BIS WORKING PAPERS
No. 12 - July 1987

PROFIT SHARES, INVESTMENT AND OUTPUT CAPACITY

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Preface

This paper discusses two current policy issues:

- to what extent changes in factor prices (measured by real labour costs or profit shares) have affected the size and composition of the capital stock;
- whether there is a risk that future employment growth will be constrained by capacity shortages.

The answer to the first question depends on the determinants of business fixed investment, and Section II of the paper, following a brief review of the literature, presents investment equations for seven industrialised countries. These suggest that the main factor behind the slowdown in capacity growth has been the lower rate of output growth. Except for two countries, profit shares are also found to influence investment spending, but, given their recent improvement, this influence has been positive or neutral during the last five years. Moreover, contrary to what would be expected, profits appear to affect replacement investment more than new investment.

The answer to the second question is also sought in empirical estimates - in this case, reduced-form employment equations. A general conclusion emerging from this section is that, for most countries, the current high rates of unemployment contain a large non-cyclical component. This may also be observed from the relatively small decline in rates of capacity utilisation compared with the marked rise in rates of unemployment. This development can in part be related to the slowdown in capacity growth, but in some European countries a fall in the labour intensiveness of the production process also appears to have taken place.

When taken together, the two sets of empirical estimates suggest that faster output growth is likely to increase employment as well as business fixed investment. However, in order to achieve durable employment effects and to avoid inflationary pressures it is important and necessary for the current moderation of real wage growth to continue.

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Introduction

A number of recent studies and reports have expressed concern that the size and composition of the capital stock may not support a sustained rise in employment, particularly in Europe.[1]

In this context, the growth of real unit labour costs, and the accompanying decline in profit shares and in the rate of return on capital are frequently mentioned as causes of a slower growth of the capital stock and of a rising capital intensiveness of investment. Moreover, several developments may be cited in support of this hypothesis:

- the falling output share of investment, especially when measured net of depreciation;
- the upward shift of the Okun curve, implying that a given rate of capacity utilisation is now associated with a higher rate of unemployment;
- the trend decline in rates of return on capital and the negative contribution of capital when entered as a component in growth accounting exercises.

The policy implication of the capital shortage/real wage hypothesis is that a sustainable fall in unemployment will have to be preceded by a rise in investment growth, which, in turn, requires continued real wage restraint or even a further fall in real wages compared with productivity.

There is no doubt that investment growth has fallen, particularly in Europe, and that a smaller share of gross investment represents additions to the capital stock. The causes of these developments must be sought in firms' decisions with respect to investment and the optimum use of the capital stock. In particular, the role of profits in influencing business fixed investment should be compared with that of other factors, such as taxes, interest rates and expected output growth. Moreover, the extent to which existing capital stocks can sustain a higher rate of growth of output and employment depends not only on the technical opportunities for changing factor proportions but also on economic decisions with respect to the optimum rate of capacity utilisation and the potential profitability of existing but idle equipment.

These interrelated issues will be analysed in this paper, which is divided into four main sections. Section I discusses developments in capital stocks, output, investment, employment, interest rates, profit shares and rates of return in seven industrialised countries (the United States, Japan, Germany, France, the United Kingdom, Canada and Sweden).[2] Section II looks at the investment function, starting with a brief review of the theoretical literature and turning then to specifications, search strategies and empirical estimates. Section III focuses on the relationship between employment and the capital stock, using a reduced-form equation designed to capture the underlying production structure, cyclical factors and the scope (technical as well as economic) for varying factor ratios in response to changes in real wage costs. Section IV sums up the empirical evidence and draws some tentative policy conclusions.

I.

Developments in investment and the capital stock

Certain features of recent investment, capital stock developments and associated changes in various capital ratios and measures of profits are illustrated on pages 56-62. Panel 1 in each graph shows growth rates of the capital stock against movements in real interest rates. The real interest rate is measured as the long-term bond rate less the current rate of change in the GDP deflator,[3] and, in all the countries, it has exceeded capital stock growth by a wide margin during the 1980s. In earlier years real interest rates tended, except in the case of Germany and for shorter periods also the United Kingdom, to lie well below capital stock growth.

Throughout the empirical parts of this paper, capital stocks exclude residential buildings and public sector equipment and structures, and are measured in gross terms;[4] i.e. they are not adjusted for current depreciation but decline when equipment and structures bought in the past reach the end of their assumed service lives.[5]

The most pronounced negative trend in capital stock growth can be observed for Germany, while in Japan growth has fallen to a lower but stable rate. In France and Sweden a trend decline started in the mid-1970s and it has not yet levelled out in France. Capital growth has been remarkably stable in the United Kingdom, and North America seems mainly to have experienced large cyclical fluctuations around a relatively low but stable trend.

Turning to the second panel, a general impression is the pronounced rise in capital/labour ratios compared with capital/output ratios and the even stronger rise in capital relative to employment. The latter is particularly evident in Europe, reflecting the trend increase in unemployment, whereas in the United States, and to some extent also in Canada, the two capital/labour ratios diverge for mainly cyclical reasons. The capital/output ratios for 1984 range between 1.3 in Japan and 2.6 in the United Kingdom, while the growth rate over the last twenty years has been highest in Japan and lowest in North America, where the average rate came to less than 1 per cent. per year. A low growth of the capital/output ratio may also be observed in France and the United Kingdom.

The third panel shows the ratios between the net operating surplus and GNP and the gross capital stock respectively. The profit shares largely mirror growth in real labour costs relative to labour productivity, while the ratio of net operating surplus to gross capital stock (a crude approximation to the rate of return on capital) is also influenced by movements in the capital/output ratio. In most cases there is a clear downward trend in both the profit share and the "rate of return", with the latter slightly more pronounced than the former because of the rising capital/output ratio. In Sweden a reversal took place after 1977, while in the United States and Germany it only started in 1981-82. In France and Japan a negative trend has continued through most of the period, though in Japan this is exaggerated by the marked rise in the proportion of employees in total employment. Canada has experienced relatively large cyclical fluctuations with no clear trend, and the same applies to the United Kingdom, though in the latter case some rise in the very low rate of return is observed after 1980-81.

The final panel shows a relatively stable pattern for the ratio of gross business fixed investment to GNP. Indeed, for several countries this ratio is now higher than during the 1970s. This is in contrast to the declining ratios generally observed for total investment/GNP, thus underlining the importance of weakening residential construction and declining public sector investment. The second curve in this panel shows the ratio between changes in the gross capital stock and business fixed investment; given the definition of the capital stock, a fall in this ratio implies that a larger proportion of gross investment is being used for replacing structures and equipment which have reached the end of their assumed service lives. Such declines are clearly evident in Germany and the United Kingdom and for part of the period also in Japan, France and Canada whereas the pattern observed for the United States mainly reflects that replacement investment is a more stable component than changes in the capital stock. Although it is interesting to note that the decline in stock growth does not seem to have been caused by a decline in the investment/GNP ratio but rather by a rise in the share of replacement investment, this observation may not be indicative of any particular behaviour. Thus the patterns of changes are very much influenced by national accounting procedures. Actual scrappings and replacement, on the other hand, are subject to firms' discretionary decisions, and these are unlikely to be based on constant service lives as assumed in the national accounts.[6]

II.

Investment equations, research strategy and empirical evidence

1. Theory

1.1 Overview.

The investment function plays a key role in macro-economics mainly for three reasons: (i) business fixed investment constitutes an important and highly variable component of aggregate demand and has a marked impact on aggregate cyclical patterns; (ii) since investment determines the growth of the capital stock it influences the supply potential of the economy; and (iii) the impact of interest rates and credit conditions on investment decisions is one of the main transmission channels of monetary policy changes. The sensitivity of business fixed investment to interest rates also determines the slope of the IS-curve and thereby the extent to which changes in fiscal policy are accompanied by crowding-out effects.

The literature on firms' investment decisions is unusually rich,[7] and an appropriate empirical test of even the most important hypotheses and models would quickly exhaust the degrees of freedom available in the data. Or, to quote Feldstein (1982):

> "The idea of estimating a single complete model that tells about all the parameters of interest and tests all implicit restrictions is generally not feasible with the available data" (p.830).

As a result, there is no generally accepted underlying theory of investment, nor is there any common view with respect to the appropriate model specification. One may, however, following Abel (1980), distinguish between two main approaches to empirical investment equations:

- a stock-oriented approach which derives the optimum or desired capital stock from specific assumptions with respect to the firms' production function, the demand for output and conditions in factor and capital markets, but leaves the annual rate of investment undetermined. A prime example of this approach is the neoclassical model, but the flexible accelerator model also belongs in this category, even though its structural and behavioural assumptions are less precise;
- a flow-oriented approach which attempts to explain the rate of investment directly but leaves the long-run optimum capital stock as an open issue. The flow approach, while assuming that firms minimise costs in the short run, does not rely on structural assumptions with respect to production techniques and conditions in product and factor markets. The main examples of this approach are models based on costs of adjustment, which determine the investment rate from minimising short-run costs, given costs of installation and the marginal return on investment, and the q-model, which essentially makes the investment rate a positive function of the ratio between the stock market valuation of firms and the replacement costs of their real capital stock.[8]

One way of reconciling the two approaches is to view the stock models as determining the long-run equilibrium and the flow models as dealing with short-run adjustments. Or, to be more precise, the flow approach may be seen as providing an analytical determination of the time pattern of capital stock adjustments which in the stock approach is entirely empirical. Some works based on this line of thinking are:

- an adjustment cost model by Eisner and Strotz (1963) which, on certain assumptions, gives the same specification as the flexible accelerator model with partial stock adjustments;[9]

- several studies [see Hayashi (1982), Summers (1981) and Yoshikawa (1980)] which link adjustment costs to the q-model by assuming a positively sloped supply curve for investment goods. A short-run equilibrium is then obtained where the marginal value of q equals 1 plus the marginal costs of investment. Artus and Muet (1984) derive a similar relationship by introducing a measure of aggregate demand uncertainty into a neoclassical putty-clay model;

- a study by Abel (1980) which derives an analytical measure of q that is closely related to the user cost of capital as defined in the neoclassical model;

- a simultaneous model in which the adjustment of the actual to the desired capital stock is estimated together with adjustment equations for employment and the rate of capacity utilisation. Nadiri and Rosen (1969) pioneered this simultaneous and interrelated factor demand model and obtained some improvement in empirical estimates as well as a theoretically more satisfactory explanation of the adjustment pattern.[10] However, they still had to make some arbitrary assumptions regarding adjustment costs.

Future studies will no doubt make further attempts at reconciling the two approaches, but this paper relies on the stock approach for four main reasons:

- while stock-based models fail to explain the lag structure of capital stock changes and investment, the search procedure proposed by Davidson et al. (1978) offers a promising way of combining short-run data consistency with long-run equilibrium conditions, and a simplified version of this approach is applied below;

- bearing Feldsteins' warning in mind, a large and comprehensive model would leave too few degrees of freedom and distract attention from the main topic of this study, viz. the influence of profits on investment

- so far investment models based on the flow approach have had less explanatory power than those using the stock approach and have tended to leave a pattern of autocorrelated errors;[11]

- most empirical investment studies show a dominating influence of output on investment. Flow-based models usually exclude output, and this may well be one reason for the autocorrelation problem and the relatively low explanatory power.

The remaining part of this section first briefly discusses the flexible accelerator model and then goes on to the neoclassical model, noting its advantages and shortcomings. This discussion is then used in deriving the more eclectic model underlying the empirical estimates.

1.2 Flexible accelerator model.

One of the earliest and most popular investment theories postulates a fixed relationship between the desired net capital stock (K*) and expected output ($\bar{Y}$), and combines this with a partial adjustment of the actual (K) to the desired capital stock:[12]

$$K_t^* = \bar{Y}_t^{\alpha} \quad \text{and}$$

$$K_t = K_t^{*\tau} K_{t-1}^{1-\tau} \quad \text{whereby}$$

$$K_t = \bar{Y}_t^{\tau\alpha} K_{t-1}^{1-\tau} \quad \text{and}$$

(i) $$\log K_t - \log K_{t-1} = \alpha\tau \log \bar{Y}_{t-1} - \tau \log K_{t-1}$$

For given values of $\bar{Y}$, the output elasticity (α) as well as the adjustment coefficient (τ) may be identified. Moreover, if the capital stock decays exponentially, equation (i) may be rewritten with gross investment ($I_{g,t}$) as the dependent variable:

$$\log I_{g,t} = \alpha\tau \log \bar{Y}_t - (\tau-\delta) \log K_{t-1}$$

where δ is the exponential decay factor.[13]

For most countries, the flexible accelerator model is able to explain a large part of the variations in gross investment, using either the above lag structure or a polynominal lag on output. As noted above, one shortcoming is that the lag structure is ad hoc and not derived from a priori assumptions with respect to economic behaviour. Moreover, the postulated relationship between output and capital stock assumes a clay-clay production structure, which may not give an appropriate description of an aggregate economy.[14] Finally, the flexible accelerator model does not assume any specific firm behaviour except that the return on new investment has to exceed some minimum level.

1.3 Neoclassical model.

Jorgenson's (1963) neoclassical investment model departs from the above model in three important respects:

- firms are assumed to choose their capital stock so as to maximise expected net wealth, whereby the real user cost of capital enters the investment function in addition to, or in combination with, output;
- the underlying production structure is based on a Cobb-Douglas function, which implies a substitution elasticity between capital and labour of unity; and
- a rational lag distribution is used instead of the partial adjustment scheme or adaptive expectations.

At the same time, Jorgenson maintains the assumption of exponential decay, so that the gross investment function becomes:

$$\text{(ii)} \qquad I_g = a \sum_{i=0}^{n} b_i (YP/c)_{t-1} + \delta K_{t-1}$$

where

P = GDP deflator,

c = user cost of capital.

In many ways this model has created a breakthrough in the development of investment functions and it is being used (sometimes in a modified form) in several macroeconomic models. However, the neoclassical assumptions have also been subjected to critical remarks, some of which pertain to the functions and specifications chosen in this paper:

(a) The assumption of perfect competition underlying the term P/c excludes output as a determinant [see Coen (1971), Brechling (1974), Artus and Muet (1984) and Poret (1986)]. By contrast, when firms are assumed to maximise net worth (or minimise costs) in imperfect markets with a given level of aggregate demand, output reappears in the investment function but together with capital costs measured relative to wages instead of output prices.[15]

(b) The Cobb-Douglas production function is likely to be too restrictive given the evidence from various production studies. If a CES production function is adopted, P/c enters separately, though non-linear estimation methods will normally be required to derive the corresponding coefficients.

(c) As pointed out by Bischoff (1971), the imposition of the same lag structure on output and capital costs implies a putty-putty production structure. If, alternatively, the structure is putty-clay, the capital output ratio can only change in step with new investment and reinvestment,[16] and the lag on P/c will be much longer than that on Y. In practice, however, it has proven very difficult to obtain robust measures regarding production techniques since the estimated sensitivity of investment to factor prices tends to be subject to large standard errors.

(d) Several authors [including in particular Feldstein and Rothschild (1974) and Coen (1975)] have criticised the exponential decay function as being extremely restrictive. Moreover, even if the capital stock decays exponentially, a number of additional assumptions are required to make depreciation a constant fraction of the lagged net capital stock. Using survey data, Feldstein and Foot (1971) find that replacement investment is a positive function of the availability of internal funds and the rate of capacity utilisation, but depends negatively on planned additions to the capital stock. This last result is important, as it suggests that firms attempt to stabilise gross investment. Equations using net investment as the dependent variable may, therefore, yield highly biased behavioural coefficients. Further arguments in favour of using gross investment as the dependent variable are that both net investment and replacement investment increase supply potential and that gross investment is the relevant concept from the point of view of aggregate demand.

(e) Another issue is the user cost of capital, which Jorgenson defined on the assumption that the marginal return (c) on investment should equal its marginal cost. Without taxes the latter depends on the price of the investment goods (P_k), firms' discount rate or opportunity cost (r) and the rate of depreciation (δ), so that the above condition may be written:[17]

(iii) $$c = P_k (r + \delta)$$

The introduction of taxes alters the equation in several ways. In the first place, the relevant left-hand variable becomes the after-tax return, which, using the statutory corporate tax rate (tc) as representative of the relevant rate, is (1-tc)c. Secondly, most tax systems include investment credits (kr) which effectively reduce the price of the investment good and allow firms to deduct depreciation (as defined in the tax code) as well as interest payments in their taxable income. Assuming that the depreciation allowance can be converted into a rate per unit of investment (z) and that investment is completely debt-financed, equation (iii) can be rewritten as:

(iv) $$(1-tc)c = P_k(1-kr-tc\ z)[r(1-tc) + \delta]$$

or $$c = P_k(1-kr-tc\ z)[r(1-tc) + \delta]/(1-tc)$$

which is the user cost or rental price of capital defined by Jorgenson. Although the above concept has been adopted for most US macroeconomic models, Chirinko and Eisner (1983) find broad differences in the actual measurement of tax variables and in their estimated impact on investment. Moreover [see Bosworth (1985)], the precise treatment of the discount rate is subject to both theoretical and empirical problems:

- the nominal discount rate is usually measured by the long-term bond rate, the ratio between dividends and stock prices or some combination of the two. However, in a perfect capital market, the two rates should be equal, so that one would suffice. At the same time, the assumption that borrowing costs are independent of firms' financial positions is questionable. Indeed, a number of earlier studies, assuming that investment mainly depends on the availability of internal funds, had found a strong and positive relationship between profits and investment;[18]

- theoretically r should be measured in real terms, but the methods used in deriving an appropriate deflator differ widely with respect to both the price index used and the assumed expectations generating process.

(f) A final problem concerns the parameter restrictions. Thus, c enters equation (ii) with a single coefficient, implying that investment responds in the same way to all of the components in equation (iv). Moreover, the combination of c with the output term, as initially proposed by Jorgenson and maintained in Bischoff's putty-clay formulation, can lead to biased estimates and false assessments. Because of the very powerful output effect, the combined coefficient is likely to be highly significant and of the right sign, even when c itself has a relatively small impact. This is illustrated in the table below, which shows three gross investment equations for the United States.

The first equation estimates gross investment as a distributed lag function of output (Y), lagged real profits (RP_{-1}) and the lagged gross capital stock (K_{-1}). The second equation is derived from a putty-clay production structure and estimates gross investment as a function of RP_{-1} and K_{-1} as before, but replaces the distributed lag on dY with a distributed lag on (P/c)dY, i.e. changes in output multiplied by the inverted real price of capital. Finally, the third equation adds a distributed lag on (P/c) as a separate variable.

United States: Illustrative investment equations.

Equation	Explanatory variables[1,2]						Statistics		
	C	ΣdY	Σ(P/c)dY	ΣP/c	RP_{-1}	K_{-1}	$\bar{R}^2$	SE	DW
(1)	-98.3 (5.2)	0.43[a]			0.21 (2.5)	0.060 (8.2)	0.98	10.8	1.58
(2)	-98.3 (3.8)		0.031[b]		0.31 (3.8)	0.046 (9.2)	0.98	11.3	1.58
(3)	-93.8 (6.2)	0.67[e]		-12.7[f]	0.17 (2.9)	0.081 (6.5)	0.99	6.7	1.96

1 c was obtained from Akhtar and Sahling (1985).

2 The distributed lag coefficients, obtained using the Almon procedure, are:

	t		t-1		t-2		t-3	
a	0.11	(3.8)	0.15	(3.4)	0.13	(2.9)	0.04	(1.0)
b	0.009	(3.5)	0.012	(3.1)	0.009	(2.2)	0.001	(0.1)
e	0.13	(6.1)	0.20	(6.6)	0.20	(6.4)	0.14	(3.3)
f	3.04	(1.6)	1.76	(0.8)	-3.80	(2.2)	-13.7	(5.8)

Although the estimated equations are only illustrative, three observations are of some interest: equation (3) has the most satisfactory statistical properties and, despite the wrong sign on (P/c), suggests that the price and output terms should be entered as separate variables; secondly, equations (1) and (2) yield almost identical R^2s and DWs, implying that (P/c), when combined with dY, has very little explanatory power;[19] and thirdly, even though most other studies find no influence for profits, when added to a neoclassical investment function, the significant coefficient on RP_{-1} in all three equations strongly suggests that this variable should not be ignored.

1.4 Eclectic model.

(a) **Model specification.** The neoclassical model offers an appealing theoretical approach to explaining investment decisions and was adopted as a broad framework for our own empirical estimates. However, a major drawback to this model is that the role of financial variables is confined to the interest rate component of the capital cost measure. As pointed out in Artus and Muet (1984), an alternative way of introducing financial variables into a neoclassical framework would be to consider the availability of internal and external funds as a separate constraint and add the corresponding regime to the more traditional Keynesian and classical ones. Following this procedure, the investment equation could be estimated either by assuming that the various regimes exist simultaneously - whereby financial variables would appear with a weight corresponding to the proportion of firms subject to the financial constraint - or by using a disequilibrium econometric procedure. This approach is theoretically appealing, particularly for countries that frequently resort to quantitative credit controls. However, when demand for and supply of credits are determined by the interest rate mechanism, it may be more appropriate to introduce financial factors by relaxing the parameter restrictions in the capital cost measure and, in particular, by making the relevant interest rate a function of internal funds and/or the debt situation of firms.

Although some of the countries analysed below have applied credit controls during some periods, we have used this second approach and modified the traditional neoclassical model to include a measure of profits.

As a first step, equation (ii) was rewritten with the desired gross capital stock as a function of expected output and the ratio between wages and the user cost of capital on the assumption that most firms are demand-constrained and have some influence on their output prices:

(v) $$K^* = Y^a(W/c)^b \qquad a,b > 0$$

where both a and b depend on the underlying but unspecified production function. Due to measurement problems the user cost of capital was approximated by:

(vi) $$c = P_k.r.TRATE$$

where P_k is the price of investment goods, TRATE the effective corporate tax rate and r a real interest rate to be defined below. Moreover, following Bean (1981) and Feldstein (1982), the various components of c were allowed to enter equation (v) with separate coefficients:

(vii) $$K^* = Y^a(W/P_k)^{b_1}(r)^{b_2}(TRATE)^{b_3} \quad \text{with } b_1 > 0 \text{ and } b_2,\ b_3 < 0$$

On the further assumption that W/P_k may be approximated by W/P (where P is the GDP deflator) and that the influence on K^* mainly depends on the deviation of W/P from trend productivity growth, W/P may be replaced by A.TR.(1-PRS), with TR a time trend, A a constant term and PRS the profit share of total factor income. Finally, since firms' borrowing costs are likely to differ from the real market rate, depending on their financial strength, r was approximated by the equation:

(viii) $$r = (1\text{-}PRS).RINT$$

where RINT is the long-term bond rate less the current rate of change in the GDP deflator, and (1-PRS) was included on the assumption that financing costs are inversely related to the profit share (or fall as a larger proportion of investment is financed by retained earnings). With these modifications the expression for the capital stock becomes:

(ix) $$K^* = A\ Y^a(1\text{-}PRS)^{b_1}(RINT(1\text{-}PRS))^{b_2}(TRATE)^{b_3}(TR)^{b_1} \qquad \text{or}$$

$$\text{(x)} \qquad K^* = A'Y^a(PRS)^{-b_1-b_2}(RINT)^{b_2}(TRATE)^{b_3}(TR)^{b_1}.$$

While the exponents of TRATE and RINT are unambiguously negative, that of PRS may be either positive or negative: on the one hand, a higher real wage or a lower profit share will lead to substitution of capital for labour (i.e. capital deepening as measured by b_1); on the other hand, a higher real wage will discourage an expansion of the capital stock due to higher financing costs (i.e. discourage capital-widening investment as measured by b_2). Unfortunately, with only a one-dimensional and aggregate measure of the capital stock it is not possible to identify both effects and there is a risk that the estimated coefficient on PRS will be close to zero and statistically insignificant. The same risk applies to the trend term, which may be capturing the influence of factors (for instance technical progress) additional to the one mentioned above, and is also likely to be correlated with some of the other investment determinants. On the other hand, the long-run capital output coefficient (a) should be positive and close to unity as it reflects the returns-to-scale parameter of the underlying production function.[20]

Equation (x) was adopted as the main long-run hypothesis, but a slightly different version, where PRS and TRATE were combined and approximated by cash-flows deflated by the investment deflator, was also tested.

(b) **Search procedure.** Since K^* is not observable and firms are unlikely to close any gap between the actual and desired capital stock within one year, (x) was estimated assuming the actual change in the capital stock (dK) to be a lagged function of the desired change (dK^*). To simplify the search for an appropriate lag structure PRS, RINT and TRATE were initially ignored, so that (x) can be written as:

$$\text{(xi)} \qquad K_t - \sum_{1}^{n} e_i K_{t-i} = A + \sum_{1}^{m} a_j Y_{t-j+1} + bTR$$

Lags on Y and K of up to three years were tested, but could in most cases be rejected, so that (xi) simplifies to:

(xii) $K_t = A + a_1Y_t + a_2Y_{t-1} + a_3Y_{t-2} + e_1K_{t-2} + e_2K_{t-2} + bTR$

which may be rewritten as:

(xiii) $dK_t = A + a_1dY_t - a_3dY_{t-1} - e_2dK_{t-1} + (a_1+a_2+a_3+e_1+e_2-1)(K)_{t-1} +$

$(a_1+a_2+a_3)(Y-K)_{t-1} + bTR$

(xiii) is, of course, only a re-parametrisation of a similar equation written in level form and as such does not add any new information. Nonetheless, (xiii) may be interpreted as an error feedback equation (EFE) and is also convenient for testing additional restrictions. Three terms are particularly relevant in this context, and their impact on capital stock changes can be explained using optimum control terminology:

- dY_t and dY_{t-1}, which reflect the impact of current and past output changes and act as a differential control mechanism;

- $(Y-K)_{t-1}$, which corrects K for deviations between the actual and desired capital/output ratio and acts as a proportional control mechanism;

- K_{t-1}, for which two interpretations are possible: in the first place, when the capital/output ratio is constant in steady state, the expected coefficient on K_{t-1} is zero, and a t-test of the estimated coefficient therefore serves as a test of this unit elasticity assumption; secondly, K_{t-1} may be seen as a cumulative control mechanism since the cumulative influence of past errors will be reflected in this term.

Although (xiii) was used only as a convenient expression and the estimates were not subjected to all the appropriate tests,[21] it will be referred to in the following as the EFE approach. However, before estimation, one last modification was introduced. As mentioned above, there is some suggestive evidence that replacement investment is influenced by some of the same factors as net investment and by net investment itself. Consequently, the appropriate decision variable would appear to be gross investment, and the equation actually used in defining the lag structure of K and Y is:

(xiv) $INV_t = A + a_1dY - a_3dY_{t-1} - e_2dK_{t-1} + (a_1+a_2+a_3)(Y-K)_{t-1} +$

$$(a_1+a_2+a_3+e_1+e_2-1)\ K_{t-1} + bTR$$

which was estimated using a log-linear specification and in all of the following tables presented as equation (a).

As a second step in the search procedure, RINT, PRS and TRATE were added, initially in both level and rate-of-change forms to test whether their influence was permanent or transitory. Particularly for PRS there is some evidence that only the speed of adjustment is affected whereas the optimum capital stock ratio remains unchanged.[22] Although theory would point to real interest rates as the appropriate measure of borrowing costs, nominal rates were also tested and, in some cases, found to be significant. The results from this step are shown as equation (b) in all the following tables.[23]

In a third step, the preferred specification under (b) was applied to changes in the capital stock (dK) as the dependent variable, leaving out variables that were now found to be insignificant. The outcome of this step is shown as equation (d) while (c) and (e) present the results from applying a partial adjustment scheme to INV and dK respectively. This form has frequently been used in the past, and the estimated coefficients are easy to convert into theoretical long-run parameters. However, it imposes restrictions compared with the more general structure under (b) and (d), and to test whether the data accept these restrictions an F-test is shown in column 4 under the test statistics. Finally, equations (b) to (d) were repeated with a linear specification and these estimates are presented in the bottom half of the tables as equations (f) to (i).

In selecting the most appropriate specification, the following criteria were used:

- explanatory power and autocorrelation statistics as shown in columns 1-3 under the test statistics. When the lagged dependent variable appears among the explanatory variables, the DW-statistic is replaced by Durbin's h-statistic, and for those equations considered for further use the LM-test for higher-order correlation is also included;[24]
- forecasting ability as measured by Z_1 and tested against the X^2-distribution. The Z_1-values in column 5 were calculated from equations estimated for the period 1960-85;[25]

- a final requirement was that the preferred structure should produce theoretically plausible parameters when applied to dK as the dependent variable and used in deriving the steady-state solution.

2. Empirical results.

2.1 Estimated equations.

The equations were estimated on annual data, in most cases covering the period 1960-85. Notation and variable definitions are explained in the insert below, and the main results shown in Tables 1-7 may be summarised as follows:

(a) For all countries the accelerator effect accounts for a major part of the variations in investment with the R^2s obtained for equation (a) attaining 0.95 or more (except for Sweden). However, in several cases there are clear signs of autocorrelation, suggesting that important variables have been left out, and/or that the lag structure has not yet been appropriately identified.

(b) Among the additional variables tested, real interest rates were found to be significant in Japan, Germany and Sweden, while in France and the United Kingdom firms pay more attention to nominal interest rates. In North America, on the other hand, neither real nor nominal rates seem to have affected investment decisions.[26] The tax rate has a significant influence only in Germany and Canada, whereas profits, in most cases measured as a share of GNP, have importantly affected firms' investment decisions except in Japan and Germany.[27] As for interest rates, changes in the level of profits appear to have permanent rather than transitory repercussions on the level of gross investment. However, for the United States and the United Kingdom this does not imply that the capital/output ratio will be affected as well, since the influence of profits is confined to replacement investment. Moreover, recalling the exponents of PRS in equation (x) on page 14. the positive coefficients obtained for the profit share suggest that financial cost effects are dominating, so that the observed increase in capital/output ratios cannot be ascribed to high real wages.

Notation and Definitions

INV	: Gross business fixed investment in constant prices as defined in national accounts.
dK	: Changes in gross capital stock in constant prices (for further discussion see footnote 4).
K	: Gross capital stock of private structures and equipment, constant prices.
Y	: GNP or GDP, constant prices.
INT	: Long-term bond rate, nominal.
RINT	: INT less rate of change in GDP deflator.
TRATE	: Corporate taxes as a percentage of net operating surplus as defined in national accounts. 1
PR	: Net operating surplus, private business sector, national accounts.
RPR	: PR deflated by investment deflator for equipment and structures.
PRS	: PR as a percentage of GNP or GDP in current prices.
CF	: Cash flow, defined as retained earnings plus depreciation.
RCF	: Cash flow deflated by investment deflator for structures and equipment.
dY	: Change in GNP or GDP.
TR	: Linear trend.

1 For the United Kingdom and Japan, appropriation accounts for the company sector are available only from 1968 and 1970 respectively. To avoid truncating the sample period, TRATE was set equal to the observed values in 1968 and 1970 for the preceding years. For all countries, TRATE was measured as a two-year moving average to remove short-run fluctuations.

(c) The trend term was found to be significant only in Japan, Germany and France, and in the latter case only for the log-linear equations. For the reasons given above, failure to identify a trend effect is not surprising, but it has the unfortunate effect of biasing the long-run capital/output elasticities. Thus the elasticities calculated for the United States, the United Kingdom and Sweden in Table 8 imply very low returns to scale in the underlying production function. The immediate source of this bias is the lagged capital stock, which, in the absence of a significant trend term, captures part of the trend effect and obtains a coefficient that is too high.

(d) By further comparison of the coefficients obtained for the INV and dK equations it is apparent that replacement investment cannot be explained merely as a function of the lagged capital stock. This gives some support to the assumption that firms' investment behaviour is best reflected in gross investment. At the same time, it leaves open the possibility that the gross investment equations are subject to aggregation biases.

(e) The log-linear EFE specification mostly yielded more satisfactory results than the linear version. The coefficients on $(Y-K)_{-1}$ in the latter were often found to be negative or insignificant, though for Germany and Japan a specification with the lagged Y/K ratio worked well and produced were small forecasting errors. However, this specification is rather ad hoc and the steady-state properties are difficult to assess.

(f) A partial adjustment scheme was tested in all cases, and for the United States, France and Sweden this parsimonious specification was not only accepted by the data but also produced the best forecast performance. Moreover, for the United Kingdom a partial adjustment scheme is a close alternative to the log-linear EFE approach.

(g) Using the various criteria listed above, the most satisfactory investment equations appear to be:

- for the United States the log-linear partial adjustment equation (c) yields plausible coefficients and the best forecast performance. Moreover, the parameters and statistical properties are reproduced in the dK equation (e). The log-linear EFE fails the forecasting test[28] while the linear EFE produces the wrong sign for lagged (Y-K) and an unsatisfactory dK equation. As noted, the interest rate was insignificant and the same applies to the trend term;

- in the case of Japan, on the other hand, both the trend and the real interest rate exerted a significant influence, whereas profits do not appear to affect investment decisions. Both the log-linear and the linear EFEs yield plausible coefficients and very close forecasts, and clearly outperform the partial adjustment scheme;

- the results for Germany are similar to those obtained for Japan in that both the trend and the real interest rate are significant and the profit

Table 1

INVESTMENT EQUATIONS, UNITED STATES

	Eq.	Dep.	C	DY	DY_{-1}	Y/K_{-1}	RCF_{-1}	DK_{-1}	K_{-1}	R^2	DW/h	LM^*	F^{**}	$Z_1^{\dagger}$
			Independent variables							Test statistics				
A. Log-linear	(a)	INV	- 4.56 (5.4)	1.85 (3.8)	1.60 (3.8)	0.69 (0.9)		6.57 (1.4)	1.23 (7.6)	0.98	1.27			
	(b)	INV	- 4.77 (8.7)	1.09 (3.3)	0.79 (1.8)	1.56 (7.8)	0.21 (1.6)		1.20 (7.9)	0.99	1.52	6.0		35.8
	(c)	INV	- 4.40 (8.4)	1.54 (7.1)			0.35 (3.3)		- 0.47 (3.4)	0.98	1.33	10.5	3.3	14.4
	(d)	DK	- 0.18 (9.6)	0.08 (4.1)	0.04 (2.0)	0.15 (12.6)			0.03 (12.4)	0.92	1.85			
	(e)	DK	- 0.18 (7.2)	0.15 (11.3)					- 0.11 (11.0)	0.85	1.35		10.0	
B. Linear	(f)	INV	- 31.5 (0.7)	0.21 (3.0)	0.17 (2.5)	- 0.01§ (0.1)	0.25 (1.4)	0.67 (1.8)	0.03 (0.6)	0.98	1.50			25.8
	(g)	INV	- 98.8 (5.4)	0.14 (5.6)			0.54 (4.5)		- 0.03 (2.4)	0.98	1.33		3.4	20.8
	(h)	DK	- 75.8 (2.1)	0.20 (3.8)	0.13 (3.2)	0.10§ (1.5)		0.58 (1.9)	0.07 (1.5)	0.95	n.d.			
	(i)	DK	-130.0 (6.9)	0.22 (9.4)					- 0.08 (6.6)	0.91	1.29		10.2	

* $X^2_{99,5} = 14.9$

** $F^{95}_{20,2} = 3.5$

† $X^2_{99,5} = 16.8$

§ $(Y-K)_{-1}$

Table 2

INVESTMENT EQUATIONS, JAPAN

	Eq.	Dep.	C	DY	DY_{-1}	Y/K_{-1}	DK_{-1}	K_{-1}	$RINT_{-1}$	TR	R^2	DW/h	LM^*	F^{**}	$Z_1^{\S}$
			Independent variables												
A. Log-linear	(a)	INV	- 0.72 (0.2)	1.17 (3.1)	0.61 (1.2)	0.74 (1.0)	4.52 (4.3)	0.84 (3.3)		0.025 (2.5)	0.98	1.97			
	(b)	INV	- 1.35 (0.5)	1.66 (4.0)	0.96 (1.9)	0.96 (1.5)	4.22 (4.4)	0.88 (3.8)	- 0.65 (2.0)	0.032 (3.3)	0.99	2.25	4.2		2.1
	(c)	INV	- 12.2 (4.6)	3.42 (8.5)				- 1.60 (4.9)	- 1.26 (2.6)	0.020 (1.2)	0.97	1.60		20.5	
	(d)	DK	- 0.04 (3.2)	0.23 (6.2)	-	0.17 (6.3)	0.55 (10.5)	-	- 0.03 (1.1)	0.004 (5.1)	0.99	-0.46			
	(e)	DK	- 1.46 (4.4)	0.44 (8.6)				- 0.32 (7.3)	- 0.13 (2.0)	0.001 (0.6)	0.95	1.08		85.5	
B. Linear	(f)	INV	- 33.6 (3.4)	0.31 (4.7)	0.18 (2.6)	21.5 (3.5)	0.86 (9.9)	0.04 (1.1)	- 0.21 (2.1)	1.14 (1.6)	0.99	2.25	4.0		6.2
	(g)	INV	- 14.2 (3.3)	0.62 (8.7)				0.22 (3.5)	- 0.28 (0.3)	-7.74 (6.0)	0.98	1.27		26.6	34.2
	(h)	DK	- 28.3 (3.3)	0.31 (3.8)	0.08 (1.0)	18.3 (3.1)	0.82 (8.7)	0.05 (3.2)	- 0.17 (1.1)	-	0.94	0.20			
	(i)	DK	- 12.5 (3.0)	0.28 (5.2)				- 0.14 (4.0)	- 0.05 (0.4)	-	0.81	0.51		17.6	

* $X_{99,5} = 14.9$

** $F^{95}_{13,3} = 3.4$

§ $X_{99,5} = 16.8$

Table 3

INVESTMENT EQUATIONS, GERMANY

	Eq.	Dep.	Independent variables									Test statistics				
			C	DY	DY_{-1}	Y/K_{-1}	DK_{-1}	K_{-1}	TR	RINT	TRATE	R^2	DW/h	LM^*	F^{**}	$Z_1^§$
A. Log-linear	(a)	INV	- 4.21 (4.5)	2.20 (4.8)	0.83 (1.6)	0.33 (0.6)	8.56 (4.3)	1.17 (7.9)				0.96	1.22			
	(b)	INV	1.18 (1.3)	2.21 (8.6)	-	2.48 (5.0)	2.85 (1.7)	0.58 (4.7)	0.04 (6.0)	- 1.13 (2.8)	- 1.39 (3.5)	0.99	1.37	9.4		92.0
	(c)	INV	0.51 (0.5)	2.52 (7.1)	-	-	-	- 1.81 (5.1)	0.03 (4.0)	- 0.81 (1.4)	- 1.61 (3.8)	0.98	1.06		10.1	
	(d)	DK	0.36 (5.2)	0.14 (7.6)	-	0.14 (4.0)	0.30 (2.5)	- 0.04 (4.3)	0.002 (4.9)	- 0.09 (3.1)	- 0.09 (3.3)	0.99	2.00			
	(e)	DK	0.33 (4.1)	0.16 (6.0)	-	-	-	- 0.19 (7.1)	0.002 (3.1)	- 0.06 (1.4)	- 0.12 (3.8)	0.97	0.96		12.8	
B. Linear	(f)	INV	-201.1 (3.9)	0.20 (7.5)	- 0.07 (2.1)	5.31 (6.7)	0.37 (4.9)	- 0.17 (3.5)	21.8 (5.1)	- 0.78 (1.7)	- 0.92 (2.4)	0.99	2.04	3.5		2.6
	(g)	INV	48.5 (0.7)	0.15 (3.6)	-	-	-	- 0.00 (0.0)	- 1.78 (0.3)	- 1.94 (1.9)	- 2.81 (3.4)	0.95	0.60		20.0	
	(h)	DK	- 80.6 (1.6)	0.18 (7.0)	- 0.05 (1.5)	3.59 (4.7)	0.54 (7.3)	- 0.19 (4.0)	18.6 (4.5)	- 1.08 (2.4)	- 0.63 (1.7)	0.94	0.31			
	(i)	DK	59.5 (1.0)	0.18 (5.0)	-	-	-	- 0.06 (0.9)	- 1.51 (0.3)	- 1.39 (1.6)	- 2.87 (4.1)	0.74	0.68		23.2	

* $X^2_{99,5} = 14.9$.

** $F^{95}_{16,3} = 3.2$

§ $X^2_{99,5} = 16.8$

Table 4

INVESTMENT EQUATIONS§, FRANCE

	Eq.	Dep.	Independent variables								Test statistics				
			C	DY	TR	Y/K_{-1}	DK_{-1}	K_{-1}	INT_{-3}	PRS_{-1}	R^2	DW/n	LM*	F**	Z_1§
A. Log-linear	(a)	INV	6.28 (2.1)	1.58 (3.4)	0.07 (2.8)	1.64 (2.4)	3.50 (1.1)	- 0.24 (0.6)			0.98	1.28			
	(b)	INV	3.65 (8.1)	1.92 (5.2)	0.07 (10.5)	1.09 (2.2)	3.01 (1.2)	-	- 1.96 (3.4)	2.23 (2.6)	0.99	1.66	7.8		92.0
	(c)	INV	4.82 (1.6)	1.77 (7.1)	0.08 (3.6)			- 1.87 (3.0)	- 1.80 (3.4)	2.11 (2.1)	0.99	1.47		11.1	
	(d)	DK	0.02 (0.6)	0.19 (7.4)	0.002 (3.4)	0.08 (2.4)	0.25 (1.3)	-	- 0.09 (2.22)	0.14 (2.0)	0.97	2.11			
	(e)	DK	0.47 (2.2)	0.17 (9.8)	0.005 (3.0)			- 0.23 (5.1)	- 0.07 (1.8)	0.05 (0.8)	0.97	1.67		4.0	
B. Linear	(f)	INV	-228.5 (4.3)	0.27 (4.5)	-	0.15 † (7.4)	-	0.18 (13.8)	- 2.64 (3.0)	5.67 (4.3)	0.98	1.42	8.6		21.2
	(g)	INV	-177.0 (3.4)	0.19 (11.4)	-			0.00 (0.3)	- 2.12 (2.4)	4.36 (3.4)	0.98	1.54	7.9	4.0	16.8
	(h)	DK	-133.3 (2.5)	0.32 (5.8)	-	0.22 † (11.0)	-	0.18 (15.2)	- 1.84 (2.3)	2.67 (2.0)	0.97	1.87			
	(i)	DK	- 90.1 (1.9)	0.24 (16.8)	-			- 0.06 (5.0)	- 1.28 (1.7)	1.61 (1.4)	0.97	1.73		3.3	

* $X^2_{99,5} = 14.8$

** $F^{95}_{17,2} = 3.6$

§ $X^2_{99,5} = 16.9$

† $(Y-K)_{-1}$

Table 5

INVESTMENT EQUATIONS, UNITED KINGDOM

	Eq.	Dep.	Independent variables: C	DY	DY_{-1}	Y/K_{-1}	DK_{-1}	K_{-1}	INT	PRS_{-1}	Test statistics: R^2	DW/h	LM^*	F^{**}	$Z_1^{\S}$
A. Log-linear	(a)	INV	- 3.88 (4.7)	1.00 (1.9)	1.57 (2.0)	- 0.24 (0.2)	- 1.39 (0.4)	1.06 (3.8)			0.96	1.21			
	(b)	INV	- 6.12 (8.7)	0.92 (2.1)	—	1.10 (2.7)	—	1.60 (9.1)	- 1.95 (3.3)	2.45 (3.3)	0.98	1.80	3.5		6.5
	(c)	INV	- 5.97 (11.0)	1.01 (3.2)				0.54 (2.6)	- 1.84 (4.0)	2.52 (3.6)	0.98	1.77	3.6	0.1	8.0
	(d)	DK	- 0.12 (2.4)	0.08 (2.9)	—	0.22 (8.2)	—	0.055 (4.7)	- 0.07 (1.6)	—	0.91	1.97			
	(e)	DK	0.00 (0.1)	0.15 (5.4)				- 0.13 (6.8)	0.02 (0.6)		0.83	1.79	2.9	8.2	
B. Linear	(f)	INV	-16.00 (5.5)	0.09 (2.3)	—	0.11† (3.1)	—	0.13 (4.8)	- 0.48 (4.1)	0.53 (3.5)	0.98	2.01	3.1		29.9
	(g)	INV	-16.40 (5.8)	0.10 (3.8)				0.02 (3.2)	- 0.44 (5.1)	0.55 (4.0)	0.98	1.97		0.1	
	(h)	DK	-18.60 (5.5)	0.16 (3.4)		0.48† (10.2)		0.35 (9.7)	- 0.25 (1.5)	—	0.84	2.24			
	(i)	DK	- 9.09 (2.2)	0.33 (6.3)				- 0.10 (6.8)	0.24 (0.06)		0.67	2.10		25.0	
C. Log-linear excluding energy sector	(j)	INV	- 6.85 (6.6)	0.79 (1.2)	—	1.83 (2.3)	—	1.83 (6.5)	- 3.97 (4.4)	2.62 (2.2)	0.93	1.25			
	(k)	DK	- 0.09 (1.3)	0.09 (2.2)	—	0.25 (5.4)	—	0.055 (3.2)	- 0.12 (1.9)		0.85	1.13			

$* \chi^2_{99,5} = 14.9$ $** F^{95}_{21,3} = 3.1$ $\S \chi^2_{99,5} = 16.8$ † $(Y-K)_{-1}$

Table 6

INVESTMENT EQUATIONS, CANADA

	Eq.	Dep.	Independent variables: C	DY$_{-1}$	Y/K$_{-2}$	PRS$_{-1}$	TRATE	DK$_{-2}$	K$_{-2}$	Test statistics: R^2	DW/h	LM*	F **	Z_1§
A. Log-linear	(a)	INV	- 1.92 (4.3)	0.82 (1.1)	1.95 (4.8)			- 1.40 (0.8)	1.13 (13.0)	0.94	1.01			
	(b)	INV	- 2.12 (3.4)	1.30 (2.2)	1.97 (6.1)	3.04[1]	- 1.70 (2.0)	-	1.08 (13.6)	0.97	1.52	9.0		4.5
	(c)	INV	- 3.06 (10.0)	1.62 (5.1)	-	2.11 (2.6)	-	-	- 0.42 (1.5)	0.97	1.02		4.2	
	(d)	DK	0.13 (1.9)	0.18 (1.9)	0.18 (2.7)	0.20 (1.5)	- 0.06 (0.6)	- 0.28 (1.1)	-	0.57	n.d.			
	(e)	DK	0.10 (2.2)	0.15 (3.5)	-	0.16 (1.5)	-	-	- 0.15 (4.0)	0.59	2.32		1.0	
B. Linear	(f)	INV	- 7.50 (1.8)	0.14 (1.9)	0.26[2] (7.7)	0.55[3]	- 0.29 (2.1)	-	0.20 (10.7)	0.97	1.52	9.5		76.8
	(g)	INV	-11.30 (3.8)	0.22 (5.6)	-	0.37 (3.0)	-	-	- 0.03 (1.5)	0.96	1.01		4.8	
	(h)	DK	- 0.75 (0.1)	0.11 (0.8)	0.31[2] (4.0)	0.33 (1.6)	- 0.23 (1.9)	-	0.18 (4.4)	0.57	2.51			
	(i)	DK	- 7.10 (1.5)	0.27 (4.2)	-	0.31 (1.6)	-	-	- 0.10 (3.3)	0.63	2.26		1.6	

* $X^2_{99,5} = 14.9$

** $F^{95}_{18,2} = 3.55$

§ $X^2_{99,5} = 16.8$

1 $\underset{(1.3)}{1.12}\ PRS_{-1} + \underset{(2.0)}{1.92}\ PRS_{-2}$

2 $(Y-K)_{-2}$

3 $\underset{(2.1)}{0.27}\ PRS_{-1} + \underset{(2.0)}{0.28}\ PRS_{-2}$

Table 7

INVESTMENT EQUATIONS, SWEDEN

	Eq.	Dep.	Independent variables: C¶	DY	DY_{-1}	Y/K_{-1}	DK_{-1}	K_{-1}	$RINT_{-2}$	PRS_{-1}	Test statistics: R^2	DW/h	LM^*	F**	Z_1§
A. Log-linear	(a)	INV	- 6.50	0.72 (0.9)	1.68 (2.2)	1.14 (1.3)	8.87 (2.3)	1.55 (3.3)			0.80	1.61			
	(b)	INV	- 7.53	0.79 (1.0)	-	1.97 (3.3)	-	1.78 (5.0)	- 0.83 (0.8)	2.39 (3.0)	0.82	1.44	12.8		
	(c)	INV	- 7.05	1.60 (2.9)				0.07 (0.3)	- 1.60 (1.9)	2.46 (3.0)	0.82	1.28	11.4	1.2	10.5
	(d)	DK	- 0.14 (2.3)	0.03 (0.9)	-	0.11 (5.9)	-	0.03 (3.4)	-	0.14 (3.0)	0.86	2.03			
	(e)	DK	- 0.12 (2.1)	0.10 (5.9)				- 0.07 (5.8)	-	0.14 (3.0)	0.86	2.13		4.7	
B. Linear	(f)	INV	-63.2	0.09 (1.4)	-	0.21† (4.3)		0.20 (5.0)	- 0.31 (0.7)	1.02 (3.3)	0.84	1.49			
	(g)	INV	-56.1	0.17 (3.7)				- 0.00 (0.2)	- 0.73 (2.0)	1.03 (3.2)	0.82	1.31	10.5	3.3	8.3
	(h)	DK	-56.8 (3.8)	0.05 (0.9)	- 0.04 (3.5)	0.21† (4.8)				1.77 (5.9)	0.85	2.33			
	(i)	DK	-61.4 (4.2)	0.21 (6.7)				- 0.03 (3.3)		1.46 (3.5)	0.74	2.01		11.5	

¶ Because of a break in the gross investment series, an intercept shift was included for 1970-84. The figures below for the INV-equations are the post-1970 intercepts.

* $X^2_{99,5} = 14.9$ ** $F^{95}_{13,2} = 3.8$ § $X^2_{99,5} = 14.9$ † $(Y-K)_{-1}$

share is not. However, a particular feature of the German estimates is the important influence of tax rate changes as well as the close forecasts produced by the linear EFE as compared with the log-linear version

- most of the equations obtained for France perform poorly when used for forecasting, implying either unstable parameters or a change in the stochastic properties. A linear partial adjustment equation (g) seems to give the best overall performance, but the log-linear and linear EFEs are close alternatives. The interest rate effect is best captured by the nominal rate, and the rather long lag is consistent with the putty-clay production structure found in several national studies;[29]

- for the United Kingdom the log-linear EFE yields the best overall performance,[30] but the log-linear partial adjustment is a surprisingly close alternative and is mainly excluded because of a poor dK function. The linear EFE and the linear partial adjustment yield plausible parameters but fail the forecasting test, and the structural parameters are not well reproduced in the dK equations. When equation (b) is applied to the private non-energy sector, the parameters look plausible, but the low DW-statistic suggests that additional variables are to be included and/or the lag structure constructed differently;

- all equations obtained for Canada display relatively long lags. Indeed, equation (e) would imply that only 15 per cent. of a desired adjustment in the capital stock is accomplished by the second year. At the same time, the autocorrelation statistics clearly reveal that the lag structure or the influence of additional variables has not been sufficiently identified. Nonetheless, the log-linear EFE forecasts reasonably well, and the structure is preserved in equation (d), which yields a long-run capital-output elasticity of unity;

- finally, for Sweden the linear partial adjustment equation (g) seems to have the best forecasting ability, yields plausible parameters and, with some decline in the explanatory power, reproduces the structure for changes in the capital stock (i). The log-linear version (equation (e)) is a close alternative, while the log-linear and linear EFEs yield very low and poorly determined current income effects. Both the real interest rate and the profit share appear to affect investment decisions and the latter remains significant also for dK whereas the real interest rate drops out.

Table 8

SUMMARY AND STRUCTURAL PARAMATERS

Country	Preferred equation	Long-run capital output elasticity	Interest rate elasticity[1]			Profit share elasticity[1]			Tax rate elasticity[1]			Adjustment coefficient[2]
			INV	DK	K	INV	DK	K	INV	DK	K	
United States ..	(c)	1.30	-	-	-	0.35[3]	-	-	-	-	-	0.11
Japan	(b)	1.00	-0.0067	-0.0003	-0.0019	-	-	-	-	-	-	0.32
Germany	(f)	0.70	-0.0060	-0.0138	-0.0050	-	-	-	-0.0071	-0.0081	-0.0011	0.19
France	(g)	0.75	-0.0200	-0.0263	-0.0029	0.0486	0.0382	0.0112	-	-	-	0.23
United Kingdom .	(b)	1.33	-0.0195	-0.0180	-0.0040	0.0245	-	-	-	-	-	0.13
Canada	(b)	1.00	-	-	-	0.0304	0.0382	0.0113	-0.0170	-0.0264	-0.0032	0.15
Sweden	(g)	1.35	-0.0180	-	-	0.0254	0.0459	0.0187	-	-	-	0.07

1 Percentage change in INV, DK or K with respect to a one point change in interest rates, tax rates or profit shares. For linear equations calculated at mean of dependent variable.

2 Percentage of desired adjustment achieved in the first year. For Canada second year.

3 Elasticity with respect to real cash flow.

2.2 Summary and comparisons.

To sum up, equation (b) was chosen for Japan, the United Kingdom and Canada, (c) for the United States, (f) for Germany and (g) for France and Sweden. Because the range of the preferred equations covers linear as well as log-linear forms and various specifications of the lag structures, a straightforward comparison between the countries is not feasible. However, in Table 8 an attempt has been made to give representative parameters, using the preferred equations whenever possible and taking their log-linear equivalents when these had acceptable properties. On this basis, the long-run capital-output elasticities are seen to range from 0.70 in Germany to 1.35 in Sweden, and the adjustment in the first year varies from 0 per cent. in Canada to 32 per cent. in Japan,[31] using equations (e) or (i). The partial elasticities with respect to interest rates, tax rates and profits all refer to the initial response (which in some cases is lagged 1-3 years), and the corresponding long-run elasticities would be several times larger. Nevertheless, the sensitivity of both INV and dK remains rather small and would, in most cases, be less than 0.5, with the possible exception of the profit share elasticities in France, Canada and Sweden. The weak response to changes in interest rates, tax rates and profit shares is also observed in the long-run elasticities of the capital stock, which are calculated from the steady-state solutions of the dK equations. For the United States all elasticities appear to be zero, while in Sweden the profit share elasticity comes to 0.019. On the other hand, when these elasticities are non-zero, changes in interest and tax rates and in the distribution of factor incomes have a permanent effect on the size of the capital stock. This in turn implies a potential influence of monetary and fiscal policy measures and real wage restraint.

2.3 Investment growth by contributing factor.

Turning to more short-run influences, Table 9 shows investment growth over consecutive five-year periods and the contributions of the various determinants, i.e. the change of each explanatory variable multiplied by the corresponding coefficient and expressed as a percentage of the investment at the beginning of the period (average annual rate). Since the sub-periods were chosen independently of cyclical developments and no attempt was

Table 9

CHANGES IN INVESTMENT BY CONTRIBUTING FACTOR

Country	Average annual percentage change				
	1965-70	1970-75	1975-80	1980-85	1965-85
United States					
Change in investment	3.0	1.2	6.0	4.4	3.6
"due to" output	4.6	4.2	5.2	3.4	4.3
capital stock	- 2.0	- 1.8	- 1.7	- 1.5	- 1.8
profits	0.5	0.5	2.2	1.9	1.3
residual	- 0.1	- 1.7	0.3	0.6	- 0.2
Japan					
Change in investment	20.0	0.6	5.0	6.4	8.0
"due to" output	10.1	0.8	6.4	3.5	5.2
capital stock	2.6	- 1.0	- 3.0	- 0.6	- 0.5
interest rate	- 0.2	1.8	- 2.2	- 0.1	- 0.2
trend	3.2	3.2	3.2	3.2	3.2
residual	4.3	- 4.2	0.6	0.4	0.3
Germany[1]					
Change in investment	5.0	- 1.7	6.0	1.0	2.5
"due to" output	12.6	6.3	6.4	2.2	6.8
capital stock[2]	- 8.0	- 7.4	- 0.6	- 1.4	- 4.4
tax rate	0.3	- 0.2	0.2	0.4	0.2
interest rate	0.3	- 0.3	- 0.1	- 0.0	0.0
residual	- 0.2	- 0.1	0.1	- 0.1	- 0.1
France					
Change in investment	6.6	2.3	4.0	- 0.4	3.1
"due to" output	8.2	6.2	5.4	1.8	5.2
capital stock	0.3	0.3	0.3	0.2	0.3
profits	- 1.7	- 1.9	- 2.0	- 0.8	- 1.6
interest rate	- 0.7	- 0.5	- 1.1	- 1.5	- 0.9
residual	0.5	- 1.8	1.4	- 0.1	0.1
United Kingdom					
Change in investment	4.2	0.6	4.8	4.6	3.5
"due to" output	2.9	2.7	2.2	1.1	2.2
capital stock	1.9	1.8	1.4	1.0	1.5
profits	- 0.5	0.6	0.6	0.0	0.2
interest rate	- 0.8	- 2.0	- 0.1	1.1	- 0.5
residual	0.7	- 2.5	0.7	1.4	0.1
Canada					
Change in investment	3.6	7.4	4.4	- 2.2	3.3
"due to" output	10.8	10.8	6.1	3.0	7.6
capital stock	- 5.4	- 4.5	- 4.1	- 3.6	- 4.4
profits	- 1.5	1.6	- 0.6	- 1.1	- 0.4
tax rate	- 0.3	1.1	1.1	0.8	0.7
residual	0.0	- 1.6	1.9	- 1.3	- 0.2
Sweden					
Change in investment	2.6	5.4	- 1.6	3.7	2.5
"due to" output	7.6	5.0	0.7	2.5	3.9
capital stock	- 0.2	- 0.2	- 0.1	- 0.1	- 0.1
profits	- 2.1	- 0.0	- 1.6	1.9	- 0.4
interest rate	1.1	0.3	- 0.6	- 2.1	- 0.4
intercept shift, 1970	- 3.6	-	-	-	- 0.9
residual	- 0.2	0.3	0.0	1.5	0.4

1 The contribution of the change in $^{Y}/K_{-1}$ is approximated by the following formula:

$$a \cdot \left(\frac{Y_{-1}}{K_{-1}} - \frac{Y_{-6}}{K_{-6}}\right) = \frac{a}{K_{-1}} \cdot (Y_{-1} - Y_{-6}) - \frac{a \cdot Y_{-6}}{K_{-1} \cdot K_{-6}} \cdot (K_{-1} - K_{-6})$$ whereby the first term is

attributed to output, the second term to the capital stock and a is the estimated coefficient with respect to $^{Y}/K_{-1}$.

2 Including the contribution of the trend.

made to smooth the data, the residuals are in some cases quite large. However, for the whole observation period they tend to net out.

Focusing on the latest five-year period, the experiences of the seven countries may be summarised as follows:

(a) In the United States, the United Kingdom and Sweden the 1980-85 growth rates of investment exceed the 20-year average, despite a relatively small output contribution. The residuals are positive, which for the first two countries could reflect the effect of various fiscal measures which are not captured by the average corporate rate. As mentioned earlier, the 1981 tax changes in the united States contained large investment incentives, though there are conflicting views as to their effect on the post-1981 investment boom.[32] In the United Kingdom a pre- announced removal of very favourable investment allowances is likely to have given a temporary boost to investment spending in 1985. Among other factors the fall in nominal interest rates (by 5 1/2 percentage points between 1980 and 1985) provided a strong incentive in the United Kingdom, while for the United States the contribution of real cash flows was above average, but lower than in the preceding five-year period. In the case of Sweden, the 1985 outcome almost doubled the average growth rate for the 1980s but also left a large unexplained residual. A recovery of the profit share after 1977, when it had fallen to only half the level recorded in the early 1960s, had a positive effect, but was more than offset by higher real interest rates.

(b) Canada and France both experienced falling investment during 1980-85, but the underlying causes appear to have been very different:

- in Canada the recorded decline together with the residual pattern mainly seem to reflect the unusually high investment level in 1980 followed by the severe 1981-82 recession and a steep deterioration in firms' profits and general financial conditions;
- in France, on the other hand, more permanent factors were behind the weaker investment performance: the contribution of output growth was less than 2 percentage points, rising nominal interest rates reduced investment growth by 1 1/2 percentage points and falling profit shares caused a further decline. Indeed, French business fixed investment has been more adversely affected by the changes in the income distribution than those of other countries, reflecting the combined effect of a

relatively high elasticity (see Table 8) and a fall in the profit share from 34.7 per cent. in 1962 to 26.1 per cent. in 1982.[33]

(c) In Germany investment growth attained 1 per cent. during the latest period but was well below the 20-year average. Weak output growth was an important factor, while changes in the tax rate had a small but positive impact. Despite a relatively high interest elasticity the contribution of real interest rates in Germany has also been modest. With the exception of the early 1970s, when the real rate temporarily fell to 0 per cent. and subsequently rose to 4 per cent., German real interest rates have been remarkably stable.[34]

(d) Finally, in Japan, investment growth rose to 6 1/2 per cent. in the last period despite lower output growth. This acceleration was mainly due to less negative interest rate and capital stock effects, with the latter probably reflecting the fact that the adjustment towards lower capital stock growth was being completed.

One general observation to be made from Table 9 is that despite the relatively small elasticities with respect to interest rates and profit shares, trend changes and short-run fluctuations in these variables have had a marked influence on investment patterns and the size of the capital stock. France provides a particularly good example in this respect, as trend changes in profit shares and nominal interest rates have reduced the growth of investment by some 2 1/2 percentage points per year. By contrast, in the United States, improvements in real cash flows have boosted investment growth by 1 1/4 percentage point per year, while in Sweden the effect of changes in profit shares is small for the entire period but sizable for intermediate years. Large interest rate effects may also be observed, but these have mainly been of a transitory nature. Thus the United Kingdom, Sweden and Japan have experienced interest rate changes which for some periods affected the growth of investment by some 2 percentage points per year, while in Canada such short-term influences have been confined to fluctuations in the profit share. Germany stands out as the country with the fewest effects from changes in interest rates and none at all from the decline in profit shares from 31.6 per cent. in 1960 to a low of 19.7 per cent. in 1981.

Table 10

UNEMPLOYMENT (UN), CAPACITY UTILISATION (CU) AND CAPITAL STOCK GROWTH (dK), 1970-85

Countries	1970-74 average			1975-79 average			1980-85 average			Peak (year)		1985 Actual		1985 Difference vis-à-vis 1970-74	
	UN	CU	dK	UN	CU	dK	UN	CU	dK	UN*	CU	UN	CU	UN	CU
United States .	5.4	81.8	4.0	7.1	80.0	3.6	8.1	77.1	3.2	4.9 (1973)	87.0 (1973)	7.2	80.3	+ 1.8	-1.5
Japan	1.3	105.2	12.1	2.0	92.3	6.4	2.4	97.5	6.5	1.2 (1970)	110.0 (1970)	2.6	102.2	+ 1.3	-3.0
Germany	1.3	86.0	5.2	4.4	80.6	3.5	7.5	80.2	3.1	0.7 (1970)	90.5 (1970)	9.3	84.0	+ 8.0	-2.0
France	2.5	86.3	5.9	4.9	82.7	4.7	8.3	82.5	3.7	2.4 (1970)	88.1 (1973)	10 1	82.2	+ 7.6	-4.1
United Kingdom	3.0	100.3	3.6	5.3	97.4	2.8	11.4	95.1	2.0	2.6 (1973)	103.1 (1973)	13.2	98.1	+10.2	-2.2
Canada	5.8	90.8	4.1	7.6	87.7	4.6	10.0	80.9	3.5	5.3 (1974)	95.6 (1973)	10.5	84.7	+ 4.7	-6.1
Sweden	2.2	57.5	4.4	1.9	33.8	3.3	2.9	36.2	2.6	1.5 (1970)	70.0 (1970)	2.8	49.3	+ 0.6	-8.2

* Figures below give lowest values observed.

III.

Employment and the capital stock

Having discussed the determinants of investment and changes in the capital stock, we now turn to the employment potential of existing capital equipment. As a starting point, Table 10 presents post-1970 trends in unemployment, utilisation rates and growth of the capital stock, and two points are worthy of further attention:

- while in all countries 1985 unemployment rates are well above the averages of the early 1970s, the extent to which this rise has been accompanied by a fall in capacity utilisation varies widely. In the United States, Japan and Canada the changes in unemployment (UN) and capacity utilisation (CU) are of approximately the same size, whereas in Germany, France and the United Kingdom changes in UN exceed those in CU by a wide margin, so that other factors appear to have influenced unemployment. Sweden is a special case in this context, as the rise in UN has been moderated by special labour market measures, and the definition of CU differs from that used for other countries;[35]
- as noted in Section I, Japan and Europe have experienced a marked decline in capital stock growth, whereas the fall is relatively moderate in North America. While for Japan this development corresponds to the acceptance of lower overall growth, the declines observed for Europe may constrain future increases in employment.

It should be noted that the CU rates refer to manufacturing, and, with the rising employment share of the services sector, their relationship with overall unemployment rates is likely to weaken over time. Moreover, divergent changes in UN and CU could be due to exceptional changes in labour supply, though for most countries this does not appear to have been the case. Nonetheless, to avoid any biases, the following will focus on employment rather than unemployment, whereas in the absence of more broadly based capacity utilisation rates, manufacturing will be taken as representative of the whole economy.

Usually employment is estimated as a function of output and some measure of real or relative labour costs. Alternatively, firms' labour demand (EM) may be related to labour costs, the capital stock and technical progress. As an illustration, consider a profit-maximising firm with a given capital stock (K) and facing a given wage (W) and output price (P). Assuming further that the underlying production function is homogeneous of degree one and letting r denote technical progress, the first-order conditions may be written:

(i) $$EM = K - a(W/P) + b\ r$$

where the expected sign of (W/P) is negative while the sign of r depends on whether technical progress is Hicks-neutral or labour-saving. In the former case, b = a while in the case of labour-augmenting technical progress b = a - 1, so that b will be very small or negative for a close to or less than 1.[36]

For the above production function the elasticity of employment with respect to the capital stock is unity, and Newell and Symons (1985) have used this property in estimating employment equations for 24 industrialised countries, finding that b in most cases is close to zero while a varies between 0.007 and 2.5. Most of the estimated equations have satisfactory statistical properties but in the light of the preceding discussion, and considering the evidence in alternative employment studies, some additional points need more specific attention before a precise relationship between employment and the capital stock can be obtained:

- equation (i) refers to firms' labour demand in short-run equilibrium, whereas most observations would be drawn from a situation of disequilibrium. In particular, the capital stock needs to be combined with or augmented by the rate of capacity utilisation;
- Newell and Symons estimated the lag structure by including two lagged values of the dependent variable (EM/K) among the determinants. Alternatively, the more general approach discussed in Section II may be applied, which would also permit testing of the long-run unit elasticity with respect to K rather than imposing it as an a priori condition;
- as mentioned earlier, recent investment may have become increasingly capital-intensive and entailed a high rate of labour-saving technical progress. The above formulation only allows for disembodied technical progress, and ideally a test for the existence and influence of embodied technical progress should be based on detailed information on the composition of the capital stock. In the absence of such data[37] the

hypothesis that, over time, the capital stocks support a gradually decreasing work force may be tested in a very crude way by combining a time trend with the capital stock rather than entering it as a separate variable;

- real wages are included in the above formulation on the assumptions of profit maximisation and a putty-putty production structure. Both are rather restrictive, but an alternative justification for including real wages may be found in Helliwell et al. (1985), who argue that real wages influence firms' choice of capacity utilisation as well as the level of the economically profitable capacity. With higher profits, firms are likely to use the capital stock more intensively. Moreover, if previously unprofitable equipment is not scrapped but merely "mothballed", a rise in profitability would increase firms' capacities as less efficient equipment is brought back into use. Especially in the case of aggregate relations, this hypothesis provides an attractive alternative to models (clay-clay and putty-clay) with limited factor substitutabilities.

Because the number of observations is relatively small,[38] it is not possible to test all of the above additional points and modifications within one general model. Instead two alternative specifications were considered.

(a) EFE approach.

Drawing on the results reported by Newell and Symons and adopting a multiplicative relationship, equation (i) may be written as:

(ii) $$EM^{*} = A\ (W/P)^{a}K$$

where EM^{*} refers to desired employment, and technical progress is ignored. On the further assumption that short-run labour demand will vary in line with actual or expected output, and measuring the influence of output by capacity utilisation rates (CU), a short-run employment equation can be specified as:

(iii) $$EM_{t} = A\ (W/P)_{t}(CU_{t}^{h}K_{t-1})$$

where K_{t-1} refers to the capital stock at the beginning of period t and CU is entered with an exponent h on the assumption that changes in CU may not have the same employment effects as changes in K. Finally, recognising the fact that employment usually adjusts with a lag, but limiting such lags to one period because of the small number of observations, equation (iii) specified in logs (indicated by small letters) becomes:

(iv) $$em_t - a_1 em_{t-1} = a_0 + a_2(w-p)_t + a_3(w-p)_{t-1} + h(a_4 cu_t + a_5 cu_{t-1}) + a_4 k_{t-1} + a_5 k_{t-2}$$

or

(v) $$dem_t = a_0 + a_2(w-p)_t + a_3(w-p)_{t-1} + a_4' cu_t + a_5' cu_{t-1} + a_4 dk_{t-1} + (a_4+a_5)(k_{t-2} - em_{t-1}) + (a_1+a_4+a_5-1)em_{t-1}$$

where a significant coefficient on em_{t-1} implies a long-run elasticity with respect to the capital stock different from unity. In the special case of h=1, equation (v) is simplified to:

(vii) $$dem_t = a_0 + a_2(w-p)_t + a_3(w-p)_{t-1}\ a_4 d(k_{t-1} - cu_t) + (a_4+a_5)(k_{t-2} + cu_{t-1} - em_{t-1}) + (a_1+a_4+a_5-1)em_{t-1}$$

(b) Technical progress.

A trend term might be added to equations (v) and (vi) above to allow for the employment effect of disembodied technical progress. However, for embodied technical progress an alternative specification is preferable. Denoting the time trend by TR, a general employment equation incorporating labour-saving embodied technical progress may be written as:

(vii) $$em_t = a_0 + \sum_{0}^{2} b_i(w-p)_{t-i} + \sum_{0}^{2} c_j cu_{t-j} + ek_{t-1} - fTRk_{t-1}$$

where a significant and positive value for f may be taken as an indication that investments have become increasingly biased against labour. (vii) was also estimated with TR entered as a separate variable and, to "save" degrees of freedom, a third version constraining e to unity was tested as well.

For all countries, EM was measured by employment in the private sector, W/P as compensation per employee deflated by the GDP deflator, and CU

Table 11

EMPLOYMENT EQUATIONS

Countries	C	L(W/P)	$L(W/P)_{-1}$	LCU	LCU_{-1}	dLK_{-1}	$LEM_{-1} - LK_{-2}$	LEM_{-1}	LK_{-1}	$TRLK_{-1}$	DW/h	SE
United States .	-3.93 (5.9)	-0.23 (3.7)	-	0.29 (12.4)	-	-	0.42 (9.6)	-0.22 (7.5)	-		1.00	0.52
"	-1.41 (1.8)	-0.03 (0.4)	-	-	-	0.11 (3.0)	0.19 (4.4)	-0.09 (4.0)	-		0.15	0.55
Japan	-1.21 (1.8)	-	-0.24 (2.4)	0.13 (4.2)	-	-	0.21 (3.0)	-0.51 (3.6)	-		-0.20	0.52
"	0.02 (0.1)	-0.10 (1.5)	-	-	-	0.11 (3.4)	0.10 (1.7)	-0.29 (1.6)	-		-1.37	0.57
Germany	-7.46 (21.3)	-0.45 (5.0)	-	0.33 (7.7)	0.21 (4.8)	-	-	-	1.0	0.00396	1.84[1]	0.66
France	4.42 (3.2)	-0.31 (2.8)	0.30 (3.6)	0.13 (4.3)	0.07 (2.0)	-	-	-	0.67 (4.1)	-0.00393 (6.7)	2.23	0.28
United Kingdom	-1.28 (0.9)	-0.25 (2.9)	-	0.53 (4.4)	0.48 (3.7)	-	0.21 (3.4)	-0.25 (1.7)	-		-0.55	0.73
Canada	0.41 (0.8)	-	-0.11 (1.3)	-	-	0.35 (7.0)	0.32 (4.4)	-0.11 (2.9)	-		0.71	0.98
Sweden	-1.81 (2.0)	-0.19 (1.5)	-	0.03 (2.3)	-	-	-	0.70[2] (4.1)	1.0	-0.00105 (1.2)	0.91	1.02

1 Corrected for autocorrelation. First-order autocorrelation coefficient = 0.15.
2 Coefficient with respect to lagged dependent variable; i.e. $\log(EM/K)_{-1}$.

by the rate of capacity utilisation in manufacturing (except for the United Kingdom). The most satisfactory estimates are shown in Table 11, and it is interesting to note that the EFE specification yielded implausible coefficients for Germany, France and Sweden. In the United States and Japan, on the other hand, the EFE specification was superior to other equations. It is also worth noting that the more restrictive version with h=1 is accepted by the data for the United States and Japan, and that for Canada the EFE only works with this additional restriction. For the United Kingdom, on the other hand, setting h=1 yielded implausible parameters. For the three countries where the technical progress model was preferred, Germany and France show a clear trend decline in the capital stock coefficient, and for Germany an initial coefficient of unity was also accepted. For Sweden, too, the constrained version produced the best results, and there is also evidence of a declining capital stock coefficient. However, all employment determinants are subject to very long lags as indicated by the coefficient on the lagged dependent variable of 0.7.[39]

To facilitate comparisons, the long-run employment elasticities are shown in Table 12 (using the general EFE approach for the United States and Japan) together with hypothetical employment changes. Taking the 1970-74 period as representative of typical values for CU, d(W/P) and dK hypothetical 1985 employment levels were calculated assuming that CU returned to the average level for 1970-74 and that the growth rate of K and W/P during 1980-85 were the same as during 1970-74. From the calculations it appears that the cyclical component of unemployment is relatively high in Canada and the United Kingdom but low in the United States and Japan.[40] At the same time, real wage moderation during 1980-85 helped employment growth in Japan, Germany and Sweden but played only a minor role in the United States and Canada. The slowdown in capital stock growth had a particularly adverse effect in France, Japan, Germany and Sweden but was of only moderate importance in North America. As shown in the penultimate column, however, the investment levels required to generate the earlier rates of capacity growth are in several cases unrealistically high, given the developments in output, profits and interest rates. Finally, the last column gives some approximate "employment trade-offs" between changes in real wages and capital stocks. For instance, for the United States a fall in real wages of 1 per cent. has the

Table 12

EMPLOYMENT EFFECTS OF CHANGES IN CAPACITY UTILISATION (CU), REAL WAGES (W/P) AND THE CAPITAL STOCK (K)

Countries	Long-run employment elasticities with respect to				1985-employment effects of return to 1970-74 values			Memo items:	
	CU	W/P	K	CU.K	CU	W/P	K	INV[1]	W/P-K trade-off[2]
United States ..	0.45	-0.35	0.66	-	+0.7	+0.2	+2.6	27.5	0.50
Japan	0.18	-0.33	0.30	-	+0.5	-9.7	+9.4	116.0	1.10
Germany	0.53	-0.43	0.90[3]	-	+1.1	-9.8	+9.9	80.0	0.50
France	0.20	-0.00	0.56[3]	-	+1.0	-	+6.2	90.0	-
United Kingdom .	2.18	-0.55	0.51	-	+4.8	-2.8	+4.2	88.0	1.10
Canada	-	-0.26	-	0.75	+5.4	-1.3	+2.2	19.0	0.35
Sweden	0.10	-0.63	0.91[3]	-	+1.7	-6.3	+8.5	77.0	0.70

1 Increase in 1980-85 investment required to generate the capital stock growth of 1970-74.

2 Calculated as the ratio between the real wage and capital stock elasticities (column 2 divided by column 3 (column 4 for Canada)).

3 Calculated for 1985.

same employment effect as a 1/2 per cent. rise in the capital stock, whereas for the United Kingdom and Japan a rise in K of 1.1 per cent. is required. For France, this trade-off does not exist, as the long-run effect of real wages on employment is close to zero.

It is, of course, an open question whether the 1970-74 developments were at all feasible in 1980-85. Peak CU rates are in all cases well above 1970-74 averages but are probably not compatible with stable and non-inflationary growth. Similarly the high growth rates of the capital stock observed for France and Japan may not be realistic under current conditions, and the changes in real wages recorded in the early 1970s were exceptionally high in several countries owing to the combined effect of wage-push and deterioration in the terms of trade.

Alternatively, the elasticities shown in Tables 8 and 12 may be combined to give a complementary assessment of the major risks and uncertainties. On this basis it appears that in Canada and the United Kingdom a large part of unemployment could be eliminated by closing the output gap, and faster capital stock growth would also boost employment growth.[41] Particularly in the United Kingdom, however, it is important that real wages do not accelerate as both the direct and indirect (via investment) employment effects are high. In France, Germany and Sweden one of the main problems is to generate faster capital stock growth and, at the same time, hold back real wage growth. In France, real wages do not directly affect employment, but lower profit shares have a large and negative effect on investment. In Germany, by contrast, the direct employment effect of real wages is the more important, while Sweden occupies an intermediate position with significant direct and indirect real wage effects. For the United States a return to the 1970-74 CU rates would reduce the unemployment rate to around 6.5 per cent., which is considered by many to be the lowest rate consistent with a stable rate of inflation. The real wage elasticity of employment is relatively high, and cash flows were found to influence investment spending, but, given the history of relatively stable real wages, this sensitivity is unlikely to pose a major risk. Finally, the Japanese situation is the most difficult one to evaluate: unemployment is low by international standards but high in relation to historical trends, and it may well be understated owing to a slow employment adjustment to output and a high degree of flexibility on the labour supply side.[42] The elasticity of employment with respect to both real wages and the capital stock is relatively low, but a return to the earlier and higher growth rates of both variables appears unlikely. Nonetheless, it is important to maintain moderate real wage growth, as a fall in profit shares would have adverse effects on employment.

IV.

Summary and Conclusions

The main purpose of this paper has been to test the hypothesis that, especially in Europe, excessive real wage growth and falling profit shares have been instrumental in reducing investment growth and the employment potential of the capital stock. We have also considered the policy implication that a sustainable rise in employment may not be feasible unless higher output growth is led by investment and that this in turn requires continued or even further wage restraint.

To test the hypothesis two equations were estimated for seven industrialised countries: an investment equation and a reduced-form relationship between employment, real wages and the capital stock. The evidence from these equations may be summarised as follows:

(i) except for Germany and Japan, changes in the profit share (or in real cash flows) have had a significant influence on gross business fixed investment, being particularly strong in France, Sweden and Canada. This finding appears to support the real wage hypothesis, but some additional points should also be taken into account:

- the main cause of the weak investment growth during the last five years has been below-trend output growth and in some countries also higher real or nominal interest rates. Changes in the distribution of factor income, on the other hand, have had either a positive or a neutral effect on investment as in several countries earlier negative trends in profit shares were reversed or brought to a halt;

- in two countries the impact of changes in the profit share is confined to replacement investment, and there is no permanent effect on long-run capital/output ratios;
- in all cases where the profit share is significant, the coefficient is positive, implying that financial cost effects outweigh substitution effects;

(ii) except for France, the employment equations provide clear evidence of a negative effect of higher real wages. The elasticities range from a high of 0.65 in Sweden to 0.25 in Canada and probably reflect both substitution and capacity effects, as firms may respond to less favourable profit conditions by reducing employment and utilisation rates and temporarily removing the least efficient equipment. A trend decline in the employment potential of the capital stock is most pronounced in France and Germany, thus supporting the view that real wages may have led to more capital-intensive investment. However, the ad hoc and reduced-form nature of the employment equations should be recalled. Moreover, the investment equations pointed to very weak substitution effects.

Looking ahead, it is also worth recalling the dominating influence of the accelerator mechanism since it implies that, ceteris paribus, stronger output growth will be accompanied by higher investment. Moreover, in several countries a rise in capacity utilisation rates would have a sizable effect on employment. Nonetheless, the estimated equations should not be interpreted as giving unqualified support to more expansionary policies. In the first place, faster output growth accompanied by higher real wages and falling profit shares would entail a significantly weaker investment trend than if real wages remained constant. Secondly, higher real wages tend to reduce the level of employment supported by a given capital stock, and even for moderate real wage increases the rise in investment required to offset the negative real wage effects could go well beyond historical trends. Consequently, even though the empirical results reported in this paper do not support the view that the recent weak growth of investment and capital stocks can mainly be ascribed to excessive real wages, they do point to continued real wage moderation as a sine qua non for a sustainable rise in output and employment.

Footnotes

* I am indebted to J. Bispham, G. Bingham and H. Bernard for many useful comments on an earlier draft of this paper. I also wish to thank H. Duffy for her expert and patient typing and S. Arthur for drawing the graphs.

1 See OECD (1985), EEC (1985), BIS (1986) and Modigliani et al. (1986). According to the second source, 80 per cent. of unemployment in Europe in 1985 could be ascribed to developments in factor prices and capital stocks.

2 The countries were chosen on the basis of capital stock data availability.

3 This is clearly a simplistic measure of real interest rates, but alternative definitions produced only minor changes in the estimates reported in Section II below. Nonetheless, the graphs are not intended to analyse the conditions for a "golden-rule growth path".

4 Since most of the stock oriented investment theories are based on the net capital stock, this particular assumption may seem rather odd. It can be argued, however, that the gross stock is the most appropriate measure of output capacity, since equipment or structures continue to provide services until they are physically removed, though at a declining rate owing to decay and probably also less efficiently on account of higher input requirements and technical obsolescence. Moreover, gross stocks are more comparable internationally, as differences in national accounting procedures are partly removed. Finally, there is some evidence that firms do not gradually depreciate structures but write them off as they are scrapped [see Coen (1975)].

5 This difference, as well as the notation used, may be illustrated by the following example concerning stocks of equipment (1975 prices) in the United Kingdom:

	1978	1979	1980
	(in billions of pounds sterling)		
K_g	161.7	167.4	173.7
K_n	95.3	98.3	101.2
I_g		10.7	11.0
$I_n = dK_n$		3.0	2.9
Depreciation = $I_{dr} = I_g - I_n$		7.8	8.1
Replacement investment = $I_r = I_g - dK_g$		5.0	4.7

Source: Flows and Stocks of Fixed Capital, OECD, Paris 1983.

I_g is gross business fixed investment as defined in the national accounts, and I_n is I_g less depreciation which is usually measured assuming a fixed service life and a linear or geometric decay. I_n also corresponds to changes in the net capital stock (dK_n) whereas dK_g, refers to changes in the gross stock and is the measure used in the graphs and in the empirical estimates. As shown in the last line the difference between dK_g and I_g equals replacement investment, denoted by I_r. In conditions of a smoothly growing capital stock, depreciation in a given year t exceeds replacement investment of the same year and for the same reason the level of the gross stock will exceed that of the net stock. Assuming a service life of n years and linear decay, depreciation is determined as

$$\sum_{t-n}^{t} n^{-1} I_i \text{ with } I_i < I_{i+1}.$$

Replacement investment, on the other hand, corresponds to investment in year t-n, which is smaller than the average of investment during the period t-n to t.

6 An additional complication is that accelerated scrappings without replacement may have produced a large but unrecorded decline in capital stocks. Estimates of scrappings and their implications for capacity utilisation rates are, however, subject to a very wide margin of uncertainty [see Wadhwani and Wall (1986)] and we shall not pursue this issue any further.

7 Interested readers will find extensive reviews in Jorgenson (1971), Clark (1979), Kopcke (1982) and Artus and Muet (1984).

8 The origin of the q-theory can be traced to work by Wicksell and Keynes, and it was first tested empirically on individual firms by Grunfeld (1960). The present form is usually associated with various studies by Tobin [see Brainard and Tobin (1968) and Tobin (1969)].

9 Eisner and Strotz defined total costs (A) as:

$$A : f(K^* - K) + g(K - K_{-1}) \qquad \text{where}$$

f( ) = costs associated with being out of equilibrium and
g( ) = costs associated with changing the capital stock.
If both f( ) and g( ) are quadratic, A may be written:

$$A = a(K^* - K)^2 + b\,(K - K_{-1})^2,$$

and minimising A with respect to K yields

$$dK = (a/(a-b))(K^* - K_{-1}) ;$$

i.e. the partial adjustment scheme as given in equation (i) below.

10 As noted by Hickman and Coen (1970), some efficiency gains may also be obtained by using a two-step estimation procedure which takes account of the different lags in employment and investment functions. By first estimating an employment function and using this to identify the parameters of the production function, the latter may be imposed on the investment function estimated at the second stage. The extension of simultaneous models to include financial investment is less frequent, partly because it requires estimating investment in nominal terms [see Anderson (1981)] and partly because the alternative investment possibilities may be captured by the opportunity costs of real investment.

11 Clarke (1979), Kopcke (1982) and von Fürstenberg (1977) compare the explanatory power of various US models while the autocorrelation problem may be seen from the results reported in Abel (1980), Hayashi (1982) and Summers (1981).

12 Different versions of the flexible accelerator model were first proposed by Chenery (1952) and Koyck (1954).

13 Strictly speaking this approximation only holds for linear equations, but in the empirical section we shall present results for both linear and log-linear specifications. It should also be noted, that the same form may be obtained by an adaptive expectation scheme for expected output or by a cost adjustment model (cf. note 9 above). As to $\bar{Y}$, investment may alternatively be expressed as a distributed lag function of the level or the rate of change [see, for instance, Clark (1979) and Kopcke (1982)].

14 I.e. factor substitution may be very limited for individual firms, but when aggregating across firms and sectors, some sensitivity of factor proportions to relative factor prices is likely to be observed.

15 The discussion of dominating constraints and the associated regimes is mostly found in labour market analysis and in the specification of labour demand functions. It is, however, also applicable to the demand for other production factors, including capital. As noted in Poret (1986), a relationship between investment, output and relative factor prices will exist under both a classical and a Keynesian regime, but can only be regarded as a behavioural equation in the latter case. Except for the COSMOS model [see Dramais (1986)], investment equations estimated on classical assumptions mostly yield very poor empirical results [see Artus and Muet (1984)]. At the same time, the use of industry surveys for predetermining the regimes and subsequently estimating an aggregate equation including both Keynesian and classical factors has met with some success for France [Poret (1986)] and, in particular, Belgium [Mulkay (1984)]. Coen (1971) adopts a classical regime and suggests that output may enter firms' investment decisions via short-term adjustment costs. However, the estimated equation, based

on output and relative factor prices, is indistinguishable from an equation derived for a Keynesian regime.

16 This is most clearly seen in Artus' (1981) formulation. Using k to denote the optimum capital output ratio, a gross investment function based on a putty-putty production structure can be written:

$$I_{gt} = k_t Y_t - k_{t-1}(1-\delta)Y_{t-1}$$

while for a putty-clay structure the corresponding function is:

$$I_{g,t} = \hat{k}_t \,(Y_t - (1-\delta)Y_{t-1})$$

where $\hat{k}_t$ is the marginal capital output ratio applying only to gross investment in period t.

17 The following explanation draws on Slemrod (1986).

18 See, for instance, Duisenberry (1958), Meyer and Kuh (1958) and Eisner (1978). More recent contributions include van Sinderen (1985), Driehuis (1986) and Deutsche Bundesbank (1986). In several investment equations for France the availability of external finance has been found to play a similar role [see Barroux and Sicsic (1985)] while a comprehensive study of Finnish investment [Koskenkylä (1985)] reports strong cash-flow effects in conditions of imperfect capital markets.

19 In assessing this result, it is helpful to recall Blanchard's (1986) observation that:

> "it is well known that to get the user cost to appear at all in the investment equation, one has to display more than the usual amount of econometric ingenuity, resorting most of the time to choosing a specification that simply forces the effect to be there" (p.153).

20 Returning to equation (v) and assuming that the underlying production structure can be described by a Cobb-Douglas function:

$$Y = A\, K^{\alpha} L^{\beta} e^{rt}$$

cost minimisation would yield the following expression for the desired capital stock:

$$K^* = Y^{\frac{1}{\alpha+\beta}} (W/c)^{\frac{\beta}{\alpha+\beta}} (\beta/\alpha)^{\frac{\beta}{\alpha+\beta}} (A.e^{rt})^{-\frac{1}{\alpha+\beta}}$$

so that in equation (v) $a = 1/(\alpha+\beta)$ and $b = \beta/(\alpha+\beta)$. Note, however, that for a linear specification with the real cost of capital (see p.8) a will be close to α.

21 Readers are referred to Bean (1981) for a more rigorous test procedure.

22 See Coen (1971), Artus and Muet (1984) and Koskenylä (1985). Stevens (1986) provides a theoretical discussion of this case, showing that when

borrowing costs are a positive function of either the level of debt or the debt/asset ratio, net profits will influence the speed of adjustment in a neoclassical investment function.

23 To save space the coefficients with respect to interest rates, tax rates and profits were multiplied by 100 in the log-linear versions in Tables 1-7, whereas in Table 8 the actual elasticities are given. Moreover, since real interest rates may be negative and variables in ratio form should be entered in a consistent manner, PRS, TRATE and RINT were included as absolute values in both the log-linear and the linear equations.

24 The LM-statistic is calculated by regressing the residuals of the initial equation on the original determinants plus residuals lagged up to p years. The R^2 of this regression multiplied by the number of observations has an X^2-distribution, and the column headed LM gives this number for the equation tested. On the assumption that most cycles last 4-5 years, the LM-test was carried out for p = 4.

25 Denoting forecast errors by FE and the standard error of the estimated equation by SE, Z_1 is calculated as

$$\sum_{1}^{n} \left(\frac{FE}{SE} \right)_i^2$$

where n is the number of years for which forecasts are made and Z_1 itself has an X^2-distribution. Because SE appears in the denominator, Z_1 tests the relative rather than the absolute accuracy and may be biased against equations with a very high R^2. For further explanation see Davidson et al. (1978).

26 This finding is strongly at odds with alternative estimates for the United States, which, mostly using a neoclassical investment function, find very significant and negative real interest rate effects. One explanation for this discrepancy may be that interest rates were entered as a separate variable, while, as mentioned earlier, the neoclassical function combines interest rates with tax variables and/or real output. Secondly, it might be noted that when various measures of real interest rates were tested, the coefficient was always positive and, except, for the real cash flow, all other variables remained significant. Shapiro (1986) discusses the conditions under which investment and real interest rates are likely to be positively correlated, and his model, though entirely different from the one used in this paper, also yields a non-significant interest rate effect.

27 Further tests showed that the absence of profit share effects in Japan and Germany is not related to the trend term nor due to an inappropriate measure of the profit share. When the trend term was suppressed and the profit share corrected for changes in the ratio of employees to total employment, the coefficients obtained remained insignificant in both the INV and the dK equations.

28 The poor forecasting performance is mainly due to an underestimate of the real cash flow effect when the sample period is confined to 1960-80. Influenced by the tax measures of 1981, real cash flows rose substantially over the period 1981-85.

29 See for instance Artus (1980).

30 A log-linear EFE specification is also supported by Bean (1981) for the manufacturing sector.

31 Since the adjustment coefficients are derived from the partial adjustment equations, which were often rejected by the data, they should be used with caution.

32 See Feldstein and Jun (1986), who report significant tax effects using the equation

$$dK/GNP = a + bRN_{-1} + c\ CU$$

where CU is the rate of capacity utilisation and RN a rate-of-return variable including the various fiscal changes. For a contrary view see Bosworth (1985), Akhtar and Sahling (1985), and Slemrod (1986).

33 National studies [in particular Courbis (1980)] have also ascribed a significant effect to profits.

34 A study by the Bundesbank (1986) reports a large and positive effect of the recent improvement in profit conditions on investment. The study, however, does not take separate account of the impact of more favourable output conditions.

35 For Sweden, CU indicates the proportion of firms which, in business surveys, report full capacity use. For the United States, Germany, France and Canada, CU refers to the proportion of capacities in use, and CU for Japan is defined in a similar way but presented as an index. For the United Kingdom, CU is representative of the whole economy and calculated as the ratio between actual GNP and potential GNP, given in Layard and Nickell (1986).

36 Sneessens and Dreze (1986) derive a similar expression for a cost-minimising firm except that W/P is replaced by W/c. The dependence on the nature of technical progress is easy to prove for a Cobb-Douglas function. However, since this issue is not the subject of this paper and Newell and Symons found no significant coefficient for the time trend, the proof is being left out.

37 The capital stocks may be disaggregated into equipment and structures, and for all countries - most particularly for the United States - the share of equipment has increased over time. This has contributed to a rise in depreciations and reinvestment but does not necessarily imply a rise in embodied labour-saving technical progress.

38 The "limiting" factor is the relatively short time series on CU. The number of observations range from 25 in the United States to 15 in Germany and Sweden.

39 Without the lagged dependent variable, the equation suffered from a high degree of autocorrelation, and the possibility cannot be excluded that the equation adopted is mis-specified. For Germany, too, the initial equation was subject to autocorrelation, but the first-order auto-correlation coefficient was only 0.15, and the correction (by the Corchran-Orcutt procedure) had only a marginal effect on the parameters.

40 This is partly due to the small employment effect of changes in CU. The EFE equations imply h-values of around 2/3 for both the United States and Japan and long-run elasticities well below those of the United Kingdom.

41 For the United Kingdom this assessment is in line with recent results reported by Layard and Nickell (1986), while for Canada Ashenfelter and Card (1986) find that current unemployment rates are exceptionally high, given developments in output.

42 Hamada and Kurosaku (1984) find that the Okun coefficient for Japan is around 28 (though rather unstable) compared with only 2.5-3.0 for the United States.

Bibliography

Abel, A.B. (1980): "Empirical Investment Equations", Journal of Monetary Economics, pp. 39-72, Supplement Volume 12.

Akhtar, M.A. and Sahling, L.G. (1985): "What is behind the Capital Spending Boom?", Quarterly Review of the Federal Reserve Bank of New York, Winter, pp. 19-30.

Anderson, G.J. (1981): "A New Approach to the Empirical Investigation of Investment Expenditure", Economic Journal, pp. 88-105.

Artus, P. (1980): "La demande effective d'investissement et la forme de la fonction de production", Annales de l'INSEE, pp. 196-205.

Artus, P. and Muet, P. (1984): "Un panorama des développements récents de l'économétrie de l'investissement", Revue Economique, pp. 791-830.

Ashenfelter, O. and Card, D. (1986): "Why have unemployment rates in Canada and the United States diverged?", Economica, pp. 71-94.

Bank for International Settlements (1986): Annual Report.

Barroux, Y. and Sicsic, P. (1985): "Les taux d'intérêt dans le modèle de la Banque de France", Cahiers Economique et Monétaire, No. 25, pp. 221-235, Banque de France, Paris.

Bean, C.R. (1981): "An Econometric Model of Manufacturing Investment in the United Kingdom", Economic Journal, pp. 106-123.

Bischoff, C.W. (1971a): "Business Investment in the 1970s: A Comparison of Models", Brookings Papers on Economic Activity, pp. 13-58.

Bischoff, C.W. (1971b): "The Effect of Alternative Lag Distributions" in Gary Fromm (ed.) Tax Incentives and Capital Spending, Brookings Institution, pp. 61-125.

Blanchard, O.J. (1986): "Comments on Investment, Output and the Cost of Capital", Brookings Papers on Economic Activity, pp. 153-158.

Bosworth, B.P. (1982): "Capital Formation and Economic Policy", Brookings Papers on Economic Activity, pp. 273-327.

Bosworth, B.P. (1985): "Taxes and the Investment Recovery", Brookings Papers on Economic Activity, pp. 1-47.

Brechling, F. (1974): "Monetary Policy and Neo-classical Investment Analysis" in Johnson and Nobay (eds.) Issues in Monetary Economics, Oxford University Press.

Ciccolo, J.H. and Fromm, G. (1979): "q and the Theory of Investment", Journal of Finance, pp. 535-564.

Clark, P.K. (1979): "Investment in the 1970s: Theory, Performance and Prediction", Brookings Papers on Economic Activity, pp. 73-113.

Chenery, H.B. (1952): "Overcapacity and the Acceleration Principle", Econometrica, pp. 1-28.

Chirinko, R.S. and Eisner, R. (1983): "Tax Policy and Investment in Major US Macroeconomic Models", Journal of Public Economics, pp. 139-166.

Coen, R.M. and Hickman, B.G. (1970): "Constrained Joint Estimation of Factor Demand and Production Functions", Review of Economics and Statistics, pp. 287-300.

Coen, R.M. (1971): "The Effect of Cash Flow on the Speed Adjustment", in Gary Fromm (ed.) op. cit. pp. 131-195. Coen,

R.M. (1975): "Investment Behaviour, the Measurement of Depreciation and Tax Policy", American Economic Review, pp. 59-75.

Corcoran, P.J. and Sahling, L.C. (1982): "The Cost of Capital: How high is it?", Quarterly Review of the Federal Reserve Bank of New York, Summer, pp. 23-31.

Courbis, R. (1980): "La détermination de l'équilibre général en économie concurrencée, Monographies du Séminaire d'Econometrie, Paris.

Davidson, J., Hendry, D., Srba, F. and Yeo, S. (1978): "Econometric modelling of the aggregate time series relationship between consumers' expenditure and income in the United Kingdom", Economic Journal, pp. 661-692.

Deutsche Bundesbank (1986): "Die Bedeutung der Ertragsverhältnisse der Unternehmen für Investitionen und Beschäftigung", Monatsbericht, April, pp. 17-24.

Dramais, A. (1986): "Compact - A proprotype macroeconomic model of the European Community in the world economy", European Economy, No. 27, pp. 111-160.

Driehuis, W. (1986): "Unemployment in the Netherlands, 1960-83", Economica, Special Issue, pp. 297-312.

Duisenberry, J.S. (1958): Business Cycles and Economic Growth, McGraw-Hill, New York.

Eisner, R. (1978): Factors in Business Investment, National Bureau of Economic Research, General Series No. 102.

European Economic Community (1985): Economic Review, November.

Feldstein, M.S. and Foot, D.K. (1971): "The Other Half of Gross Investment: Replacement and Modernisation Expenditures", Review of Economics and Statistics, pp. 49-58.

Feldstein, M.S. and Rothschild, M. (1974): "Towards an Economic Theory of Replacement Investment", Econometrica, pp. 393-423.

Feldstein, M. (1982): "Inflation, tax rules and investment: Some Econometric Evidence", Econometrica, pp. 852-862.

Feldstein, M.S. and Jun, J. (1986): "The Effects of Tax Rules on Non-residential Fixed Investment: Some Preliminary Evidence from the 1980s", National Bureau of Economic Research, Working Paper, No. 1857.

Griliches, Z and Wallace, N. (1965): "The Determinants of Investment Revisited", International Economic Review, pp. 311-329.

Grunfeld, Y (1960): "The Determinants of Corporate Investment" in A.C. Harberger (ed.), The Demand for Durable Goods, Chicago University Press.

Hall, R.E. and Jorgenson, D.W. (1971): "Application of the Theory of Optimal Capital Accumulation", in Gary Fromm (ed.) op. cit., pp. 9-59.

Hall, R.E. (1977): "Investment, Interest Rates and the Effects of Stabilisation Policies", Brookings Papers on Economic Activity, pp.61-123.

Hamada, K. and Kurosaka, Y. (1984): "The Relationship Between Production and Unemployment in Japan", European Economic Review, pp. 71-94.

Hayashi, F. (1982): "Tobin's marginal q and average q: A neoclassical interpretation", Econometrica, pp. 213-224.

Helliwell, J., Sturm, P., Jarrett, P. and Salou, G. (1985): "Aggregate Supply in Inter-link: Model Specification and Empirical Results", OECD Working Paper, No. 26.

Jenkinson, N.H. (1982): "Investment, Profitability and the Valuation Ratio", Bank of England, Discussion Paper, No. 17.

Jorgenson, D.W. (1963): "Capital Theory and Investment Behaviour", American Economic Review, pp. 247-259.

Jorgenson, D.W. (1971): "Econometric Studies of Investment Behaviour: A Survey", Journal of Economic Literature, pp. 1111-1147.

Kopcke, R.W. (1982): "Forecasting Investment Spending", New England Economic Review, November-December, pp. 13-33: The Performance of Statistical Models.

Koyck, L.M. (1954): Distributed Lags and Investment Analysis, North-Holland, Amsterdam.

Koshenkylä, H. (1985): Investment behaviour and market imperfections with an application to the Finnish corporate sector, Bank of Finland, Series 13.38.

Meyer, J. and Kuh, E. (1958): The Investment Decision, Harvard University Press, Cambridge, U.S.

Modigliani, F., Monti, M., Drèze, J., Giersch, H. and Layard, R. (1986): "Reducing unemployment in Europe: the rôle of capital formation", Report of the CEPS Macroeconomic Policy Group, Economic Papers, No. 47, EEC, Bruxelles.

Mulkay, B. (1984): "Function d'investissement néo-classique dans un modèle macro-économique avec rationnement", Recherches Economiques de Louvain, pp. 247-276.

Nadiri, M.I. and Rosen, S. (1969): "Interrelated Factor Demand Functions", American Economic Review, pp. 457-471.

Nerlove, M. (1972): "Lags in Economic Behaviour", Econometrica, pp. 221- 52.

Newell, A. and Symons, J. (1985): "Wages and employment in the OECD countries", Centre for Labour Economics, London School of Economics, Discussion Paper No. 219.

OECD (1985): Economic Outlook, December.

Poret, P. (1986): "Econométrie de l'investissement et enquêtes de conjunctures", Economie et Prévisions, Ministère de l'Economie, des Finances et de la Privatisation, Paris.

Shapiro, M.D. (1986): "Investment, Output and the Cost of Capital", Brookings Papers on Economic Activity, pp. 111-152.

Slemrod, J. (1986): "Taxation and Business Investment" in P. Cagan (ed.) Essays in Contempory Economics, American Enterprise Institute.

Sneessens, H.R. and Drèze, J.H. (1986): "A Discussion of Belgian Unemployment, Combining Traditional Concepts and Disequilibrium Econometrics, Economica, Special Issue, pp. 89-119.

Stevens, G.V.G. (1986): "Internal Funds and the Investment Function: Exploring the Theoretical Justification of Some Empirical Results", Special Studies Paper, No. 199, Federal Reserve Board, Washington.

Summers, L.H. (1981): "Taxation and Corporate Investment: A q-theory Approach", Brookings Papers on Economic Activity, pp. 67-141.

Tobin, J. (1969): "A General Equilibrium Approach to Monetary Theory", Journal of Money, Credit and Banking, pp. 15-29.

Tobin, J. and Brainard, W.C. (1977): "Asset Markets and the Cost of Capital", in B. Balassa and R. Nelson (eds.) Economic Progress, Private Values and Public Policy, Cowles Foundation Paper, No. 440, North-Holland, Amsterdam.

van Sinderen, J. (1985): "Some Major Causes of Developments in Dutch Business Investment", Ministry of Economic Affairs, Discussion Paper, No. 8503.

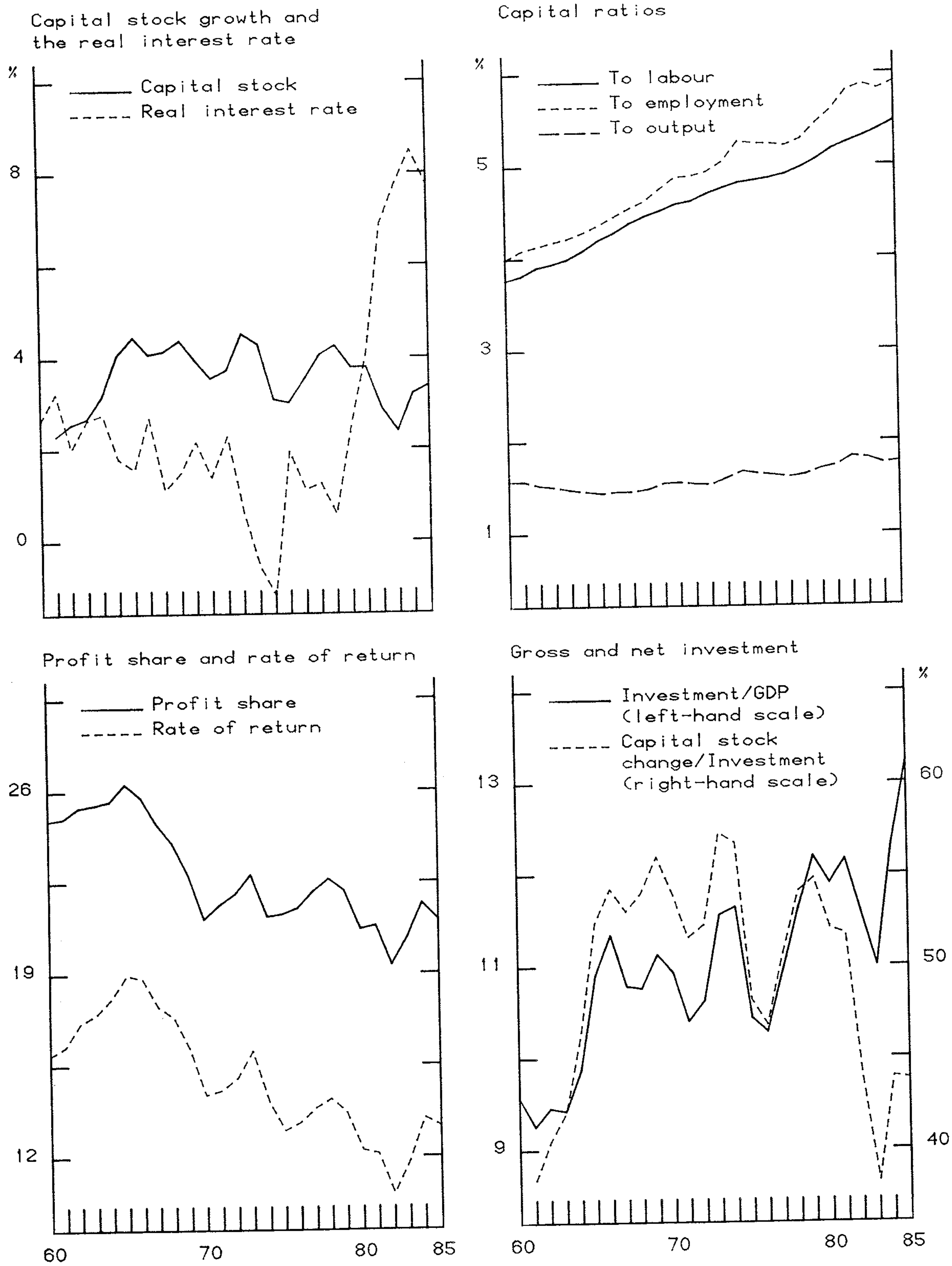
von Fürstenberg, G.M. (1977): "Corporate Investment, Does Market Valuation matter in the Aggregate?", Brookings Papers on Economic Activity, pp. 347-403.

Wadhwani, S. and Wall, M. (1986): "The UK Capital Stock - New Estimates of Premature Scrapping", Centre for Labour Economics, London of School of Economics, Discussion Paper, No. 245.

Yoshikawa, H. (1980): "On the q-theory of Investment", American Economic Review, pp. 739-743.

Graph 1 *

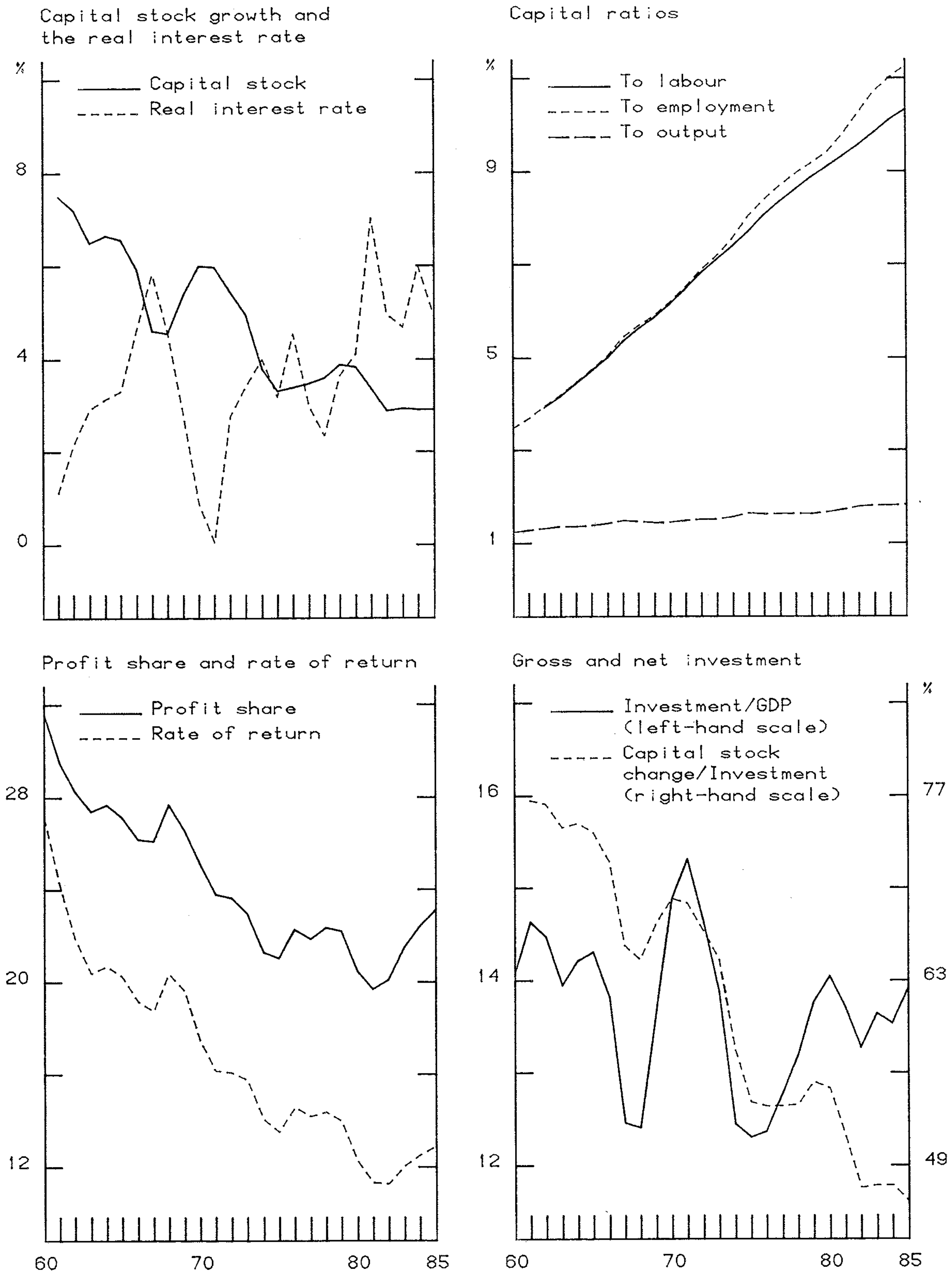
United States



* For explanations, see page 63.

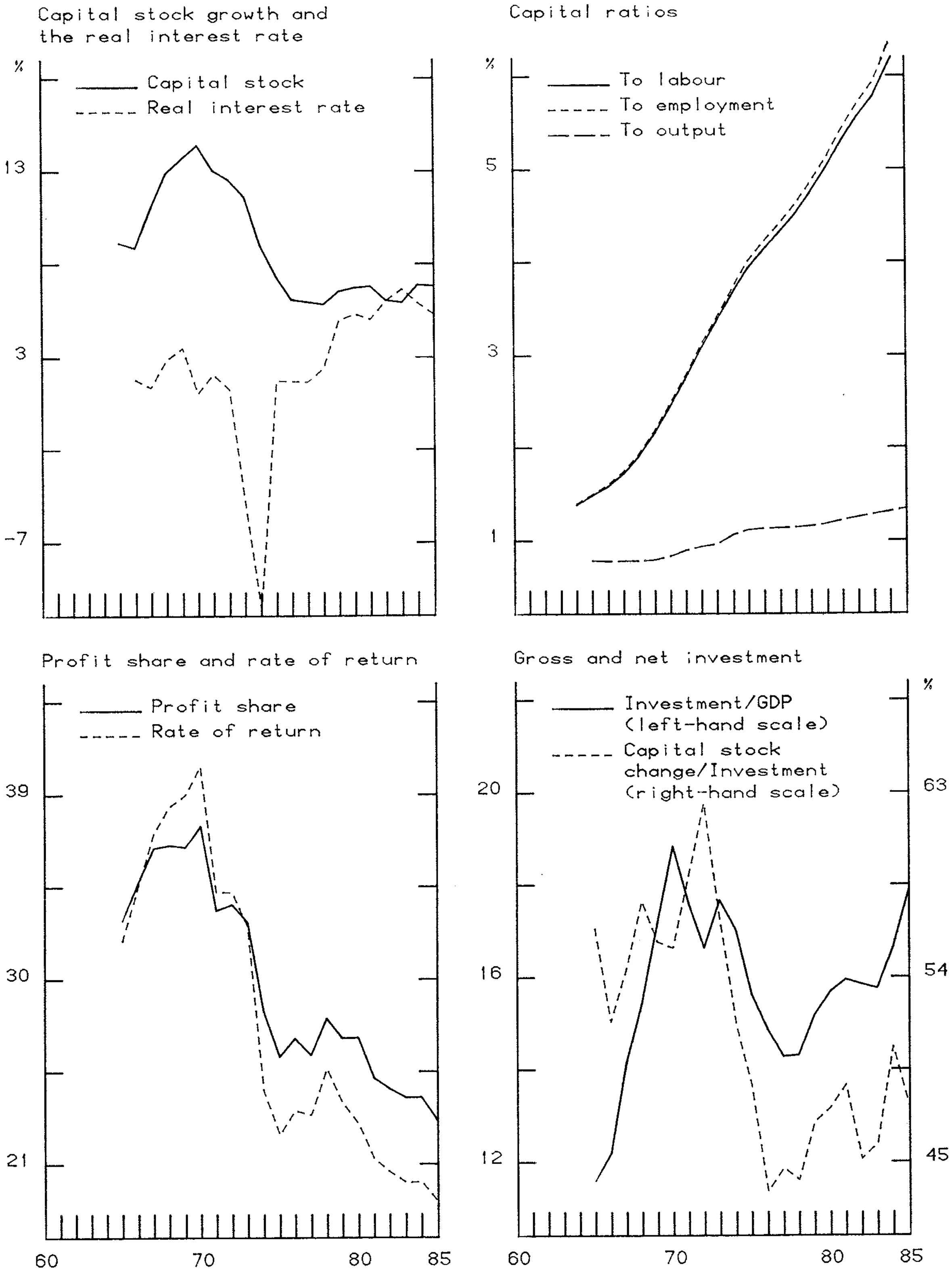
Graph 2

Germany



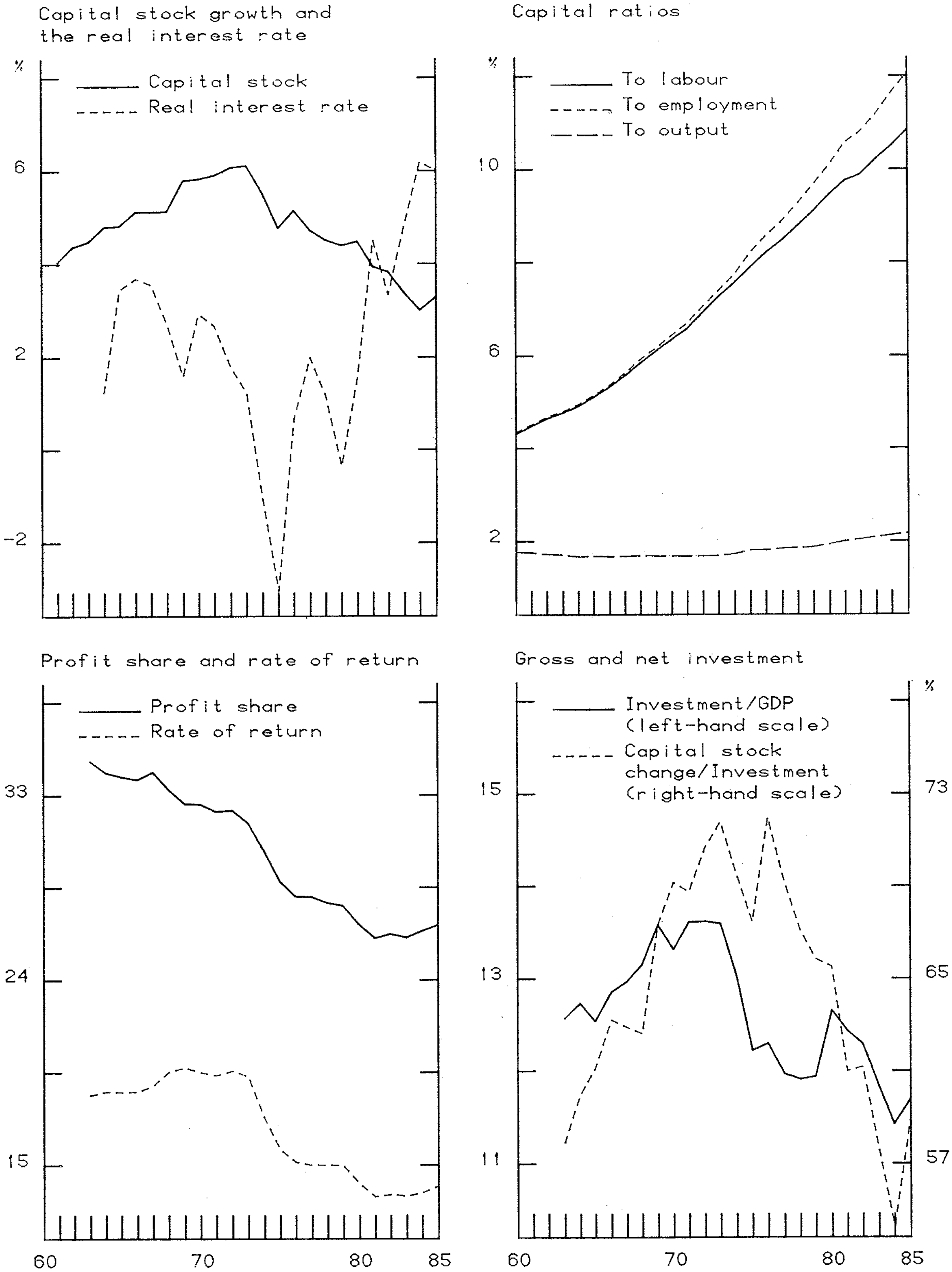
Graph 3

Japan



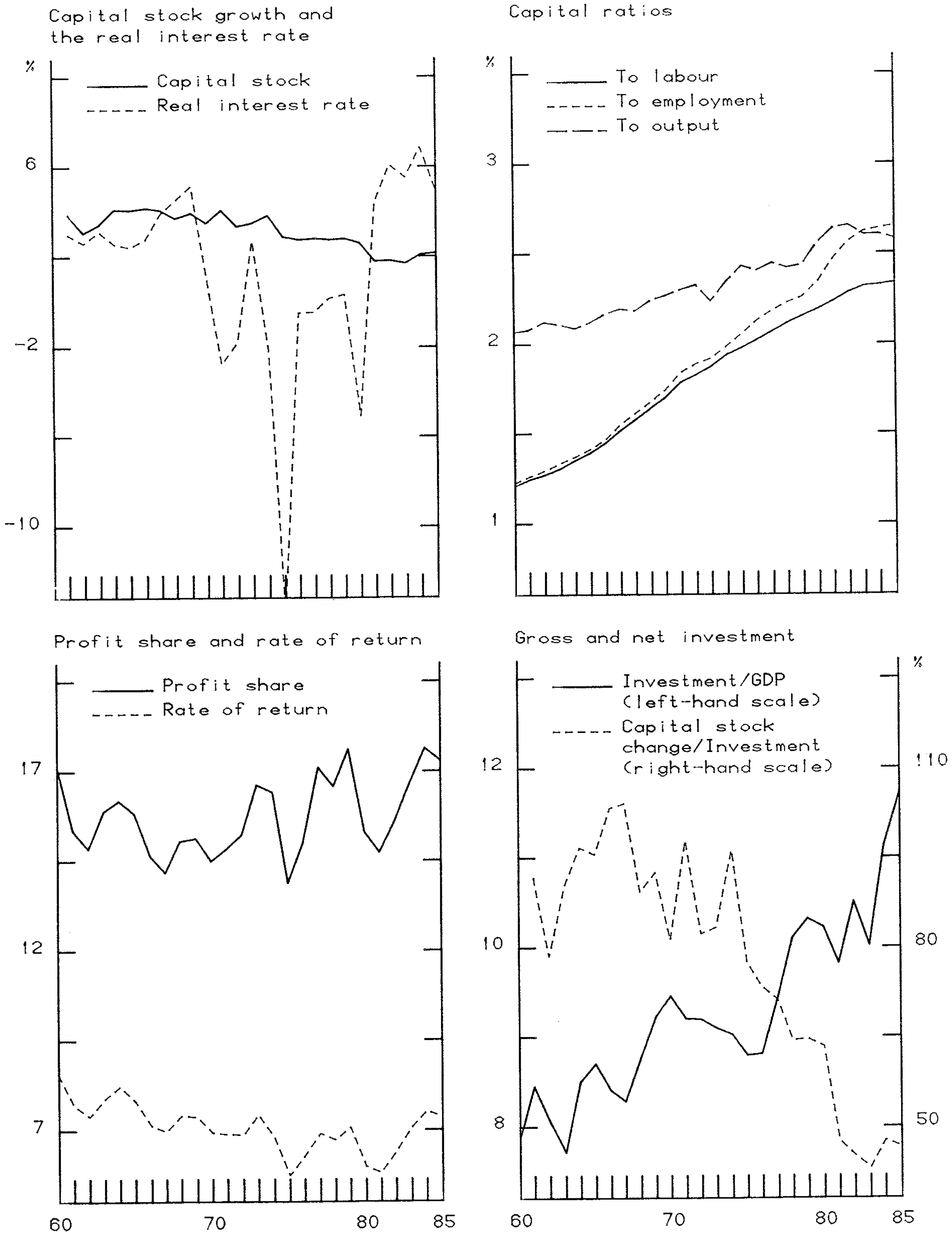
Graph 4

France



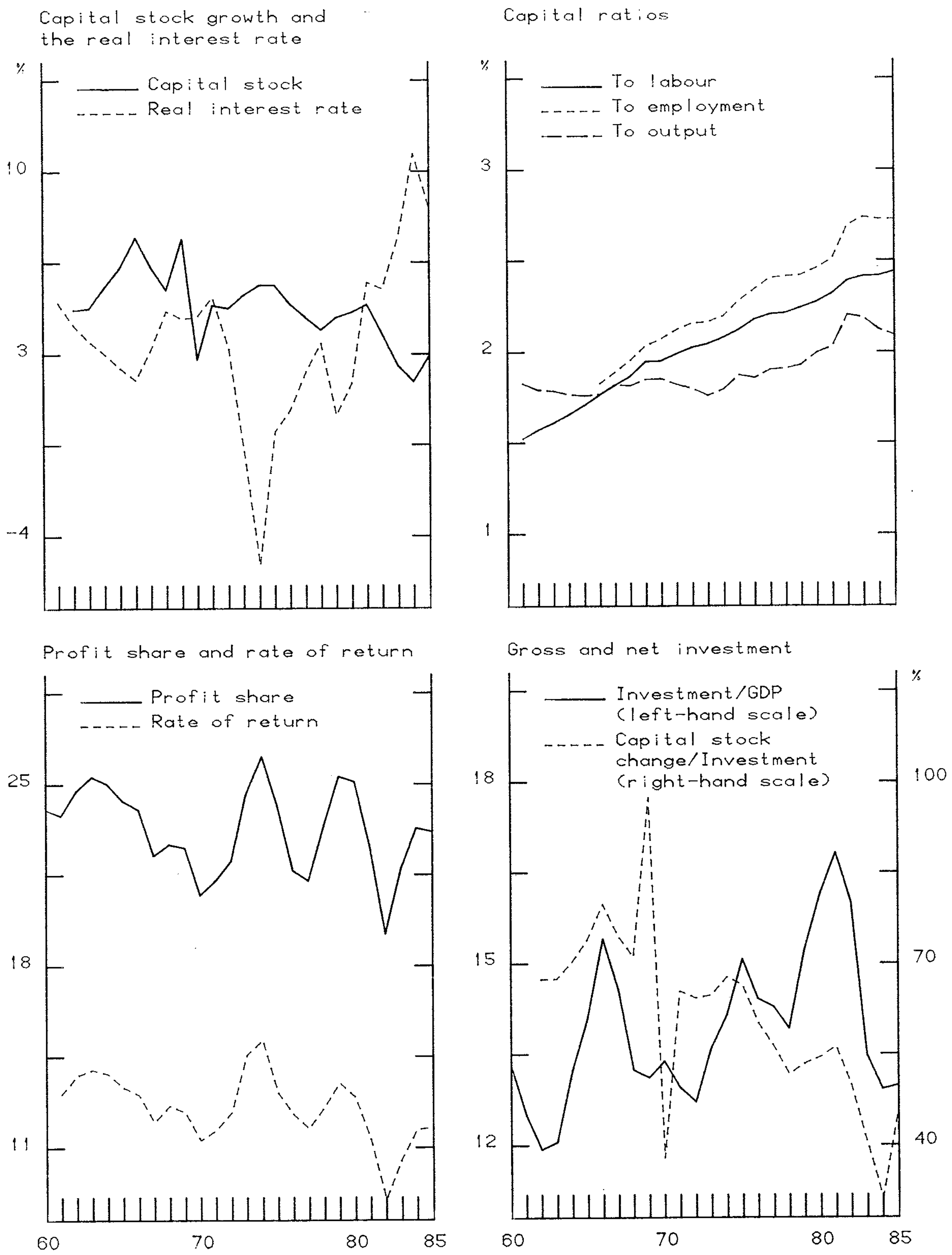
Graph 5

United Kingdom



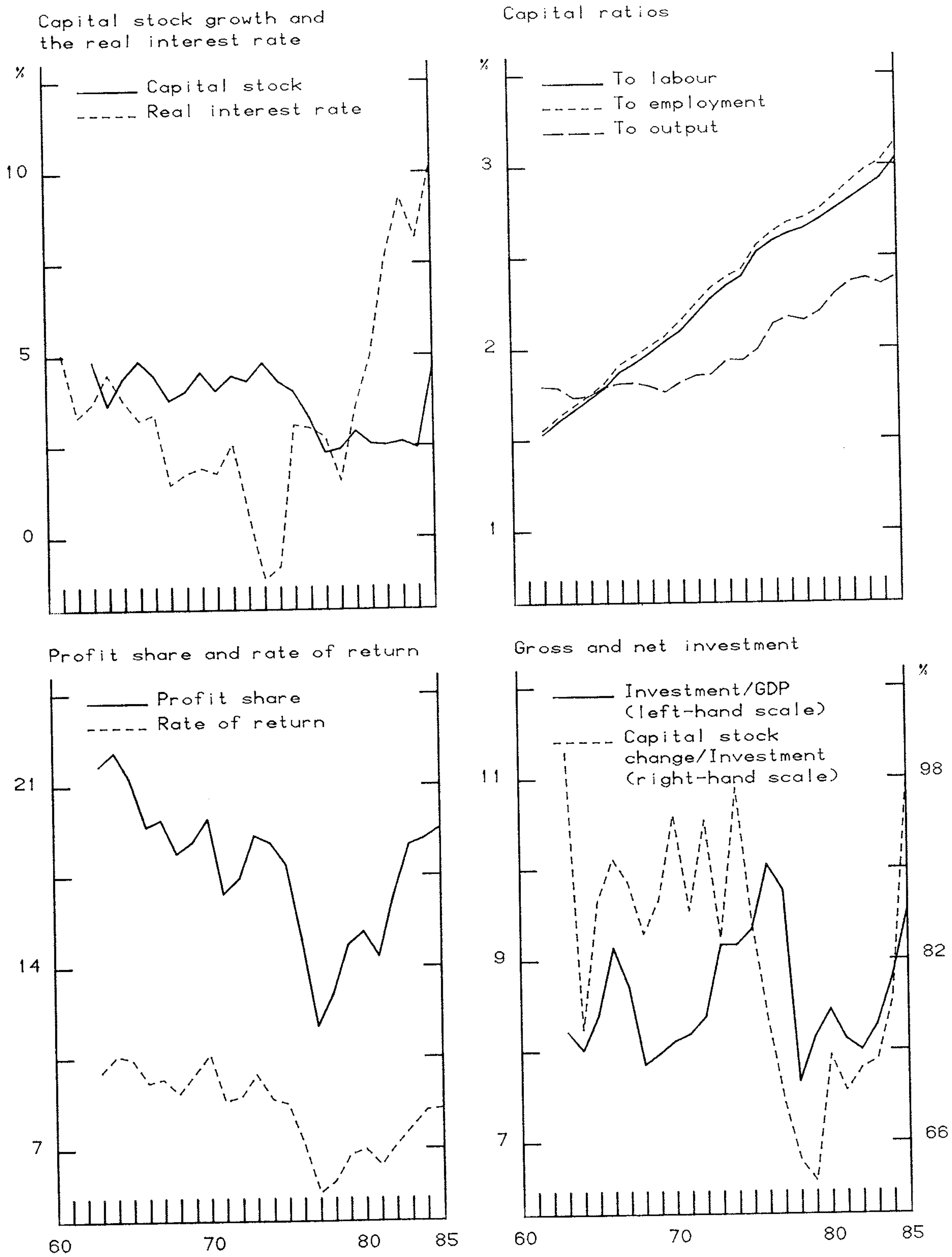
Graph 6

Canada



Graph 7

Sweden



Definitions and variables

1st Panel.

Capital Stock: Percentage change in gross capital stock, constant prices.

Real interest rate: Long term bond rate less current percentage change in GDP-deflator.

2nd Panel.

Capital ratios: Gross capital stock relative to total labour force, total employment and GDP, respectively.

3rd Panel.

Profit share: Net operating surplus (national accounts definition) as a percentage of GDP in current prices.

Rate of return: Net operating surplus as a percentage of the gross capital stock in current prices.

4th Panel.

Investment/GDP: Gross business fixed investment as a percentage of GDP, constant prices.

Capital stock change/investment: Change in gross capital stock as a percentage of gross business fixed investment, constant prices.