THE INFLUENCE OF UNCERTAINTY ON INVESTMENT IN THE UK: A MACRO OR MICRO PHENOMENON?[1]

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Abstract

While the theory examining the relationship between uncertainty and investment has suggested new research avenues, it has not had strong predictive power. Nevertheless, at the policy level the benefits for investment of a more stable economic climate are being emphasised. These considerations point to the need for empirical work. Accordingly, this paper draws on industry level panel data, obtained by marrying the UK Census of Production with the CBI Industrial Trends Survey, and applies dynamic panel data methods to distinguish between macro and micro sources of uncertainty and to consider the role of financial factors. It is found that both sources of uncertainty exert a considerable negative impact on investment, while financial factors may be important in some industries.

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1. Introduction

Weak physical investment has characterised many countries in the European Union in the 1990s. At the same time, economists of a variety of persuasions are increasingly emphasising the causal links running from investment to output. We may mention here not just the endogenous growth theorists, but also those recognising the role played by investment in shaping the international competitiveness of economies and thereby influencing external constraints on growth. Attempts however to influence the rate of investment and capture any favourable spillover effects that may accrue requires an understanding of the determinants of investment. Here theoretical understanding has been enhanced by a new emphasis on the roles of uncertainty, irreversibility, and lumpiness in shaping the investment decision. But theoretical insights have lacked predictive power, and much work remains for empirical analysis. This paper contributes to the empirical picture by estimating investment functions using survey-based information at an industry level. These data are used to explain the rate of investment in UK manufacturing, a sector historically characterised by rates of investment which are low by international standards (for a discussion see Kitson and Michie 1996 or Temple 1997). While the use of survey data is subject to certain well known limitations, it does allow for the introduction of a direct expectational element into the analysis.

The paper addresses two broad questions relating to the role of uncertainty. First, how important has uncertainty been in explaining the poor investment performance of UK manufacturing? Second, is the uncertainty reported by survey respondents primarily of a "macro" nature - i.e. a reflection of the volatility of the whole economy - or is it of a more "micro" character, a result of uncertainty at a sectoral level? These questions are of particular interest given the recent policy emphasis on creating a stable macro environment and the favourable impact that such an environment may have for the underlying growth of productive potential.

Beyond the question of uncertainty, the method adopted in this paper also permits an examination of the role that financial factors play in the investment process, a possible influence which theoretical work on capital market imperfections has suggested may be much more important than traditional approaches have suggested.

The paper is arranged as follows. Section 2 examines some relevant developments in investment theory. Section 3 outlines the use of the Confederation of British Industry's (CBI) Industrial Trends Survey (ITS) in modelling uncertainty and financial effects on investment. Section 4 introduces the chosen specification. Section 5 discusses the results of the econometric analysis. Section 6 concludes.

2. Current Issues in Investment Theory

Recent theoretical literature has seen a renewed interest in the role of irreversibility and uncertainty in shaping the investment decision of profit maximising firms (for a fuller discussion than is possible here see Driver and Temple [1999]). Much of the literature has been concerned with understanding the dynamics of investment. An early result, establishing the relevance of an arbitrage condition for the investment decision, but in a situation of deterministic demand, was that continually falling investment costs (or a rising value of investment opportunities) would tend to delay investment in the absence of rivalry (Barzel 1968; see also Dixit and Pindyck 1994, p.138). More recently however, interest has focussed on stochastic demand. It is now well known, for example, that *irreversible* investment (undertaking an investment project entails sunk costs), combined with ongoing *uncertainty* (the future benefits or costs of the investment project are unknown, but this is partially resolved by additional information) and *time flexibility* (i.e. if the investment project is not undertaken today, the firm retains the option of undertaking the project tomorrow) may have a substantial impact on investment behaviour (Abel et al 1996).

The modern literature on the impact of uncertainty complements the traditional view that increased uncertainty will raise the investment of a risk-neutral competitive firm, unless substitutability between factors is very high, because marginal profit is convex in the uncertain variable (Hartman, 1972, 1976; Abel, 1983,1985).[2] However this finding is modified by irreversibility and imperfectly competitive conditions (Bertola, 1988; Pindyck, 1988; Dixit and Pindyck, 1994); if for example a risk neutral, monopolistic firm cannot dispose of installed capital, increased uncertainty may reduce current investment

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2 It should also be noted that even in perfect competition, the traditional convexity result only applies in the case of a risk neutral firm and may be reversed under risk aversion (Aiginger 1987, Pleeter and Horowitz 1974, Nickell 1978, Saltari and Travaglini 1999, and Nakamura 1999). Furthermore in models with capacity rationing or excess capacity, and as is natural with stochastic demand, the traditional results may again be reversed (Driver et al 1996a).

since the option value of waiting is increased.[3] For the case of price-taking firms, the former (convexity) effect tends to dominate and the partial equilibrium effect is still for uncertainty to raise investment (Caballero 1991; see also Abel and Eberly 1993 and 1994). However, Pindyck (1993) has criticised this result showing that with free entry the expected price changes in response to market demand shocks; a mean preserving spread in the stochastic term in market demand reduces the expected value of price in later periods because new entry will occur under favourable demand.[4]

It can therefore be seen that theoretical work does not lead to any clear-cut conclusions regarding the impact of investment, so that the importance of uncertainty is clearly an empirical matter. In the main, research that has tried to evaluate the issue empirically has found a negative effect for uncertainty (Caballero and Pindyck 1993, Pindyck and Solimano 1993, and Ferderer 1993a,b). For the U.K., despite the different theoretical framework and measure of uncertainty, both Driver and Moreton (1991) and Price (1995) conclude that more uncertainty leads to less investment. Finally Alesina and Perotti (1993) established a negative correlation between social and political instability and investment.

It seems clear that the issue needs to be studied at a more dis-aggregated level. This is partly because uncertainty may actually arise at a firm specific - or industry specific - level, but also because existing theory suggests that uncertainty has quite different implications for different industries, depending, for example, on different degrees of irreversibility or on market structure as discussed above. These of course are issues which the aggregate models of investment are incapable of addressing. Available papers, which do approach the issue at a micro level, include those by Leahy and Whited (1996), Driver *et al* (1996b) and Guiso and Parigi (1999). In these cases, uncertainty has a significant negative effect on firm's investment. To complement these studies, it is one of the key objectives of the current paper to distinguish between macro and micro sources of uncertainty, a distinction which we believe to be of considerable relevance from a policy perspective given the emphasis currently given to the advantages of a stable macro-economy. Our plan is to pursue a micro level approach which explicitly considers

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3 The combination of different forms of adjustment costs with option theory models makes it even more difficult to obtain unambiguous prediction concerning the uncertainty-investment relationship (Hammermesh and Pfann 1996; Pindyck 1991).

4 Leahy (1993) generates the result that competition is irrelevant to the decision to delay; competition reduces the value of the option by reducing the value of the investment. Thus the trigger value is the same for the firm that ignores competitors as for those that consider them.

"unobservable expectations", following a suggestion made recently by Chirinko (1996): "Expectations of the future are important, perhaps paramount, in determining investment expenditures. Complicated models - regardless of their descriptive accuracy- will not make substantial progress in improving understanding of investment behaviour unless they deal adequately with unobservable expectations". Our approach to this problem is to use direct measures of expectations from CBI survey data, which we now consider in more detail.

3. The CBI Industrial Trends Survey

The Industrial Trends Survey (ITS) of the CBI (and its forerunner, the Federation of British Industry) has been producing data on the current state of opinion in UK manufacturing since 1958. Of particular interest in the current context is question 16 of the ITS, for which data exists, on a quarterly basis since 1979. Part C of the question invites respondents to consider which factors, including uncertainty about demand, are "expected to limit capital expenditure authorisations over the next twelve months". Available replies are:

- inadequate net return on proposed investment (CBI16CA);
- a shortage of internal finance (CBI16CB);
- an inability to raise external finance (CBI16CC);
- the cost of finance (CBI16CD);
- uncertainty about demand (CBI16CE);
- shortage of labour including managerial and technical staff (CBI16CF);
- other (CBI16CG).

It should be noted that respondents are able to give more than one of the above answers. The percentage replying positively to each of these possibilities we designate CBI16CA, CBI16CB, CBI16CC, CBI16CD, CBI16CE, CBI16CF, CBI16CG respectively. The set of questions can be regarded as constituting a relatively complete set of expected constraints which can be tested for explanatory power when entered in standard specifications. The information in these survey replies reflects a view of the investment process painted on a rather broader canvas than is common in economic theory. We may note here that the framework not only allows for the consideration of uncertainty but

also that it is based on imperfect competition and allows for capital market imperfections. It is therefore possible to estimate effects other than uncertainty, the possible influence of financial factors. Here, controversy dates from the famous Modigliani and Miller result (that the financing decisions of firms are essentially orthogonal to the investment decision) and which is based on arbitrage possibilities in perfect capital markets. While the list of possible violations to the assumptions of the Modigliani-Miller theorem is a substantial one, the literature has focused on the idea that capital structures reflect information asymmetries between management and owners and/or lenders. Typically, management may be expected to possess more information about the value of the firm's investments (and of their own efforts) than either debt or equity holders. Hubbard (1998) provides a comprehensive overview of the role of such capital market imperfections.

Figure 1 illustrates each of the possible survey answers for aggregate manufacturing for the period 1979-1998. The two most important replies in terms of percentages responding positively are Q16CA - an inadequate return, and Q16CE - uncertainty about demand. The former rose strongly in the period to the middle 1980s but has since stabilised. The demand uncertainty response shows something of a cyclical pattern, yet at no stage during the recovery of the 1990s has reported uncertainty diminished to the extent witnessed in the recovery of the 1980s. The remaining categories of reply appear less important, at least at this aggregate level. The percentage of firms being reported as being financially constrained remains relatively steady at around 20-25%, with only a mild cyclical influence, while the cost of finance features strongly only for very limited periods of tight monetary policy; external finance does not appear to be important at all.

[Figure 1 about here]

Of course there are often major problems in interpreting survey data – and this is one explanation of why more use has not been made of such evidence in empirical economics. In the present case we may point for example to the imprecision of answer CBI16CA – an inadequate net return on proposed investment; this would appear to cover aspects of both the expected profitability of an investment, the cost of finance, and possible risk premia. More important for this paper is the interpretation of answer CBI16CE – uncertainty about demand. It is quite possible that respondents may be giving this as a reason on the basis of low *expected* demand as well as on the basis of the *variability* of demand. Since we are

interested of course in the latter's impact on investment, it is necessary that we control as tightly as possible in our empirical analysis for the former factor. For this reason we make use of both a measure of real demand as well as a measure of capacity utilisation also drawn from the CBI survey. Most studies utilise question 4 of the CBI Survey to capture utilisation. However, previous work of ours has emphasised the ambiguity of this question (Temple and Urga 1997) and so we use Question 14 of the Survey which explicitly distinguishes between skilled labour (CBI14B) and capital (CBI14D) as factors limiting output over the following four months.

The CBI data is available for fifty industries; this allows us to consider the interaction between uncertainty and the degree of monopoly with the latter being measured by a standard concentration ratio obtained from ONS sources.

4. Modelling Approach

We now introduce our investment specification which includes the direct expectational series discussed in Section 3. Given the broad spectrum of answers possible in the ITS, we required a general specification. However, there is no single model in the literature which can be said to be truly general. Most models stemming from standard profit maximisation under constraints include variables in demand, relative prices and financial variables (Catinat et al 1987). A common specification is the standard Euler-type equation or equations based on solving the optimal control trajectory when convex costs of adjustment of fixed capital are assumed. These specifications can be modified to take account of financial constraints. Alternative specifications may be based on delivery lags without convex adjustment costs, threshold models based on fixed or discontinuous adjustment costs, or models based on real options theory. A fairly general specification (for which a derivation on the basis of an imperfectly competitive firm is considered in Appendix 1), is however as follows:

$$\ln(I) = h\ [\ln(W^e),\ \ln(P^e),\ \ln(Y^e),\ A^e,\ CF^e,\ FV^e,\ CU^e,\ \ln(PI^e),\ s^2_d\ ] \tag{1}$$

where:

      Superscript e denotes expected values

 I is the volume of investment

W is the real product wage per unit of labour input

P is the price of output

Y is real output (value added)

A is an index of technical progress

CF is cash flow.

FV are financial factors, such as real debt, interest rates and the market value of

the firm.

CU is the degree of capacity utilisation

PI is the price of investment goods relative to output prices

s^2_d is the variance in demand

Data on these variables were all available to us in some form, except for the technology term which is modelled by a time trend. The relative price and cash flow terms are taken from ONS sources (with expectations being captured by a lag structure). Cash flow (CF) is not directly available but a proxy available from official sources which we employ is gross value added less labour cost expressed as a proportion of gross value added; this we designate as PROF. The CU term and the remaining expected constraint terms, including the uncertainty term are represented by the various CBI series discussed in section 3. The details are given in Appendix 2.

In order to make use of the CBI data (which is only available for individual industries), we cannot estimate (1) using observations on individual firms. In any case, we believe a strong case can be made for investigation at the level of the industry. First, for manufacturing at least, the annual *Census of Production* (CoP) and other official industry level data provide annual observations at a quality level superior to that contained in company accounts. Note that this data source allows us to obtain reasonable measures of relative product wages and the relative price of investment goods at the level of the industry. Generally these can only be proxied at the level of the firm[5]. Second, and more importantly, it will still enable us to pursue our objective of distinguishing between micro and macro sources of

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5 Other influences on the cost of capital – namely interest rates and depreciation rates – we model by time dummies and industry fixed effects respectively. In the case of interest rates, there is also question 16CD in the CBI industrial trends survey asking respondents about the "cost of finance" as a factor limiting capital expenditure authorizations.

uncertainty. Existing studies of the role of uncertainty in UK manufacturing (Driver and Moreton 1991; Price 1995) are at an aggregate level and hence are incapable of drawing such a distinction. Our estimation strategy explicitly allows us to exploit cross sectional variation to estimate how much of the impact is derived from macro uncertainty - exchange rate instability, GDP or inflation volatility and so forth - and how much is attributable to more local factors.

As outlined in Section 2, a further objective in the estimation was to explore the links between industrial structure and uncertainty. It seems clear that while macro uncertainty is, to an extent, common across industries, at a micro-level both the extent of uncertainty, and its impact (in both size and sign), may differ, *inter-alia*, according to the degree of monopoly.

Our earlier discussion has pointed to the limitations as well as the richness of the ITS. Accordingly, we first consider a "core" model which makes no use of the ITS data on investment constraints, although it does include an ITS based measure of capacity utilisation (see above). We then consider the impact of the inclusion of the CBI Survey question 16 variables in their entirety.

Investigation of micro versus macro influences on investment is facilitated by dynamic panel data methods. This allows us to exploit different levels of aggregation across industries and sectors. The full panel consists of 80 "industries" at approximately the three digit SIC level; we also consider aggregates of these industries formed into 17 "sectors" at approximately the two digit level. In order to distinguish macro from micro effects we exploited common patterns of variation across the sectors and industries using time dummies. The simplest dynamic form of equation (1) may be written as follows:

$$\ln I_{i,t} = a_i + l_j + l_t + b_1 \ln Y_{i,t} + b_2 \ln(PI)_{i,t} + b_3 PROF_{i,t} + b_4 \ln W_{i,t} + g_1 CBI14B_{i,t} + g_2 CBI14D_{i,t} +$$
$$d_1 CBI16CA_{i,t} + d_2 CBI16CB_{i,t} + d_3 CBI16CC_{i,t} + d_4 CBI16CD_{i,t} + d_5 CBI16CE_{i,t} + d_6 CBI16CF_{i,t} +$$
$$d_7 CBI16CG_{i,t} + e_{i,t}$$

$$\text{with } i = 1,.....,80; \quad j = 1,.......,17; \quad t = 1979,.....,1992; \tag{2}$$

a_i represents the individual industry effect, l_j the sectoral effect, and l_t the common effect across industries at time t. We leave the choice between fixed and random effects estimators as an empirical

issue which address below.

5. Discussion of Results

A summary of results is presented in Tables 1 to 3. Table 1 presents both the core model as discussed in the previous section and the results when Question 16 responses from the ITS are included. The reported results are based on a very simple pooled OLS regression in levels (using a random effects estimator and DPD Gauss routines). Comparisons with a fixed effects estimator using a standard Hausman test based on equation (v) favoured the random effects model. Our interpretation of this result is that the presence of the l_j (the sectoral dummies) absorbs the heterogeneity across individual industries picked up by the individual effects a_i (the individual industry fixed effects). Note that the M_1 and M_2 statistics suggest (in all the Tables below) that each of the specifications (with a singular, but marginal, exception) passes the usual mis-specification tests.

Considering Table 1 first, equations (i) to (iv) show results with and without time dummies and the 2-digit sectoral dummies. The time dummies reflect macro influences, and the industry dummies reflect more localised sectoral influences.

As column (i) and (ii) together show, the exclusion of sectoral dummies produces marginal mis-specification which is eliminated once they are included. The significance of both sets of dummies as reported by W_1, W_2, and W_3 suggests that (iv), with both sets of dummies, is our preferred estimation of the core model. A few points are however in order. The relative price of plant and machinery (ln PI) is clearly correlated with both sets of dummies. When they are included, this variable becomes correctly signed and highly significant. The real product wage is also correlated with both types of dummy, and becomes significantly positive in its impact when either type of dummy is included. Theory is of course ambivalent on the sign of this coefficient since it depends on whether the negative effect on output outweighs any positive substitution effects. It is of course possible that the positive impact may reflect simultaneity, with higher industry growth causing both higher growth and higher wages. However, a conventional Sargan test (on equation (v) in Table 1) reveals no such source of bias ($c_{12}^2 = 8.01$.) with the coefficient remaining almost unchanged at 0.08 against 0.10 when the equation is instrumented as

above. In fact the positive coefficient confirms an earlier empirical study of UK manufacturing by Denny and Nickell (1992)[6.]

Table 1 shows that capacity utilisation factors are also important, especially shortage of physical capacity (CBI14D); they too are correlated with macro influences. However, our preferred model (iv) still suggests an important long run impact of physical capacity shortage if not skilled labour shortage (CBI14B).

Column (v) indicates the effect of introducing the information contained in CBI question 16 in its entirety. It is important to note that the coefficients on variables in the baseline model (iv) are almost completely unchanged. This underscores the robustness of the large negative coefficient on CBI16CE; we believe that this indicates that the uncertainty response in the ITS is not simply reflecting an expectation of low demand, but is instead providing genuinely new information. CBI16CC (the response related to an external financing constraint) also shows both a significant and negative coefficient. However, CBI16CD (the response to the cost of finance), shows a significant but apparently perversely signed coefficient. We consider this further below.

Given the set of results in Table 1, we felt able to explore further the relationship between coefficient estimates and the dummy variables which capture the macro impact. These experiments on the general model (v) are reported in Table 2 columns (i) through (iii). The variables which retain significance when both types of dummy are included are: the survey responses to external financing constraints (CBI16CC), uncertainty about demand (CBI16CE), and the cost of finance (CBI16CD). CBI16CC is not significantly correlated with either set of dummies and shows little difference between the experiments. For CBI16CE, the estimated negative impact of uncertainty increases when either or both sets of dummy are excluded. CBI16CD becomes positively (and perversely) signed only when time dummies are included.

Given the importance of the dummies in interpreting our results, the preferred specification of the general

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6 They note that even in a model where the capital-labour ratio is exogenous, higher wages may increase investment where shift working is prevalent because investment reduces the intensity at which the capital stock is worked and hence may reduce labour costs by lowering the premium attached to shift working.

model (v) in Table 1 is the parsimonious model (iv) in Table 2, which is based on the estimated coefficients which are significant at the conventional level (CBI16CC, CBI16CD, CBI16CE). Again the coefficient on CBI16CD is positive and significant when time dummies are present. This rather robust finding is open to a range of interpretations. It needs to be noted that there is a strong correlation between responses to this question and the set of time dummies – indeed nearly 40% of the variance in these responses is explained by a common macro effect tracking rates of interest in the economy. This suggests that our finding is quite consistent with a more conventional macro-economic impact coming from interest rates. As for the cross-industry variation, a relatively straightforward explanation would be that the differential response across industries may be due to some unobservable factor (for example industry indebtedness) which is positively related to investment. It may however also reflect a genuine underlying positive effect on investment. In the real options framework interest rate uncertainty has two effects on investment. First, increased spread increases the expected future return via Jensen's inequality. Second, it creates a value to waiting. These effects influence the response to the level of interest rates with the sign of the effect being ambiguous (Ingersoll and Ross 1992) [7].

The specification in Table 2 (iv) was subject to further tests: first of all to test the validity of our preferred random effects model and secondly to test possible endogeneity of the CBI variables. With regard to the former, the p-value of the Hausman test was found to be 0.87 (thus the null hypothesis that the individual effects are not correlated with the regressors is accepted, i.e. the random effects model is valid). Secondly, the endogeneity hypothesis of the CBI16 variables is rejected: the Sargan tests were $c_1^2 = 1.67$, 2.30 and 0.98 when we instrumented CBI16CC, CBI16CD and CBI16CE respectively using as instruments the first and second lag of the variables. The coefficients remained almost the same, i.e. -0.28, 0.073, and –0.10 respectively.

The set of experiments reported in Table 3 considers the possible interaction between uncertainty and industrial structure that is suggested in some of the associated theoretical literature. Our measure of industrial structure is the five firm sales concentration ratio reported in the *Census of Production*. A feature of this variable is that in most industries it varies little over time, therefore possessing something of the character of a fixed effect. Equation (i) includes this variable and needs to be compared with that

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7 A referee has kindly suggested this interpretation of the result.

of Table 2 equation (iv). It can be seen that the concentration ratio has a positive influence on investment and, unsurprisingly, both the profits and wages variables become insignificant. This finding squares with the analysis of Worthington (1992) on the positive impact of market power on investment[8.]

To explore the nature of our uncertainty variable further, we allowed for a differential impact of uncertainty upon investment depending upon the degree of concentration (as suggested *inter alia* by Guiso and Parigi ,1999, Ghosal and Lougani 1997 and Bhattacharya and Hope 1999). For this purpose the panel was divided into three groups of industry - low, medium, and high concentration. For consistency, we allowed for a similar possibility for the two other CBI question 16 variables retained.

The results confirm the negative overall impact of CBI16CC and CBI16CE for each of the concentration groupings. The results for CBI16CE suggest that there is little evidence of a heterogeneous industry response to uncertainty about demand according to market structure, with coefficient estimates numerically almost equal. On the other hand, estimates for CBI16CC, suggest a far from homogeneous response, with both high and low concentration industries showing much larger negative responses to external financial constraints than the medium concentration group - this last being consistently insignificant in all the reported experiments. As for CBI16CD, the evidence across the columns suggests an insignificant impact upon investment, which emphasises the possibility of a spurious correlation between this variable and unobserved macro effects.

We summarise the implications of our preferred specification in Figure 2. It shows the estimated contribution of the different factors to the growth of aggregate investment in plant and machinery over the period 1980 to 1992, which fell by 3.8% in volume terms. The important influences are output, the relative the price of investment goods, capacity utilisation, and uncertainty, the latter factor producing a combined (and negative) influence on investment of nearly 6%. In addition, external finance constraints CBI16CC are important, especially for low concentration industries. This finding may reflect a "finance gap" that is sometimes reputed to exist for small and medium sized enterprises.

[Figure 2 about here]

Note that the impact of uncertainty estimated here is based only on cross sectional variation over time

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8 It could however (given our use of only 17 sectoral dummies) indicate a fixed effect coming from capital intensity

and hence ignores the possible effect of macro-uncertainty. To obtain an estimate of the latter we compare the estimated impact of uncertainty contained in Figure 2 from equation (ii) with estimates obtained from Table 3 equation (iv) where no time dummies are included. Figure 3 shows the increase in the estimated impact of uncertainty under these conditions, with a total negative impact on aggregate investment of over 8% over all three groups of industries. The figure also shows the decomposition between the impact of the macro and the micro sources of uncertainty. The sources are of roughly importance for the low and medium concentration industries. For the high concentration group of industries, macro influences are less important than micro influences, but the overall impact of uncertainty is smaller than for the other groupings.

[Figure 3 about here]

6. Conclusion

This paper has sought to increase empirical understanding of the role that uncertainty plays in shaping the investment decision by utilising data from a panel of industries and exploiting evidence from the CBI Survey. The results from our core model suggested that there was a unit elasticity between investment and output, with significant negative impact coming from the relative price of investment goods. There was also evidence of positive effects coming from profitability, from the real product wage, and from physical capacity utilisation.

Building on this model, the addition of variables from the CBI Survey suggested that there were additional negative impacts from both external financing constraints and from the responses to uncertainty about demand as a limiting factor on investment authorisations. Whereas there was little evidence of industrial heterogeneity in relation to the impact of this latter factor, in relation to the role of external finance, we found that this appeared to depend upon the degree of industrial concentration, with a significant impact experienced in the low and high concentration industries.

As with much survey based evidence there remains a key question regarding the interpretation of our findings. In particular, further work is required to elucidate what respondents may mean in indicating uncertainty as a key factor influencing investment. Our results however suggest that a rough

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or from Jensen's hypothesis of excess investment resulting from "free cash flow" (Jensen 1986).

decomposition can be made between uncertainty operating at a macro level, and that varying between sectors. We found that for those industries outside the high concentration group, there was an approximately equal impact coming from macro and micro factors. For the high concentration group on the other hand, neither influence was as important.

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APPENDIX 1

DERIVATION OF EXPRESSION 1 IN TEXT

Suppose that an imperfectly competitive firm faces a demand curve of the form:

$$Y = Y(P,d) \tag{A1}$$

where Y is value added, P is the price of value added for the firm relative to the aggregate price level, and d is a demand shifter. Let us suppose that the technology of a representative firm takes the form:

$$Y[.] = F[A_t, L_t, K_t] \tag{A2}$$

where:

      A is an index of technical progress
      L are labour inputs
      K are capital inputs

A revenue function ($R=YP(Y;d)$) can now be specified of the form: $R (A_t, L_t, K_t, d)$ so that the firm attempts to maximise the sum (over time) of its profit stream. This we write as:

$$\Pi_t = R (A_t, L_t, K_t, d) - C_1 [CF_t, K_t, FV_t] - C_2 [I_t,X_t] - C_3 [CU_t] - W_tL_t - PI_tI_t \tag{A3}$$

where (suppressing time subscripts):

      CF is cash flow.
      FV are financial factors, such as real debt, interest rates and the market value of
  the firm.
      I is the level of investment
      X is a vector including the relative cost of purchase of physical assets or any other factor affecting the adjustment of the capital stock.
      CU is the degree of capacity utilisation
      W is the real product wage per unit of labour input.
      PI is the price of investment goods relative to the price of output

The profit function assumes that we are in an environment where profits are influenced by variety of costs associated with adjusting the capital stock to its desired level. We specify three types of costs, $C_1 [.],C_2 [.],C_3 [.]$ which we assume to be separable. In C_1 we allow for agency costs or those associated with other financial considerations (Devereux and Schianterelli 1989, Hubbard 1998) on the assumption that the firm's financial situation is relevant for real investment decisions. This function embodies the incentive to invest by supposing that managers maximise profits *net* of expected bankruptcy costs. The C_2 term captures the standard neo-classical implementation (internal) costs which arise when the firm's adjusts its capital stock and which prevent it moving immediately to the equilibrium capital stock. The C_3 (external) cost term reflects costs related to capacity utilisation and is strictly only relevant where price does not adjust upwards to clear the market; this may happen because of regulatory or entry considerations or simply because the firm hazards that it will lose less goodwill in the event of capacity shortage by rationing selective customers rather than imposing general price rises.

Note that the separable form of the profit function allows us to distinguish between various forms of costs including the distinction between real and financial factors. We assume that the desired level of the capital stock will depend upon variables that influence the probability of bankruptcy (see for instance Nickell and Wadhwani 1988 and Wadhwani 1986, 1987). This possibility has received increasing attention in the literature. Here we aim to provide further empirical evidence on this point, using profitability and CBI Survey data. A more formal justification for the impact of financial factors on the desired capital stock can however be provided as follows.

The firm faces bankruptcy when
$$R (.) - wL - \rho D + B < 0.$$

Where D is real debt, w is the wage rate, ρ is the interest rate, and B is the firm's borrowing set by the banking sector. The theoretical and empirical results of Wadhwani (1986), and Nickell and Wadhwani (1988), suggest that the borrowing limit depends on the size of the debt, the market value of the firm and other factors such as gearing (interest payments/ trading profits). We may then specify a modified real revenue function, NR, net of bankruptcy costs (BC)

$$NR (.) = R(.) - BC * G[(WL - R(.))/K + FV + s^2_d]$$

where G is the probability of bankruptcy. G depends *inter alia* on the variance of the demand shifter s^2_d.

We now reach an investment demand equation via the marginal product of capital given by (and suppressing the time notation):

$$(\partial \Pi / \partial K)^e = f(W^e, P^e, A^e, Y^e, CF^e, FV^e, CU^e, PI^e, d^e) \qquad (A4)$$

Where the superscript e represents a mathematical expectation. In order to derive a form of demand equation capable of estimation we assume that C_1, C_2 and C_3 terms and the expected marginal product of capital are specified in a multiplicative way. It is now possible to derive a log-linear specification. In this implementation Y includes the impact of both P and d, possibly in non-linear form. However, the partial derivative of marginal revenue with respect to K may also therefore contain d in a non-linear form. It is a standard result (eg Aiginger 1987) that this may impart a bias to capital input relative to the certainty case, although the direction and magnitude of the bias cannot be predicted without further information. Here we shall allow the data to decide by including an s^2_d term – the variance in the demand shifter - in the estimated factor demand equation in addition to its indirect effect on financial variables.

$$\ln(I) = h [\ln(W^e), \ln(P^e), \ln(Y^e), A^e, CF^e, FV^e, CU^e, \ln (PI^e), s^2_d] \qquad (A5)$$

This is expression (1) in the text.

APPENDIX 2

DATA DEFINITIONS AND NOTES

For balanced data set (number of industries = 80; 1979-1992)

variable definitions for tables 1-3 and their construction

sectoral dummies - 17 (based on two digit classification of the 1980 Standard Industrial Classification)

ln (I)	= log of net acquisitions of plant and machinery deflated by deflator for plant and machinery.
ln(Y)	= log of gross value added (Source CoP) deflated by PN, the price of value added
ln(W)	= log of Total Labour Costs (Source CoP) divided by Total Employment (Source CoP) and deflated by the price of value added PN (see below).
ln(PI)	= log of deflator of plant and machinery (source: Office for National Statistics) divided by an index of output prices PO (see below)
PROF	= gross value added less total labour costs all divided by gross value added (source: CoP)
PO	= price of output derived from a weighted average of export prices (source: NEDO) and producer prices (source: NEDO, Annual Abstract). Weights determined by shares of exports in gross output in 1985
PN	= price of value added; derived from $PO=PMF2^{MW} *DJCM^{SW} *PN^{(1-MW-SW)}$

where PMF2 is 2 digit deflator of prices of fuel and materials (source: Annual Abstract of Statistics)

DJCM is the price of service inputs proxied by the GDP deflator at factor cost

MW is the share of materials in gross output in 1985 and SW is the share of services in gross output in 1985

CBI SURVEY DATA.
Source: Industrial Trends Survey

annual averages of quarterly data 1979-1992; however data begins only 1979q4, so 1979 data based upon only one observation.

Question 16c asks:

"What factors are likely to limit (wholly or partly) your capital expenditure authorisations over the next twelve months?"

CBI16CA = % of respondents citing inadequate net return on investment

CBI16CB = % of respondents citing shortage of internal finance

CBI16CC = % of respondents citing inability to raise external finance

CBI16CD = % of respondents citing cost of finance

CBI16CE = % of respondents citing uncertainty about demand

CBI16CF = % of respondents citing shortage of labour including managerial and technical staff

CBI16CG = % of respondents citing other reasons

Capacity Utilisation Data

Capacity utilisation data is based on Question 14 of the ITS which asks
"What factors are likely to limit output over the next four months?"

CBI14B is the percentage of firms responding skilled labour; and
CBI14D is the percentage of firms responding physical capacity

TABLE 1
Panel Estimates: Dependent Variable = ln (I)
Estimation by OLS, DPD pooled estimates
sample period 1979-1992
number of industries = 80

variable	(i) coefficient	t ratio	(ii) coefficient	t ratio	(iii) coefficient	t ratio	(iv) coefficient	t ratio	(v) coefficient	t ratio
ln I(t-1)	0.85	49.3	0.82	36.0	0.74	28.0	0.78	29.7	0.78	30.1
ln Y	0.16	7.2	0.19	7.0	0.26	8.7	0.22	7.5	0.23	7.6
ln PI	0.01	0.6	-0.24	-4.5	-0.29	-5.0	-0.28	-4.3	-0.27	-4.1
PROF	0.24	3.6	0.13	2.4	0.17	2.3	0.14	1.9	0.14	2.0
ln W	-0.06	-3.1	0.09	2.7	0.10	2.4	0.10	1.8	0.10	1.8
CBI14B*100	0.05	1.8	-0.04	-1.2	0.15	4.4	0.02	0.5	-0.02	-0.6
CBI14D*100	0.34	10.6	0.20	6.0	0.27	8.6	0.15	4.6	0.14	4.0
CBI16CA*100									-0.01	-0.4
CBI16CB*100									-0.03	-0.8
CBI16CC*100									-0.23	-1.7
CBI16CD*100									0.09	2.1
CBI16CE*100									-0.08	-2.6
CBI16CF*100									0.10	1.5
CBI16CG*100									-0.10	-1.0
Time dummies	NO		YES		NO		YES		YES	
Ind Dummies	NO		NO		YES		YES		YES	
W1	459564 (7)		23996(7)		13208(7)		14244(7)		14780(14)	
W2			177 (12)				161(12)		141(12)	
W3					68(16)		63(16)		48(16)	
W4							264(28)		205(28)	
M1	-1.95		-1.68		-0.09		-1.34		-1.33	
M2	-1.59		-1.62		0.26		-1.21		-1.14	

Notes to Table 1:
a) The asymptotic absolute t-ratios are robust against heteroscedasticity.
b) The M1 and M2 statistics test first and second order serial correlation respectively in the residuals. The statistic is asymptotically distributed as standard normal under the null of no serial correlation. If the residuals have been transformed to either first difference or orthogonal deviations, first order serial correlation is to be expected but not second order (See Arellano and Bond (1991)).
c) The W1 statistic is a Wald type test of joint significance of the reported coefficients, asymptotically distributed as chi-squared(k) under the null of no relationship, where k represents the degrees of freedom.
d) W2, W3 and W4 finally test the joint significance of the time dummies, industry dummies, and joint significance of both time and industry dummies respectively. All these statistics are asymptotically distributed as chi-squared(k) under the null of no relationship, where k represents the degrees of freedom.

TABLE 2
Panel Estimates: Dependent Variable = ln (I)
Estimation by OLS, DPD pooled estimates
sample period 1979-1992
number of industries = 80

	(i)		(ii)		(iii)		(iv)		(v)		(vi)		(vii)	
variable	coefficient	t ratio	coefficient	t ratio	coefficient	t ratio	coefficient	t ratio	coefficient	t ratio	coefficie	t ratio	coefficie	t ratio
ln I(t-1)	0.84	42.9	0.81	34.6	0.75	27.8	0.78	30.0	0.81	36.9	0.75	27.7	0.84	50.0
ln Y	0.17	7.3	0.20	7.4	0.25	8.4	0.22	7.6	0.20	7.9	0.25	8.3	0.17	8.0
ln PI	0.02	1.6	-0.23	-4.2	-0.32	-5.4	-0.28	-4.2	-0.22	-4.2	-0.32	5.5	0.03	3.3
PROF	0.21	3.2	0.13	2.4	0.14	2.0	0.15	2.1	0.14	2.6	0.17	2.4	0.22	3.4
ln W	-0.09	-4.5	0.07	1.9	0.12	3.0	0.10	1.8	0.07	2.0	0.13	3.1	-0.10	-5.1
CBI14B*100	0.01	0.3	-0.04	-1.1	0.04	1.2								
CBI14D*100	0.23	7.3	0.16	4.9	0.19	5.9	0.15	4.4	0.17	5.3	0.24	8.1	0.28	9.3
CBI16CA*100	0.07	2.3	0.01	0.4	0.01	0.3								
CBI16CB*100	0.02	0.5	-0.02	-0.8	0.05	-1.4								
CBI16CC*100	-0.31	-2.4	-0.30	-2.1	-0.26	-2.0	-0.24	-1.9	-0.30	-2.3	-0.33	-2.7	-0.29	-2.3
CBI16CD*100	-0.06	-1.5	0.06	1.6	-0.05	-1.2	0.09	2.1	0.07	1.6	-0.04	-1.1	-0.04	-1.1
CBI16CE*100	-0.11	-4.0	-0.11	-4.1	-0.11	-3.8	-0.06	-2.4	-0.11	-4.4	-0.13	-4.7	-0.13	-5.2
CBI16CF*100	0.21	3.0	0.09	1.3	0.19	2.7								
CBI16CG*100	0.07	0.7	-0.07	-0.8	-0.00	-0.00								
Time dummies	NO		YES		NO		YES		YES		NO		NO	
Ind Dummies	NO		NO		YES		YES		NO		YES		NO	
W1	506784(14)		24433(14)		14077(14)		14161(9)		23959(9)		13520(9)		479907(9)	
W2			136(12)		35.0(16)		154(12)		142(12)					
W3							50(16)				30(16)			
W4							211(28)							
M1	-2.46		-1.71		-0.57		-1.36		-1.79		-0.59		-2.37	
M2	-1.36		-1.32		0.20		-1.11		-1.34		0.05		-1.61	

For explanations see notes to Table 1.

TABLE 3
Panel Estimates: Dependent Variable = ln (I)
Estimation by OLS, DPD pooled estimates
sample period 1980-1992
number of industries = 80

variable	(i) coefficient	t ratio	(ii) coefficient	t ratio	(iii) coefficient	t ratio	(iv) coefficient	t ratio	(v) coefficient	t ratio
ln I(t-1)	0.76	27.7	0.76	27.7	0.79	33.0	0.73	25.9	0.81	40.3
ln Y	0.25	7.9	0.26	8.2	0.23	8.2	0.29	9.0	0.21	8.4
ln PI	-0.22	-3.3	-0.22	-3.4	-0.21	-4.1	-0.32	-5.2	0.02	1.6
PROF	0.11	1.5	0.11	1.5	0.11	1.9	0.16	2.1	0.19	2.5
ln W	0.02	0.3	0.02	0.3	0.03	1.0	0.09	2.0	-0.12	-5.8
CBI14D*100	0.15	4.6	0.15	4.5	0.17	5.5	0.24	8.0	0.27	9.0
CBI16CC*100	-0.25	-1.7								
CBI16CD*100	0.09	1.9								
CBI16CE*100	-0.07	2.5								
CONC*100	0.05	2.0	0.05	1.5	0.03	0.9	0.03	1.0	0.06	1.8
CBI16CC*DL*100			-0.35	-1.8	-0.33	-1.8	-0.34	-1.8	-0.23	-1.0
CBI16CC*DM*100			-0.08	-0.4	-0.11	-0.5	-0.24	-1.1	-0.17	-0.8
CBI16CC*DH*100			-0.34	-1.3	-0.38	-1.5	-0.43	-2.0	-0.45	-2.1
CBI16CD*DL*100			0.07	1.1	0.04	0.7	-0.07	-1.0	-0.04	-0.7
CBI16CD*DM*100			0.08	1.6	0.06	1.1	-0.01	-0.1	-0.01	-0.2
CBI16CD*DH*100			0.13	1.2	0.10	1.0	-0.02	-0.1	0.00	0.0
CBI16CE*DL*100			-0.07	-1.9	-0.10	-3.2	-0.14	-3.9	-0.12	-3.6
CBI16CE*DM*100			-0.06	-2.0	-0.09	-3.5	-0.12	-4.1	-0.12	-4.2
CBI16CE*DH*100			-0.08	-1.7	-0.11	-2.4	-0.13	-2.6	-0.14	-3.1
Time dummies	YES		YES		YES		NO		NO	
Ind Dummies	YES		NO		YES		YES		NO	
W1	13391(10)		14434(16)		23490(16)		13939(16)		444657(16)	
W2	148(11)		144(11)		134(11)					
W3	49(16)		48(16)				30(16)			
W4	203(27)		193(27)							
M1	0.49		0.55		0.05		1.05		-1.16	
M2	-0.28		-0.21		-0.51		1.00		-0.64	

For explanations see notes to Table 1.
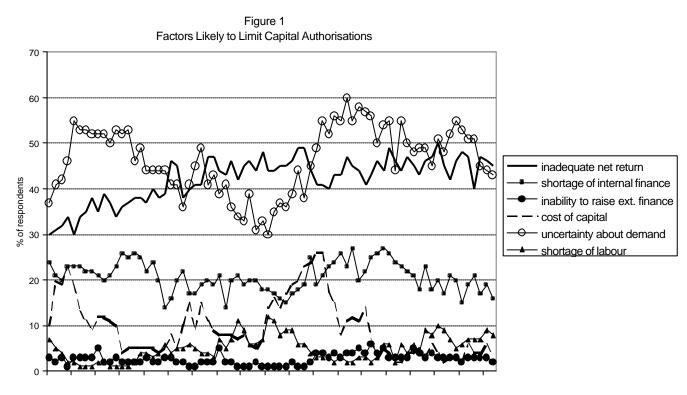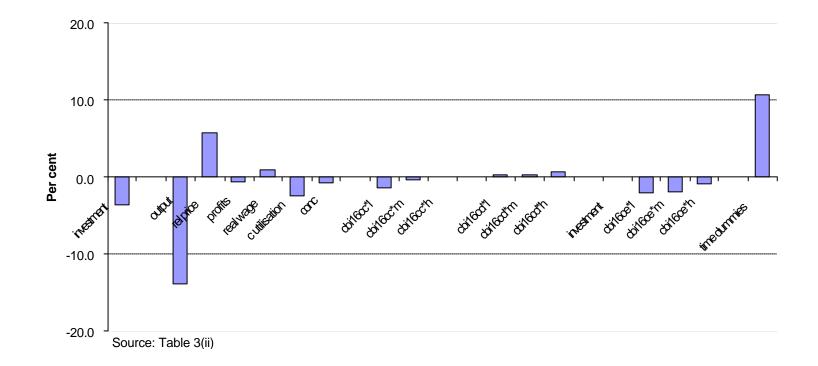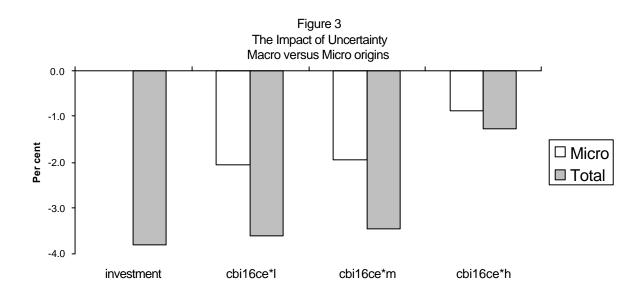
Figure 1
Factors Likely to Limit Capital Authorisations

Figure 2
Why Investment Did Not Grow
Estimated Contributions to Change in Investment
1980-1992

Source: Table 3(ii)

Figure 3
The Impact of Uncertainty
Macro versus Micro origins

Source: Tables 3(ii), 3(iv)