Contrasts between classes of assets in fixed investment panel equations as a way of testing real option theory

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Abstract

This paper reports estimation of investment equations for two classes of fixed assets: plant & machinery and building for a large sample of UK manufacturing industries. It exploits the different degree of irreversibility that characterises these assets to test the power of real options theory to explain investment under uncertainty. Additionally, the paper uses a specially constructed industry-specific measure of irreversibility for plant and machinery investment to test for real options effects within that class of investment.

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Introduction

Real Option appraisal rules for investment under uncertainty differ from discounted cash flow rules in that an extra "irreversibility" premium is added to the discount rate calculated from the Capital Asset Pricing Model or from some variant of it. This irreversibility premium is often argued to be sizeable in relation to the discount rate (See for example Pindyck 1991; Dixit and Pindyck 1994).

In this paper we argue that the size and even the sign of the irreversibility premium in the real options approach depends not only on industry conditions but also on the class of asset under consideration. The latter point allows us to test the effect of real options theory by comparing two assets – plant & machinery and new building – which are distinct in terms of their associated irreversibility. It is often argued that building assets are less specific than plant. Evidence for this comes from the relative effectiveness of plant and of building in deterring entry. This suggests that plant capital is more irreversible (i.e. sunk) than building capital (Kessides 1990).

The paper is organised as follows. In Section 1 of the paper we review the real options approach, distinguishing between deferment options and other types of option. Section 2 specifies hypotheses in respect of contrasts that would be expected between the two classes of investment goods under option theory. Section 3 specifies an investment equation, while Section 4 presents the results of a set of investment equations for both classes of capital goods using SURE and Panel estimation; these results are interpreted and discussed. Section 5 expands the analysis by using a specially constructed industry-specific index of irreversibility for plant and machinery which allows us to check for interaction effects between irreversibility and uncertainty for this class of investment. Section 6 concludes.

1. Investment Theory and Real Options

Until quite recently, investment theory has been dominated by models of continuous adjustment implied by the convex cost of adjustment approach. Such models have typically been solved using stock market valuation for the marginal value of a unit of capital; by representing that marginal value by a vector autoregression; or by invoking rational expectations for the value of marginal q. However such models have tended to disappoint in empirical estimation (Whited, 1998; Chatelain and Teurlai, 2001; Driver and Meade, 2001).

Recently a class of models has been proposed which focuses on potential discontinuities in the adjustment process (Abel and Eberly 1994; Dixit and Pindyck 1994; Abel *et al*, 1996; Chirinko and Schaller, 2002). The theory suggests that under a variety of circumstances the firm will be faced with a “zone of inaction” in respect of the marginal value of capital, q, where it is optimal to keep the capital stock constant even if it differs from its frictionless optimal value[2]. These circumstances include either fixed costs of adjustment, piecewise linear costs of adjustment, or the presence of uncertainty. It is

[2] A number of empirical studies have also confirmed this prediction of discontinuous adjustment at least for

intuitively obvious that fixed costs of adjustment will cause firms to concentrate investment in bursts. When adjustment costs are piecewise linear with possibly different slopes for upward and downward adjustment, the derivative with respect to investment is undefined when investment is zero and this gives rise to a zone of inaction. Finally, the presence of uncertainty combined with irreversible assets creates a “value to waiting” if the underlying stochastic variable has some persistence and if investment affects the future return on capital.[3] This is the case of the real option to defer: here the threshold marginal q depends on the level of uncertainty and there is an irreversibility premium over the normal cost of capital (Dixit and Pindyck 1994).[4] Using what they regard as typical parameters representing volatility, Dixit and Pindyck show that the present value of a fully irreversible project would have to be twice the investment cost before investment would be justified. Put differently, there is an irreversibility premium which should be added to the usual cost of capital in appraising investment projects.

Subsequent work has questioned the magnitude and even the sign of the irreversibility premium. The Dixit and Pindyck example above considers a firm with complete irreversibility (no abandonment options) and no adjustment costs. Other authors have focused on the case of partial irreversibility under various forms of adjustment costs. One

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large projects (Caballero et al 1995; Nilsen and Sciantarelli 1996)

[3] The exceptional case where the return of capital is invariant to the capital stock is where there are constant returns to scale and perfect competition. . Where firms have monopoly power or where there are decreasing returns to scale the profit function of the firm is concave in the capital stock. For a review of the issues here see Caballero (1991) and Pindyck (1993)

[4] Dixit and Pindyck illustrate this by specifying a standard Brownian motion process for the value of the firm (V) as $dV= \alpha V dt+\sigma V dz$. Denoting the option value as F(V), the basic Bellman equation is : $rFdt=E(dF)$, where $F=\max E[(V-I)\exp(-rt)]$. To expand dF requires the use of Ito's lemma. The Bellman equation thus becomes: $rFdt=\alpha VF'(V)dt+1/2\sigma^2 V^2 F''(V)dt$. Imposing the usual boundary conditions (See Dixit and Pindyck 1994, Chapter 5) gives a general solution of the form:$F(V)=AV^{\$.}$ The root β is the solution of the non-linear equation:
$1/2\sigma^2\beta(\beta-1)+\alpha\beta-r=0$. This can be substituted into the boundary conditions, giving the critical value for V $=V^*=\beta/(\beta-1)$. If we follow the parameterisation in Dixit and Pindyck (1994) viz:$r=0.04$; $\sigma^2=0.04$; $\lambda_1=0.1$,

such model is given below, inspired by Abel and Eberly (1994), Abel *et al* (1996), and in particular by Chirinko and Schaller (2002).

The real option to defer and the irreversibility premium with general costs of adjustment

An arbitrage condition for the return on a unit of capital with shadow value (q) may be written as:

…(1)

$$p_{K,t} - dq_t = rq_t - E[q_{t+1} - q_t]$$

where π_K is the marginal revenue product of capital which is affected by the stochastic process for demand, assumed to evolve as a log random walk. The left hand side is the marginal revenue product of capital less the depreciation on a unit of capital. The right hand side is the opportunity cost of a unit of capital consisting of foregone interest and offsetting expected capital gain.

Rearranging terms and substituting (given non-zero investment) the marginal cost function with respect to investment (C_I) for the shadow value q, we obtain

$$(1 + r + d)C_{I,t} = p_{K,t} + E[C_{I,t+1}]$$

…(2)

The marginal investment cost at time t ($C_{I,t}$) is the sum of the purchase price (p) and the adjustment cost $G(I_t,K_t)$. The expectation of C_I for the next period however must take account of the irreversibility of investment. This is because firms cannot adjust smoothly in the presence either of fixed costs or uncertainty when investment assets are at least partially irreversible. Thus firms may be stuck in a position where their investment is not

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we get a value of 2 for β .

optimal - in the sense that without threshold effects it would be changed - but which in the presence of threshold effects it is not optimal to change. [5] The anticipation of this non-optimality is one element of the irreversibility premium. The other element occurs if the firm anticipates disinvestment at the distress price p^-.

The expected next period marginal cost of investment may be written as

…(3)

$$E[C_{I,t+1}] = p_{t+1} + G(I_{t+1}, K_{t+1}) + \eta$$

Where η is the irreversibility premium discussed above. This premium raises the threshold or hurdle rate at which it is optimal for firms to invest. One component of the premium (η_1) is a function of the price spread between purchase and (distress) sale price. The other component (η_2) is the cost to the firm of being in the zone of inaction[6]. Investment is related to marginal q in a non-linear manner as shown in Figure 1. The irreversibility premium rotates the q relation under uncertainty downwards so that it the investment response is more cautious.

The option to expand

It is not, however, clear that the irreversibility premium is always positive: indeed we may talk of an "expandability" premium when the former is negative. The Chirinko and Schaller model assumes that the same process governs price under disequilibrium upward capacity adjustments as governs the normal purchase price; the same assumption also applies to the convex adjustment function.[7] This complication is identified in the contribution of Abel et al (1996).

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[5] If the demand shift between t and t+1 is sufficiently adverse so as to move firms outside the zone of inaction, they will optimally sell capital at the distress price (p^-).

[6] This cost is represented as the purchase price of a unit of capital times the probability that it was unnecessary to purchase it at time t. The latter probability of being in the zone of inaction is itself determined by the magnitude of fixed costs and the uncertainty parameters.

[7] Were this not the case the disequilibrium purchase price would reflect the cost of having to install or obtain capital in a situation of deficient capacity. Since this price or cost of adjustment will be encountered

The context of their model is largely similar to the Abel and Eberly (1994) and Chirinko and Schaller (2002) approach. In a two-period investment model, the ex-ante investment may no longer be appropriate in the light of the realisation of the stochastic variable **e**. In the second period, one might prefer to sell part of the capital invested or exercise a right to buy more at a pre-arranged price. Here, unlike the Chirinko and Schaller case, the ex-post price for a disequilibrium adjustment, *whether up or down,* is distinguished from the ex-ante purchase price. This complication results in the following premium …(4) to be added to the Jorgenson cost of capital term (Abel *et al*, 1996, expression 17):

$$(p - p^{-})F(e_L) + \int_{e_L}^{e_H}[p - R_K(K,e)]dF(e) - (p^{+} - p)[1 - F(e_H)]$$

Here p, p^{-}, p^{+} are the first period purchase price of a unit of capital and the corresponding selling and buying prices respectively; F(e) is the distribution function of the underlying stochastic variable and R_K is the marginal return on capital installed which may have to be evaluated at a non-optimal level of the capital stock. The terms e_L and e_H are the critical values of the stochastic variable at which the original capital is no longer optimal *ex post:* either because the return is no longer greater than the return from selling the capital or because the return has risen to the rental on new capital purchased at the option price. Capital should then be bought or sold until the marginal return equals the lower or upper rentals p^{-} or p^{+}.

The effect of this modification is to allow the hurdle rate to lie above or below the usual cost of capital rate. There will be a positive irreversibility premium if the combined effect

only if capacity is deficient, its expectation at time t will depend on investment at time t.

of partial irreversibility (η_1) and the expected disequilibrium gain or loss (η_2) exceeds the expected ex-post additional expansion cost.[8] However, where this condition is not met we may speak of an "expandability" premium which is a negative irreversibility premium and where the focus is on potential shortage rather than excess capacity.

2. Specifying hypotheses

The existence of a real options deferral effect depends on a number of enabling conditions. These include:

(a) the existence of at least partial irreversibility in the sense of a wedge between purchase and resale price

(b) the ability to obtain options that can be exercised at a variable date

(c) persistence in the stochastic variable affecting the profitability of investment, so that information arrives over time.

Thus uncertainty will affect both the size of the inaction zone and will have an interaction effect with q outside of that zone.[9] Insofar as a deferral option effect is present we would expect, at industry level, a negative effect of uncertainty on investment authorisations with the size and significance of the effect depending on the level of irreversibility and other industry-specific effects noted above, namely the existence of a value to waiting and the opportunity to acquire options.

[8] Note that the interpretation of η_2 in Abel *et al* (1996) includes the conditional gain of higher than expected demand at sub-optimal capacity.

[9] Whether or not this would lead to a lower level of the capital stock is not certain. The most interesting argument here is that while investment may be slowed by a higher threshold it is also true that firms may not find it optimal to dispose of excess capital (in the sense that the current level is not what would have been chosen had information on the realisation at t+1 been known at t) due to the irreversibility effect noted earlier (Abel and Eberly, 1999).

Were the deferral option route the only way in which uncertainty affected investment it would be easy to test real options theory by contrasting the uncertainty effect across two assets with different degrees of irreversibility. Specifically it would be possible to contrast the coefficient of uncertainty in investment equations for plant and for buildings. The deferral option effect predicts a greater uncertainty coefficient for plant on the assumption that this asset is more use-specific and consequently has lower resale value. [10]

Interpretation of the uncertainty coefficients in investment equations is difficult because the deferment option is not the only transmission mechanism from uncertainty to investment. (See Driver *et* al, 2002). We have already noted that any price premium required for acquiring or installing extra capital ex-post could change the sign of the irreversibility coefficient. Similarly, phased projects which offer an option to abandon at each stage (sometimes known as compound options) can result in a negative irreversibility premium. In this case the options effect may be positively signed and greater uncertainty may induce a *higher* level of investment (Bar-Ilen and Strange 1996, Leahy and Whited, 1996, Dixit and Pindyck, 1994). The intuition here is that an option is worth more the higher the uncertainty and if its price remains unchanged, higher uncertainty is a signal for options to be bought i.e. for the first stage of a project to be completed.[11]

[10] The view that plant is more irreversible than building is supported by work on entry barriers (Kessides 1990) He shows that plant investment is more effective in impeding entry than is building, presumably because the sunk component of the former is greater. It should be noted that irreversibility may be attenuated by the existence of either fast growth or fast depreciation both of which effectively neutralise the effect of irreversibility (Bertola and Caballero1994). As our investment equations will be industry specific, differential growth is not a consideration. Differential depreciation rates could affect the degree of effective irreversibility. However the mean age of plant is generally taken as twelve years so any effect would only relate to a long time horizon in most industries.

[11] In effect this is an application of the convexity approach to uncertainty.

Thus, if compound options are operating it is likely that the sign of the uncertainty coefficient will be positive and this effect seems more likely in respect of building than plant as the former is more likely to be phased. The implication of these ideas is that the uncertainty effect on investment should be more negative (or less positive) in the case of plant than in the case of building whatever type of real option effect is being experienced.

3. Specification of the investment equations

To test the existence of real options effects we contrast investment equations for both plant and buildings for a set of UK industries. Given the difficulties in estimating Euler equation models – which are strictly appropriate only for continuous rather than discontinuous adjustment - we have recourse to a standard flexible accelerator model which incorporates direct expectations and survey data from the main UK employers organisation, the CBI. The survey data (which are publicly available and which feed into the EU industrial database) record investment authorisation rather than actual investment, though these two variables are linked by a well determined realisation function (European Commission, 1997).[12] The survey questions are detailed in Appendix 1. The specification for the investment authorisations (Auth) equation (see Appendix 2 for its full derivation) is

$$Auth_{it} = b_{i,0} + b_1 Auth_{i,t-j} + b_2 opt_{it} + b_3 yfterm_{i,t} + b_4 ybterm_{i,t} + b_5 ybterm_{i,t-1} + b_6 cuterm_{i,t-1} + b_7 unc_{i,t-j} + b_8\, fi_{i,t-j} + b_9 dlcu_{i,t} + e_{i,t} \qquad (5)$$

[12] There is some modelling advantage in using authorisations in that one can dispense with gestation lags. One disadvantage, in the case of our survey data, is that the data is qualitative being recorded in the form of the percentage of respondents replying “more” or “less” to the level of authorisations planned in the next period. However, a useful result is that the balance (more minus lessis closely correlated with rates of change: Driver and Moreton 1992 and also Smith and McAleer, 1995. We denote this balance as “Auth”, to represent investment growth.

The specification of the investment equation for both assets is identical and follows fairly closely the accelerator-type specifications in the literature (e.g. Berndt 1990): it includes an error correction term in the form of a capacity utilisation variable directly recorded in the Survey (*cuterm*). The main regressor is a term in actual past output (*ybterm*). A term in expected output (*yfterm*) was constructed analogously to this, using the expected figures from the Survey. The variables *ybterm* and *yfterm* are both included as regressors because the expected output term relates solely to short-term expectations (over the next quarter) and thus cannot fully supplant the lag structure on actual output. The basic specification is modified by terms reflecting confidence, uncertainty, and the possibility that capital market imperfections, in the form of finance constraints, may be influencing investment outcomes. The explanatory variable measuring industry-level business confidence or optimism (*opt*) is obtained from replies to question 1 of the Survey. Our uncertainty variable (*unc*) is based upon the cross-sectional dispersion of beliefs across firms in an industry about prospects for the *industry*. Assuming a high degree of homogeneity in demand conditions within the industry, cross-section dispersion of beliefs about the same sector may be regarded as a measure of uncertainty. The precise measure used is the concentration of responses to the survey question on industry optimism. We therefore compute the measure as the entropy (concentration) of the three replies (up/same/down). Writing S_i for the share of reply j, j=1,3 we define: unc = Σ [- S_i log S_i]. An even spread in the replies (each share S_i equal to one third) corresponds to maximum entropy and maximum uncertainty.

This constructed variable has been used successfully in other contexts involving surveys with three possible replies to measure the extent of disagreement among respondents (Fuchs, Krueger and Poterba 1998). Dispersion across forecasters is also used by the IMF as a measure of macro-level uncertainty. Using lack of consensus as a measure of uncertainty is supported in a number of studies (Zarnowitz and Lambros 1987, Bomberger 1999). [13]

4. Results and Discussion

First, we performed unrestricted SURE estimation – summary statistics for each industry for both plant and machinery and buildings are given in Appendix 3. In order to better understand these results, we moved to a more parsimonious representation of the estimates by pooling across industries. Table 1, columns 1 and 2, reports the preferred pooled models (fixed effects for plant and machinery; random effects for buildings). It is worth noting that the pooled model is accepted for plant and machinery while unrestricted SURE is the appropriate model for buildings.

Next, the sign of the summed UNC coefficients in the SURE estimation (where jointly significant at the 10% level) is used to form two sub-samples with positive and negative uncertainty effects; this produces four sub-samples in all. This sample splitting is clearly necessary at least for the buildings case since the test for homogeneity, as already mentioned, was decisively rejected in the total sample. The results here are presented in the remaining four columns of Table 1. Finally to control for any remaining industry specificity that may interfere with the contrast between plant and building we confine attention in Table 2 to those industries in each of the sub-samples that are common between plant and building. A summary of the results in so far as the sign, magnitude and

[13] In the US the Livingstone survey records personal intervals of belief. Guiso and Parigi (1999) have used Italian data with similar belief dispersion. The relation between these measures of dispersion and our index of lack of consensus is discussed in Bomberger (1996,1999). Driver and Moreton (1991) and Ferderer (1993) use dispersion across forecasts at a macro level to investigate the effect of uncertainty on investment.

significance of the summed standardised uncertainty coefficients is presented in Table 3.[14] Appendix 4 details the composition of the panels.

[Insert somewhere here Tables 2 and 3]

Discussion of the results

The specification of the investment equations is clearly supported by the data for both Plant & Machinery and Building. The coefficients in the SURE equations are generally significant and signed in accordance with expectation. The diagnostics are generally acceptable and a reasonable proportion of the investment variance is explained by the variable set.

The whole-panel results for plant and machinery confirm the findings in Driver et al (2002) of an overall negative effect of uncertainty on plant and machinery investment with the fixed effects model being preferred.[15] However for the case of buildings there is considerable heterogeneity across industries and the Breusch-Pagan test finds in favour of unrestricted SUR estimation. Confining attention to the samples of negative significant and positive significant coefficients for each asset class, we find that the negative uncertainty effect is 25% greater in magnitude for the plant & machinery case in line with the theory advanced earlier. If the long-run coefficients are computed, the difference is even greater. For the panel set relating to the positive coefficients, the uncertainty is large and significant for buildings but is not statistically significant for plant & machinery. This again accords with expectations. The remaining diagnostics are mostly acceptable though

[14] Standardised coefficients are the estimated coefficients on uncertainty multiplied by the ratio of the standard deviation of uncertainty to the standard deviation of investment authorisation.

[15] The joint significance level of 0.13 would be considerably higher if the additional lagged uncertainty

the heterogeneity test is failed at 5% for plant and machinery for the case of negative coefficients. The results in Table 2 relate to the comparison of panels that are restricted to those industries that have common negative effects for both assets and common positive effects for both assets as observed from the SUR estimation. Here the results for the negative case are not so clear-cut as before with a marginally higher negative uncertainty coefficient for building (-0.25 as compared to –0.21). However the long-run effect is still marginally more negative for plant and machinery. For the positive panels the results are broadly in line with those in Table 1 with only buildings having a significant positive effect.

5. Measures of irreversibility

We now turn to a more detailed analysis of the plant and machinery equations using industry-specific data on irreversibility of assets. The UK Census of Production contains data on disposals and acquisitions at current value by 3-digit industry. We use these data as follows to construct measures of irreversibility[16].

Our intuitive starting point is that the ratio of disposals to acquisitions will be higher where disposals have value. The ratio will be low or close to zero if second-hand markets are thin or non-existent. It would not, however, be entirely appropriate to use the simple ratio of disposals to acquisitions as an indicator of thick markets for disposals. Disposals and acquisitions may be different functions of industry characteristics such as size and growth. We expect a positive correlation between disposals and acquisitions due to the

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terms - which are not strictly needed here and which reduce the power of the test - were omitted.

[16] Source: Office of National Statistics. Disposals refers to the sale for any purpose of second-hand plant and machinery, including scrap: the nominal value of the latter is thought to be relatively small. Acquisitions relate to new and second-hand purchases of plant and machinery. Although similar data exists for buildings these data include land sales and purchases which make the figures difficult to interpret.

fact that acquisitions will proxy both the size and growth of the industry (the sum of depreciation and growth). As our interest is not in the dynamics we first time-average the data to obtain the mean for each industry of disposals (D_i) and of acquisitions (A_i). Disposals will also depend on the extent to which second-hand goods are marketable in the industry (M_i). Using initially a log-linear specification to illustrate:

$$d_i = b_o + b_1 a_i + b_2 m_i + e_i, \quad \ldots (6)$$

where e_i is an error term and lower case letters indicate logs.

Rewriting (6)

$$d_i - a_i = b_o + (b_1 - 1)a_i + b_2 m_i + e_i, \quad \ldots (7)$$

The M_i variable, of course, is unobserved and has to be estimated as a residual. As we have no strong priors as to the functional form of (7) we carried out non-nested testing of linear versus non-linear forms. We rejected the latter in favour of linearity using a range of tests implemented in Microfit 4, including the PE test (MacKinnon, White and Davidson 1983) and the BM test (Bera and McAleer 1989).

The residual from a linearised form of (7) is an estimate of the extent of second-hand markets for each 3-digit industry. Using a correspondence table it was then possible to derive measures for the set of CBI industries which comprise our sample. As there is no strong case for interpreting the residual as a cardinal measure, we use its reverse ranking as an ordinal measure of irreversibility ($irra_i$). As a measure for comparison we also compute the reverse ranking of the ratio of the raw time-averaged figures (D_i / A_i) . We call this unadjusted measure ($irrb_i$). All rankings are detailed in Appendix 4.

Next, we ran the plant and machinery panel regression for the full set of industries including both the uncertainty measure (unc) and the interaction of unc with the measure of irrevesibility (irra and irrb). The results are shown in Table 4.[17] There is clear significance for the interaction effect with irrb. It is signed negatively, in accordance with the prior expectation that greater irreversibility would strengthen the negative uncertainty effect. The interaction using the unadjusted ratio is significant only at the 10% level.

[Insert somewhere here Table 4]

We also experimented with the shorter panels for cases where the SUR results indicated negative or positive coefficients. For these panels we computed new rankings to reflect the fact that many industries were omitted. The results, reported in Table 4, are shown only for the adjusted closed- up reverse rankings (irrc). For the negative sample the interaction effect is significant at the 10% level and contributes to making the uncertainty effect more negative, the greater the uncertainty. For the positive coefficient set, by contrast, higher irreversibility appears to counteract the negative effect of uncertainty and this is highly significant - at the 1% level. It may be seen from the coefficients that the effect of uncertainty becomes positive when the closed up rank is greater than five. It should be noted however that there are only six rankings in all in this sample. The result here is consistent with higher irreversibility industries adopting phased approaches to investing. Under these conditions, higher uncertainty would possibly increase the case for immediate investment.

[17] Extra lags on unc do not contribute any explanatory power

6. Conclusions

In this paper we estimated investment authorisation equations for two classes of assets: plant & machinery and buildings. We compared the results using SUR and Panel estimation. Our focus is on a comparison of the magnitude, sign and significance of the uncertainty terms. We computed standardized coefficients and report the joint significance of the uncertainty term and two lags. We find that the effect of uncertainty is different between plant and buildings. Several results stand out. First there is greater heterogeneity in the building equations so that the whole panel results cannot easily be compared across assets. When both the asset panels are split into those industries with positive coefficients and those with negative coefficients, there is strong contrast between the asset classes for both panels. Specifically, the negative effect of uncertainty on plant and machinery investment is much greater than for building for those industries with negative coefficients in the SUR estimation. At the same time the positive effect of uncertainty is strongly significant for building and not significant for plant. These results give some support to the theory of deferment options operating more strongly in the case of plant and for expansion or compound options operating more strongly in the case of buildings. We hypothesized that for plant, investment would be less phased and more in the nature of a sunk cost than is the case for buildings. Both these characteristics weaken the abandonment option and effectively increase irreversibility. The results were qualified but not overturned when attention was confined to a more restricted set of industries comprising industries with common significant signs on the uncertainty coefficient across the two asset classes.

Finally some additional results were presented for plant and machinery for which it proved possible to interact a specially constructed industry-specific proxy for irreversibility with the industry-specific uncertainty term. This interaction was negative and significant in line with the expectation of real options theory that irreversibility should amplify the negative influence of uncertainty on fixed investment. For the smaller samples of industries identified in SUR estimation as having negative or positive uncertainty effects the interaction term was shown to amplify the negative influence in the case of the negative sample and to show a very significant positive interaction term in the case of the positive sample. The results here underscore those obtained from the comparison of the two asset classes. Here we are effectively comparing the effect of uncertainty across many (plant and machinery) assets. The results in Table 4 show that in general, the greater the irreversibility, the greater the negative effect of uncertainty. The results summarised in Table 2 gave little support for a positive role for uncertainty in the plant and machinery panels – even when attention was confined to those industries with positive coefficients in the SUR estimation. However for the results reported in Table 3, we do now find a positive and highly significant interaction term between irreversibility and uncertainty for exactly that sub-panel. This suggests that irreversibility may be attenuating the effect of uncertainty on plant and machinery investment in a small subset of industries.

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Figure 1: The q effect with fix costs and irreversibility.

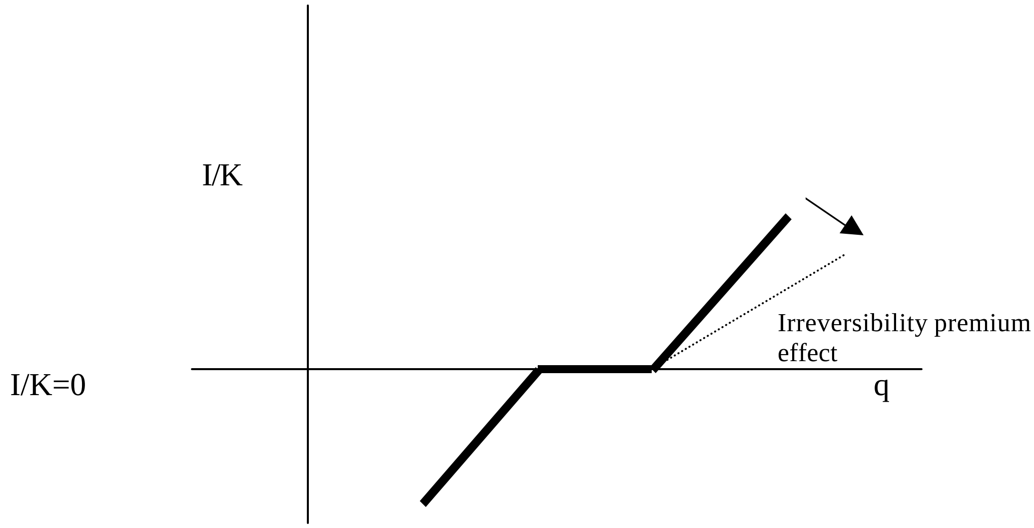

Table 1: Results of Panel Estimations a :Dependent Variable: Investment Authorisation

	Plant and Machinery	Buildings	Plant and Machinery		Buildings	
Model chosen	**Fixed Effects Model for total sample**	**Random-Effects Model for total sample**	**Random-Effects Model Industries with Negative Coefs. for Uncertainty Terms**	**Random-Effects Model Industries with Positive Coefs. for Uncertainty Terms**	**Random-Effects Model Industries with Negative Coefs. for Uncertainty Terms**	**Random-Effects Model Industries with Positive Coefs. for Uncertainty Terms**
Explanatory Variables [a]	**Standerdised Coef. [b] (t value) [c]**	**Standerdised Coef. (t value)**	**Standerdised Coef. (t value)**	**Standerdised Coef. (t value)**	**Standerdised Coef. (t value)**	**Standerdised Coef. (t value)**
Auth_1	0.29	0.28	0.37	0.21	0.28	0.18
	(16.95)**	(16.73)**	(8.20)**	(3.75)**	(8.55)**	(2.93)**
Auth_2	0.16	0.17	0.17	0.06	0.14	0.11
	(9.60)**	(10.04)**	(3.84)**	(0 .98)	(4.29)**	(1 .96)+
Opt	0.19	0.15	0.21	0.27	0.16	0.18
	(9.57)**	(6.93)**	(4.10)**	(3.93)**	(3.73)**	(2.41)*
Yfterm	0.04	0.03	0.08	0.08	0.03	-0.03
	(3.32)**	(2.08)*	(1.94)+	(1. 47)	(1 .12)	(-0.53)
Ybterm	0.07	0.08	0.03	0.06	0.08	0.01
	(4.72)**	(4.88)**	(0 .77)	(1. 10)	(2.59)**	(0. 14)
Ybterm_1	0.08	0.06	0.08	0.09	0.12	0.04
	(5.16)**	(3.82)**	(2.19)*	(1.72)+	(4.08)**	(0. 79)
Cuterm_1	0.08	0.07	0.10	0.11	0.12	0.20
	(2.36)*	(2.05)*	(1. 40)	(0. 98)	(2.04)*	(1. 69)+
Unc	**-0.04**	0.00	**-0.11**	-0.01	**-0.06**	0.08
	(-2.79)**	(-0.23)	**(-3.00)****	(0. 19)	**(-2.15)***	(1. 41)
Unc(-1)	-0.005	-0.01	-0.02	**0.08**	**-0.09**	**0.12**
	(-0.33)	(-0.42)	(-0.58)	**(1.73)+**	**(-3.07)****	**(2.35)***
Unc (-2)	0.01	0.02	**-0.07**	-0.03	-0.02	-0.01
	(0. 76)	(1 .12)	**(-2.06)***	(0 .59)	(-0.58)	(-0.10)
sum of unc, unc(-1), and unc(-2)	**-0.03**	**0.01**	**-0.20**	**0.04**	**-0.16**	**0.20**
Joint Significance Test for unc, unc(-1) and unc(-2) [d]						
$Chi^2(1)$	2.35	0.13	16.22**	0.44	17.13**	6.99**
Prob > Chi^2	0.13	0.72	0.0001	0.51	0.00	0.01
fi_1	-0.01	-0.018	0.04	0.08	-0.03	0.02
	(-0.88)	(-1.29)	(0 .98)	(1.81)+	(-0.31)	(0 .35)
Dlcu	-0.01	-0.02	-0.08	0.02	-0.14	-0.09
	(-0.18)	(-0.67)	(-1.16)	(0. 24)	(-3.17)**	(-0.86)
Constant	-6.85	-17.69	5.86	-17.37	-13.92	-65.50
	(-1.29)	(-4.46)	(0 .44)	(-0.97)	(-1.62)	(-3.23)
No. of Observations	3515	3515	546	378	1014	378
R^2	0.5007	0.393	0.5598	0.5785	0.4257	0.4944
Joint Significance Tests						
F Test (for fixed-effects model)	36.14**	-	-	-	-	-
Wald Chi^2 Test (for Random-effects model)	-	2192.68**	579.98**	395.29**	684.89**	281.68**

Tests for fixed/random effects						
Hausman Test for random effects model [e]	$Chi^2(82)$ =104.39**	$Chi^2(83)$ =63.67	$Chi^2(82)$ =8.16	$Chi^2(85)$ =13.76	$Chi^2(84)$ =35.99	$Chi^2(86)$ =5.73
Prob > Chi^2	0.048	0.9433	1.00	1.00	1.00	1.00
Test for Heterogeneity						
Breusch-Pagan Test of independence [f]	$Chi^2(861)$=904.006	$Chi^2(861)$=1015.72**	Chi^2 (21)=36.195*	Chi^2 (10)=13.615	Chi^2 (78)=79.179	Chi^2 (10)=13.996
Prob > chi2	0.1502	0.0002	0.0208	0.1913	0.4415	0.1732
The model the test favours	Panel	Unrestricted SURE	Unrestricted SURE	Panel	Panel	Panel

Note: [a] time dummies are included in the regression.

[b] Coefficient is Standardised coefficient which is defined as

Estimated coefficient * (standard deviation of explanatory variables/ standard deviation of investment authorisation)

[c] **= significant at 1 % level. *= significant at 5 % level. + = significant at 10 % level.

[d] Joint Test is carried out for the non-standardised coefficients for unc, unc(-1), and unc(-2).

[e] Hausman specification test examines the appropriateness of the fixed or random effects model. If the test shows a significant result, the fixed-effects model is chosen over the random-effects model.

[f] Breusch-Pagan test of independence tests the hypothesis that error terms of Unrestricted SUR Estimation with the same specification are contemporaneously uncorrelated.

Table 2: Results of Panel Estimations a Common case: the same set of industries for building and plant & machinery)

	Plant and Machinery		Buildings	
Model chosen	**Random-Effects Model Industries with Negative Coefs. (overlapping with the case of buildings) Standerdised Coef.** [b]	**Random-Effects Model Industries with Positive Coefs. (overlapping with the case of buildings) Standerdised Coef.**	**Random-Effects Model Industries with Negative Coefs. (overlapping with the case of buildings) Standerdised Coef.**	**Random-Effects Model Industries with Positive Coefs. (overlapping with the case of buildings) Standerdised Coef.**
Explanatory Variables [a]	**(t value)** [c]	**(t value)**	**(t value)**	**(t value)**
Auth_1	0.36	0.23	0.34	0.16
	(7.49)**	(3.48)**	(6.66)**	(2.12)*
Auth_2	0.17	0.02	0.07	0.09
	(3.53)**	(0 .24)	(1 .33)	(1 .35)
Opt	0.21	0.26	0.17	0.12
	(3.75)**	(3.31)**	(2.86)**	(1. 45)
Yfterm	0.08	0.08	0.06	-0.04
	(1.98)*	(1. 39)	(1 .38)	(-0.59)
Ybterm	0.06	0.04	0.04	0.02
	(1 .30)	(0. 62)	(0 .90)	(0. 26)
Ybterm_1	0.11	0.05	0.11	0.04
	(2.62)**	(0 .88)	(2.38)*	(0. 60)
Cuterm_1	0.07	0.19	0.09	0.28
	(0. 95)	(1. 48)	(1. 08)	(2.07)*
Unc	**-0.13**	0.02	**-0.16**	**0.11**
	(-3.47)**	(0. 27)	**(-3.80)****	**(1.77)+**
Unc(-1)	-0.01	**0.10**	-0.06	**0.13**
	(-0.23)	**(1.82)+**	(-1.45)	**(1.99)***
Unc (-2)	-0.06	-0.05	-0.03	-0.03
	(-1.61)	(0 .81)	(-0.80)	(-0.51)
sum of unc, unc(-1), and unc(-2)	**-0.21**	**0.07**	**-0.25**	**0.21**
Joint Significance Test for unc, unc(-1) and unc(-2) [d]				
$Chi^2(1)$	14.30**	0.85	17.72**	5.23**
Prob > Chi^2	0.0002	0.36	0.00	0.02
fi_1	0.03	0.05	-0.01	-0.01
	(0 .72)	(0 .94)	(-0.28)	(0 .19)
Dlcu	-0.08	-0.04	-0.08	-0.18
	(-1.09)	(-0.29)	(-1.05)	(-1.36)
Constant	5.86	-17.37	-13.92	-65.50
	(0 .31)	(-0.83)	(0. 94)	(-3.08)
No. of Observations	468	300	468	300
R^2	0.5782	0.5948	0.5093	0.5277
Joint Significance Tests				
F Test (for fixed-effects model)	-	-	-	-
Wald Chi^2 Test (for Random-effects model)	518.07**	308.31**	392.30**	234.62**

Tests for fixed/random effects				
Hausman Test for random effects model [e]	Chi^2(85) =7.84	Chi^2(85) =15.39	Chi^2(82) =9.78	Chi^2(82) =5.74
Prob > Chi^2	1.00	1.00	1.00	1.00
Test for Heterogeneity				
Breusch-Pagan Test of independence [f]	Chi^2 (10)=21.20*	Chi^2 (6)=13.10*	Chi^2 (10)=18.227+	Chi^2 (6)=9.636
Prob > chi2	0.0198	0.0415	0.0512	0.1408
The model the test favours	Unrestricted SURE	Unrestricted SURE	Unrestricted SURE	Panel

Note: [a] time dummies are included in the regression.

[b] Coefficient is Standardised coefficient which is defined as

Estimated coefficient * (standard deviation of explanatory variables/ standard deviation of investment authorisation)

[c] **= significant at 1 % level. *= significant at 5 % level. + = significant at 10 % level.

[d] Joint Test is carried out for the non-standardised coefficients for unc, unc(-1), and unc(-2).

[e] Hausman specification test examines the appropriateness of the fixed or random effects model. If the test shows a significant result, the fixed-effects model is chosen over the random-effects model.

[f] Breusch-Pagan test of independence tests the hypothesis that error terms of Unrestricted SUR Estimation with the same specification are contemporaneously uncorrelated.

Table 3: Summary Table: Effects of Uncertainty on Uncertainty Authorisation

	Whole Sample	Positive Unc Coefficients from SURE	Negative Unc Coefficients from SURE	Positive Common Cases	Negative Common Cases
Plant and Machinery					
Sum of Standardised Coefficients of *Unc, Unc(-1) and Unc(-2)*	**-0.03** [b]	0.04	**-0.20**	0.07	-0.21
[Chi^2 (1)] [a]	**[2.35]**	[0.44]	**[16.22]****	[0.85]	[14.30]**
(Prob> Chi^2)	**(0.13)**	(0.51)	**(0.00)**	(0.36)	(0.00)
Buildings					
Sum of Standardised Coefficients of *Unc, Unc(-1) and Unc(-2)*	0.01	**0.20**	-0.16	**0.21**	**-0.25**
[Chi^2 (1)]	[0.13]	**[6.99]****	[17.13]**	**[5.23]****	**[17.72]****
(Prob> Chi^2)	(0.72)	**(0.01)**	(0.00)	**(0.01)**	**(0.00)**

Note: [a] **= significant at 1 % level. *= significant at 5 % level. + = significant at 10 % level.
[b] Bold numbers indicate that the absolute values of sum of coefficients is greater than those in the corresponding case.

Table 4: Panel Estimations for Plant and Machinery

Model chosen	Fixed Effects Model for Total Sample	Fixed Effects Model for Total Sample	Random Effects Model for Industries with Negative. Coef. for SURE	Random Effects Model for Industries with Positive. Coef. for SURE
Explanatory Variables [a]	**Standardised Coef. [b] (t value) [c]**	**Standardised Coef. (t value)**	**Standardised Coef. (t value)**	**Standardised Coef. (t value)**
Auth_1	0.33	0.33	0.44	0.19
	(19.77)**	(19.77)**	(9.68)**	(3.48)**
Opt	0.18	0.18	0.12	0.30
	(8.64)**	(8.65)**	(2.05)*	(4.51)**
Yfterm	0.06	0.06	0.10	0.06
	(4.05)**	(4.07)**	(2.13)*	(1. 08)
Ybterm	0.06	0.06	0.01	0.07
	(3.97)**	(3.96)**	(0. 16)	(1. 29)
Ybterm_1	0.06	0.06	0.05	0.08
	(3.97)**	(3.96)**	(1. 14)	(1. 57)
Cuterm_1	0.14	0.14	0.36	0.15
	(3.86)**	(3.86)**	(3.23)**	(1. 36)
Unc	**0.04**	**0.01**	**-0.06**	**-0.03**
	(1. 14)	**(0 .36)**	**(-1.51)**	**(-0.64)**
Unc *irra [e]	**-0.15**	**-**	-	-
	(-2.41)**	**-**	-	-
Unc *irrb [f]	**-**	**-0.10**	-	-
	-	**(-1.54)**	-	-
Unc *irrc [g]	-	-	**-0.03**	**0.13**
	-	-	**(-0.88)**	**(3.08)****
fi_1	-0.02	-0.02	0.02	0.07
	(-1.23)	(-1.28)	(0. 43)	(1. 59)
Dlcu	-0.05	-0.05	-0.29	-0.01
	(-1.49)	(-1.50)	(-2.88)**	(-0. 05)
Constant	5.86	-6.85	-6.85	5.86
	(-2.87)	(-2.71)	(-2.49)	(-0. 91)
No. of Observations	3225	3225	468	378
R^2	0.4546	0.4641	0.5274	0.5862
Joint Significance Tests				
F Test (for fixed-effects model)	32.57**	32.50**	-	-
Wald Chi^2 Test	-	-	424.00**	410.75**
(for Random-effects model)				
Tests for fixed/random effects model				
Hausman Test for random effects model [g]	$Chi^2(82)$ =109.57*	$Chi^2(82)$ =101.84+	N.A.	$Chi^2(81)$ =5.46
Prob > Chi^2	0.0227	0.0681		1.00

Note: [a] time dummies are included in the regression.

[b] Coefficient is Standardised coefficient which is defined as Estimated coefficient * (standard deviation of explanatory variables/ standard deviation of investment authorisation)

[c] ** = significant at 1 % level. *= significant at 5 % level. + = significant at 10 % level.

[d] irra denotes the reverse ranking of industry based on the adjusted ratio of disposal and acquisition (d/a) defined as the residual in the regression where d/a is estimated by a and constant.

[e] irrb denotes the reverse ranking of industry based on the unadjusted ratio of disposal and acquisition (d/a). g.

[f] irrc denotes the closed-up reverse ranking of industry based on the adjusted ratio of disposal and acquisition within the negative or the positive sample (d/a)

[g] Hausman specification test examines the appropriateness of the fixed or random effects model. If the test shows a significant result, the fixed-effects model is chosen over the random-effects model.

APPENDIX 1: CBI Data

The Industrial Trends Survey

In this paper, we draw upon the Industrial Trends Survey carried out by the main employers' organisation, the Confederation of British Industry (CBI) with over 1000 replies on average each quarter. It has been published on a regular basis since 1958 and has been widely used by economists. Our panel data set is restricted to the period 1978 Q1 to 1999 Q1, since the question on authorisation of investment was added in 1978. The responses in the survey are weighted by net output with the weights being regularly updated. The survey sample is chosen to be representative and is not confined to CBI members

Survey Questions
CBI Industrial Trends Survey Questions

Question 1
Are you more, or less, optimistic than you were four months ago about the general business situation in your industry?

Ques*tion 3b*
Do you expect to authorise more or less capital expenditure in the next twelve months than you authorised in the past twelve months on: plant and machinery? (Possible Choices: 'More', 'Same' or 'Less')

Ques*tion 4*
Is your present level of output below capacity (i.e., are you working below a satisfactory full rate of operation)? ('Yes', or 'No')

Question 8
Excluding seasonal variations, what has been the trend over the PAST FOUR MONTHS, and what are the expected trends for the NEXT FOUR MONTHS, with regard to: Volume of output? ('Up', 'Same' or 'Down')

Question 16(c)
Part C of the question invites respondents to consider which factors are "expected to limit capital expenditure authorisations over the next twelve months". We aggregate the following reply categories

- a shortage of internal finance;
- an inability to raise external finance;

TABLE A1

CBI Table no		***1980 SIC codes***
22	Coal and petroleum products	1115,120,140,152
23	Extraction of minerals and metaliiferous ores	210,231,233,239
24	Ferrous metals	221,222,223
25	Non-ferrous metals	224
26	building materials	241,242,243,244,245,246
27	glass and ceramics	247,248
28	industrial chemicals	2511,2512,2514,2515,2516,2562,2564,2565,2567,2569
29	agricultural chemicals	2568,2513
30	pharmaceuticals and consumer chemicals	255,257,258,259
31	man-made fibres	260
32	foundries; and forging, pressing, stamping	311,312
33	metal goods nes	313,314,3162,3163,3164,3165,3166,3167,3169
34	hand tools and implements	3161
35	constructional steelwork	3204
36	heavy industrial plant	3205
37	agricultural machinery	321
38	metal working machine tools	3221
39	engineers small tools	3222
40	industrial machinery	323,324,327,3285,3286
41	contractors' plant	325
42	industrial engines, pumps, compressors	3281,3283,3287,3288
43	heating, ventilating and refrigerating equipment	3284
44	other mechanical engineering	326,3289,329
45	office machinery and data processing equipment	330
46	electrical industrial goods	341,342,343,3442,347,348
47	elctronic industrial goods	3441,3443,3444,3453
48	electrical consumer goods	346
49	electronic consumer goods	3452,3454
50	motor vehicles	351,352,353
51	Shipbuilding	361
52	aerospace and other vehicles	362,363,364,365
53	instrument engineering	371,372,373,374
54	Food	411,412,413,414,415,416,418,419,420,421,422,423
55	drink and tobacco	424,426,427,428,429
56	wool textiles	431
57	spinning and weaving	432,433,434
58	hosiery and knitwear	436
59	textile and consumer goods	438,4555,4557
60	other textiles	435,437,439,4556
61	Footwear	451
62	leather and leather goods	441,442
63	clothing and fur	453,456
64	timber and wooden products other than furniture	461,462,463,464,465,466
65	furniture, upholstery, bedding	467
66	pulp,paper, and board	471
67	paper and board products	472
68	printing and publishing	475
69	rubber products	481 and 482
70	plastics products	483
71	other manufacturing	491,492,493,494,495

APPENDIX 2: Derivation of the Investment Intentions Specification and variable definitions

The specification is an extended form of Driver and Moreton (1992, Chap. 8). As in Driver and Moreton, our investment equation draws upon a common specification with the flexible accelerator derived as an optimal response to adjustment costs. In our accelerator specification, we include the variable on uncertainty to investigate the effect of uncertainty on investment authorisation.

We express a log-linear accelerator equation linking investment authorisatons (A) to output change (ΔY) as:

$$\Delta \log A = b_0 + b_1 \Delta \log \Delta Y + ECT + e$$

where ECT is an error correction term and e is an error term.

Using a Taylor expansion we note that $\Delta \log (\Delta Y)$ may be proxied as follows.

$$\Delta \log (\Delta Y) = \Delta \log (Y) + \Delta\Delta \log(Y)$$

Using the survey balances to proxy growth rates (See McAleer and Smith 1995), this may be written as:

$$Auth = b_0 + b_1[BAL(Y) + \Delta BAL(Y)] + ECT + e \quad \text{(A1)}$$

where Auth is, as in the text, the balance statistic (more minus less) for investment authorisation responses (Plant and Machinery) and BAL(Y) represents the balance of output responses .

The error correction term ECT may be written as a lag of $\log (\Delta Y^*/\Delta Y)$
where Y* is maximum or potential output. Using a Taylor expansion this term may be expressed as

$$\log (Y^*/Y) - \Delta \log(Y/Y^*) = -[\log(CU) + \Delta \log(CU)] \quad \text{(A2)}$$

where CU is the percentage of firms reporting capacity utilisation above normal (% answering "NO" to question 4 of the Industrial Trends Survey which reports

Thus, the final specification is:

$$Auth = b_0 + b_1 yterm + b_2 cuterm\ (-1) + e \quad \text{(A3)}$$

where yterm and cuterm are the square bracketed terms in (A1); (A2) respectively: and where the sign on b_2 is expected to be positive.
(A3) can be directly estimated by the CBI survey data. In the reduced form of equation which is estimated, we further assume that investment authorisation is affected by the lagged authorisation ($Auth_{t-1}$), the measure of being optimistic about the general business situation (opt), the degree of uncertainty (unc), the current value of the differentiated log terms in capacity utilisation (dlcu) and the lagged expectation of financial constraint (fi). Since the CBI survey have two kinds of information on output, that is the forward-looking term and the backward-looking term (see Question 8 in the Appendix 1), our model includes both forward and backward terms of yterm, denoted by yfterm and ybterm respectively. We include only the current value of yfterm and both the current and lagged values of ybterm in our specification. The reduced form of equation which is estimated and used in the text is:

$$Auth_{it} = b_0 + b_1 Auth_{i,t-1} + b_2 opt_{it} + b_3 yfterm_{it-j} + b_4 ybterm_{it} + b_5 ybterm_{it-1}$$
$$+ b_6 cuterm_{i,t-1} + b_7 unc_{i,t} + b_8 dlcu_{it} + b_9 fi_{i,t-1} + e_{it} \quad \text{(A4)}$$

Appendix 3 Summary Statistics on Unrestricted SURE Results

CBI classification and Industry

		Plant & Machinery		Buildings	
		R^2	DW	R^2	DW
24	Ferrous metals	0.63	1.85	0.56	1.90
25	Non-ferrous metals	0.49	1.79	0.34	2.15
26	Building materials	0.71	2.15	0.56	1.80
27	Glass and ceramics	0.81	2.25	0.77	2.05
28	Industrial chemicals	0.57	2.04	0.46	2.04
30	Pharmaceuticals and consumer	0.42	2.11	0.41	1.86
32	Foundries; and forging, pressing and	0.67	2.11	0.68	2.00
33	Metals goods n.e.s.	0.77	2.28	0.65	1.87
34	Hand tools and implements	0.69	2.20	0.61	2.19
35	Constructional steelwork	0.66	2.13	0.44	1.88
36	Heavy industrial plant	0.19	2.08	0.14	2.09
37	Agricultural machinery	0.51	1.80	0.28	1.92
38	Metal working machine tools	0.54	2.23	0.47	2.13
39	Engineer's small tools	0.63	1.79	0.62	2.11
40	Industrial machinery	0.50	2.46	0.54	2.20
41	Contractors' plant	0.63	1.58	0.61	1.99
42	Industrial engines, pumps and	0.52	1.69	0.39	2.04
43	Heating, ventilating and refregiating	0.53	2.17	0.51	1.73
44	Other mechanical equipment	0.73	2.13	0.47	1.99
46	Electrical industrial goods	0.39	2.02	0.24	2.29*
47	Electronic industrial goods	0.41	2.21	0.29	1.99
48	Electrical consumer goods	0.58	1.90	0.34	2.11
49	Electronic consumer goods	0.35	1.99	0.28	1.79
50	Motor vehicles	0.58	2.28	0.40	2.02
52	Aerospace and other vehicles	0.38	1.89	0.42	2.06
53	Instrument engineering	0.41	1.83	0.31	2.24
54	Food	0.34	2.25	0.49	2.25
55	Drink and Tabacco	0.26	1.86	0.26	1.89
56	Wool textiles	0.58	2.19	0.59	2.01
57	Spinning and weaving	0.69	1.64	0.38	1.84
58	Hosiery and knitwear	0.51	1.69	0.28	2.04
59	Textile consumer goods	0.38	2.21	0.48	1.98
61	Footwear	0.54	2.27	0.48	2.33
62	Leather and leather goods	0.67	2.04	0.67	2.05
63	Closing and fur	0.63	2.02	0.61	1.90
64	Timber and wooden products other	0.69	1.99	0.70	1.94
65	Furniture, upholstery and bedding	0.68	2.25	0.65	2.39
66	Pulp, paper and board	0.52	1.95	0.38	1.92
67	Paper and board products	0.51	2.05	0.50	2.10
68	Printing and publishing	0.56	2.35	0.40	1.92
69	Rubber products	0.58	2.00	0.57	2.23
70	Plastic products	0.61	2.06	0.51	2.15

Appendix 4 Composition of Panels and Ranking of D/A (disposal and acquisition ratio) at Industry Level

	*CBI classification and Industry**	Industries with Negative and significant Coefficient in SURE estimation Estimation for Plant & Machinery Investment	Industries with Positive and significant Coefficient in SURE estimation Estimation for Plant & Machinery Investment	Industries with Negative and significant Coefficient in SURE Estimation for Building Investment	Industries with Positive and significant Coefficient in SURE estimation Estimation for Building Investment	Reverse Ranking of D/ A (irra)[*a]	Reverse Adjusted Ranking of D/A (irrb)	Reverse Adjusted closed-up Ranking of D/A (irrc) : The Sample with Negative coefs. in SURE	Reverse Adjusted closed-up Ranking of D/A (irrc) : The Sample with Positive coefs. in SURE
23	Coal and petroleum product					**30**	**19**	**-**	**-**
24	Ferrous metals					**43**	**44**	**-**	**-**
25	Non-ferrous metals					**40**	**34**	**-**	**-**
26	Building materials			**X**		**38**	**37**	**-**	**-**
27	Glass and ceramics					**41**	**38**	**-**	**-**
28	Industrial chemicals			**X**		**24**	**45**	**-**	**-**
30	Pharmaceuticals and consumer chemicals	**X**		**X**		**39**	**41**	**5**	**-**
32	Foundries; and forging, pressing and stamping					**31**	**24**	**-**	**-**
33	Metals goods n.e.s.			**X**		**14**	**23**	**-**	**-**
35	Constructional steelwork	**X**		**X**		**12**	**9**	**2**	**-**
36	Heavy industrial plant			**X**		**13**	**10**	**-**	**-**
37	Agricultural machinery					**42**	**36**	**-**	**-**
38	Metal working machine tools					**2**	**2**	**-**	**-**
39	Engineer's small tools		**X**			**3**	**3**	**-**	**1**
40	Industrial machinery					**9**	**20**	**-**	**-**
41	Contractors' plant					**6**	**4**	**-**	**-**
42	Industrial engines, pumps and compressors		**X**		**X**	**19**	**27**	**-**	**3**
43	Heating, ventilating and refregiating equipment			**X**		**20**	**28**	**-**	**-**
44	Other mechanical equipment				**X**	**11**	**25**	**-**	**-**
45	Office machinery and data processing					**21**	**16**	**-**	**-**
46	Electrical industrial goods					**10**	**31**	**-**	**-**
47	Electronic industrial goods		**X**		**X**	**23**	**30**	**-**	**5**
48	Electrical consumer goods					**44**	**-**	**-**	**-**
49	Electronic consumer goods		**X**		**X**	**22**	**22**	**-**	**4**
50	Motor vehicles					**18**	**43**	**-**	**-**
51	Shipbuilding					**15**	**11**	**-**	**-**
52	Aerospace and other vehicles					**36**	**33**	**-**	**-**
53	Instrument engineering					**27**	**21**	**-**	**-**
54	Food	**X**		**X**		**26**	**39**	**3**	**-**
55	Drink and Tabacco	**X**		**X**		**34**	**35**	**4**	**-**
56	Wool textiles					**8**	**7**	**-**	**-**
57	Spinning and weaving	**X**				**7**	**5**	**1**	**-**
58	Hosiery and knitwear			**X**		**1**	**1**	**-**	**-**
59	Textile consumer goods					**37**	**29**	**-**	**-**
61	Footwear					**33**	**17**	**-**	**-**
62	Leather and leather goods					**32**	**14**	**-**	**-**
63	Closing and fur					**17**	**12**	**-**	**-**
64	Timber and wooden products other than furniture		**X**		**X**	**16**	**13**	**-**	**2**
65	Furniture, upholstery and bedding					**25**	**15**	**-**	**-**
66	Pulp, paper and board	**X**		**X**		**45**	**42**	**6**	**-**
67	Paper and board products			**X**		**5**	**6**	**-**	**-**
68	Printing and publishing					**4**	**8**	**-**	**-**
69	Rubber products	**X**		**X**		**-**	**-**	**-**	**-**
70	Plastic products					**28**	**32**	**-**	**-**

*Industries that are omitted from the table are those with missing observations for either CBI survey data for the data on disposal or acquisition.