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The Accelerator Model of Investment:
An Appraisal on French Data

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Abstract

The accelerator model of investment in its empirical formulation dominates nearly all other models of investment behavior throughout the world. This paper examines this model in the context of French data and contends that the empirical superiority of the model is spurious, being largely related to simultaneous equation bias. As an alternative, an income or profits based model is shown to be at least as creditable a description of the data once scope for this bias is removed.

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I. Introduction

The dominant model of company sector investment in France and indeed in virtually every other country is the accelerator model. The derivation of the accelerator can be approached in a number of different ways, each with varying degrees of theoretical plausibility. Insofar as the empirical formulation is identifiable as an accelerator, however, the end result is almost always the same: investment or the change in the capital stock is related to current and lagged values of output supplemented by lagged values of the dependent variable. It is to this specification that the accelerator owes its real success. For the model does not dominate economic modeling because of its theoretical plausibility but because of its apparently overwhelming empirical superiority over other models. Thus Jurgenson's neoclassical model, built on the assumption of perfect capital markets with its emphasis on relative factor prices evolved into a model whereby the latter have ended up as at best an auxiliary to the accelerator. Similarly, the profits or income based model, rationalized in terms of capital market imperfections, has also tended to take the back seat leaving output as the prime mover of investment. It is the thesis of this paper that the empirical dominance of the accelerator model is largely spurious, related to simultaneous equation bias, and that an income or profit based model has at least as much to offer as an output based one.

Financial effects on investment, of various kinds, have recently been explored by Malécot and Hamon (1986). They used a combination of cross section and time series data to consider the determination of enterprise net fixed investment in France on a disaggregated basis. Despite the apparent success of a number of financial terms the results nonetheless tend to confirm the empirical dominance of the accelerator in the explanation. In their case the problem of the simultaneous determination of output and investment is largely avoided in a Keynesian macroeconomic sense (one enterprise's investment is another's output), since microeconomic data is used. But simultaneity is reintroduced by virtue of the relatively wide (annual) time interval employed. The relationship between capital and output in the production function of an enterprise means that over a period as long as a year there is bound to be an observed correlation as new capital is employed to produce output. This point is noted by Poret (1986) who argues that the relationship between investment and output in the accelerator model must thereby be spurious. This hypothesis, although stated, is not however tested for. In fact, since the data used by Poret is both annual and aggregated the accelerator is likely to reflect both macro and micro simultaneity. It is therefore not surprising that although alternative relationships he considers are encouraging, they consistently fail to match the explanatory power of the accelerator.

Simultaneity in the micro sense is avoided in what follows by virtue of the choice of a relatively short time interval (quarterly). It is meanwhile the object of the paper to actually test for the presence of macroeconomic (or any other type of) simultaneity and show that, once this has been properly accounted for, the relative position of an income model (and perhaps that of other models) may be considerably enhanced vis-à-vis the accelerator.

II. Company Disposable Income

The idea that current profitability should influence investment is really based on two elements. The first is that current profitability is an indicator of future profitability with obvious implications for investment plans. As will be argued with the accelerator, this is not a very robust theory of the determination of expectations. It would by no means be necessarily true if expectations were formed rationally. The other element of the profits theory is that profitability affects cash flow. This theory relies upon the assumption of imperfect capital markets, where the implicit discount rate applied to internally generated funds is substantially below that of externally generated funds (i.e., borrowing). This model makes no particular assumption about the formation of expectations, but simply asserts that investment should respond positively if the cash flow constraint is eased and vice versa. Since this element, which is the one developed here, relies on cash flow it is more pertinent to consider a measure of company disposable income rather than profits.

Disposable income has been defined here as the sum of gross saving including capital transfers and subsidies but before deducting dividends. Essentially this is equivalent to the gross operating surplus less net interest payments, social security contributions, taxes and other transfers. This is taken to be, at least in the short run, largely exogenous to company sector decisions. Dividends are, however, regarded as a choice variable. Thus company disposable income is allocated between company expenditure on fixed capital and stocks, dividend distributions and net borrowing (the financing requirement). This definition of income is analogous to that in household accounts. Thus personal disposable income is allocated between physical investment (mainly housing), consumption and the financial surplus. Indeed, the relationship being posited between company expenditure and income is rather like that of the Keynesian consumption function. Both relationships depend upon the existence of imperfect capital markets for their theoretical derivation. Both relationships tend to concentrate more on the short than on the long run. Chart 1 shows the relationship, on an annual basis, between company disposable income and expenditure over the period 1963 to 1983. Both income and expenditure data have

CHART 1
COMPANY INCOME AND EXPENDITURE

(F 100 million 1970 prices)

(Annual data)

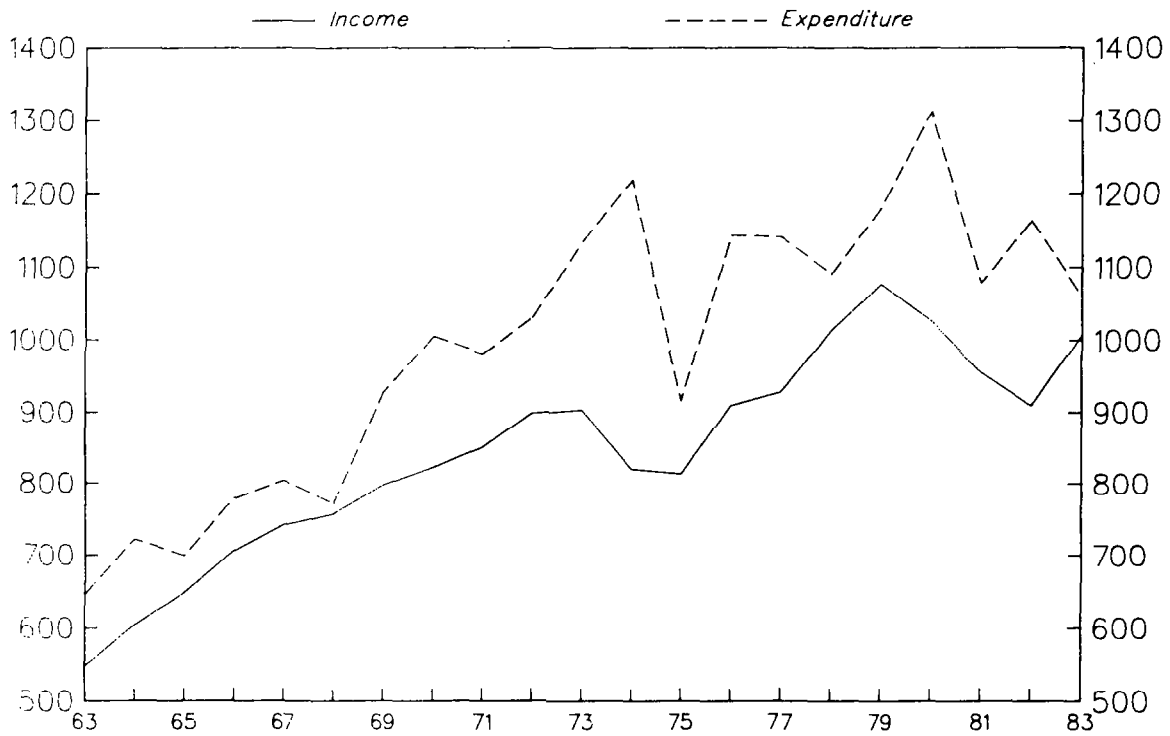
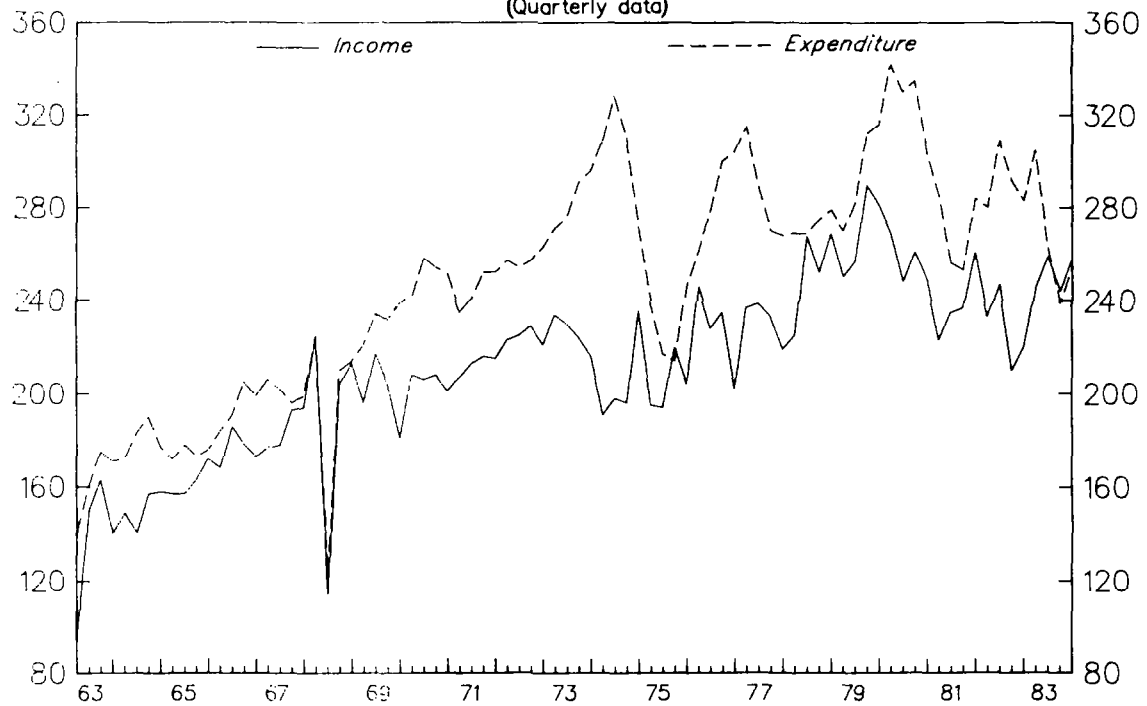


CHART 2
(F 100 million 1970 prices)
(Quarterly data)





been compiled in current prices. ^{1/} In order to offset common trending due to price inflation the two series shown in the chart have been deflated by the GDP deflator. A relationship between the two is apparent, with expenditure lagging income by about one year.

In order to test this hypothesis more rigorously it is necessary to perform some regressions. Before doing this, however, one must take account of one important feature of the equivalent quarterly series. Chart 2 shows the behavior of these two series on a quarterly basis where it is immediately revealed that there was a very significant drop in both income and expenditure in the second quarter of 1968. This reflects, of course, the May 1968 strikes and it will be necessary to separately account for this in order to avoid spurious contemporaneous correlation between the two variables. Since the annual Chart indicates a lag of up to one year in the relationship between income and expenditure it will be appropriate to include lags of up to four quarters for income. For consistency lags of up to four quarters were also permitted for the dependent variable. The presence of these lags means that the May 1968 episode cannot be dealt with by a single dummy variable. The presence of lagged values of income and expenditure requires that lagged dummies be entered as well and, if the effect of the episode is to be separated out entirely, these must be constrained in a nonlinear way. Since this is beyond the scope of this study and since also it is possible that, while disturbing the dynamics, the effect of the strikes on income may not be entirely irrelevant on expenditure in the longer run, the expedient adopted here was to enter five dummies, one contemporaneous and four lagged. The current term in income was excluded in order to avoid the possibility of simultaneous equation bias. Finally, a time trend was included to preempt spurious correlation due to common trending. With both income (Y) and expenditure (E) deflated by the GDP deflator, as noted above, this gives us the following specification:

$$E = a + \sum_{i=1}^4 b_i E_{-i} + \sum_{i=1}^4 c_i Y_{-i} + \sum_{i=0}^4 d_i \text{MAY68}_i + e \cdot \text{TIME}$$

The result of fitting this equation to the data period 1964 Q1 to 1983 Q4 is shown as Equation 13 in Table 5. Rather than discuss this equation now it is convenient to consider a more parsimonious representation. This is shown as Equation 1 in Table 1. It is an acceptable restriction on the general equation reported as Equation 13 in Table 5 ($\chi^2(7)=0.81$). It also passes the Chow split sample test ($F(8,64)=1.915$). The equation relates expenditure to income lagged two, three and four times. This makes sense. Managers are likely to want to look at a whole year's estimate of income in order to remove the influence of seasonal factors and noise. However, income in the quarter

^{1/} The source of this data is the French Quarterly National Accounts 1963-83, INSEE, April 1984.

just ended will probably not have been compiled at the time that expenditure is authorized and certainly not when the decisions are taken (if there is a lag between initial decisions and final authorization). The missing quarter will therefore probably be estimated as a function of the previous three. Thus it is income lagged two, three and four periods which prove significant (Y234). It was noted that the current term in income was omitted owing to fears of simultaneity. It would also be reasonable to omit it on the grounds that the relevant information would not be at hand in time for decisions to be taken anyway, as argued above. A specification was, however, tried that included the current term, and although the estimated coefficient was positive, it was not statistically significant and could be dropped on the normal criteria. The last three lags on the May 1968 dummy also proved insignificant, but the current and first lag on this term show up as highly significant. This is interesting because it suggests that the strikes undoubtedly exerted an independent influence on expenditure. But the effect on expenditure from the drop in income induced by the strikes, which in this model came through with a lag of at least two quarters, is clearly not irrelevant. If it were irrelevant the significance of lagged income would have required a significant lagged dummy too to offset this effect. Thus the strike exerted an important cash flow effect which affected subsequent expenditure.

The longer run properties of the model suggest that increases in income are eventually fully exhausted in investment expenditure. The precise long-run propensity to spend is estimated at 1.17, statistically indistinguishable from unity. This long-run coefficient is not, however, well determined (few are in econometrics). Table 1 shows the same equation estimated over the two subperiods, 1964 Q1 to 1973 Q4 and 1974 Q1 to 1983 Q4, used for the Chow test. The long-run propensity to spend works out at 1.32 in the earlier period and 0.62 in the later period.

While the interest of this paper is primarily in the relationship between income and expenditure, it is instructive to consider briefly the allocation of income to dividends and the financial surplus. To do this a very naive income allocation model has been estimated, using as regressors the variables used in the equation in Table 1 plus current income. The results of regressing dividend payments and the financial surplus, both deflated by the GDP deflator, on these variables is shown in Table 2. For completeness expenditure is also regressed on these variables and the result shown in Table 2 as well. Since current income is included the adding up properties of the allocation ensure that the coefficients on current income sum to unity while those attaching to all other explanatory variables sum to zero, as can be seen. The equation for expenditure is little changed from that shown in Table 1, since, as already noted, the current income term is not significant in this equation. In fact it is clear that virtually all current income goes into the financial surplus. A small amount goes to dividends, but this is barely significant, as one would expect. In the long run a rise in income leads to a fall in the financial surplus. While the short-run

CHART 3
COMPANY INCOME AND EXPENDITURE
(Effect of F10 billion income increase)

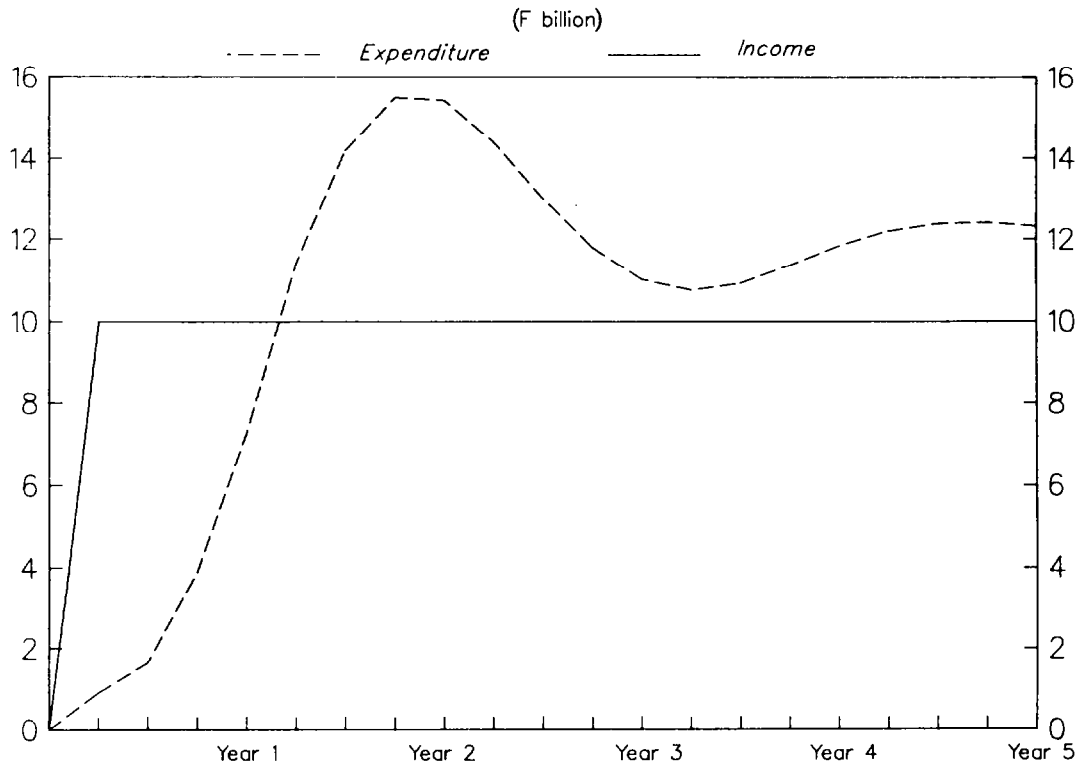
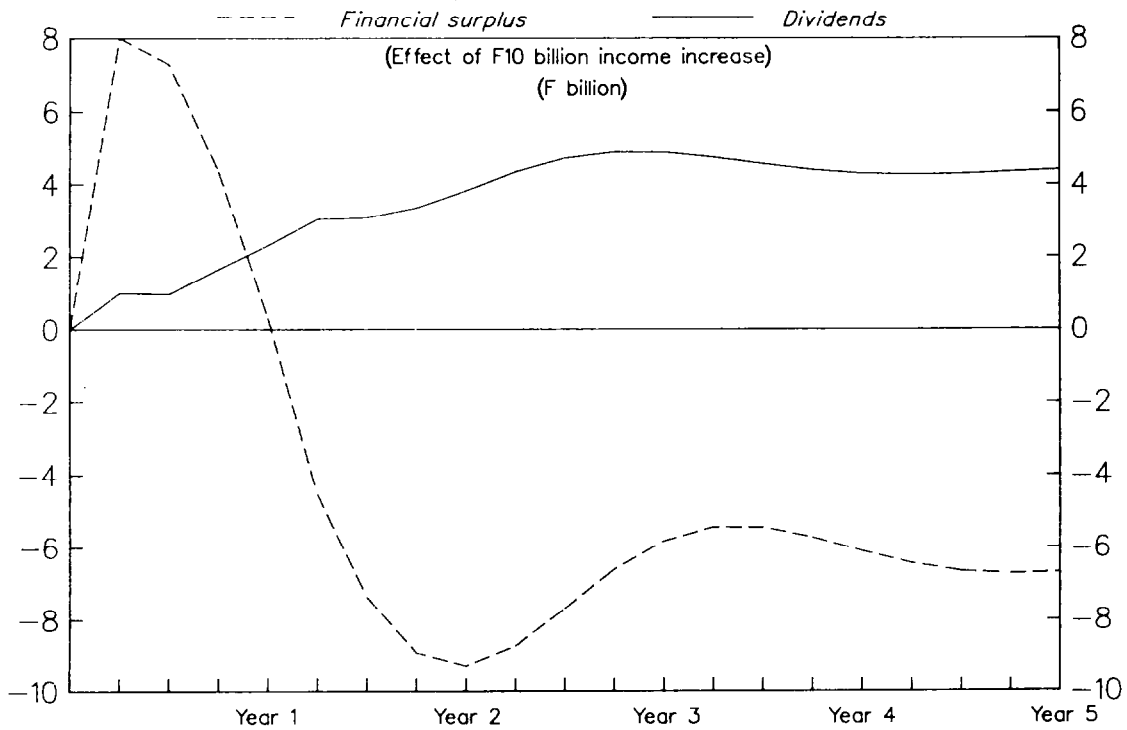


CHART 4
FINANCIAL SURPLUS AND DIVIDENDS
(Effect of F10 billion income increase)



effect of a rise in income on dividend payments is small, in the longer run it is more significant. The dynamics of an F 10 billion increase in income in this model are shown in Charts 3 and 4. Chart 3 shows expenditure responding (significantly) only with a lag, rising to some F 15-16 billion by the end of the second year, after which it subsides to F 11-12 billion. Chart 4 shows the effect on the financial surplus, initially benefitting by nearly the full amount of the income increase, but being subsequently eroded so that it returns to zero after one year. After that it follows, inversely, the expenditure profile. Finally, dividend payments respond positively, but only gradually to the increase in income. In the long run slightly under half the increase in income goes towards higher dividends. With the increase in expenditure slightly greater than that of income, this implies a decline in the financial surplus of slightly greater than half the income increase. Note that this does not necessarily imply a worsening balance sheet. If the proceeds of the dividend payments are reinvested in new equity, this would in turn lead to more or less balancing finance for the financial deficit.

The equations shown in Table 2 are obviously very rudimentary and as an income allocation model they leave a lot to be desired. It would be of interest to try a number of auxiliary variables such as interest rates and liquidity, as well as look for stock effects from cumulated investment (inventories and fixed capital) and net borrowing. It is not, however, the objective of this paper to derive a complete explanation of the determination of investment. The objective is rather to reveal the contribution that the income model can make to our understanding of this category of expenditure. As we shall see in the next section, the dominance of the accelerator model, which has hitherto rendered the income model a mere auxiliary, may well be an illusion. The income model should therefore be regarded as at least as important as the accelerator.

III. The Accelerator Model

1. The theoretical problem

The accelerator is often identified as a Keynesian construct. This is primarily owing to its widespread use in econometrically estimated macroeconomic models, themselves seen as one of the main by-products of the Keynesian revolution. Keynes himself, of course, explicitly rejected the idea that investment might behave in such a mechanistic manner. The idea of the accelerator, however, actually has a much longer history than even Keynesianism. Possibly the earliest example of this type of approach to the theory of investment may be that of Aftalion (1909). Later proponents, such as Clark (1917), gave a clearer exposition of what is now known as the "naive" accelerator. The naive accelerator, as its name suggests, proved inadequate as a theory of investment, on account of clear incompatibility with the data. This problem, however, was overcome by the "flexible" accelerator, variants

of which now dominate econometric models throughout the world. This model can be set up in a fairly general way, but its essence is more easily conveyed in terms of the following simple framework.

For the moment let it be assumed that either (i) there is a fixed capital output ratio or (ii) relative input prices are constant. The first approach to the accelerator is via the capital stock adjustment principle. Suppose that the desired capital stock is proportional to current output (0).

$$K^* = a0$$

Owing to the existence of adjustment costs, net investment (NI) in any one period closes only a portion of the gap between actual and desired capital.

$$\begin{aligned} NI &= m(K^* - K_{-1}) \\ &= ma0 - mK_{-1} \end{aligned}$$

Thus net investment is a function of current output and the lagged capital stock. The problem with this formulation is well known. If adjustment costs slow the adaptation of the actual capital stock to the desired then, in an optimising world, the desired capital stock would be a function not just of current output, but of expected future output as well. This leads naturally to the second approach to the accelerator. According to this the desired capital stock is a function of expected future, or permanent, 1/ output.

$$K^* = a0^P$$

How is permanent output to be measured? In a now famous study Koyck (1954) proposed that permanent output might be proxied by a distributed lag on past output, with weights that decline geometrically. Thus

$$0^P = (1-v)(0 + v0_{-1} + v^2 0_{-2} + \dots)$$

Ignoring adjustment costs in this case, the actual capital stock is brought equal to its desired level in each period. By virtue of the Koyck transformation:

$$K = a(1-v)0 + vK_{-1}$$

Since

$$NI = K - K_{-1}$$

1/ In the sense of Milton Friedman's permanent income concept.

then

$$NI = a(1-v)O - (1-v)K_{-1}$$

which is formally indistinguishable from the earlier derivation. If both the permanent income concept and the adjustment cost hypothesis are combined, it is obvious that the result will be essentially the same: net investment is a function of output and the lagged capital stock.

The model can be easily generalized to the case where factor prices are allowed to play a role. ^{1/} This normally leads to the addition of relative factor prices to the right hand side of the relationship as, for example, in Jurgenson's model. Similarly, the transition from net to gross investment is relatively straightforward, since replacement investment can be taken to be proportional to the previous period's capital stock, thereby leading to a formulation qualitatively similar to those above. From an empirical point of view, however, the measurement of the capital stock, K , is sometimes viewed as a problem. On account of this, therefore the level of K in the previous period is often, though not always, substituted by lagged values of investment. This is justifiable on the grounds that the capital stock is equal by definition to the cumulated value of past net investment.

If it was the absence of output expectations that was the problem with the first approach to the accelerator, then it is the measurement of these expectations that is the real problem with the second approach. The Koyck distribution is not, of course, the only model of "permanent output" that has been put forward. Others, for example, deLeeuw (1962), have suggested different distributions of weights on past values of output. In general, agnosticism about the lag structure has led empiricists to let the data decide, starting from a theoretical formulation with a generalized nonspecific lag distribution on output. That expectations of future output should depend systematically upon any simple arrangement of current and past values of output is, however, questionable. Nowadays expectations are everywhere assumed to be rational or forward, rather than backward, looking. This means that they will depend upon "news" in a wide range of variables, not just output. A reduced form relationship or autoregressive model might possibly be able to represent the process according to which such expectations are formed, but only, as Lucas (1976) has shown, where policy rules are invariant. Once expectations of future output are taken to depend upon values of variables other than past output, however, the model begins to lose its character as an "accelerator."

^{1/} Where assumptions (i) and (ii) above are withdrawn.

2. The empirical problem

The accelerator model in its empirical guise relates investment to current and lagged values of output. In this section it will be demonstrated that the apparent success of this formulation is owing chiefly to a spurious relationship. Since this paper is working at a fairly aggregate level, output (O) was here measured by industrial production. Manufacturing production was tried but proved marginally less significant than industrial production. Mindful of the problem of the events of May 1968 which affected output as much as they affected company income and expenditure, the initial specification assumed was

$$E = a + \sum_{i=1}^4 b_i E_{-i} + \sum_{i=0}^4 c_i O_{-i} + \sum_{i=0}^4 d_i \text{MAY68}_{-i} + e \cdot \text{TIME}$$

This specification is therefore exactly parallel to that for the income model. The result of estimating this general specification is shown as Equation 7 in Table 3. ^{1/} Output proves highly significant in explaining expenditure. The fit of the equation is markedly superior to that of the income model. The general specification for the income model (which excludes the insignificant current income term) shown as Equation 13 in Table 5 has a standard error of 13.12 as compared with 10.61 for the accelerator equation. It is noteworthy that the May 1968 dummies are not particularly significant, suggesting that they contribute little concerning this episode that the output variable does not also independently supply to the explanation. The time trend is significant and negative, suggesting, in the terminology for the accelerator, a trend decline in the capital output ratio, which would presumably be related, amongst other things, to technology. What is most notable, however, about this equation, is the very large coefficient on the current term in output, followed by a significant smaller negative coefficient on the first lag in output. This is a common feature of many estimated accelerator models. Most of the work is done by the current term in output. Since industrial production is much larger in volume than expenditure, a given increase in production in the current period triggers a much larger proportionate increase in investment expenditure by a factor of nearly two although the long-run proportionality is close to one. This "flip-back" coefficient on current output is highly suspicious and a sure sign of simultaneity. This is something that will be tested for. Before doing this it is worth demonstrating the fate of an income term when entered as an auxiliary into this type of equation. Equation 8 in Table 3 shows a version of the general model that drops the last three lags on the May 1968 dummy, as in the preferred income equation. The standard error of the equation drops to 10.38. Adding the Y234 term in income that does

^{1/} The dependent variable therefore represents total expenditure, i.e., fixed investment and stockbuilding. This is not a problem for the accelerator since this formulation is used as frequently to explain stockbuilding as it is fixed investment.

the work in the preferred income model results in a further improvement in fit in Equation 9. But the improvement is only slight and the coefficient on the Y234 income term is only awarded a t-statistic of 2.3, half that, for example, of the current term in output. The income term thus barely deserves the title even of "auxiliary". This is the normal finding in accelerator models.

To test for the exogeneity of output this paper makes use of the Wu-Hausman test.^{1/} The idea of this test is as follows. Suppose there are two estimates: B_1 which is consistent and asymptotically efficient under the null hypothesis of correct specification; and B_2 , which is consistent under both the null and the alternative hypothesis. Then, since B_1 is efficient it is known that:

$$\text{Cov}((B_1 - B_2), B_1) = 0$$

(Otherwise a more efficient estimator could be constructed.) Hence:

$$\begin{aligned} \text{Cov}(B_1, B_2) &= \text{Cov}(B_1, (B_2 - B_1) + B_1) \\ &= \text{Cov}(B_1, (B_2 - B_1)) + \text{Var}(B_1) \\ &= \text{Var } B_1 \end{aligned}$$

Therefore:

$$\begin{aligned} \text{Var}(B_2 - B_1) &= \text{Var}(B_2) - 2\text{Cov}(B_1, B_2) + \text{Var}(B_1) \\ &= \text{Var}(B_2) - \text{Var}(B_1) \end{aligned}$$

From the asymptotic normality of the estimator this gives a test of the null hypothesis:

$$(B_2 - B_1)' [\text{Var}(B_2 - B_1)]^{-1} (B_2 - B_1) \sim \chi^2(K)$$

where K is the dimension of B . This test can be tedious to compute, but in many applications there is an easy method to use. Consider the model:

$$y = XA + ZC + u$$

where X is a matrix of k potentially endogenous variables
 Z is a matrix of m variables known to be exogenous

then a test of the null hypothesis that X is not correlated with u is equivalent to a test of the hypothesis that B equals zero in the regression

$$y = XA + (X - \hat{X})B + ZC + u$$

^{1/} This test was developed by Wu (1973) and later formalized by Hausman (1978).

where \hat{X} represents the predicted values from a first stage regression of X on Z and n additional instruments W . The term $(X - \hat{X})$ is the error term from the first stage regression. This will comprise both pure white noise and that endogenous component of X that is related to the dependent variable, all exogenous influences being captured in \hat{X} . Thus if this error term is significant in the second regression, it means that X contains a significant endogenous component that is related to the dependent variable. If, on the other hand, there is no endogeneity, the error term will be pure white noise and therefore insignificant in the second regression.

The problem with this test is its lack of power under usual circumstances. Its strength depends directly upon the quality of instruments, W , and it is therefore essential to seek to obtain the best possible instruments for the suspected regressors. In the case of output, the objective was to find variables which represented demand which might be expected to influence supply (output) while themselves being independent of either contemporaneous supply or company investment expenditure. Two instruments were selected on this criterion. The first was government expenditure (consumption plus investment on its own account) which was felt to be sufficiently the product of a combination of exogenous policy decisions and lags in their implementation to be independent of either current output or income. The second instrument chosen was the volume of exports of (physical) goods. This was considered to be the product of exogenous foreign demand considerations including relative prices and lagged commitments to supply which would be largely independent of current variations in output. The result of regressing output on these instruments plus the independent and pre-determined variables in the original (income supplemented) accelerator model was to produce the equation shown as Equation 10 in Table 4. Both the instruments prove highly significant, suggesting that they may be fairly good instruments. As noted above, the Wu-Hausman test consists of testing for the significance of the error term from this output equation in the (income supplemented) accelerator model. The next Equation 11 in Table 4 shows the effect of doing this. The error term attracts a t -statistic of 1.34. While this does not indicate significance at the usual confidence levels, it is sufficiently high to be extremely worrying. In view of the weakness of this test a t -value much above unity would normally be reason to be concerned. Since the simultaneous relationship between output and expenditure, should it exist, would be positive, there is a prior expectation that the coefficient on the error term in the equation being considered should be positive too. Under these circumstances the t test becomes a one tailed rather than two tailed test. While the t -value of the error term is below 1.65, the 95 percent value of t on a one tailed test, it is above

1.28, the 90 percent value of t . In other words a coefficient like that of the error term should be thrown up by chance alone in only 10 percent of cases.

One final test remains to be done. This is a test to check for the absence of overidentifying restrictions being applied to the instruments. In other words it is to check that the instruments used for output should not have been used directly in the expenditure equation. If they should then there is the danger of the equation suffering from omitted variable bias. This would obviously invalidate the Wu-Hausman test. The test consists of computing the residuals from the second stage of the 2SLS process, but where the instrumented value of the supposedly endogenous variable is replaced by the actual value. This would be equivalent to computing the residuals from the regression discussed above, with the error term and its coefficient omitted from the calculation, as the coefficients on the other variables are the same as would be taken in the second stage of 2SLS. These residuals are then regressed on the variables of the first stage of the 2SLS process, i.e., on the independent or predetermined variables and the instruments. They should be uncorrelated and the relevant test statistic is TR^2 where T is the number of observations and is distributed as $\chi^2(n-1)$ where n is the number of additional instruments. As Equation 12 in Table 4 shows, this test is passed ($\chi^2(1)=1.62$).

Before leaving the Wu-Hausman test it is worth noting some of the coefficients on the other variables (which, as noted, are those that would be taken in 2SLS). The coefficient on current output has been reduced to a third of its original value and, although care must be taken in interpreting the other t -statistics in this equation, it no longer appears to be significant. The coefficient on the income term (Y234), by contrast, has risen by 50 percent. The coefficients on the May 1968 dummies have also increased. In fact, the equation is beginning to look more like the income equation in Table 1.

If the current term in output is significant solely by virtue of simultaneity there is a strong case for only estimating accelerator models with lagged values of output. This would be defensible on the grounds of plausibility too. It seems unlikely that managers would have much contemporaneous production information available at the time investment decisions were being taken, there normally being a lag between such decisions and actual expenditure. If the current term in output is excluded the result is to produce an equation like Equation 14 in Table 5. While the set of output terms cannot be dropped, the impression of significance is greatly reduced. The coefficient on the first output term is only 0.15. If this equation is compared with its direct equivalent for the income model, Equation 13 in Table 4, it can be seen that there is little to choose between the two. The standard

error of the income model is 13.13, indistinguishable from that of the restricted accelerator model of 12.97. The income model would have to be considered at least as important as the accelerator.

IV. Conclusion

This paper has sought to question the supremacy of the accelerator model for company investment in fixed capital and inventories. It is shown to depend crucially upon the inclusion of the current term in output. While the hypothesis that this current term is spuriously significant owing to simultaneity is not proven beyond doubt, the results are sufficient to warrant considerable anxiety lest this be true. In the meantime the paper seeks to argue that an income based model of company expenditure has at least as much to offer as the accelerator model, if proper account is taken of the problem of simultaneity.

References

- Aftalion, A., "La réalité des surproductions générales, essai d'une théorie des crises générales et périodiques," Revue d'Economie Politique, (1909).
- Clark, J. M., "Business acceleration and the law of demand," Journal of Political Economy, Vol. 25, No. 1 (March, 1917), pp. 217-235.
- Hausman, J. A., "Specification tests in econometrics," Econometrica, Vol. 46, No. 6, pp. 1251-1272.
- Institut national de la statistique et des études économiques, "Les comptes nationaux trimestriels, séries longues 1963-83," Archives et Documents, INSEE, No. 103 (April 1984).
- Koyck, L. M., "Distributed lags and investment analysis," (Amsterdam: North Holland, 1954).
- deLeeuw, F., "The demand for capital goods by manufacturers: A study of quarterly time series," Econometrica, Vol. 30, No. 3 (July, 1962), pp. 407-423.
- Lucas, R., "Econometric policy evaluation: a critique," Journal of Monetary Economics supplement, Vol. 2 (1976) pp. 19-46.
- Malecot, J-F., and Hamon, J., "Contraintes financières et demande d'investissement des entreprises," Revue Economique, No. 5 (September, 1986), pp. 885-922.
- Poret, P., "Econométrie de l'investissement et enquêtes de conjoncture," Economie et Prévision, Direction de la Prévision, No. 74 (1986).
- Wu, D., "Alternative tests of independence between stochastic regressors and disturbances," Econometrica, Vol. 41, No. 4 (1973) pp. 733-750.

Table 1. Preferred Income Equation

Dependent variable: Company expenditure

Equation 1. Regression period: 1964 1 - 1983 4

Constant	3.30
Std err of Y est	12.60
R squared	0.93
Durbin Watson	1.93
No. of observations	80.00
Degrees of freedom	72.00

	<u>E-1</u>	<u>E-2</u>	<u>E-3</u>	<u>E-4</u>	<u>Y234</u>	<u>MAY68</u>	<u>MAY68-1</u>
X Coefficients	0.85	-0.12	-0.11	-0.12	0.19	-111.00	48.67
Std err of coef.	0.10	0.10	0.09	0.07	0.03	12.88	17.15
t-value	8.65	-1.13	-1.27	-1.63	5.81	-8.62	2.84

Equation 2. Regression period: 1964 1 - 1973 4

Constant	-7.64
Std err of Y est	7.82
R squared	0.97
Durbin Watson	2.08
No. of observations	40.00
Degrees of freedom	32.00

	<u>E-1</u>	<u>E-2</u>	<u>E-3</u>	<u>E-4</u>	<u>Y234</u>	<u>MAY68</u>	<u>MAY68-1</u>
X Coefficients	0.79	-0.07	-0.04	-0.06	0.17	-107.08	47.09
Std err of coef.	0.15	0.09	0.08	0.07	0.06	8.25	19.19
t-value	5.17	-0.81	-0.49	-0.85	2.71	-12.97	2.45

Equation 3. Regression period: 1974 1 - 1983 4

Constant	107.28
Std err of Y est	13.83
R squared	0.80
Durbin Watson	2.01
No. of observations	40.00
Degrees of freedom	34.00

	<u>E-1</u>	<u>E-2</u>	<u>E-3</u>	<u>E-4</u>	<u>Y234</u>
X Coefficients	0.70	-0.05	-0.08	-0.34	0.16
Std err of coef.	0.14	0.18	0.19	0.14	0.04
t-value	4.89	-0.28	-0.42	-2.38	3.90

Note: Expenditure, income and output are all measured in terms of 1970 prices and in units of F 100 million.

Table 3. Accelerator Model

Dependent variable: Company expenditure
Regression period: 1964 1 - 1983 4

Equation 7. Accelerator model general equation.

Constant -32.21
Std err of Y est 10.61
R squared 0.96
Durbin Watson 1.85
No. of observations 80.00
Degrees of freedom 64.00

	<u>E-1</u>	<u>E-2</u>	<u>E-3</u>	<u>E-4</u>	<u>0</u>	<u>0-1</u>	<u>0-2</u>	<u>0-3</u>	<u>0-4</u>	<u>TIME</u>	<u>MAY68</u>	<u>MAY68-1</u>	<u>MAY68-2</u>	<u>MAY68-3</u>	<u>MAY68-4</u>
X Coefficients	0.75	-0.04	0.22	-0.46	0.40	-0.29	0.04	-0.17	0.16	-1.07	-17.11	-10.82	10.89	0.99	4.61
Std err of coef.	0.12	0.15	0.16	0.14	0.07	0.11	0.11	0.11	0.09	0.39	18.44	23.54	22.71	23.09	17.74
t-value	6.38	-0.28	1.37	-3.27	5.75	-2.68	0.33	-1.54	1.76	-2.75	-0.93	-0.46	0.48	0.04	-0.26

Equation 8. Accelerator model refined equation

Constant -31.79
Std err of Y est 10.40
R squared 0.96
Durbin Watson 1.87
No. of observations 80.00
Degrees of freedom 67.00

	<u>E-1</u>	<u>E-2</u>	<u>E-3</u>	<u>E-4</u>	<u>0</u>	<u>0-1</u>	<u>0-2</u>	<u>0-3</u>	<u>0-4</u>	<u>TIME</u>	<u>MAY68</u>	<u>MAY68-1</u>
X Coefficients	0.76	-0.05	0.23	-0.46	0.40	-0.26	0.00	-0.17	0.17	-1.06	-19.71	-3.78
Std err of coef.	0.11	0.15	0.15	0.13	0.07	0.09	0.08	0.07	0.07	0.37	17.16	19.80
t-value	6.65	-0.36	1.53	-3.54	5.98	-2.81	0.02	-2.32	2.49	-2.90	-1.15	-0.19

Equation 9. Accelerator model with income term

Constant -2.77
Std err of Y est 10.11
R squared 0.96
Durbin Watson 1.94
No. of observations 80.00
Degrees of freedom 66.00

	<u>E-1</u>	<u>E-2</u>	<u>E-3</u>	<u>E-4</u>	<u>0</u>	<u>0-1</u>	<u>0-2</u>	<u>0-3</u>	<u>0-4</u>	<u>TIME</u>	<u>MAY68</u>	<u>MAY68-1</u>	<u>Y234</u>
X Coefficients	0.71	-0.08	0.19	-0.41	0.33	-0.21	0.02	-0.15	0.14	-1.07	-34.62	-3.67	0.08
Std err of coef.	0.11	0.14	0.15	0.13	0.07	0.09	0.07	0.07	0.07	0.36	17.93	19.24	0.04
t-value	6.27	-0.54	1.28	-3.23	4.70	-2.30	0.23	-2.07	1.99	-3.01	-1.93	0.19	2.22

Table 4. Accelerator: Instrumental Variables

Regression period: 1964 1 - 1983 4

Equation 10. Industrial production as dependent variable

Constant -405.57
 Std err of Y est 15.73
 R squared 0.99
 Durbin Watson 1.69
 No. of observations 80.00
 Degrees of freedom 65.00

	<u>E-1</u>	<u>E-2</u>	<u>E-3</u>	<u>E-4</u>	<u>O-1</u>	<u>O-2</u>	<u>O-3</u>	<u>O-4</u>	<u>TIME</u>	<u>MAY68</u>	<u>MAY68-1</u>	<u>Y234</u>	<u>GOVSPG</u>	<u>EXPTS</u>
X Coefficients	-0.12	-0.24	-0.33	0.58	0.90	0.16	0.18	-0.40	-4.78	-184.95	160.21	0.22	1.89	0.21
Std err of coef.	0.18	0.22	0.23	0.20	0.10	0.11	0.11	0.10	1.25	17.85	23.08	0.05	0.45	0.13
t-value	-0.69	-1.05	-1.47	2.92	9.10	1.40	1.64	-3.99	-3.82	-10.36	6.94	4.16	4.18	1.62

Equation 11. Wu-Hausman test for exogeneity of output

Constant -45.08
 Std err of Y est 10.05
 R squared 0.96
 Durbin Watson 1.94
 No. of observations 80.00
 Degrees of freedom 65.00

	<u>E-1</u>	<u>E-2</u>	<u>E-3</u>	<u>E-4</u>	<u>O</u>	<u>O-1</u>	<u>O-2</u>	<u>O-3</u>	<u>O-4</u>	<u>TIME</u>	<u>MAY68</u>	<u>MAY68-1</u>	<u>Y234</u>	<u>ERROR</u>
X Coefficients	0.66	-0.14	0.10	-0.32	0.15	-0.04	0.05	-0.11	0.07	-1.15	-71.87	28.59	0.12	0.23
Std err of coef.	0.12	0.15	0.16	0.14	0.15	0.16	0.08	0.08	0.08	0.36	33.05	30.75	0.05	0.17
t-value	5.66	-0.91	0.65	-2.26	0.99	-0.21	0.61	-1.39	0.83	-3.28	-2.15	1.07	2.59	1.34

Equation 12. Basman test for suitability of instruments

Constant -7.28
 Std err of Y est 10.22
 R squared 0.02
 Durbin Watson 1.96
 No. of observations 80.00
 Degrees of freedom 65.00
 Chi-squared (1) 1.62
 Critical value (95%) 3.84

	<u>E-1</u>	<u>E-2</u>	<u>E-3</u>	<u>E-4</u>	<u>O-1</u>	<u>O-2</u>	<u>O-3</u>	<u>O-4</u>	<u>TIME</u>	<u>MAY68</u>	<u>MAY68-1</u>	<u>Y234</u>	<u>GOVSPG</u>	<u>EXPTS</u>
X Coefficients	-0.02	-0.01	0.01	-0.03	0.01	0.01	0.00	0.01	0.32	-3.64	-0.91	-0.00	-0.02	-0.09
Std err of coef.	0.12	0.15	0.15	0.13	0.06	0.07	0.07	0.07	0.81	11.59	14.99	0.03	0.30	0.08
t-value	-0.21	-0.04	0.05	-0.25	0.08	0.14	0.02	0.22	0.39	-0.31	-0.06	-0.04	-0.08	-1.07

Table 5. Income and Accelerator Models Compared

Dependent variable: Company expenditure
Regression period: 1964 1 - 1983 4

Equation 13. Income model - lagged values only

	Constant	E-1	E-2	E-3	E-4	Y-1	Y-2	Y-3	Y-4	TIME	MAY68	MAY68-1	MAY68-2	MAY68-3	MAY68-4
Std err of Y est	11.70														
R squared	13.13														
Durbin Watson	0.93														
No. of observations	1.99														
Degrees of freedom	80.00														
	65.00														
X Coefficients		0.89	-0.15	-0.15	-0.10	-0.09	0.22	0.17	0.24	0.06	-108.69	44.20	-7.61	-10.81	6.41
Std err of coef.		0.12	0.17	0.17	0.12	0.10	0.11	0.12	0.11	0.17	13.96	20.59	21.36	20.92	16.86
t-value		7.19	-0.89	-0.90	-0.78	-0.86	2.01	1.48	2.20	0.37	-7.78	2.15	-0.36	-0.52	0.38

Equation 14. Accelerator model - lagged values only

	<u>E-1</u>	<u>E-2</u>	<u>E-3</u>	<u>E-4</u>	<u>O-1</u>	<u>O-2</u>	<u>O-3</u>	<u>O-4</u>	<u>TIME</u>	<u>MAY68</u>	<u>MAY68-1</u>	<u>MAY68-2</u>	<u>MAY68-3</u>	<u>MAY68-4</u>
Constant	-20.34													
Std err of Y est	12.97													
R squared	0.94													
Durbin Watson	2.02													
No. of observations	80.00													
Degrees of freedom	65.00													
X Coefficients	0.71	-0.18	0.03	-0.24	0.15	0.11	-0.17	0.06	-1.16	-100.15	78.30	11.52	-27.77	5.10
Std err of coef.	0.14	0.18	0.19	0.16	0.09	0.13	0.13	0.11	0.48	14.02	21.66	27.76	27.55	21.58
t-value	4.99	-0.98	0.19	-1.47	1.59	0.89	-1.31	0.56	-2.44	-7.14	3.62	0.41	-1.01	0.24