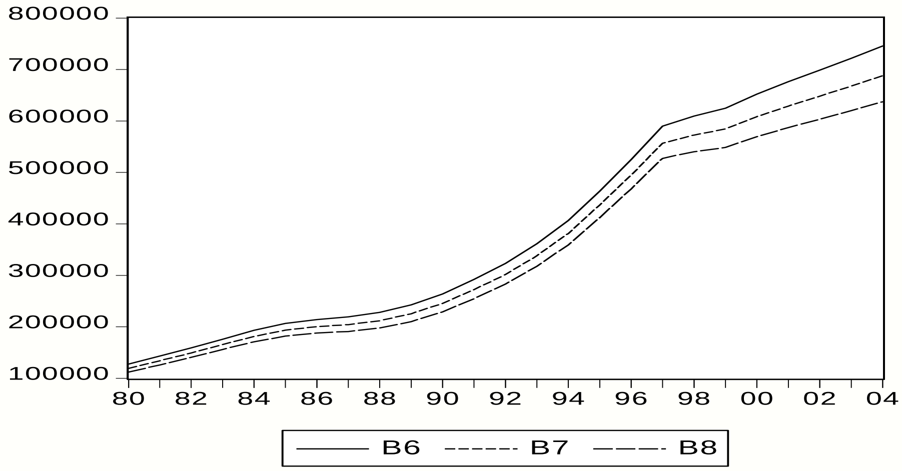
Figure 8. Estimates of Capital Stock: Comparing the Effect of Initial Values, 1955-1965

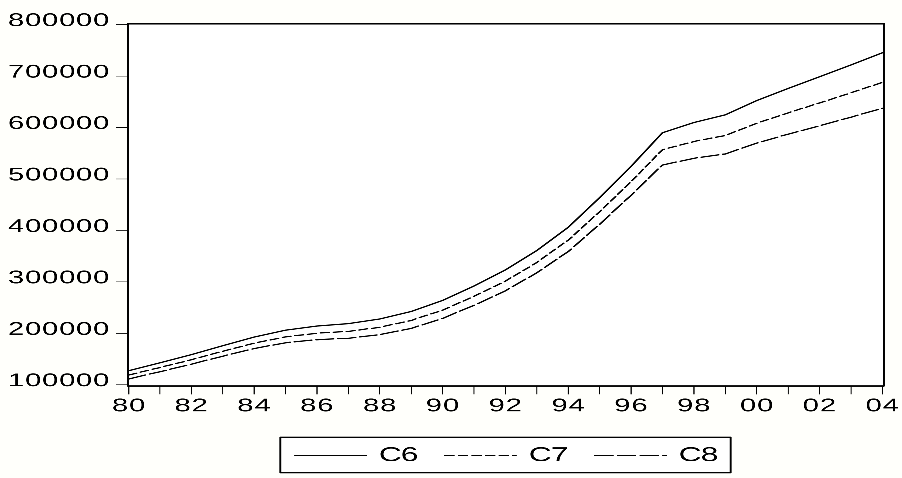


For an explanation of acronyms, see Table 5.

Figure 9. Estimates of Capital Stock: Comparing the Effect of Depreciation Rates, 1980-2004







For an explanation of acronyms, see Table 5

Table 6 provides the values of estimated capital stock for the year 2004. The differences across the variants for a given depreciation rate are negligible. The depreciation rate of 6 per cent leads to a capital stock value in 2004 that is about 7.7 per cent greater than that for the depreciation rate of 7 per cent, and about 14.5 per cent greater than that for the depreciation rate of 6 per cent.

Table 6. Estimated Values of Capital Stock in 2004 (RM 1987 Million)

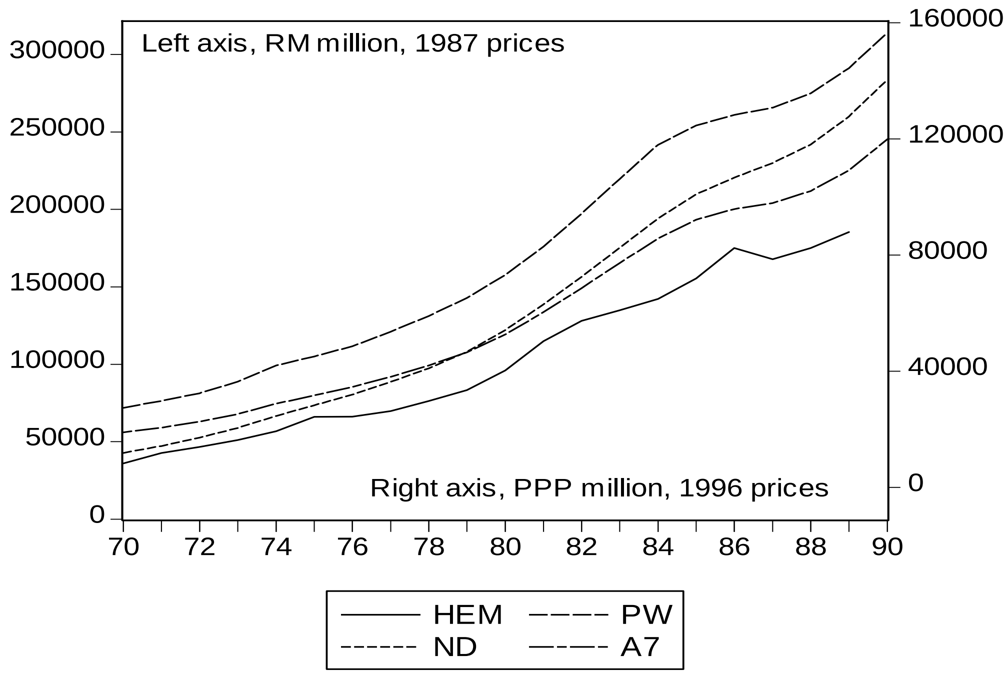
Variant	Depreciation Rate		
	6%	7%	8%
A	745,472.42	687,830.00	637,393.70
B	745,424.00	687,801.30	637,376.80
C	745,324.80	687,705.90	637,301.70

4. CONCLUDING REMARKS

This paper has addressed the derivation of net capital stock for Malaysia for the period 1955-2004. It has required the careful assembling of the core series on gross fixed capital formation, as well as the derivation of the implicit GDP and investment deflators. Various depreciation rates and starting values were used to estimate nine alternative series of capital stock by the perpetual inventory method. The capital stock data across Variants A, B and C do not differ much once the effect of the initial value becomes negligible. As for the depreciation rate, the stock figures are larger the lower the depreciation rate, but the evolutions across the three rates are the same. The clear and consistent patterns across these alternative series arise from the use of the same real GCFC series in the calculation, as well as the same methodology of derivation.

It is useful to compare the derived series with the other published series. Only one series is selected here for clarity, and the patterns for the others can be inferred. Figure 10 plots the estimated capital stock for Variant A with a depreciation rate of 7 percent against the ND, PW and HEM series for the period 1970-1990, again a shortened sample to facilitate examination. The A7 series follows somewhat the HEM series, although it has larger values. Both the ND and PW series grow more rapidly than A7.

Figure10. A Comparison of Estimated Capital Stock, Malaysia, Various Authors; This Study, 1970-1990

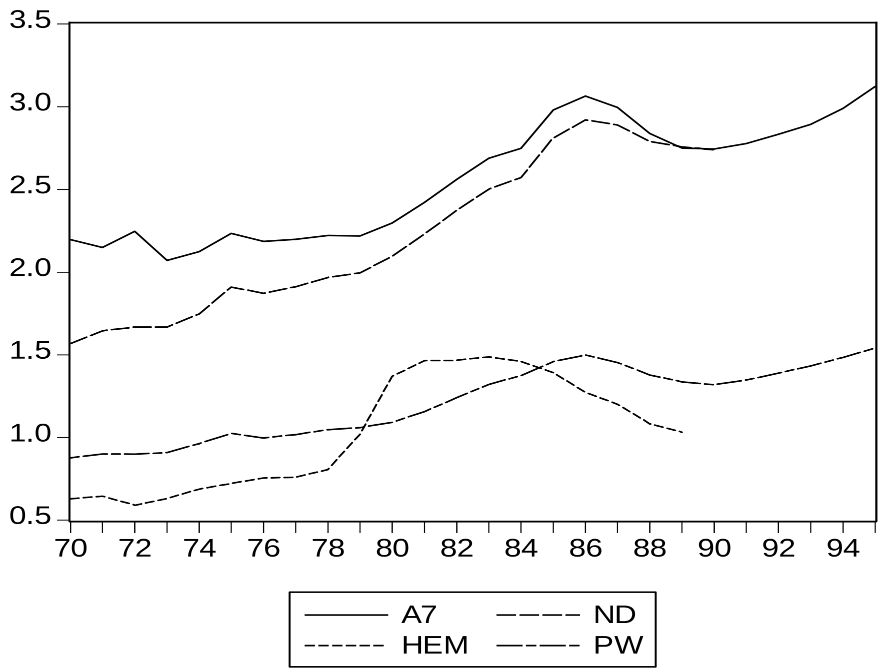


A7. This study, see Table 5.
HEM. Series from Halipah (1990), Variant I for capital stock.
ND. Series from Nehru and Dhareshwar (1993), valued in 1987 RM.
PW. Series from Penn World Data Set, Marquetti (2005), valued in 1996 PPP.

Figure 11 and 12 compare two measures computed from capital stock. In Figure 11, the capital-output ratios are compared. These ratios increase for all the series, except HEM. The ratio is higher for A7 than for the other series. In Figure 12, we contrast the growth rate of the A7 series with that for PW, ND and that from Abdul Wahab (2004)

(AWM).[10] The years for which these are compared are 1980 to 2000. The patterns on the whole are similar, except for HEM. We expect the growth rate to be slower the higher the depreciation rate. The growth rates for AVM are higher suggesting that a lower depreciation rate was used by Abdul Wahab (2004).[11]

Figure 11. A Comparison of Estimated Capital-Output Ratios, Malaysia, Various Authors; This Study, 1970-1995



A7. This study, see Table 5.
HEM. Computed. Capital stock from Halipah (1990), Variant I, GDP factor cost, this study
ND. Computed from capital stock and output from Nehru and Dhareshwar (1993).
PW. Computed from capital stock and output from Penn World Data Set, Marquetti (2005).

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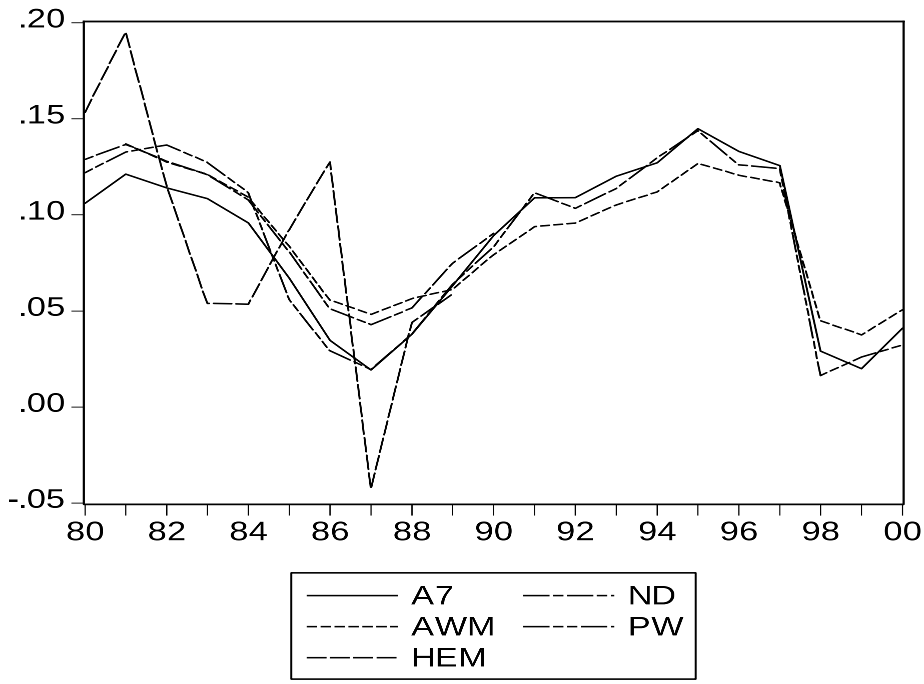
[10] The Wahab paper provides information on productivity for Malaysia. However, no information is provided on the derivation of capital stock.
[11] AVM's growth rates are higher than that for capital stock variant A6, suggesting that the overall depreciation rate used in the paper is less than 6 per cent.

Figure 12. A Comparison of Growth Rates of Capital Stock, Malaysia, Various Authors; This Study, 1980-2000



A7. This study, see Table 5.
HEM. Computed. Capital stock from Halipah (1990), Variant I.
ND. Computed. Capital stock from Nehru and Dhareshwar (1993).
PW. Computed. Capital stock from Penn World Data Set, Marquetti (2005).

On the basis of the discussion, the derived series are quite reasonable. The preferred initial value of capital stock used is that for Variant A, which is an average of estimated values from detailed studies of capital stock, and the preferred depreciation rate is 7 per cent. Table 7 provides the data for this series.

Table 7. Estimates of Total Net Capital Stock, Malaysia, 1955-2004

Year	RM Million	Year	RM Million	Year	RM Million
1955	21,548.00	1971	59,721.14	1988	212,042.34
1956	23,500.72	1972	63,565.29	1989	225,439.37
1957	25,744.07	1973	68,463.94	1990	245,544.62
1958	27,357.06	1974	75,064.03	1991	272,268.49
1959	29,048.78	1975	80,355.43	1992	301,947.70
1960	30,486.70	1976	85,804.27	1993	338,224.36
1961	32,391.02	1977	92,329.25	1994	381,216.65
1962	35,118.62	1978	99,581.75	1995	436,426.49
1963	37,571.47	1979	108,145.85	1996	494,500.63
1964	40,243.23	1980	119,617.72	1997	556,629.59
1965	43,027.23	1981	134,109.98	1998	572,842.52
1966	45,567.48	1982	149,418.41	1999	584,311.54
1967	48,134.73	1983	165,637.39	2000	608,249.73
1968	51,147.91	1984	181,510.57	2001	628,722.25
1969	53,422.88	1985	193,669.15	2002	647,960.70
1970	56,699.72	1986	200,407.70	2003	667,563.45
		1987	204,283.16	2004	687,830.01

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