A Study of Imports, Part 4. Producer Capital Goods Ready for Use

Terence J. Baker and J. Durkan

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TERENCE J. BAKER
J. DURKAN

SECTION 4: A STUDY OF IMPORTS. PART 4. PRODUCERS CAPITAL GOODS READY FOR USE

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§4.1. *Introduction*

Previous editions of the Quarterly Economic Commentary have analysed the behaviour of imports of consumption goods and imports of materials for further non-agricultural production. This part of the study presents an analysis of imports of Producers Capital Goods ready for use, on the same lines. This basic similarity of procedure is dictated by the desirability of maintaining a uniform treatment for all categories of imports in what is essentially a study of the method of disaggregation as a useful technique for short-term forecasting. Hence regression analysis is applied to seasonally corrected quarterly data both in absolute terms and in terms of percentage changes.

Previous studies aimed at deriving forecasting or structural equation for investment imports have not been too successful.* The analysis and forecasting of investment behaviour, abound in conceptual difficulties, no less than data difficulties. Early results confirmed our fears and argue against undue expectations. Thus the analysis is based more on absolute levels than in the case of previous categories, and percentage changes are analysed only in the form of three-quarter moving averages, and not in the more rigorous terms of simple percentage changes.

§4.2. *The dependent variable*

A special problem arises with the dependent variable, imports of Producers Capital Goods, in the analysis. Imports in this category represent replacement investment and additions to the stock of capital. Replacement investment includes retirements due to obsolescence and the physical deterioration, evidenced by declining productivity, of the existing stock of capital. Additions to the stock of capital due to capital deepening and/or capital widening lead to an expansion of available capital services. Rarely, if ever, will replacement investment or additions to the stock of capital be homogeneous, even from year to year. Thus the value of imports of Producers Capital Goods contains a volume effect, a technical progress effect and what might be called a cost effect (due to changes in the price of inputs into industries producing Capital Goods other than those dependent on quality changes in such inputs). Ideally a price deflator for Producers Capital Goods should eliminate the latter effect. Unfortunately, the wholesale price index of imported Capital goods, the only deflator available, is not entirely satisfactory. Like other price indices it does not take account of quality changes, which, of course, are of particular importance in the case of producers' capital goods. Hence it must be regarded as biased upwards — a point noted by Geary and Pratschke, and the volume of imports of Producers Capital Goods obtained using the deflator is thus biased downwards. Thus the correct volume of Capital goods imports lies somewhere between the value and volume figures. Since the authors have found no satisfactory method of dealing with the quality problem, the analysis is conducted in terms of both the value and volume of Producers Capital Goods with a predilection for the value figures, as it is value that we wish to forecast. An examination in detail of the components of this category of imports reveals that imports of Ships and Aircraft involve large sporadic movements in the quarterly data. Accordingly, an attempt has been made to eliminate the effects of Ships and Aircraft imports. The Trade Statistics lists Ships and Aircraft and parts together and a fairly arbitrary decision, based in part on a detailed breakdown

* ESRI Paper No. 40.

provided by the C.S.O. for 1968, was made for each quarter's imports of parts. The residuals were taken to represent imports of Ships and Aircraft and were subtracted from quarterly totals of imports of Producers Capital Goods. While this is open to criticism it was felt that leaving Ships and Aircraft in Capital Goods was demanding too much of the error term. Agricultural machinery imports form a small proportion of imports of Producers Capital Goods ready for use. While ideally, in a disaggregated study, these should be abstracted from the total and treated separately it was felt that further disaggregation was unlikely to prove fruitful. Examination of the data does not suggest that any allowance need be made for major dock strikes.

§4.3. *The independent variables*

Unlike imports of Consumption Goods, which are encompassed in the Index of Weekly Retail Sales, and imports of Raw Materials for further non-agricultural production, which are almost totally for use in manufacturing industry, imports of Producers Capital Goods cannot be directly related to any one series as no quarterly gross capital formation figures are published. This lack of a quarterly investment index with which imports of Producers Capital Goods can be directly related moves the forecasting problem onto a different plane, i.e. onto that of the determinants of investment behaviour, a region notoriously difficult of treatment and evidencing considerable lack of success. Thus throughout this part of our study it is assumed that the expectations on which investment decisions are made are for the most part based on past performance, weighted towards the present. Therefore, reliance is placed on current values and distributed lags in the case of both absolue data, as described in §4.4, and three-quarter moving averages.

That imports in this category include inputs into all sectors of the economy, viz. agriculture, transportable goods industries, building and construction, public utilities etc., further compounds the problem of the selection of the explanatory variables, as no quarterly series encompassing these variables is available. Thus the explanatory variables selected are chosen as proxies — either singly or in concert.

The factors most likely to determine the level of Producers Capital Goods imports are the level of production in transportable goods industries, the degree of capacity utilisation in such industries, the tendency to and extent of capital deepening in industry, the level of profits and the cost and ease of borrowing. In the case of Ireland it is not felt necessary to consider a relative price variable, as nearly all imports of Producers Capital Goods are non-competing imports.

Of the possible explanatory variables suggested above, the volume of production of transportable goods industries is selected firstly as a series representing *total* output, secondly, as a series whose current and lagged values help determine the level of replacement investment, and lastly as a series on whose current and lagged values future aggregate investment decisions are based.

In addition and complementary to the volume of production of transportable goods industries, the level of capacity utilisation in such industries is also relevant. The greater the degree of capacity utilisation the greater — potentially at least — the likelihood of investment and the greater the volume of imports of capital goods. Black, Simpson and Slattery* in a recent paper have constructed a capacity index based on the growth of output, the level of unemployment in transportable goods industries and a post-hoc onlooker approach. A capacity utilisation index was obtained by considering actual production as a percentage of this capacity index. The approach adopted here is slightly different, relying entirely on the volume of production index. It has been assumed that production grows exponentially. A linear trend has been fitted to the log of the volume of production (three-quarter moving average) and deviations from this trend are taken

* ESRI Paper No. 51.

as indicatory of capacity utilisation. An index is derived from these deviations. This index is not to be considered as absolute in any sense — it is rather an index of the ratio of levels of capacity utilisation. The assumption of an exponential growth in production is well borne out by the fit of the linear trend to the log of the volume of production, with an R^2 of .9887. Except for some slight differences in the earlier period our capacity utilisation index agrees fairly well with that of Black, Simpson and Slattery, on a graphical comparison. In a belief that capacity utilisation is a state rather than a process, a further, synthetic, capacity utilisation variable was constructed, by assigning values 1, 0, —1 to periods of high, average, and low capacity utilisation respectively. This has the advantage, first, of eliminating sharp quarterly fluctuations within a definite period of high, average or low utilisation, and secondly of being suitable as a forecasting variable using information on capacity constrains from the F.I.I.-E.S.R.I. quarterly industrial survey.

Over the period under discussion there has been a sustained rise in earning in transportable goods industries. O'Mahony* has suggested that the rate at which entrepreneurs substitute capital for labour is influenced by the relative prices of these factors. Hence a capital deepening index has been constructed as the ratio of the wholesale price index number of transportable Capital (almost totally imported) used in industry to average hourly earnings in industry. Both series show strong upward trends, their ratio a strong downward trend. Even taking into consideration the strictures noted earlier on the validity of the wholesale price index number and its bias, this constructed series suggests a tendency for capital to become relatively cheaper than labour and hence the possibility of the substitution of capital for labour in industry.

There are no available quarterly series for the level or rate of profits, or for the ease, as distinct from the cost, of borrowing money for investment purposes. However, a composite approach to these factors can be made by taking the price index of ordinary stocks and shares as a variable. This index reflects current profits, and the market assessment of future average profits, as well as long term interest rates and the availability of funds for this type of asset. Thus a rise in the index indicates that current profits are rising, or that future profits are expected to rise, or that interest rates are falling, or that there is an increasing volume of funds seeking employment. Any of these factors, or any combination of them, seems likely to encourage industrial investment. Thus it is reasonable to expect a high level of the index or a rapid rate of increase in it to be associated with a high or rising rate of capital formation and thus of capital goods imports. The association can be direct, in that it is easier and cheaper to raise equity capital for investment in a high market, or indirect in that business managers' expectations as to prospects are likely to be influenced by the behaviour of the stock market. A further advantage of this variable is that the index represents firms in all sectors of the economy, and thus has a wider representation than the volume of production index for the transportable goods industries. Inspection reveals no regular seasonal pattern in the index of share prices, and so no seasonal correction is necessary.

The remaining variables tested can be described quite briefly. The ordinary overdraft interest rate of the commercial banks is included as an indicator of the general level of interest rates in the economy. Again, no seasonal correction is necessary. The agricultural price index is included, in case it might influence imports of capital goods for use in agriculture. From a study of early results it became clear that some of the increase in the value figures for 1968 were due to price effects resulting from the devaluation of November 1967. Accordingly, a dummy variable for devaluation has been included in many of the equations dealing with the value of imports.

The above general discussion of possible explanatory variables excludes any direct mention of government inducements to investment. Although such measures as grants

* ESRI Paper No. 24.

and tax relief obviously must have a considerable effect on the level of investment, there do not appear to have been sufficient changes in the inducements offered during the period under review to justify an attempt to construct a variable for this factor. Likewise such public utilities as E.S.B. and C.I.E., which engage in heavy investment programmes are not directly considered in the analysis, for want of a suitable quarterly variable to represent their activities. As explained already, imports of ships and planes, which account for a major part of the capital expenditure of other semi-State bodies, are excluded altogether from the analysis.

§4.4. *The Structure of the Equations*

In §4.2 it was noted that the problem of forecasting imports of Producers Capital Goods is essentially different from the problem of forecasting other categories of imports. For the latter current behaviour appears to be dominant, for the former current and lagged values of the independent variables, as in part influencing future expectations, are relevant. Ideally the lag structure should be empirically investigated. Considerations of time have militated against this approach. The model selected in most formulations is a simple Koyck distributed lag model of the form:

$$y_t = \beta x_t + \lambda y_{t-1} + u_t$$

The lagged value of the dependent variable deserves careful interpretation. In its initial formulation — that current imports of capital goods are determined by current and past behaviour — the model takes the form:

$$y_t = \beta x_t + \beta_1 x_{t-1} + \beta_2 x_{t-2} + \ldots\ldots + u_t$$

Assuming that the coefficients decline geometrically, i.e.

$$\beta_i = \beta\lambda^i \ (i, = .0, 1, 2, \ldots\ldots); \ 0 < \lambda < 1$$

the above reduces after some algebraic manipulation to:

$$y_t = \beta x_t + \lambda y_{t-1} + u'_t$$

where $u'_t = u_t - \lambda u_{t-1}$.

As our computer programme did not include a Durbin-Watson test the problem of the induced serial correlation inherent in the formulation of u'_t is handled, by considering Geary's sign change test of residual autoregression. The lagged dependent variable in our formulation is then to be considered as a compound variable summarising the influence of past economic activity. It must be recognised that, where more than one explanatory variable and its lagged terms are considered in an equation, the simple distributed lag form implies certain rigidities on the behaviour of the lag structure of all independent variables. In the interest of simplicity no attempt is made to take account of such possible differing lag structures. For regressions on the absolute data this simple model is used almost exclusively.

In dealing with percentage changes, three-quarter moving averages are used throughout. The use of three-quarter moving averages is justified by the necessity of eliminating sharp quarterly fluctuations particularly on the Producers Capital Goods imports side.

Their use in primarily current terms implies a fairly short reaction time for Irish business. On occasion the lagged value of the dependent variable is introduced.

§4.5. *Absolute Levels, Value Figures*

A multiple regression programme was used to test many specified combinations of the possible explanatory variables introduced in §4.3. A few experimental runs were made excluding the lagged dependent variable but in all such cases the residuals clearly indicated serial correlation, tested using Geary's sign change. The results of the more interesting combinations are given in Table 4.1.

TABLE 4.1: IMPORTS OF PRODUCERS CAPITAL GOODS, LESS SHIPS AND AIRCRAFT, ABSOLUTE VALUE LEVELS, REGRESSION ANALYSIS

A. *Variables*

Dependent Y = capital goods imports (excluding ships and aircraft) seasonally corrected quarterly. £m. current values (II Q 1958–IV Q 1968).

Independent X_1 = volume of production index, transportable goods industries, seasonally corrected quarterly (1953=100).

X_2 = capacity utilisation index (see §4.3)

X_3 = capital deepening in transportable goods industries.

X_4 = price index no. of ordinary stocks and shares (1953=100).

$X_5 = X_{4,\ t-1}$

X_6 = agricultural price index no. seasonally corrected quarterly (1953=100).

X_7 = ordinary overdraft rate of commercial banks.

X_8 = dummy variable for capacity utilisation, based on X_2.

X_9 = dummy variable for devaluation (1, 2, 3, 4 for the four quarters of 1968 and 5 thereafter).

$X_{10} = Y_{t-1}$.

B. *Significance and Fit*

Equation No.	Variables Significant at 1%	5%	10%	20%	Not Significant at 20%	R	F Value	Standard Error of Estimate
A_1	1,10		4		3,5,6,7,8	.991	235.3	.598
A_2	1	8	4		3,5,6,7	.989	219.1	.661
A_3	1,10	8				.989	600.5	.610
A_4	1,10					.988	848.6	.628
A_5	1,4,10				7	.991	517.6	.570
A_6	4,10				8	.989	577.1	.622
A_7	4,10		3		8	.990	446.7	.613
A_8	1,3	8				.975	258.3	.918
A_9	4	1,8	3			.988	388.5	.656
A_{10}	1					.969	623.1	1.016
A_{11}	1,4,10		9			.991	548.8	.554
A_{12}	1,9,10					.990	638.3	.592
A_{13}	4,10	9				.990	622.2	.600

C. *Regression Coefficients*

Equation No.	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	Intercept
A_1	.039		.026	.012	.002	−.012	−.057	−.116		.482	−4.329
A_2	.051		−.017	.017	.010	−.019	−.192	−.329			0.527
A_3	.036							.204		.735	−2.705
A_4	.036									.729	−2.688
A_5	.032			.011			−.067			.507	−2.163
A_6				.017				−.125		.624	−0.088
A_7			−.051	.016				−.077		.486	5.065
A_8	.059		−.165					.290			12.768
A_9	.028		−.061	.025				.254			4.148
A_{10}	.199										−8.212
A_{11}	.025			.010					.217	.572	−1.700
A_{12}	.028								.344	.760	−1.740
A_{13}				.011					.280	.734	0.186

D. *Selected Equations:*

A_3; $Yc = -2.705 + .036X_1 + .204X_8 + .735X_{10}$

A_{11}; $Yc = -1.700 + .025X_1 + .010X_4 + .217X_9 + .572X_{10}$

A_{12}; $Yc = -1.740 + .028X_1 + .344X_9 + .760X_{10}$

It can be seen that variables X_1, X_4, X_9 and X_{10} are significant whenever they are included. Each of these variables shows the expected positive sign throughout and their regression coefficients remain reasonably stable, with the single and unimportant exception of X_1 in equation A_{10} where it is used as the sole independent variable. In the three equations where X_9, the devaluation dummy, is included, it is significant at, at least, the 10 per cent level. This is more surprising than might seem likely, as this variable affects only four quarters out of the total of 43 observations. As it stands, this suggests that devaluation had a marked effect on the price of imported capital goods, although it is also possible that the variable is picking up the effect of some other, unknown, factor.

The index of capacity utilisation, X_2 performs less well than its dummy formulation, X_8. Hence none of the equations shown in Table 4.1 contains X_2. X_8 is significant at the 5 per cent level in four of the equations illustrated, but its sign is perverse in one of these. When X_4 is included, X_8 tends to lose its significance and to have the wrong sign, suggesting that the share price index might pick up the existence or absence of spare capacity—perhaps not too surprising a result.

X_3, the capital deepening index is significant at the 1 per cent level in one, and at the 10 per cent level in two, of the illustrated equations and shows the proper sign. Where X_{10} is included as an independent variable in the regression, X_3 is significant only when taken in conjunction with X_4 and not with X_1. This result is difficult to explain in context and the inclusion of this variable seems to add little to the analysis.

Variables X_5, X_6, X_7 do not appear significant in any of the equations shown. In the regressions tried, X_6 is nowhere significant: X_5, where used rather than X_4, gives a higher standard error of the estimate and a lower R^2—certainly not suggesting that a lagged, rather than a current formulation, of the main independent variable in the distributed lag model, is appropriate: X_7 is significant in a few of the equations not illustrated in the table. However in these cases its sign is positive, although theoretical considerations dictate that its "expected" sign should be negative, despite the complication of interest rates rising through the period studied as a result of changing attitudes to inflation.

Of the equations selected in Table 4.1, A_3, A_{11} and A_{12} seem most likely to be useful for forecasting purposes. The fit obtained for the three equations is satisfactory and the standard error of the estimate is low. Equations A_3 and A_{12} rely mainly on transportable goods industries and variables derived from transportable goods industries. Equation A_{11} introduces expectational factors into the analysis in the form of X_4.

§4.6 *Absolute Levels, Volume Figures*

In §4.2 it was noted that various difficulties arise in deciding whether the dependent variable should be treated in value or volume terms. In §4.5 the value of imports of Capital Goods was taken as the dependent variable. This section of the analysis proceeds by means of volume figures, where the volume is obtained by deflating the value figures by the wholesale price index number of imported Capital Goods (1953 = 100). The independent variables are as in §4.5, with X_{11}, the lagged volume dependent, replacing X_{10}, the lagged value dependent in §4.5, and X_9, the devaluation dummy, being dropped. Table 4.2 presents some results of the regressions run. By comparison with Table 4.1, the fit, as measured by R^2 is lower in general. The standard error of the estimate is also lower—but the mean value of Y in this case is also lower. Hence not too much can be inferred from the lower s^2.

The pattern of the results is similar to that of §4.5 with X_1, X_4, X_{11} significant in most cases at the 1 per cent or 5 per cent level. The coefficients of these three variables remain reasonably stable, although that of X_{11} varies rather more than its counterpart in §4.5.

TABLE 4.2: IMPORTS OF PRODUCERS CAPITAL GOODS, LESS SHIPS AND AIRCRAFT, ABSOLUTE VOLUME LEVELS, REGRESSION ANALYSIS

A. *Variables*

Dependent Y=capital goods imports (excluding ships and aircraft) seasonally corrected quarterly £m. at 1953 constant prices (II Q 58–IV Q 68).

Independent $X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8$ as in table 4.1.
$X_{11}=Y_{t-1}$.

B. *Significance and Fit*

Equation No.	Variables Significant at				Not Significant at 20%	R	F Value	Standard Error of Estimate
	1%	5%	10%	20%				
B_1		11	6	1,4	3,5,7,8	.986	147.0	.504
B_2		4,6	8	1,3,5	7	.983	152.6	.529
B_3	1,11		8			.983	362.7	.523
B_4	1,4	7,8				.978	208.6	.594
B_5	4,11	1		7		.985	304.7	.495
B_6	4,11				8	.983	380.7	.511
B_7	1,11					.981	524.9	.532
B_8	1					.945	345.6	.893

C. *Regression Coefficients*

Equation No.	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_{11}	Intercept
B_1	.020		−.007	.011	.004	−.035	−.086	−.144	.364	3.531
B_2	.018		−.045	.014	.008	−.048	−.172	−.251		9.517
B_3	.023							.146	.741	−1.265
B_4	.034			.020			−.468	−.274		1.002
B_5	.021			.008			−.183		.533	−0.079
B_6				.012				−.076	.577	0.535
B_7	.022								.750	−1.194
B_8	.078									−4.018

D. *Selected Equations:*

B_3; $Y_c = -1.265+.023X_1+.146X_8+.741X_{11}$

B_4; $Y_c = -1.002+.034X_1+.020X_4-.468X_7-.274X_8$

B_5; $Y_c = -.079+.021X_1+.008X_4-.183X_7+.533X_{11}$

Of the remaining variables, the capacity utilisation variable X_8 behaves worse, and with the exception of B_3 has an incorrect sign. X_7 is rather better than in §4.5, being negative in the equations illustrated and significant at the 5 per cent and 20 per cent level in two of these.

The remaining variables do not, in general appear to be significant. The best equations from this set are B_3, B_4 and B_5.

§4.7 *Three-quarter moving average of percentage change*

While the fit provided by the use of absolute values of the series is good and the standard errors reasonably low, the common rise through time of many of the series, detracts from the meaning of the functional relationships indicated, as there are

inevitably severe problems of multi-collinearity. A more rigorous test of the relationships is required. In this part of our study of imports, for reasons outlined in §4.4, three-quarter moving averages of percentage first differences are resorted to, rather than the simple percentage changes used throughout the remainder of our study. Most of the analysis is in current terms, (or with the addition of the lagged dependent variable), which presupposes a fairly short reaction time between the decision to invest, (based on the behaviour of the independent variables considered here) and the actual importation of capital goods. The values of the coefficients of the lagged dependent variables in the regressions on the absolute data, converging as they do rapidly to zero bear this out.

In dealing with percentage changes various alternative forms of the capacity utilisation index were tried—X_5 and X_6 are identical with X_2 and X_8 respectively of §4.5, while X_7 and X_8 are changes in X_5 and X_6 respectively.

Selected results for percentage changes in the value of imports are presented in Table 4.3. Although the fit, measured by R^2, is not particularly great in any of the equations, in all of those shown the regressions are significant, using the F-test. The results compare fairly well with similar exercises on imports of consumer goods and imports of raw materials using three-quarter moving averages, in terms of R, F, or the standard error of the estimate.

A feature of the regressions run was the significance of the regression coefficients of X_5 and X_6, which pair performed equally well. X_6, being computationally easier to deal with, was adopted throughout the table, wth the exception of equation C_8. The variables X_7 and X_8 were rarely significant and hence were dropped from the table.

X_6, the capacity utilisation variable is significant throughout at either the 1 per cent or 5 per cent level. Its regression coefficient maintains its expected positive sign and is relatively stable.

X_1, the transportable goods variable, is generally significant at the 1 per cent or 5 per cent levels and has the expected sign—its coefficient remaining constant depending on the inclusion or exclusion of X_3. In equation C_{10} the simple correlation between Y and X_1, is .429 ($R^2 = .18$), significant at better than the 1 per cent level. The inclusion of X_6, as in equation C_9 raises the R^2 from .18 to .39. The simple correlation between Y and X_6 is .52 (for Y and X_5 it is .54) again in itself highly significant. The implication of all this is that the current level of capacity utilisation is rather more important for percentage changes in the three-quarter moving average of capital goods imports, than for the absolute level of such imports, with which the capacity utilisation variable is hardly at all correlated, though it is significant in some of the absolute value equations.

X_2, the capital deepening variable is disappointing having, in all selected equations, the wrong sign. Not surprisingly X_4 is nowhere significant.

X_3, the share price index variable performs rather less well than might have been expected from the absolute data. However it is generally significant at the 5 per cent or 10 per cent level and its coefficient is positive throughout. Taken in conjunction with X_1, and X_6 it does improve the fit and lower the standard error.

X_9, the devaluation variable is again significant at the 5 per cent level at least in the limited number of equations in which it appears.

X_{10}, the lagged dependent variable is significant at the 5 per cent level in one, and at the 10 per cent level in three, of the selected equations. Its inclusion, however, makes very little difference to the fit.

It is reassuring that the results shown in Table 4.3 broadly confirm those of Table 4.1. The same factors, industrial production, capacity utilisation, share prices and devaluation tend to be significant in the first difference as in the absolute formulations. In both formulations the signs for all these variables are in the expected positive direction, and the regression coefficients are reasonably stable.

TABLE 4.3: VALUE OF IMPORTS OF PRODUCERS CAPITAL GOODS, LESS SHIPS AND AIRCRAFT, AT CURRENT PRICES, 3 QUARTER MOVING AVERAGES, PERCENTAGE CHANGES, REGRESSION ANALYSIS

A. *Variables*

Dependent Y = value of capital goods imports, less ships and aircraft, s.c. % 1st differences of 3-quarter moving averages (III Q 1958–III Q 1968).

Independent X_1 = volume of production index, s.c. transportable goods industries, % 1st differences of 3-quarter moving averages.

X_2 = capital deepening effect in transportable goods industries, % 1st differences of 3-quarter moving averages.

X_3 = price index number of ordinary stocks and shares, % 1st differences of 3-quarter moving averages.

X_4 = agricultural price index, s.c., % 1st differences of 3-quarter moving averages.

X_5 = capacity utilisation index, as X_2 in tables 4.1 and 4.2.

X_6 = dummy variable for capacity utilisation, as X_9 in tables 4.1 and 4.2.

X_7 = change from quarter to quarter in X_5.

X_8 = change from quarter to quarter in X_6.

X_9 = dummy devaluation variable.

$X_{10} = Y_{t-1}$.

B. *Significance and Fit*

Equation No.	Variables Significant at 1%	5%	10%	20%	Not Significant at 20%	R	F Value	Standard Error of Estimate
C_1		1,6	10	2,3	4	.690	4.99	2.699
C_2	6	1	3		2,4	.668	5.47	2.734
C_3		1,6	3,10	2		.690	6.17	2.659
C_4	6	1	3		2	.667	7.03	2.695
C_5	1,6	10		2		.673	7.24	2.677
C_6		1,6	3,10			.676	7.37	2.667
C_7	6	1	3			.657	9.14	2.688
C_8		3,5			10	.632	7.99	2.765
C_9	1,6					.626	11.93	2.744
C_{10}	1					.429	8.58	3.137
C_{11}	6	9	1		3	.694	8.13	2.605
C_{12}	6,9	1				.686	10.67	2.596
C_{13}	6,9		3			.673	9.91	2.641

C. *Regression Coefficients*

Equation No.	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	Intercept
C_1	.841	.560	.150	.014		1.338				.221	1.209
C_2	0.85	.450	.194	−.042		1.798					1.657
C_3	.837	.556	.152			1.340				.220	1.213
C_4	.816	.462	.188			1.799					1.651
C_5	1.037	.622				1.454				.259	1.379
C_6	.826		.167			1.218				.197	0.537
C_7	.807		.197			1.656					1.040
C_8			.268		.582					.130	−56.178
C_9	1.074					1.901					1.282
C_{10}	1.308										1.128
C_{11}	.599		.110			1.670			1.237		1.498
C_{12}	.691					1.792			1.452		1.695
C_{13}			.156			1.699			1.497		2.384

D. *Selected Equations:*

C_6; $Y_c = .537 + .826X_1 + .167X_3 + 1.218X_6 + .197X_{10}$

C_{11}; $Y_c = 1.499 + .599X_1 + 1.670X_6 + .110X_3 + 1.237X_9$

C_{12}; $Y_c = 1.695 + .691X_1 + 1.792X_6 + 1.452X_9$

A similar exercise has been carried out for the volume of imports of Capital Goods. Selected results are given in Table 4.4. The pattern evident in Table 4.3 is repeated for the volume figures, with X_1 and X_0 predominating. The general level of fit is rather lower and the standard error of the estimate rather higher than in Table 4.3. With the exception of X_2 significant variables have the correct sign attached. From the set D_4, D_6 and D_7 have been selected for predictive purposes.

TABLE 4.4: VOLUME OF IMPORTS OF PRODUCERS CAPITAL GOODS, LESS SHIPS AND AIRCRAFT, 1953 CONSTANT PRICES, 3-QUARTER MOVING AVERAGES, PERCENTAGE CHANGES, REGRESSION ANALYSIS

A. *Variables*

Dependent Y = value of imports of capital goods (at 1953 prices), less ships and aircraft, % 1st differences of 3-quarter moving averages.

Independent $X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8$, as in table 4.3.
$X_{11} = Y_{t-1}$.

B. *Significance and Fit*

Equation No.	Variables Significant at 1%	5%	10%	20%	Not Significant at 20%	R	F Value	Standard Error of Estimate
D_1	6	1	2	3	4,11	.680	4.718	2.753
D_2	6	1	2,3		4	.671	5.555	2.742
D_3	1,6	2		11		.667	7.003	2.715
D_4	1,6	2				.648	8.671	2.737
D_5		1,6		3	11	.647	6.303	2.777
D_6	6	1		3		.637	8.209	2.768
D_7	1,6					.617	11.352	2.788
D_8	1					.445	9.386	3.131

C. *Regression Coefficients*

Equation No.	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_{11}	Intercept
D_1	.925	.753	.143	−.163		1.542			.139	1.210
D_2	.885	.691	.178	−.228		1.822				1.459
D_3	1.124	.852				1.590			.189	1.281
D_4	1.136	.805				2.021				1.664
D_5	.955		.135			1.303			.136	0.135
D_6	.931		.158			1.594				0.426
D_7	1.145					1.792				0.622
D_8	1.365									0.476

D. *Selected Equations:*

D_4; $Y_c = 1.664 + 1.136X_1 + .805X_2 + 2.021X_6$
D_6; $Y_c = .426 + .931X_1 + .158X_3 + 1.594X_6$
D_7; $Y_c = .622 + 1.145X_1 + 1.792X_6$

§4.8 *Forecasting Tests*

As in the case of consumers goods imports and imports of non-agricultural raw materials, it is possible to "test" the performance of the equations in forecasting imports of Capital Goods (excluding Ships and Aircraft), in a period not included in the estimation of the parameters of the equations, and comparing the actual outcome with the forecast. For the absolute data the first three quarters of 1969 can be "tested". For the

percentage first differences of the three quarter moving averages the fourth quarter of 1968 together with the first two quarters of 1969 can be "tested". For the volume figures the third-quarter actual is preliminary. In this part of our study rather more equations are tested than in the previous two parts. Two points deserve mention for this wider selection. First, the maintenance men's dispute in the first quarter of 1969 seriously affected the transportable goods volume of production index and, while the second quarter of 1969 partly made up for this, there was a considerable loss on the half year—a loss which is unlikely to have affected investment plans of business for these quarters. Secondly, the share price index was falling for most of 1969, partly mirroring movements on other stock exchanges (especially London) and partly reflecting uncertainty concerning prospects for the Irish economy. For the index to fall in a period when most current economic indicators were rising steeply is an unusual occurence and may have some unsettling affect on the forecasting tests. However, this variable is included in only some of the equations tested and comparison between those and equations which exclude it might indicate the extent of any distortion thus caused.

The results of the tests are set out in Table 4.5. Part A compares the actual with the predicted for the regressions on absolute data. Part B (i) deals with the percentage changes in the three quarter moving averages, while Part B (ii) considers the absolute values represented by the percentage changes in B (i).

In general the results are encouraging. The final column in part A, comparing the actual with the predicted, deserves mention—the predicted total is not the sum of the predictions for the separate quarters (with the exception of B_4 which does not involve lagged terms), but that obtained using the predicted value Y for any quarter as the lagged value of X_{10} and X_{11} respectively for the next quarter. From the point of view of forecasting a year ahead it is this interactive procedure which must be resorted to. Where the next quarter is required then the immediate past quarter, which is known, can be used. The absolute value figures are fairly close both for the quarters and for the predicted totals. The absolute volume figures are not so good. The three quarter moving averages predictions are, in terms of the absolute values, very close to the actual, both as far as the individual quarters and the total for the period are concerned. The value figures seem to be rather better than volume in predicting the percentage changes.

§4.9 *Conclusion*

The analysis in this part of our import study has involved the calculation of a large number of regression equations, with a small number of independent variables. As far as the dependent variable is concerned the analysis has not provided any clear-cut answer to the quality problem. In terms of the absolute data the value figures give higher R^2 and lower s^2 for the equations. The forecasting tests seem to favour the value figures also. However, in dealing with percentage changes the value and volume figures perform equally well on the forecasting of the absolute levels—though the value figures are better in "predicting" the percentage changes; and it is these that are important from a long term point of view.

Considering the regressions on the absolute data and the regressions on the percentage changes in conjunction, it seems fairly clear that imports of Producers Capital Goods less Ships and Aircraft are closely related to the volume of production of transportable goods industries. It further appears, perhaps surprisingly, that this relationship is largely a current one. Similarly it appears that the behaviour of the share price index is an important determinant of capital goods imports, although the precise way in which this operates must remain open to speculation.

Of the variables selected as potentially important, the level of capacity utilisation is dominant as far as percentage changes are concerned. The importance of this variable in

TABLE 4.5: FORECASTING TESTS

A. *Regressions on Absolute Data*

Equation	Dependent Variable	1st Q 1969 Actual	1st Q 1969 Predicted	2nd Q 1969 Actual	2nd Q 1969 Predicted	3rd Q 1969 Actual	3rd Q 1969 Predicted	Total Period Covered Actual	Total Period Covered Predicted
		£m.		£m.		£m.		£m.	
A_3	Value of Imports of Capital Goods less Ships and Aircraft £m. Current Prices	20.2	19.8	22.5	21.0	24.1	22.7	66.8	61.9
A_{11}		20.2	20.8	22.5	21.6	24.1	22.6	66.8	64.9
A_{12}		20.2	21.0	22.5	22.1	24.1	23.6	66.8	67.5
B_3	Volume of Imports of Capital Goods less Ships and Aircraft £m. at 1953 constant Prices	13.8	13.9	15.3	14.6	(16.0)	15.8	(45.1)	43.9
B_4		13.8	13.7	15.3	14.0	(16.0)	13.3	(45.1)	41.0
B_5		13.8	13.9	15.3	14.4	(16.0)	14.9	(45.1)	42.9

B. (i) *Regressions on percentage 1st differences of 3-quarter moving averages.*

Equation No.	Dependent Variable	4th Q 1968 Actual	4th Q 1968 Predicted	1st Q 1969 Actual	1st Q 1969 Predicted	2nd Q 1969 Actual	2nd Q 1969 Predicted
		%		%		%	
C_6	% changes of 3-quarter moving averages of Imports of Capital Goods less Ships and Aircraft at current prices	5.42	3.60	7.02	6.06	6.88	5.80
C_{11}		5.42	6.97	7.02	7.26	6.88	5.46
C_{12}		5.42	7.34	7.02	8.12	6.88	6.46
D_4	% changes of 3-quarter moving averages of Imports of Capital Goods less Ships and Aircraft at constant prices	3.85	1.97	5.68	5.19	Not available	
D_6		3.85	2.09	5.68	4.51	(5.37)	4.14
D_7		3.85	1.58	5.68	5.28	(5.37)	4.93

B. (ii) *Absolute Values of Results of* B (i).

Equation No.	4th Q 1968 Actual	4th Q 1968 Predicted	1st Q 1969 Actual	1st Q 1969 Predicted	2nd Q 1969 Actual	2nd Q 1969 Predicted	Total Period Covered Actual	Total Period Covered Predicted
	£m		£m		£m		£m	
C_6	19.5	19.1	20.8	20.6	22.3	22.0	62.6	61.7
C_{11}	19.5	19.7	20.8	20.9	22.3	22.0	62.6	62.6
C_{12}	19.5	19.8	20.8	21.0	22.3	22.2	62.6	63.0
D_4	13.5	13.2	14.3	14.2	Not available		27.8	27.4
D_6	13.5	13.3	14.3	14.1	(15.0)	14.9	(42.8)	42.2
D_7	13.5	13.2	14.3	14.2	(15.0)	15.0	(42.8)	42.4

the regressions implies that any deviations from the exponential trend in the growth of transportable goods industries will have a marked effect on the growth of imports of capital goods. The simplicity of the variable makes it useful for forecasting purposes. Further experimentation by defining more different degrees of capacity utilisation than provided for by the —1, 0, +1 formulation may prove worthwhile—though it is suspected that this may be only marginal, at least as far as percentage changes are concerned.

The remaining variables do not appear to be very significant in determining quarter to quarter movements in imports of Producers Capital Goods, at least in the approach adopted in this study. The data, of course, are not perfect, so that a properly constructed capital deepening series might prove significant, using our approach.

The forecasting tests show reasonable consistency between the actual and predicted values over the period of the tests for most of the selected forecasting equations. Within the period tested the absolute data regressions closely approximated the actual, with the value figures performing rather better than the volume. Even the percentage change predictions are in most cases quite close to the actual within the test period, while the smallness of the base makes any difference in absolute terms very slight.

The distributed lag formulation can only be considered a first approximation. Empirical research is required to discover the lag structure, if it exists. Information is required as to the age structure of the capital stock as bunching of replacement investment can cause large imports not readily picked up by the explanatory variables used.

As in the case of the two previous categories of imports, further testing is required for this category before any of the equations can be fully accepted as a working tool for forecasting. However, given the difficulty of the problem, the exercise can be regarded as reasonably successful, both from the point of establishing structural relationships and as giving an encouraging preliminary results in testing for forecasting purposes.