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TIME-SERIES FOR THE BRITISH POST-WAR ECONOMY

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One product of my recent investigation into the determinants of real fixed capital formation in the post-war British Economy was the following set of time-series. As far as can be determined, these series are unique and have not been duplicated elsewhere. Aggregate rates for Initial Allowances, Investment Allowances and Annual Allowances are provided for the period extending from 1956 to 1965 inclusive. Finally, an aggregate rate of Corporate Taxation is tabulated. This tax-rate takes into account the Income Tax, the Profits Tax, and a number of other features of British practices during the post-war period. These additional features are embodied in an adjustment factor applied to the rate for the Profits Tax. The extension of the series for the tax-rate beyond the range of the other series resulted in the inclusion of a period during which the rates of the two principal taxes could not be aggregated in a simple linear manner and the expression for the aggregate tax-rate had to be modified. This break is indicated in the text.

Contents.

Gross Domestic Fixed Capital Formation is abbreviated as GDFCF throughout the following description.

(1) Initial and Investment Allowances (v_3, v_4)

Definitions:-

m Number of years covered by the sample.

T Number of quarters covered by the sample.

v_{3t} Ratio of Initial Allowances, chargeable against current gross profits defined for tax purposes, to current expenditures for GDFCF. ($t = 1, 2, \ldots, T$)

v_{4t} Ratio of Investment Allowances, chargeable against current gross profits defined for tax purposes, to current expenditures for GDFCF. ($t = 1, 2, \ldots, T$)

w_{ij} ith annual weight for the jth category of investment assets. ($i = 1, 2, \ldots, m$; $j = 1, 2, \ldots, J$. We set $J = 3$)

p_{tj}^{k} Rate of the kth allowance for expenditures on the jth category of investment assets during the t-th quarter. ($k = 3, 4$; $j = 1, 2, 3$; $t = 1, 2, \ldots, T$)

s_{ij} Seasonal factor corresponding to the j-th quarter of the i-th year. ($j = 1, 2, 3, 4$; $i = 1, 2, \ldots, m$)

$\otimes$ Kronecker Product, defined by $A \otimes B = (a_{ij} \cdot B)$.

$*$ Schur Product, defined by $A * B = (a_{ij} \cdot b_{ij})$.

Notation:-

$$v^3 = \begin{pmatrix} v_{31} \\ .. \\ v_{3t} \\ .. \\ v_{3T} \end{pmatrix}, \quad v^4 = \begin{pmatrix} v_{41} \\ .. \\ v_{4t} \\ .. \\ v_{4T} \end{pmatrix}, \quad \ell^4 = \begin{pmatrix} 1 \\ 1 \\ 1 \\ 1 \end{pmatrix}, \quad \ell^3 = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}$$

$$\ell^{3\prime} = (1, 1, 1), \qquad w_i = (w_{i1}, w_{i2}, w_{i3}),$$

$$p^k = \begin{pmatrix} p^k_{11}, p^k_{12}, p^k_{13} \\ \cdots \\ p^k_{t1}, p^k_{t2}, p^k_{t3} \\ \cdots \\ p^k_{T1}, p^k_{T2}, p^k_{T3} \end{pmatrix}, \quad W = \begin{pmatrix} w_{11}, w_{12}, w_{13} \\ \cdots \\ w_{i1}, w_{i2}, w_{i3} \\ \cdots \\ w_{m1}, w_{m2}, w_{m3} \end{pmatrix} = \begin{pmatrix} w_1 \\ \cdots \\ w_i \\ \cdots \\ w_m \end{pmatrix}$$

$$S = \begin{pmatrix} s_1 \\ \cdots \\ s_i \\ \cdots \\ s_m \end{pmatrix}, \quad S_i = \begin{pmatrix} s_{i1} \\ s_{i2} \\ s_{i3} \\ s_{i4} \end{pmatrix}, \quad Q = (S, S, S) = \ell^{3\prime} \otimes S.$$

The indices for Initial and Investment Allowances are defined as:-

$$(\underline{1}) \qquad v^k = [p^k * (W \otimes \ell^4) * Q]\, \ell^3 \; ; \quad k = 3, 4.$$

Specification of Components:-

s_{ij} Expenditures on GDFCF in the j-th quarter of the i-th year in current prices divided by the simple arithmetic mean of quarterly expenditures for that year. A major objection to this specification stems from the implicit homogeneity assumption that the seasonal pattern for each category of investment assets is the same. This assumption accords well with the mathematical models used for aggregate analysis but, in practice, it was found that the ratios of expenditures on different categories of assets had cyclical patterns whenever data was available and permitted these ratios to be computed. The ratio of expenditures for plant and machinery to those for building and

works, as a percentage, can be characterized by the quarterly means over the sample period, (131, 118, 119, 124) for series in current prices and (130, 116, 119, 123) for series in 1958 prices. Regression of the ratio on a set of three seasonal dummy variables and a constant (corresponding to the fourth quarter) yields the following results. Each cell in the table contains the estimated coefficient and its associated t-value.

Table 1

Ratio	$100R^2$	Q1	Q2	Q3	Constant
Current prices	43.88	.0738	- .0613	- .0461	1.2378
		2.6342	-2.1874	-1.6464	
1958 prices	40.45	.0701	- .0640	- .0435	1.2271
		2.3866	-2.1779	-1.4806	

The differences between the two results stem from the period 1959 to 1962 when the current-price ratios were 3 - 5% above the ratios in 1958 prices. Similar results are obtained for the ratio of the expenditures for plant and equipment to total investment expenditures, other than for dwellings, although the resulting t-statistics are reduced as might be expected.

w_{ij} Proportion of expenditures for the j-th category of investment assets in total expenditures on GDFCF in current prices during the i-th year.

j = 1: Plant, machinery and new mining works.

j = 2: New ships.

j = 3: Industrial buildings, adjusted for 'transfer costs'.

These annual weights are tabulated below:

Table 2

	w_{i1}	w_{i2}	w_{i3}	$w_i.\ell^3$	$w_{i1} + w_{i3}$
1956	.4695	.0371	.2746	.78	.74
1957	.4836	.0450	.2771	.80	.75
1958	.4894	.0455	.2874	.82	.78
1959	.4778	.0471	.2845	.81	.76
1960	.4774	.0429	.2845	.80	.76
1961	.4813	.0312	.2979	.81	.78
1962	.4575	.0245	.3154	.80	.77
1963	.4685	.0187	.3086	.80	.78
1964	.4542	.0220	.3052	.78	.76
1965	.4649	.0168	.3058	.79	.77

The choice of expenditures for GDFCF in current prices for these specifications is obviously correct in view of the manner in which the allowances are provided.

The coverage of the allowances was not complete. Investment Allowances were claimable on about 80% of all expenditures for GDFCF while the coverage of Initial Allowances is marginally smaller:-

$$0.7812 \leq w_i.\ell^3 \leq 0.8223$$

$$0.7441 \leq w_{i1} + w_{i3} \leq 0.7771$$

One consequence of the variability of the sums of these weights is the need to place emphasis on rates of allowances rather than on total allowances permitted. The government has control over the rates directly but it has only partial control over the total level of allowances. Hence the common treatment of total allowances as a policy instrument is invalid to the extent that total allowances depend on the composition of investment

expenditures (and the generation of sufficient income) as well as on individual rates of allowances. During the currency of the Investment Grant scheme, total grants will be independent of the need to generate sufficient income but will depend on the spatial distribution of expenditures by asset-types. Governmental recognition of this restriction on control emerged during the early months of 1969 when the extent of the government's under-estimate for total grants in the preceding period was disclosed.

p^k_{tj} Table 3, provided below, formed the basis of these elements. The columns were consolidated into four categories - Industrial Buildings, New Mining Works, New Ships, and Plant and Machinery.

Key to Table 3. Column Headings:-

(1) New Industrial Buildings.

(1') New Industrial Buildings, Agricultural and Forestry Buildings and Works.

(2) New Mining Works.

(3) Dredging.

(4) Insulation of Industrial and Agricultural Buildings.

(5) Fuel-Saving Plant.

(6) New Ships.

(7) Motor Cars, Second-Hand Plant and Ships.

(8) Other Plant and Machinery.

(Investment Allowances on new assets were replaced from 17 January, 1966, by Investment Grants. After this date the rates for the Initial Allowances apply only to cases where Grants were not given. Special provisions were made for expenditures in Development Districts.)

Table 3

Rates of Initial and Investment Allowances (%)

Source: Annual Abstracts.

Initial Allowances	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
6. 4.1946 - 5. 4.1949	10	10	0	10	20	20	20	20
6. 4.1949 - 5. 4.1952	10	10	0	10	40	40	40	40
6. 4.1952 - 14. 4.1953	0	0	0	0	0	0	0	0
15. 4.1953 - 5. 4.1954	10	40	0	10	20	40	20	20
6. 4.1954 - 17. 2.1956	0	40	0	0	0	0	20	0
18. 2.1956 - 5. 4.1956	10	40	0	0	0	0	20	20
6. 4.1956 - 8. 4.1957	10	40	10	0	0	0	20	20
9. 4.1957 - 14. 4.1958	10	40	10	0	0	0	20	20
15. 4.1958 - 6. 4.1959	15	40	15	15	30	0	30	30
7. 4.1959 - 5.11.1962	5	20	5	5	10	0	30	10
6.11.1962 - 16. 1.1966	5	20	5	5	10	0	30	10
17. 1.1966 -	15	30		15	30			30
Investment Allowances	(1')							
6. 4.1954 - 17. 2.1956	10	20	0	10	20	20		20
18. 2.1956 - 5. 4.1956	0	0	0	10	20	20		0
6. 4.1956 - 8. 4.1957	0	0	0	10	20	20		0
9. 4.1957 - 14. 4.1958	0	0	0	10	20	40		0
15. 4.1958 - 6. 4.1959	0	0	0	10	20	40		0
7. 4.1959 - 5.11.1962	10	20	10	10	20	40		20
6.11.1962 - 16. 1.1966	15	30				40		30

During the period from 6 April 1954 to 17 February 1956, either the Initial Allowances with rate 40% or the Investment Allowances with rate 20% could be claimed on expenditures on new mining works. We assumed that the

second allowance was claimed.

The Initial Allowances were claimable at a rate that was double the corresponding rate for Investment Allowances during the sub-period of choice. Hence the assumed behaviour presupposes a low cost of capital, a short life for the purchased asset, or a high feedback effect on the stream of Annual Allowances. We have no information on the choices made during this period so that an assumption was necessary. The inevitable bias is negligible due to the truncation of the whole sample period in 1956 but would require more attention if an attempt were made to extend the series for allowances into the earlier post-war period.

One consequence of the assumption is the equality of rates of the Investment Allowances for new mining works and for plant and machinery, as illustrated by columns (2) and (8) of Table 3, so that the four consolidated categories of assets can be reduced to three for the computation of the series corresponding to these allowances. The two columns indicate that the rates for the Initital Allowances associated with the two categories were not equal. During most of the sample period, the rates associated with new mining works were double those associated with plant and machinery. Unfortunately we were compelled to equate the rates for this study. The lower rate was taken. These decisions were inevitable in view of our inability to derive separate annual weights for the proportion of expenditures on new mining works in total expenditures on GDFCF, non-dwelling, valued in current prices. The choice of the lower rate was indicated by the size of expenditures on plant and machinery in this total. Consequently, the set of annual weights for three consolidated categories ($j = 1, 2, 3$ defined above) were derived and the rates of both the Initial and the Investment Allowance claimable for expenditures on new mining works were set equal to those

corresponding to expenditures on plant and machinery.

Table 4

Component and Final Series for Initial and Investment Allowances, 1956 to 1965

p^3			p^4			s	v^3	v^4	$v^3 + v^4$
.1	.0	.05	.1	.2	.05	.9524	.0578	.0648	.1226
.2	.0	.1	.0	.2	.0	.9604	.1166	.0071	.1237
.2	.0	.1	.0	.2	.0	.9912	.1203	.0073	.1276
.2	.0	.1	.0	.2	.0	1.0956	.1330	.0081	.1411
.2	.0	.1	.0	.2	.0	.9633	.1199	.0087	.1286
.2	.0	.1	.0	.36	.0	.9692	.1206	.0157	.1363
.2	.0	.1	.0	.4	.0	.9834	.1224	.0177	.1401
.2	.0	.1	.0	.4	.0	1.0829	.1378	.0195	.1573
.2	.0	.1	.0	.4	.0	.9908	.1254	.0180	.1434
.28	.0	.14	.0	.4	.0	.9691	.1737	.0176	.1913
.3	.0	.15	.0	.4	.0	.9828	.1866	.0179	.2045
.3	.0	.15	.0	.4	.0	1.0573	.2007	.0192	.2199
.3	.0	.15	.0	.4	.0	.9218	.1751	.0173	.1924
.13	.0	.06	.19	.4	.1	.9732	.0771	.1344	.2115
.1	.0	.05	.2	.4	.1	.9904	.0614	.1420	.2034
.1	.0	.05	.2	.4	.1	1.1146	.0707	.1593	.2300
.1	.0	.05	.2	.4	.1	.9495	.0588	.1341	.1929
.1	.0	.05	.2	.4	.1	.9534	.0590	.1346	.1936
.1	.0	.05	.2	.4	.1	1.0068	.0623	.1421	.2044
.1	.0	.05	.2	.4	.1	1.0903	.0675	.1540	.2215
.1	.0	.05	.2	.4	.1	.9515	.0599	.1289	.1888
.1	.0	.05	.2	.4	.1	.9749	.0614	.1321	.1935
.1	.0	.05	.2	.4	.1	1.0251	.0646	.1411	.2057
.1	.0	.05	.2	.4	.1	1.0476	.0660	.1420	.2080

Table 4 (Continued)

p^3			p^4			s	v^3	v^4	$v^3 + v^4$
.1	.0	.05	.2	.4	.1	.9763	.0599	.1297	.1896
.1	.0	.05	.2	.4	.1	.9865	.0606	.1310	.1916
.1	.0	.05	.2	.4	.1	1.0093	.0671	.1340	.2011
.1	.0	.05	.24	.4	.12	1.0262	.0630	.1614	.2244
.1	.0	.05	.3	.4	.15	.8752	.0545	.1701	.2246
.1	.0	.05	.3	.4	.15	.9746	.0607	.1895	.2502
.1	.0	.05	.3	.4	.15	1.0343	.0659	.2010	.2669
.1	.0	.05	.3	.4	.15	1.1150	.0695	.2168	.2863
.1	.0	.05	.3	.4	.15	.9536	.0578	.1821	.2399
.1	.0	.05	.3	.4	.15	.9604	.0582	.1834	.2416
.1	.0	.05	.3	.4	.15	1.0082	.0611	.1924	.2535
.1	.0	.05	.3	.4	.15	1.0710	.0649	.2045	.2694
.1	.0	.05	.3	.4	.15	.9975	.0617	.1916	.2533
.1	.0	.05	.3	.4	.15	.9582	.0592	.1841	.2433
.1	.0	.05	.3	.4	.15	.9817	.0607	.1886	.2493
.1	.0	.05	.3	.4	.15	1.0646	.0658	.2045	.2703

Since these series are based on only two factors, the rates of allowances and the proportions of expenditures for a group of consolidated asset-types to total expenditures, they suffer from two sources of biases. First, Initial and Investment Allowances cannot be claimed if gross income is insufficient to exceed them. This was one of the principal reasons for the replacement of these allowances by a grant scheme according to official declarations. In such cases of insufficient income, tax provisions permitted the deferral of allowances. Second, there have been claims that small companies failed to give adequate attention to depreciation allowances and omitted to claim the allowances; in which case they would not receive them. These biases are probably small.

(2) Annual Allowances (v_1)

In the Finance Act of 1965, these allowances were renamed 'Writing-Down Allowances' in recognition of the abandonment of the preceding-year basis and the use of the accounting-period basis within the Corporation Tax Scheme.

Definitions:-

v_1 Ratio of Annual Depreciation Allowances, chargeable against current gross profits defined for tax purposes, to current Capital Consumption after both annual series have been allocated over quarters. Note that the series for Annual Allowances are based on actual aggregate allowances in contrast to the treatment of Initial and Investment Allowances outlined above. The aggregate rate for Annual Allowances will depend on current and past rates of Initial Allowances and on the stream of investment expenditures within the preceding period extending over the lives used for assets in tax provisions. No simple formula can be derived to represent this.

f_i Ratio of the i-th annual level of Annual Allowances to that of the sum of total Initial and Investment Allowances.

d_i Ratio of expenditures for GDFCF, non-dwelling, valued in 1958 prices to Capital Consumption at 1958 replacement cost.

A_1 Value of Annual Allowances.

R Capital Consumption valued in 1958 prices.

q Implicit deflator of GDFCF, non-dwelling. That is, the ratio of GDFCF, non-dwelling, in current prices to the corresponding value in 1958 prices.

I GDFCF, non-dwelling, in 1958 prices.

Notation:-

$$F = \begin{pmatrix} f_1 \\ .. \\ f_i \\ .. \\ f_m \end{pmatrix}, \quad D = \begin{pmatrix} d_1 \\ .. \\ d_t \\ .. \\ d_T \end{pmatrix}. \quad If = \begin{pmatrix} \phi_1 \\ \\ \phi_t \\ \\ \phi_T \end{pmatrix} \text{ then } \hat{\phi} = dg(\phi_1, \ldots, \phi_T).$$

From the definition of v , we have the following equation

$$A_1 = v_1 qR$$

Hence,

$$v_1 = \frac{A_1}{qR} = \frac{A_1}{(v_3+v_4)Iq} \cdot \frac{(v_3+v_4)I}{R}$$

$$= \frac{A_1}{(v_3+v_4)Iq} \cdot (v_3 + v_4) \cdot \frac{I}{R}$$

The index of Annual Allowances is defined by:-

$$(\underline{2}) \qquad v^1 = (F \ \theta \ \ell^4) * (\hat{S}^{-1}\ell^T) * (v^3+v^4) * D.$$

The resulting series for v^1 is presented in Table 6 below and the levels used clearly reflect the major revision of basic tax lives, on which these allowances are based, in November 1962. (Maudling announced the changes in this month and established them by retrospective legislation in the Finance Act of the following year). An alternative series can be obtained by suppressing the factor $(\hat{S}^{-1}\ell^T)$. This factor was included in this study to take account of the differences in seasonal treatments used to derive the series of Replacement Investment, or Capital Consumption, and Gross Investment. It reflects the replacement assumption embodied in the mathematical model used to derive the expressions for desired capital stock in my study of investment expenditure.

The series for (f_i) were derived from depreciation tables found in

the sections containing supplementary notes of 'National Income and Expenditure' for 1967 and earlier years.

(3) The Tax Rate. (u)

Definitions:-

u_{1t} Rate of the Profits Tax on Corporate Profits (that is, on net income defined for tax purposes) in the t-th quarter.

u_{2t} Rate of the Income Tax on Corporate Profits in the t-th quarter, $(t = 1, 2, \ldots, T)$.

λ_i Adjustment factor attached to the Profits Tax payments to represent the influence of Special Contributions, the Excess Profits Levy and the post-war refunds of the Excess Profits Tax in the i-th year. A brief historical survey of these taxes will be forthcoming. $(i = 1, 2, \ldots, m)$.

u_t^d Rate of the Profits Tax on Distributed Profits in the t-th quarter.

u_t^r Rate of the Profits Tax on Undistributed Profits in the t-th quarter.

ϕ_i^d Proportion of profits distributed in the i-th year.

ϕ_i^r Proportion of profits retained in the i-th year.

Notation:-

$$U^{dr} = \begin{pmatrix} u_1^d & , & u_1^r \\ .. & , & .. \\ u_t^d & , & u_t^r \\ .. & , & .. \\ u_T^d & , & u_T^r \end{pmatrix} , \qquad \phi = \begin{pmatrix} \phi_1^d & & \phi_1^r \\ .. & , & .. \\ \phi_i^d & & \phi_i^r \\ .. & , & .. \\ \phi_m^d & & \phi_m^r \end{pmatrix} , \qquad = \begin{pmatrix} \lambda_1 \\ .. \\ \lambda_i \\ .. \\ \lambda_m \end{pmatrix}$$

The index for the Rate of Taxation (U) is defined by:-

$$(3) \qquad \begin{cases} U = (U^1 * \lambda) + U^2 , \\ U^1 = [U^{dr} * (\phi \, \theta \, \ell^4)] \cdot \ell^2 \end{cases}$$

Specifications for Components:-

(u_{1t}, u_t^d, u_t^r) Standard rates of these taxes, presented in the Annual Reports of H.M. Commissioners of Inland Revenue (henceforth abbreviated by Annual Reports). Note the neglect of the Abatement Provision for small incomes and of the differences between personal and corporate taxation. These two factors introduce biases with opposing signs but the latter has greater order of magnitude. Due to the neglect of the first factor the series for the tax rate is upward biased. To eliminate this bias, the distribution of income over companies classified by size of income is necessary information. The withdrawal of the Abatement Provision when the Corporation Tax scheme was introduced probably had little effect on the stream of investment expenditures in the aggregate, although there have been claims that this withdrawal will lead to an ossification of the corporate sector.

The progressive structure of the taxation rates for personal income implies that the rate paid by companies is markedly lower than that paid by unincorporated firms with a sufficient level of income. Consequently, the tax rate used in this study understates the rate relevant outside the corporate sector and is compatible with the interpretation of the enterprise as a company, or a group of companies. Since the dependent variables in our empirical results do not distinguish between the expenditures of the corporate sector of the economy and other expenditures, the series for the tax rate can be treated as biased downwards with the extent of the bias determined by the distribution of income between the corporate sector and the unincorporated sector, and by the differential treatment of income accruing to companies and to 'individuals'.

ϕ_i^d In the year in which the accounting period finished (indexed by i), the ratio of the amount charged at the distributed rate, whether from current profits or tax reserves, to the total chargeable profit after the deduction of Abatement and of the amount chargeable at the flat rate of tax.

Source: Annual Reports.

Differential rates were abolished with effect from 1st April 1958. After that date we equated u_{1t}, u_t^d, and u_t^r. Provided the proportions ϕ_i^r and ϕ_i^d sum to unity, arbitrary levels can be set for them after this date and the explicit calculation of the weights can be avoided for much of the period under review.

The series used for ϕ_i^d is contained in Table 5 below. Two alternative series can be derived from the tables presented in the following two references:-

(a) E.T. Balopoulos: 'Fiscal Policy Models of the British Economy', North Holland, 1967. Table 3.7.

(b) Alan Williams' contribution to 'Foreign Tax Policies and Economic Growth', NBER-Brookings Institution, 1966. Tables 2 and 3.

No attempt was made to convert the proportions of gross income given by Williams into proportions of net income, or to compute separate and alternative tax rates on the bases of (a) and (b).

λ_i Sum of the total payments for the Profits Tax and the National Defence Contributions, the Excess Profits Tax (negative during the period extending from 1951/52 to 1956/57), the Special Contribution and the Excess Profits Levy as a proportion of total payments for the Profits Tax and National Defence Contributions

as indicated in Exchequer Revenue.

Source: Annual Abstracts.

Table 5

1950/51	.2523	1.0546
1951/52	.2346	.9901
1952/53	.2884	.9939
1953/54	.2676	1.3090
1954/55	.2747	1.4003
1955/56	.2644	1.0808
1956/57	.2742	1.0246
1957/58	.2911	1.0135
1958/59	.2809	1.0110
1959/60		1.0163
1960/61		1.0065
1961/62		1.0042
1962/63		1.0029
and after.		1.0000
	ϕ_i^d	λ_i

The principal deficiency of the (λ_i) series is the neglect of the payments lag. Whereas most of the other series, including (u_{1t}), were based on tax rates, the series for the adjustment factor was based on Exchequer Receipts. No attempt was made to shift the series temporally although a fixed-period translation could easily have been achieved. Even if the average payments lag were variable over the period, as it probably was due to the seasonal payments pattern, such a shift may have improved the final series.

The adjustment factor was attached to the Profits Tax, rather than to the Income Tax or to the sum of the two taxes, since the scope and

collection of the additional taxes were more like those of the Profits Tax than those of the Income Tax. Series for the aggregate rates for the Profits Tax, adjusted Profits Tax, the Income Tax, and the overall rate of taxation are presented in Table 6 below. These series were extended backwards to the first quarter of 1950. Until 1st January 1952, the liability to Profits Tax was a deductible expense for the purposes of Income Tax and the index for the rate of taxation was modified to take account of this. Since that date, the computation of both taxes has taken no account of the liability for the other so that the additivity feature of (3) is valid. The resulting series do not take account of the differences between the tax provisions affecting the two major taxes, other than this single additivity feature.

Table 6

Series for tax rates, 1950 to 1965, and for the rate of Annual, or Wear and Tear, Allowances, 1956 to 1965

V^1	U^1	$U^1 * \lambda$	U^2	U	
	.1539	.1868	.45	.5527	1950
	.1504	.1586	.45	.5372	
	.1504	.1586	.45	.5372	
	.1504	.1586	.45	.5372	
	.2019	.2129	.45	.5671	
	.1938	.1919	.45	.5566	
	.1938	.1919	.45	.5566	
	.1938	.1919	.45	.5566	
	.1124	.1113	.475	.5863	1952
	.0867	.0862	.475	.5612	
	.0867	.0862	.475	.5612	
	.0867	.0862	.475	.5612	

Table 6 (Continued)

V^1	U^1	U^{1*}_{λ}	U^2	U	
	.0867	.0862	.475	.5612	1953
	.0785	.1028	.45	.5528	
	.0785	.1028	.45	.5528	
	.0785	.1028	.45	.5528	
	.0785	.1028	.45	.5528	
	.0802	.1123	.45	.5623	
	.0802	.1123	.45	.5623	
	.0802	.1123	.45	.5623	
	.0802	.1123	.45	.5623	
	.0779	.0842	.425	.5092	
	.0779	.0842	.425	.5092	
	.0848	.0917	.425	.5092	
.7301	.0908	.0981	.425	.5231	1956
.7236	.1040	.1066	.425	.5316	
.7517	.1040	.1066	.425	.5316	
.8247	.1040	.1066	.425	.5316	
.9114	.1040	.1066	.425	.5316	
.9210	.1086	.1101	.425	.5351	
.9300	.1086	.1101	.425	.5351	
.9627	.1086	.1101	.425	.5351	
.7670	.1086	.1101	.425	.5351	
.9981	.1	.1011	.425	.5261	
1.0584	.1	.1011	.425	.5261	
1.2970	.1	.1011	.425	.5261	
.9219	.1	.1011	.425	.5261	
1.0200	.1	.1016	.3875	.4891	
.9656	.1	.1016	.3875	.4891	
1.1004	.1	.1016	.3875	.4891	

Table 6 (Continued)

V^1	U^1	$U^1*\lambda$	U^2	U	
.8351	.1	.1016	.3875	.4891	1960
.8055	.125	.1258	.3875	.5133	
.8407	.125	.1258	.3875	.5133	
.9137	.125	.1258	.3875	.5133	
.9471	.125	.1258	.3875	.5133	
.9358	.15	.1506	.3875	.5381	
.9786	.15	.1506	.3875	.5381	
.9849	.15	.1506	.3875	.5381	
.8928	.15	.1506	.3875	.5381	
.8670	.15	.1504	.3875	.5379	
.8698	.15	.1504	.3875	.5379	
1.0062	.15	.1504	.3875	.5379	
1.0877	.15	.1504	.3875	.5379	
1.1078	.15	.15	.3875	.5375	
1.1338	.15	.15	.3875	.5375	
1.2356	.15	.15	.3875	.5375	
1.1920	.15	.15	.3875	.5375	1964
1.1458	.15	.15	.3875	.5375	
1.1991	.15	.15	.3875	.5375	
1.2802	.15	.15	.3875	.5375	
1.3823	.15	.15	.3875	.5375	
1.2715	.15	.15	.4125	.5625	
1.2735	.15	.15	.4125	.5625	
1.3854	.15	.15	.4125	.5625	

(4) Capital Consumption and the Depreciation Parameter

Throughout this section we shall abbreviate National Income and Expenditure as NIE. Five sets of data were considered:-

(i) Dean's estimates, JRSS Part 3, 1964.

(ii) Pyatt's estimates, 'Capital, Output and Employment 1948-1960' published for the Department of Applied Economics, University of Cambridge.

(iii) Feinstein's estimates, 'Domestic Capital Formation in the United Kingdom 1920-1938' published by Cambridge University Press in 1965.

(iv) NIE estimates of Net Capital Stock at current replacement cost.

(v) NIE estimates of gross Capital Stock at 1958 replacement cost.

The paucity of data in this field is not the primary difficulty that is encountered in empirical studies although it is a major one. This difficulty is the direct consequence of the failure of economists to achieve a consensus view as to the relevant definition or definitions of capital stock.

We chose gross concepts and the series used for capital consumption and the estimated depreciation parameter are based on the fifth set of data. Dean's estimates include series for capital stock and capital consumption in the manufacturing and the construction industries during the period extending from 1948 to 1961, and an inventory of the stock of capital in these industries at the end of 1961. These estimates were not used for this study since both the time span of the series and their coverage were insufficient. Dean's methods underly the estimates that were used.

The NIE estimates of Net Capital Stock at current replacement cost do not contain separate estimates for dwellings but the use of simple proportionality assumptions and the NIE series for Gross Capital Stock can provide an adjustment for this omission. The net capital stock estimates were not used

since we held the view that the concept of capital stock corresponding to a characterization of productive processes should not be a net concept which is explicitly two-dimensional. Net Capital Stock estimates take account of the decline in life-expectancy of continuing assets as well as of the current provision of capital services and, hence, are inappropriate for the role of an argument for a production function. They may be suitable for growth analyses and our arguments do not preclude suitability in that context. Similar grounds can be indicated for a rejection of a net concept on other bases within the context of studies of investment. Some of these will be discussed in forthcoming papers "Net Worth" and "Partitions of Investment".

Feinstein's estimates are restricted to the pre-war British economy and, under the principle of selective estimation, can be used with circumspection. The NIE estimates of Gross Capital Stock at 1958 replacement cost are based, in part, on the results due to Feinstein and Maywald.

Pyatt's estimates are disaggregated by asset-type and by industry. He provides series for net stock, gross stock and his alternative stock measure based on constant-price accounting. When the series are extended beyond the terminal date of 1960, they may be a valuable source of information.

The NIE estimates of Gross Capital Stock at 1958 replacement cost contain separate information on dwellings so that this component of gross stock can be subtracted. These estimates are available for 1948, 1951, 1954, 1958 and 1961 to 1966 inclusive. As associated annual series for Capital Consumption in 1958 replacement prices is available for the period extending from 1950 to 1966 inclusive. The NIE tables are sufficiently detailed to permit the elimination of the dwelling component again. These two series were the only series used in this study to estimate the quarterly series for

Capital Consumption and the Depreciation Parameter. The annual NIE figure for capital consumption was centred on the third quarter, scaled, and linked by linear segments to provide the quarterly series, R_t. This series is tabulated elsewhere. Our choice of seasonal allocation was motivated by the replacement behaviour assumed in the adopted models. Some allocative scheme has to be assumed due to the absence of any direct data on the seasonal patterns of scrappage and this scheme will always specify either the absence of a seasonal pattern in replacement or the presence of a seasonal pattern in replacement that is similar to that experienced in another measured variable. We can contrast the attitude of Jorgenson specifying no seasonal pattern and that exemplified by the following quotation due to Greenberg: "The manner in which the model treats replacement expenditures is based on the thinking of businessmen as noted by Eisner (1956) and Greenwald (1962), who suggested that such expenditures are not made automatically, but are decided upon according to criteria similar to those that determine expansion investment". (Econometrica, July 1964). Acceptance of the first attitude implies no seasonal component in the formulae for R_t whereas acceptance of the second imposes the inclusion of the S (the seasonal pattern of gross expenditures) series in the formulae. Similarly a case can be presented for including the element S^{-1} in the formulae.

Table 7

Depreciation Parameters by Asset-Type and in Aggregate

Column Headings:-

1. Aggregate Expenditures.
2. Plant and Machinery.
3. Other (i.e. Non-Dwelling) Buildings and Works.

4. Vehicles, Ships and Aircraft.

	(1)	(2)	(3)	(4)
1951	.02568	.03182	.01648	.05080
1954	.02554	.03293	.01467	.05491
1958	.02665	.03370	.01462	.05770
1961	.02756	.03470	.01505	.05841
1962	.02768	.03477	.01491	.05986
1963	.02798	.03515	.01492	.06167
1964	.02837	.03528	.01494	.06493
1965	.02850	.03519	.01492	.06703
1966	.02879	.03525	.01507	.07101
Mean	.02742	.03431	.01506	.06060

For each category, the table contains the ratio of capital consumption to gross capital stock, both at 1958 replacement cost. The number of decimal places is misleading in all cases since numerators and denominators of the ratios have only three significant figures. The mean of the aggregate ratio, 0.02742, was taken as representative of a (constant) depreciation parameter δ. Some doubt must be placed on this approximation, even though the first column of Table 7 suggests a slight upward trend in the ratio during the post-war period. The lives used for the perpetual inventory are based on tax lives and we have very little indication of actual lives so that both numerators and denominators of the ratios are suspect even if the gross capital concept is appropriate. The annual ratios for asset-types show greater heterogeneity than the corresponding aggregate ratios. However, the means for asset-types are still adequate summary statistics for each set of ratios.

The ratio of gross investment expenditures for plant and machinery to those for buildings and works fell slightly during the period under review in

the British economy. This slight shift may explain the differences between the second and third columns of Table 7. Evidence of concomitant U.S. experience (a threefold increase in gross stocks of structures and a fivefold increase in equipment stocks during the period extending from 1946 to 1960 has been reported) has little relevance and must not be used to imply that the gross ratio has a significant trend in the British economy due to compositional shifts.

Since sectoral estimates of the distribution of asset-types are not available, separate estimates of capital consumption and the depreciation parameter for private and public sectors could not be derived and the aggregate estimates were used.

For given actual lives and statutory lives, the ratio of capital consumption (estimated as a by-product of the derivation of gross capital stock measures) to gross stock will be constant if gross investment expenditures are growing at a constant rate. The current and one-quarter-lagged investment expenditures variables have a correlation coefficient of 0.9318 during the sample period used in this study, after the variables have been seasonally adjusted. Hence, investment expenditures do have a heavy trend component and a constant depreciation parameter, defined in terms of gross measures, appears to be an adequate approximation.

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These series were compiled in the first quarter of 1968 while I was a post-graduate student at the London School of Economics and Political Science. The original version was distributed in June 1968 and a revised version followed in February 1969 to be embodied in my doctoral thesis. Special credit should be given to Professor J. D. Sargan (L.S.E.), Derek A. White (Economic Council of Canada) and Denis Anderson (International Bank for Reconstruction and Development).