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Transaction Costs and Profitability in UK Manufacturing

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Abstract:

This paper explores the impact of transaction costs on performance at firm and industry levels using a sample of 7350 UK manufacturing firms. This is achieved by estimating a profit function with estimated transaction costs as a right hand side variable. The discussion has two specific objectives. (1) To show how firm and average industry transaction costs can be estimated using a stochastic frontier method. (2) To examine a central claim of transaction cost theory that links these costs to performance. In addition the different impacts of static and dynamic transaction costs are emphasised, with the different impacts being respectively negative and positive on profitability. Broadly speaking it is shown that such costs do impact on performance in a way consistent with both static and dynamic costs, in different industries, and that the impacts hold after a series of robustness checks. In addition it is shown that the impacts can depend on monopoly power, firm scale, and firm growth.

Key words: transaction costs, stochastic frontier analysis, profitability analysis, UK manufacturing.

JEL: C21, D23, L60

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Introduction

A long tradition exists in industrial organisation (IO) literature that links firm structure and development to transaction cost (TC) factors, for instance: vertical integration (Williamson 1971, 1975; Lieberman 1991), diversification (Williamson 1975, 1981; Teece 1980, 1982), and multinational development (Williamson 1985; Buckley and Casson 1976; McManus 1972; Hennart 1982). It is pertinent to recognise that these firm structure characteristics are, in other contexts, determinants of market structure. Analysing the possible linkages between such market structure characteristics and profitability has an even longer IO tradition, based on an SCP logic, starting with Bain (1951, 1956). In terms of empirical work this latter tradition involves estimating profit functions with various right hand side market structure variables. It follows that in principle these two traditions might be linked: TCs might be viewed as part of a market's fundamental demand-supply characteristics, along with for example technology and elasticity factors, that (in the long-run) influence market structure and hence conduct and performance. This suggests a standard profit function might be estimated with TCs on the right hand side.

This paper explores this linkage in the context of UK manufacturing firm and industry data. An initial issue that perhaps explains why a TC based profit equation has not apparently been attempted, is that TCs are rarely measured. Buckley and Chapman (1997), for example, claim that TC thinking is often formulated in a manner that places it outside the domain of quantification. For this apparent reason they are usually asserted, proxied or imputed. In core IO discussion two characteristic ways seem to exist that adds an empirical perspective to TC discussion. First, examples or cases are provided. In this tradition Williamson (1985) analyses the (non)occurrence of vertical integration in the context of Kodak. More recently the General Motors integration with Fisher Body in 1926 has been the subject of considerable discussion (for example Klein 2000; Coase 2000; Freeland 2000). Examples are useful for illustrative purposes but rarely is there an attempt to refute their relevance. This is one part of Coase's (2000, 2006) criticisms of a "hold-up" (i.e. TC) explanation of the General Motors case. The second core IO empirical tradition is econometric. Here investigation is based on identification of key variables suggested by TC theory, e.g. asset specificity and uncertainty. For example Monteverde and Teece (1982) and Lieberman (1991) in their analyses of vertical integration and Armour and Teece (1978) and Steer and Cable (1978) on the "M" form hypothesis use proxy or imputed variables. This second line of approach is clearly informative. But in a strict sense it can only generate conclusions that suggest consistency between TC theory and evidence. In principle other explanations might exist that are consistent with the econometric results.

Outside the core IO literature there is relevant work undertaken in the area of agricultural economics. Three particular traditions appear to exist here. First, Hobbs (1997) has used questionnaire based surveys to assess the level and significance of TCs. In the current context the opportunity costs of this approach is prohibitive if the intention is to duplicate the coverage used here involving 7350 firms. The second agricultural economics empirical TC tradition involves analysis of international and local price bands (for example De Janvry et al, 1991). While this approach yields useful results in the analysis of agriculture, extension of the method beyond this industry would seem to be problematic. Finally, Key et al (2000) estimate production and consumption functions and use results to analyse the impact of TCs. This latter approach is developed in the current study and extended beyond agricultural economics.

Given this background it is now possible to specify the objectives of this paper:

1. To estimate firm and average industry TCs in a way that is not restricted to particular industries.
2. To examine a central claim of TC theory that links TCs to performance (profitability) i.e. estimate profit equations with firm and industry TCs as right hand side variables.

An important introductory issue involves defining TCs. Usually these are compared to friction in the physical sciences: the costs of search, negotiation and policing involved with the production and exchange of goods and services (Arrow 1974). More specifically (from Williamson, 1985) TCs are:

1. "Maladaption" costs with inefficient transactions.
2. "Haggling" and "bonding" costs.
3. Set-up and running costs of organisations.

How this definition is rendered operational is considered below.

There are two distinct approaches or methodologies adopted by TC writers. First there is what is often called static TCs, as exemplified in the writing of Williamson (1985, 1991) as well as much of the earlier cited TC literature. Here the reasoning is equilibrium based (Dietrich 1994, 2007) with increases in TCs reducing firm profitability. It follows that static TC theory views profit oriented decision makers as having an incentive to minimise TCs. The second approach is often labelled dynamic

TC analysis (e.g. Langlois 1992; Langlois and Robertson 1995). This is based on process, or neo-Austrian, reasoning. Management capacity and organisational slack is required to plan and enact firm change. It follows that increasing TCs increases firm profit opportunity. But this positive effect of TCs on profitability may be bounded, i.e. a "Penrose effect" (after Penrose's 1959 analysis of firm growth) may apply with dynamic diminishing returns to management. This possibility is examined later with a quadratic form on the TC explanatory variable. In addition later discussion will attempt to identify the relevance of these two distinct TC approaches.

An important issue exists with empirical development of these abstract ideas. There is often a comparison (sometimes implicit) with perfect markets for which TCs are zero. In practice TCs for a firm can never be zero as there is always a need for some minimum level of management/organisation costs and some slack. This minimum requirement defines a lower bound to firm TCs. Using standard TC reasoning, this lower bound is likely to be industry specific and dependent on factors such as necessary asset specificity and uncertainty. If firm TCs are less than this lower bound a firm is not viable. The linkages (either positive or negative) between TCs and firm profitability apply above this lower bound. Among other things this suggests an appropriate estimating technique that recognises this bound.

The rest of the discussion is organised as follows. In the next section it is shown how stochastic frontier analysis can be used to estimate firms TCs, where these are viewed as management and slack above a necessary industry specific minimum bound. Following this the discussion turns to the data and empirical method that is used in this study. The next section reports results for profitability equations that include industry and firm TCs as right hand side variables. Following discussion of the first set of results, further analysis is undertaken to control for non-identifiable fixed effects on profitability, the possible endogeneity of TCs and possible spurious correlation via left hand side and right hand side denominators. Finally the paper ends with general discussion and a conclusion.

Measuring firm transaction costs

A measure of transaction costs for firm i (TC_i) is required, and to control for firm size this is expressed as a proportion of firm revenue (TC_i/R_i) i.e. we need to measure transaction cost intensities analogous to that used in the analysis of advertising. To measure TCs in this way we can initially define a trans-log stochastic frontier model with inputs labour (L) and capital (K) that generate firm revenue (R)

$$\ln R_i = a_0 + a_1 \ln L_i + a_2 \ln K_i + a_3(\ln L_i)^2 + a_4(\ln K_i)^2 + a_5 \ln L_i \ln K_i + v_i - u_i \qquad [1]$$

Any stochastic frontier model such as [1] is based on an asymmetric total residual ($v_i - u_i$) (Kumbhaker and Lovell, 2000). The conventional residuals are $v_i \rightarrow N(0, \sigma)$. The u_i measure the (in)efficiency of firm i, i.e. the distance from the productive frontier. In terms of TC language this distance from the frontier is above necessary management and "maladaption" costs. To estimate u_i three possible distributions are characteristically used: half normal: $N^+(0, \sigma)$, exponential and truncated normal. The work reported below initially estimated u_i for all three distributions. But estimation of truncated normal efficiency terms was not effective.[1] Hence the results reported below use half normal and exponential distributions for u_i.

[1] With truncated normal u_i the maximum likelihood iterations were frequently either non-concave or did not converge. In addition when estimation of u_i was possible the estimates were frequently unrealistically small compared to half normal and exponential formulations as reported below.

Stochastic frontier modelling, such as formulation [1], is now the standard econometric method of efficiency analysis and is arguably superior to alternative parametric and non-parametric methods (Greene, 2007). This is the case for two broad reasons. First, the inclusion of standard residuals (v_i) allows for data noise in a way that cannot be accommodated with non-parametric methods. Secondly, the explicit modelling of firm efficiency (u_i) allows efficiency to impact on all estimated coefficients which is not the case with other parametric methods.

With cross section data, as used here, effective stochastic frontier estimation requires independence of v_i and u_i. This assumption appears to be empirically valid with the results reported below. With a cross section – time series panel this assumption is not necessary. But a panel based method is deemed inappropriate for current purposes. The present analysis is based on 7350 UK manufacturing firms that existed in both 2003 and 1998 (the reason for this earlier year is explained below). This data set covers the full firm size range, and hence allows an effective analysis, of for example market structure impacts, than a more restricted sample of larger firms. Part of the validation analysis undertaken here involves projecting forward to 2004 for the 2003 sample. This reduces the data set from 7350 to 4680 firms. The 2670 "lost" firms are primarily small and medium sized and occurs because of data availability as well as real firm exit which itself is greater for small rather than larger firms. It follows that a panel data set covering the full firm size range would be highly unbalanced for small and medium sized firms, with obvious impacts on estimation effectiveness. Alternatively an (approximately) complete panel must be firm size restricted given the data source discussed shortly. It follows from these comments that the data set used here identifies the significance of issues involving the (approximate) full firm size range e.g. market concentration effects, but is silent on other issues e.g. dynamic effects which are left for later work.

Using the stochastic frontier model specified in [1] we can define the degree of efficiency (e) of the i'th firm

$$e_i[0,1) = \exp(-u_i) = \frac{R_i}{R_i^{FR}} \qquad [2]$$

where R_i^{FR} is notional frontier revenue for firm i, i.e. with $u_i = 0$.

Using [2] it follows that

$$1 - e_i = \frac{R_i^{FR} - R_i}{R_i^{FR}} \qquad [3]$$

In [3] $R_i^{FR} - R_i$ is a monetary measure of TCs (above the necessary minimum) in terms of an imputed opportunity cost of "unexploited" firm revenue. This claim that $R_i^{FR} - R_i$ is an empirical measure of TCs is arguably consistent with the definition offered above that TCs are (1) "maladaption" costs with inefficient transactions; (2) "haggling" and "bonding" costs; and (3) set-up and running costs of organisations. With the qualification that all these costs are those above the necessary minimum.

It follows that we can re-write [3] as

$$1 - e_i = \frac{TC_i}{R_i^{FR}} \qquad [4]$$

In [4] the denominator is not a measure of actual firm size. So we can define:

$$\frac{1 - e_i}{e_i} = \frac{TC_i}{R_i^{FR}} \div \frac{R_i}{R_i^{FR}} = \frac{TC_i}{R_i} \qquad [5]$$

The formulation in [5] is our required measure of firm TC intensity.

Data and empirical method

The first stage of the empirical method involves estimation of trans-log stochastic frontier functions as specified in [1] at two digit UK industry level for 2003. R_i, L_i and K_i are respectively firm turnover, number of employees and total assets. The data is extracted from the common data source Financial Analysis Made Easy (FAME). For reasons set out below a common data set for 1998 is also needed. The total number of firms involved is 7350 in SICs 20-36 i.e. most UK manufacturing. SICs 23 and 37 are excluded because of insufficient firms in both 1998 and 2003 for effective stochastic frontier estimation. For each of the 16 two digit industries, using 2003 data stochastic frontier models were estimated, with u_i being estimated as both half normal and exponential distributions. Hence a total of 32 separate production functions were estimated using standard STATA routines. For reasons set out below an equivalent set of production functions is required using 1998 data. The method used here is therefore based on estimating 64 stochastic frontier production functions.

The stochastic frontier regressions are well specified (full details are available from the author). The only significant issue is a requirement to control for heteroskedasticity in u_i. This is a common issue and reflects a firm size impact on the extent of inefficiency (Kumbhaker and Lovell, 2000). Intuitively, larger firms can be more inefficient in absolute terms. Effective estimation therefore required modelling u_i in each industry as a linear function of a firm's capital:labour ratio. Post-estimation involves predicting e_i as defined in [2] and following this TC_i/R_i as defined in [5] can be calculated. The various firm TC estimates calculated at the two digit level are collected into the full data set involving 7350 firms.

Table 1 here: see end

The general sample data characteristics at the industry level for 2003 are shown in table 1. The key characteristics can be highlighted as follows. The two final columns show industry median estimates for TC intensity with half normal and exponential distributions for u_i.[2] These TC estimates clearly differ by industry, hence we might conclude the somewhat standard matter that industry specific determinants exist. In addition the average exponential estimates are consistently less than the half normal estimates, also a somewhat standard finding (Greene, 2007). Table 1 also shows that the industries differ in their numbers equivalent Herfindahl index and profit per employee, both of which is to be expected. The reason for using profit per employee is considered below.

Tables 2a and 2b here: see end

Tables 2a and 2b show correlation matrices at respectively industry and firm levels for key variables to be used here. Note that the firm level equivalent of the numbers equivalent Herfindahl index is taken to be a firm's market share, but a <u>reduction</u> in 1/H requires an <u>increase</u> in large firm market share. The only real similarity between the two correlation matrices is that profit per employee and exponential estimates of TCs appear to be positively correlated at both industry and firm levels. Apart from π/L and TCe the other correlations at industry and firm levels are somewhat different. This suggests that an adequate analysis of profitability variation should take account

[2] It can be noted that the TC estimates reported in table 1are of the same order as those reported by Wallis and North (1986). The latter authors use a different methodology, they simply add up what they consider to be resources used in transaction industries. Their results show that TCs have grown from 25% of GNP in 1870 to 45% in 1970.

of both levels. This reflects the long standing finding that intra-industry variability in profitability and its determinants is as important as inter-industry variability (for example Ravenscraft 1983, Mueller 1986, Hall and Weiss, 1967).

In table 2b we can recognise the small but positive correlation between K/L and π/L. This correlation may be driven by the common denominators (i.e. number of employees in both cases), but the low value indicates this may not be the only explanation. A similar possibility of spurious correlation might also exist between π/L and TC intensity: employment is an input into the 2003 production function that generates 2003 revenue. But the difference between the (π/L, TCh) and (π/L, TCe) coefficients is informative in this regard. If the small but positive correlation between π/L and TCe is driven by the denominators we might expect this to also be the case for the (π/L, TCh) correlation, but the latter is effectively zero. In addition it is standard in the analysis of, for example, advertising's impact on profitability to measure advertising as a proportion of revenue and profitability as, for example return on sales or capital (see, for example, the seminal work of Comanor and Wilson 1967, and the system based analysis of Geroski 1982). This standard analysis of advertising appears not to be concerned with the "denominator effects" suggested here, even though some time ago it was recognised that spurious relationships may be identified (Miller, 1969). Finally, any spurious correlation between π/L and TC/R requires assumptions about firm and average industry K/L. In short we can be aware of the possibility of spurious correlation involving denominators, but this preliminary discussion indicates that any such problem is possibly not significant. Separating potential spurious correlation from a more substantive impact of TCs on profitability is part of the analysis undertaken below. In general terms later analysis confirms this earlier discussion and indicates that the “denominator problem” appears not to be significant.

Transaction costs and profitability

Analysis of the relationship between profitability and TCs is undertaken in two stages. First, profit functions are estimated with control variables and TC variables at industry and firm levels. Following this the validity of the basic relationships identified in the first stage is explored to take account of (1) non-identifiable determinants of profitability; (2) the possible endogeneity of TCs and (3) the possible spurious positive correlation between profitability and TC intensity through the denominators of the ratios used.

In all regressions estimated here profitability is measured as profits per employee. In the industrial organisation field, return on sales is a common measure of profitability because, among other reasons, this is derived as a left hand side variable in theoretical profit equations based on standard oligopoly models. This is not used here for two reasons. First this would introduce potentially spurious correlation because the denominators of profit and TC ratios would the same. Secondly, organisational problems are largely caused by human interaction and the management of employees. Hence in this context firm performance can track these issues if profitability is measured per employee. In all the regressions estimated here profit is measured as firm profit before tax.

Three control variables are used in the profit equations:

1. Firm 2003 capital:labour ratio. Capital is measured as total firm assets and labour as the number of employees. This is intended to track potential scale effects on profitability. But in later discussion this variable is used, in addition, for other purposes.

2. Firm sales growth over the five year interval 1998-2003 i.e. $(R_{2003})/(R_{1998})$. It is anticipated that sales growth positively impacts on profitability.

3. Firm 2003 market share i.e. the ratio of firm sales to total sales of all firms at the two digit industry level. This is intended to track potential monopoly effects on profitability.

Quadratic effects are introduced when significant to track possible non-linear relationships on profitability.

Table 3 here: see end.

Table 3 reports the firm level profit regression with only the control variables. The negative coefficient on revenue growth is counter intuitive and should be seen in the light of later discussion, as is also the case with the insignificant estimate for market share. The significant quadratic effect with K/L has a maximum at K/L = 72165, derived by differentiating the quadratic and setting the first derivative equal to zero. This maximum K/L impact is considerably outside the K/L data range, hence we can conclude that the quadratic relationship is monotonically positive but with diminishing effect on profitability. Literature on firm growth and profitability in the UK (for example, Dunne and Hughes 1994) indicates declining firm profitability with increased firm size. One interpretation of the result here is that the monotonically positive relationship is tracking the denominators of the K/L and π/L ratios but the diminishing effect is countering this automatic correlation in a way that is consistent with the wider literature.

Table 4 here: see end.

Table 4 reports the first set of estimates that include TC variables. These first results identify TC effects at the industry level. Firm specific impacts are introduced below. The intention here is to examine the sign of the relationship between TCs and profitability, and in addition the possible existence of a "Penrose effect" with a positive relationship. For this reason a full set of quadratics on TC/R are included. In table 4 TC effects are introduced as industry slope dummies. The quadratic TC/R is the first set of columns reflects the impact of the omitted dummy (SIC22). In the standard way, the industry slope dummies therefore reflect the additional effects. An equivalent set of industry intercept dummies were also included but the results are of secondary importance and so are not reported here. It is clear that the introduction of industry TC effects has a significant impact on overall explanatory power, as indicated by the adjusted R^2 compared to table 3. In addition it is clear that the TC impacts on profitability are consistent with both positive and negative industry specific impacts; a more detailed analysis is undertaken shortly. Of course the positive relationships may result from "denominator effects", but at this stage we can draw the potential conclusion that effects of both signs might exist. With respect to the control variables in table 4, for K/L and revenue growth the estimates are equivalent to those reported in table 3. But the market share effects are different. Although insignificant, the estimated minima occur at market shares of 0.15 and 0.11 for respectively the half-normal and exponential estimates. This indicates that increasing market share has a positive impact on profits only for the largest firms.

The formulation reported in table 4 implicitly assumes that (1) all firms (in an industry) have the same incentive to reduce TCs; and (2) have the same opportunities to invest in dynamic TCs. Or more probabilistically, the incentives and opportunities are randomly associated with firm types. But the correlation matrices reported in tables 2a and 2b indicate that firm and industry effects appear different. In which case the implicit assumptions in (1) and (2) need not be valid. To examine the possibility that TC incentives and opportunities are systematically related to particular firm types, as well as TCs having industry specific impacts, we can hypothesise that incentives and opportunities depend on three factors: (1) monopoly power, defined by market share at the two digit level; (2) firm sales growth, as defined earlier; and (3) technical conditions of production, as proxied by firm K/L. It follows that these three factors will have direct effects on π/L (as control variables) and potential indirect effects with π/L that interact with TC/R. The results of introducing both industry and firm specific TC effects in this way are reported in table 5.

Table 5 here: see end.

When tables 4 and 5 are compared it is clear that the interaction terms have a significant impact on overall explanatory power, particularly for the exponential TC cost regression. With respect to the direct effects of the control variables, K/L has the same qualitative impact as in table 4, as does the effect of market share on profitability. But we can see that revenue growth has the intuitively expected positive direct impact on profitability via the squared term (the linear term is zero). It is interesting that the identification of this expected effect requires the use of the TC interaction terms that are intended to track firm specific managerial incentives and opportunities.

Table 6 here: see end.

The industry specific TC impacts on profitability, not reported in table 5, are summarised in table 6. Here there is an assumed relevant range for a firm's TC intensity that has an upper bound of one. With this bound the quadratic TC effects in table 5 define three general effects: monotonic positive, monotonic negative and inverted U. It is clear that there is evidence for both static TCs (i.e. a monotonic negative impact) and dynamic TCs (i.e. a monotonic positive impact). The exponential estimates, for which TC/R are smaller (see table 1), show a lower incidence of dynamic TCs. This is consistent with the planning and management of change requiring a certain degree of organisational excess capacity, along the lines suggested by Penrose (1959).

Finally, with respect to table 5, we can make reference to the interaction effects. All interpretation of these interaction terms are restricted to the relevant data ranges. For the (TC/R, Rev Gr) terms, it is apparent that slower firm growth increases the positive impact of TCs on profitability (or reduces the negative impact), a result that is the same for both TC measures. A possible interpretation here is that firm growth impacts on development incentives. For the (TC/R, Share) terms, the results imply that increased market share increases the positive impact of TCs on profitability, but with diminishing effect. This effect is consistent with both TC measures. A possible interpretation here is that monopoly power increases dynamic incentives and abilities, along the lines suggested by Schumpeter (1942) and Galbraith (1967). Alternatively we might suggest that reduced monopoly power increases TC economising incentives and hence the relevance of static TC analysis. For the (K/L, TC/R) terms the results also show the same impact for both TC measures. We can summarise this impact as follows: increased capital intensity increases the negative impact of TCs on profitability (over the relevant range for K/L). Or equivalently, reduced scale of production increases the dynamic TC effects on profitability. A possible interpretation here involves the flexibility advantages of smaller scale production. Note that this effect cannot be accounted for by denominator spurious correlation.

<u>Transaction costs and profitability: further analysis</u>

This section of the paper introduces three possible qualifications to the results identified in the previous section:

1. Many effects on profitability cannot be readily identified hence the earlier results may suffer from missing variable bias. An attempt will be made to control for any missing variables by first differencing the profit equation over the interval 1998-2003. The intention here is to remove any non-identifiable fixed effects on profitability.
2. The second complexity introduced here involves accounting for the possible endogeneity of TCs. This involves estimating a TC equation and using predicted TC/R in the profit equations rather than actual TC/R.
3. Finally an attempt will be made to control for any "denominator effects" that might be introducing spurious correlation. These "denominator effects" of TC/R on π/L potentially operate via the 2003 production function i.e. increasing 2003 L

automatically increases 2003 R. To control for this possible effect 2003 right hand side variables will be used to explain 2004 π/L.

Tables 7a, 7b here: see end.

Tables 7a and 7b report first difference regressions for the interval 1998-2003. In these regressions the interaction terms have been omitted because their interpretation is difficult with a first difference model. As the interaction terms were included to track firm, rather than industry, specific effects, their omission implies that a first differenced model can be used to analyse industry specific TC effects. If the firm specific effects are constant over the 1998-2003 interval these will be removed as fixed effects. In addition the year 1998 TC/R industry levels are included as right hand side variables in the form of slope dummies. There are two reasons for including TC/R levels. First, the results are interesting in their own right i.e. do levels of TCs appear to influence future changes in profitability. Secondly, repeat reference has been made to a potential "denominator problem" that might bias results. While we might experience spurious correlation via denominators when left and right hand side variables are both in levels or first differences, no such spurious correlation can be expected when we regress a dependent variable in first differences on independent variables in levels.

In tables 7a and 7b the control variables show the same qualitative estimates as with earlier level based regressions. In particular note the expected positive coefficient on revenue growth (note not the change in growth); earlier this expected sign was not estimated without interaction terms. Experiments with the control variable 1998 levels being used as independent variables yielded insignificant coefficients when the TC/R levels are also included. With respect to the change in the industry TC intensities, more of the industries show negative or insignificant effects on profitability. A negative relationship is viewed here as indicating the relevance of static TC theory. But some industries still have positive impacts of TC/R on π/L in both tables 7a and 7b. In addition for these industries with positive impacts the quadratic term is negative indicating a "Penrose effect" of diminishing effectiveness of transaction investments.

Turning to the final three columns in tables 7a and 7b, two features of the estimated coefficients can be highlighted. For many industries the level results are similar in sign and significance as the first difference coefficients. Of particular significance are the positive estimated impacts on profitability for SICs 21, 27, 29, 30 (in 7a). For these industries as we can conclude that the level of TCs appears to be associated with a growth in profitability, without qualification of a potential denominator effect. In short, there appears to be evidence for a dynamic view of TCs in some industries. The second feature of the levels estimates is that for some industries they differ from the change in TC/R estimated coefficients. For example, in SICs 26 and 32 a negative impact on profitability in TC/R changes coincide with a positive impact in levels. Alternatively in SIC34 a positive relationship in changes coincides with an insignificant relationship in levels. These differences add a potentially rich perspective to TC theory. If we view organisational expenditures as <u>assets</u> their levels may influence future profitability, particularly if these assets are sunk. These levels may require a different explanatory framework compared to when organisational resources are viewed as <u>variable</u> expenditures with their changes influencing changes in profitability. In both cases static and/or dynamic TCs may be useful.

The discussion can now turn to the second complexity highlighted above that involves accounting for the possible endogeneity of TCs and the extent to which this may have biased earlier results. This involves estimating TC equations and using predicted TC/R in profit equations rather than actual TC/R. To model TCs the key factor from static theory (e.g. Williamson, 1985) is asset specificity. This is proxied here by K/L, with industry K/L slope dummies as well as intercept dummies in the TC equation. In addition firm growth and market share are used as explanatory variables in TC equations. The logic here concerns the determination of dynamic TCs, as discussed above. Using the same logic as earlier, firm specific TCs are modelled using interaction terms. The resulting regression equations are reported in table 8. It is apparent that the modelling used here is effective in accounting for variation in TC/R. In addition the significance of the explanatory variables indicates that both firm and industry specific factors are relevant to explain the determination of TCs.

Table 8 here: see end

Table 9 here: see end

Table 9 reports the estimated profitability equations with predicted TC/R as an explanatory variable. These regressions are the equivalent of those reported in table 5 above. The key issue here is, of course, the TC effects on profitability. Table 10 summarises the industry TC effects based on the dummies not reported in table 9. Comparison of tables 10 and 6 indicates a reduced importance of a positive impact of TCs on profitability, particularly for the exponential measure of TC/R. But there is still some evidence in support of the relevance of dynamic TCs.

Table 10 here: see end.

For the firm specific TCs, i.e. the interaction terms in table 9, the K/L interaction terms indicate different results for the two different TC/R measures. Earlier in table 5 these interaction terms gave similar results. The half normal results in table 9 are consistent with those found earlier: reduced K/L reduces the negative impact of TCs. A possible interpretation here, offered earlier, involved possible flexibility advantages of smaller scale production. In table 9, for the exponential measures of TC/R these flexibility advantages of smaller scale are not evident. Instead once the endogeneity of TC/R to K/L is recognised increasing scale of firm of activity increases the positive impact of TCs on profitability. If these results are considered reliable, and if the flexibility interpretation is accepted, of significance may be the estimated size of half-normal and exponential TC/R. It will be recalled (see table 1) that exponential TC/R estimates are consistently smaller. This may indicate that in the absence of sufficient investment in organisational assets the flexibility advantages of smaller scale activity need not exist.

With respect to the revenue growth interaction terms in table 9 we also see different results for the two TC/R measures, if the estimated coefficient for (TC/R)*RevGr is viewed as non-zero given the t statistic of 1.77. The exponential results are consistent with those in table 5, this was interpreted earlier as slower firm growth having an incentive effect for the development of dynamic TCs. But the half-normal results are somewhat different. Here, up to TC/R = 0.72 increasing revenue growth increases the positive impact of TCs on profitability. Using a similar interpretation to that just offered the level of TCs may be relevant here. After controlling for the endogeneity of

TC/R to firm growth, lower TCs, i.e. working closer to the productive frontier, appears to promote the dynamic incentives from lower firm growth. Finally for the market share TC terms, over the relevant range of TC/R < 1, increasing market share increases the positive impacts of TCs on profitability. The earlier (in table 5) U shaped relationship can therefore be viewed as a result of TC/R endogeneity. Table 9 can therefore be interpreted that for all market shares increasing market power increases dynamic TC incentives or reducing market power increases static TC incentives.

Table 11 here: see end

Finally in this section we will control for the possible "denominator effects" that might be introducing spurious correlation. These "denominator effects" of TC/R on π/L potentially operate via the 2003 production function i.e. increasing 2003 L automatically increases 2003 R. To control for this possible effect 2003 right hand side variables will be used to explain 2004 π/L. Because of data availability and firm exit using 2004 π/L reduces the sample size from 7350 to 4680 firms, with the reduction particularly affecting the presence of small firms. Table 11 shows summary results that can be compared to those in table 5. The industry TC effects will be summarised below. The firm specific interaction terms are, for K/L and RevGr, qualitatively the same as the earlier table over relevant data ranges. For the TC/R and market share terms the relationships reported in table 11 are either positive over relevant data ranges (for half normal estimates) or insignificant, i.e. they are closer to the results after controlling for endogeneity reported in table 9.

Table 12 here: see end

The industry specific TC effects can be derived from the slope dummy variables not reported in table 11. The overall results are summarised in table 12. For the half normal estimates of TC/R it is apparent that there is mainly a positive relationship between 2003 TCs and 2004 profitability. This more than replicates the earlier results reported in table 5. Using earlier logic this reinforces the conclusion that in many UK manufacturing industries dynamic TCs are important. For the exponential estimates in table 12 we see a reduced importance of a monotonic positive relationship that mirrors earlier findings. But in addition in table 12, 10 from the 16 industries have slope dummies that are insignificant at, at least, the 10% level. For all earlier results the industry slope dummies are consistently significant. If we exclude the insignificant results in table 11 for the exponential estimates, the significant six industries have two monotonic positive and four monotonic negative relationships i.e. the significant results mirror earlier findings. If the logic underlying the results in tables 11 and 12 is accepted we can conclude that earlier findings do not appear to be significantly biased by a spurious “denominator effect”.

Discussion and conclusions

The profit equations estimated here indicate that for UK manufacturing both static and dynamic TCs are relevant. In addition this relevance appears to be at both firm and industry levels and in addition can be identified in a first difference profit equation for both TC changes and levels. These conclusions appear robust to endogeneity analysis as well as controlling for possible spurious correlation. In this final section of the paper an attempt will be made to identify the possible characteristics of the industries that have been classified as positive or negative in their relationships between TC/R and profitability.

Table 13 here: see end

Consider table 13 that summarises the industry level results presented above in tables 5 and 6. N is the number of industries defined as either monotonic positive or monotonic negative in table 6. The final four columns show median values across the industries in each category for the numbers equivalent Herfindahl index, industry profitability, revenue growth and TC intensity levels. Although the numbers of industries involved are small a set of conclusions appear to be present. Firms in industries with a positive relationship between TC intensity and profitability appear to exhibit less competitive market structures, lower profitability and revenue growth and lower TC intensity levels. These generalisations apply to both TC measures.

To a large extent these industry level conclusions appear to be consistent with the firm level analysis undertaken above using interaction terms. Consider first the apparent relationship with 1/H. This indicates the possible presence of a “Schumpeter” effect in the positive impact of TCs on profitability as well as more competitive markets promoting TC economising. These relationships with 1/H appear to be particularly the case with exponential TC estimates. A possible interpretation here is that as these estimates are lower than for half normal TCs (see table 1), the general lower degree of slack might lead to a stronger market structure impact. These industry level conclusions are consistent with firm level results reported above. But the earlier results reported a subtlety with respect to firm flexibility: a smaller scale of production appeared to promote greater positive TC effects on profitability (as indicated by the interaction between TC/R and K/L). A possible way of reconciling these market structure and flexibility effects is to use the distinction, emphasised earlier, between TCs as sunk assets and TCs as current expenditures, as explored with the differenced model reported in tables 7a and 7b. More competitive market structures require, *ceteris paribus*, smaller firms. The lower organisational overheads involved imply smaller TCs as sunk assets that also support the competitive structures. It follows that the greater relative importance of TCs as current expenditures will be picked up as flexibility advantages of smaller scale.

With respect to π/L and revenue growth in table 13, there is evidence of an incentive effect in organisational development consistent with the firm level results found earlier. Finally with respect to TC/R in table 13 there is evidence in support of a "Penrose" effect, also found earlier, in that the negative relationships between TC/R and profitability involve higher levels of TC/R. This effect is particularly strong with the half normal TC estimates. This is perhaps not surprising as these TC estimates are higher than the exponential form, and hence are more likely to pick up a "Penrose" effect.

In short, these general conclusions at both firm and industry levels indicate a robust set of findings regarding the impacts of TCs on firm performance. They also indicate that these impacts can be complex, indicating a danger with oversimplified analysis. Finally, the robustness of the results indicate that TC effects can be effectively modelled using the stochastic frontier methodology introduced here and open up a potentially wide set of applications for future research using this methodology.

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Table 1
2003 industry level sample data characteristics

SIC	N	1/H	Profit per employee	Revenue growth	TC/R half normal	TC/R exponen.
20	141	40.10	4.05	1.26	0.34	0.20
21	270	17.98	1.83	1.08	0.19	0.12
22	971	44.30	4.19	1.16	0.42	0.26
24	751	12.88	5.16	1.16	0.56	0.32
25	456	82.58	2.58	1.13	0.25	0.15
26	241	11.89	4.64	1.13	0.28	0.20
27	267	7.95	1.59	0.95	0.46	0.28
28	1053	38.18	1.96	1.01	0.36	0.22
29	739	29.54	2.67	1.03	0.44	0.24
30	164	8.59	2.72	1.02	0.25	0.11
31	503	26.32	1.30	1.03	0.36	0.21
32	273	12.42	1.24	0.95	0.43	0.27
33	370	32.03	4.03	1.16	0.44	0.26
34	151	10.03	1.51	1.17	0.49	0.27
35	183	6.68	2.84	1.13	0.53	0.31
36	817	58.35	2.28	1.14	0.28	0.17

Notes

1. N = number of sampled firms in the industry; 1/H = numbers equivalent Herfindahl index defined at the 2 digit level.
2. Firm revenue growth is defined over the five year interval 1998 to 2003: R_{2003}/R_{1998}.
3. Industry averages for profit per employee, revenue growth, and the TC/R data are medians for the sample of firms in each industry.
4. The two final columns report median transaction cost estimates for half normal and exponentially distributed efficiency effects.

Table 2a
2003 industry level correlations: N=16

	1/H	π/L	Rev Gr	TCh	TCe
1/H	1.0000				
π/L	0.0632	1.0000			
RevGr	0.3168	0.6462	1.0000		
TCh	-0.4041	0.1579	0.0379	1.0000	
TCe	-0.3713	0.1903	0.0372	0.9662	1.0000

Table 2b
2003 firm level correlations: N=7350

	K/L	Share	π/L	Rev Gr	TCh	TCe
K/L	1.0000					
Share	0.0163	1.0000				
π/L	0.1572	0.0215	1.0000			
Rev Gr	0.0019	-0.0012	-0.0157	1.0000		
TCh	0.1561	-0.0101	0.0002	-0.0011	1.0000	
TCe	0.4769	-0.0071	0.1717	-0.0011	0.4069	1.0000

1/H = the numbers Herfindahl index defined at the 2 digit level; Share = firm market share with the total market defined as the sum of firm revenues at the two digit industry level; K/L = firm capital:labour ratio defined as the ratio of firm total assets to number of employees; π/L = profit per employee; Rev Gr = R_{2003}/R_{1998}; TCh and TCe are transaction cost intensities under respectively half normal and exponential assumptions. In table 2a the data is that used in table 1.

Table 3
OLS regression: dependent variable: firm profit per employee

	Coeff.	t stat
K/L	.0840009	43.34
$(K/L)^2$	-5.82e-07	-40.72
Rev Gr	-.0377337	-1.76
Share	36.05227	0.25
Cons	-5.197244	-3.08

N=7350
$adjR^2 = 0.204$

Table 4
OLS regressions: dependent variable 2003 π/L

	Half normal					Exponential			
	Coeff.	t stat		Coeff	t stat	Coeff.	t stat	Coeff	t stat
K/L	.1162444	58.25	int20	51.64014	0.88	.1239457	56.38	60.11521	0.80
$(K/L)^2$	-7.86e-07	-56.40	intsq20	.9527216	0.04	-8.05e-07	-53.87	.647884	0.02
Rev Gr	-.0392787	-2.20	int21	68.10988	6.15	-.0405536	-2.32	75.16652	6.13
Share	-364.2193	-1.49	intsq21	-1.162134	-3.12	-318.4418	-1.33	-1.395505	-3.00
$Share^2$	1201.23	1.13	int24	-11.56834	-1.60	1464.635	1.41	53.31943	11.54
TC/R	-54.25172	-12.78	intsq24	.8294653	3.86	-61.68538	-13.42	-.7601264	-12.24
$(TC/R)^2$	.616265	11.98	int25	51.809	3.58	.774675	12.49	57.9821	3.27
Cons	20.07344	4.57	intsq25	-1.12259	-1.63	11.85332	2.93	-1.640588	-1.52
			int26	119.4239	2.47			135.8133	3.70
			intsq26	-46.1454	-6.48			-39.23322	-8.02
			int27	137.4005	22.26			152.2005	25.25
			intsq27	-3.083142	-32.98			-2.982142	-33.67
			int28	-3.966794	-0.46			17.65357	2.14
			intsq28	-1.169366	-3.53			-1.13713	-4.30
			int29	74.62894	14.36			89.54632	14.51
			intsq29	-.9332056	-13.17			-1.37472	-12.49
			int30	101.2753	3.17			9604.578	10.08
			intsq30	-8.246281	-1.02			-43727.29	-15.16
			int31	59.80902	9.91			69.76789	9.27
			intsq31	-.803459	-9.91			-1.141172	-8.00
			int32	1.416559	0.07			-6.827788	-0.31
			intsq32	10.89827	4.94			17.53943	5.50
			int33	30.71221	2.08			34.45009	2.32
			intsq33	.3948681	0.29			.3946238	0.42
			int34	67.58563	10.70			75.76744	10.90
			intsq34	-.8597313	-9.04			-1.082257	-8.99
			int35	23.02662	1.72			20.20739	1.63
			intsq35	-.1271169	-0.18			.2375852	0.42
			int36	53.05906	9.05			57.78581	9.82
			intsq36	-.6072986	-6.74			-.7269971	-8.86

adj R^2 = 0.451 N = 7350 adjR^2 = 0.474
omitted dummy = SIC22 (N=972)
intxy = (TC/R)*dummy(SICxy)
intsqxy = $(TC/R)^2$*dummy(SICxy)
intercept dummies not reported

Table 5
OLS regressions: dependent variable π/L

	Half normal			Exponential	
	Coeff	t stat		Coeff	t stat
K/L	.1407462	57.18		.102828	37.27
$(K/L)^2$	-8.06e-07	-50.51		2.37e-06	18.11
Rev Gr	-.0277197	-0.46		-.0039748	-0.07
$(Rev\ Gr)^2$	.0000254	1.23		.0001359	6.65
Share	-597.3471	-2.26		-627.0653	-2.70
$Share^2$	1581.029	1.52		1538.274	1.59
TC/R	-29.82199	-6.71		-28.41477	-6.02
$(TC/R)^2$	-.3411939	-3.03		.28776	4.40
(TC/R)*(K/L)	-.00765	-14.24		-.0044243	-22.76
$(TC/R)^2$*(K/L)	.0002538	10.68		8.61e-06	13.14
(TC/R)*(Rev Gr)	-.151008	-1.01		-1.420557	-8.44
$(TC/R)^2$*(Rev Gr)	-.0548624	-3.34		.2075496	20.20
(TC/R)*share	448.0436	1.55		1387.72	7.64
$(TC/R)^2$*Share	-99.16152	-2.76		-308.416	-12.14
Cons	4.389281	1.00		4.118737	1.08

$adjR^2 = 0.475$ N = 7350 $adjR^2 = 0.540$
Slope and intercept dummies not reported

Table 6
Transaction cost impacts on profitability

	Half normal	Exponential
Monotonic +ve	8 industries	6 industries
Monotonic -ve	7 industries	9 industries
Inverted U	1 industry	1 industry

Notes
Calculations based on regression results in table 5.
The quadratic effects are measured over an assumed relevant range of TC/R < 1.

Table 7a
OLS regression: dependent variable 1998-03 change in π/L (half normal estimates)

	Coeff.	t stat		Coeff.	t stat		Coeff.	t stat
ΔK/L	.1177434	52.11	Δint20	-18.3919	-0.23	int98_20	-2.872869	-0.05
$\Delta(K/L)^2$	-7.98e-07	-50.94	Δintsq20	6.254778	0.20	intsq98_20	2.3814	0.08
Δshare	-484.5063	-1.72	Δint21	18.14981	1.67	int98_21	23.59721	1.28
RevGr	.9814552	2.76	Δintsq21	-.7025364	-1.80	intsq98_21	-.7538504	-1.95
ΔTC/R	.3755554	0.36	Δint24	-57.1155	-8.70	int98_24	-56.2061	-8.71
$\Delta(TC/R)^2$	-.0030831	-2.21	Δintsq24	1.12944	5.06	intsq98_24	1.124748	5.04
Cons	-10.04553	-2.55	Δint25	-5.297906	-0.36	int98_25	-5.315488	-0.37
			Δintsq25	-.3821254	-0.53	intsq98_25	-.3861476	-0.53
			Δint26	-38.30508	-0.62	int98_26	109.2765	1.66
			Δintsq26	-31.81194	-3.59	intsq98_26	-59.38907	-2.94
			Δint27	28.17937	4.97	int98_27	29.1531	5.21
			Δintsq27	-1.451919	-15.51	intsq98_27	-1.455014	-15.54
			Δint28	-39.10399	-4.69	int98_28	-35.75073	-4.41
			Δintsq28	-.2783394	-0.80	intsq98_28	-.2867695	-0.82
			Δint29	24.59177	7.18	int98_29	31.21923	4.89
			Δintsq29	-.3858489	-7.36	intsq98_29	-.6491094	-5.10
			Δint30	74.44828	2.21	int98_30	69.99164	2.08
			Δintsq30	-12.25391	-1.45	intsq98_30	-12.23886	-1.45
			Δint31	-22.01618	-2.72	int98_31	-15.31144	-2.28
			Δintsq31	.9803762	3.72	intsq98_31	.8725162	3.65
			Δint32	-65.0745	-3.03	int98_32	-27.07235	-1.01
			Δintsq32	12.09669	4.93	intsq98_32	7.854976	2.51
			Δint33	-17.82921	-1.20	int98_33	-22.98947	-1.55
			Δintsq33	.7561736	0.53	intsq98_33	.7581786	0.53
			Δint34	13.64107	2.56	int98_34	130.3323	1.15
			Δintsq34	-.2657976	-3.07	intsq98_34	-77.0359	-1.10
			Δint35	-14.92728	-1.00	int98_35	-10.77451	-0.34
			Δintsq35	-.4630393	-0.57	intsq98_35	-1.047694	-0.16
			Δint36	1.173213	0.23	int98_36	2.173763	0.43
			Δintsq36	-.0287554	-0.33	intsq98_36	-.0325354	-0.37

adjR^2 = 0.440 N = 7350
Intercept dummies not reported
Omitted dummy = SIC22 (N=972)
intxy = (TC/R)*dummy(SICxy)
intsqxy = $(TC/R)^2$*dummy(SICxy)
Δintxy = change in intxy over the interval 1998-03.
Δintsqxy = change in intsqxy over the interval 1998-03.
int98_xy = 1998(TC/R)*dummy(SICxy)
intsq98_xy = $1998(TC/R)^2$*dummy(SICxy)

Table 7b
OLS regression: dependent variable 1998-03 change in π/L (exponential estimates)

	Coeff.	t stat			Coeff.	t stat			Coeff.	t stat
ΔK/L	.1249671	48.80		dint20	-21.72126	-0.22		int98_20	-3.629302	-0.05
$\Delta(K/L)^2$	-8.10e-07	-46.41		dintsq20	8.988348	0.19		intsq98_20	3.479451	0.08
Δshare	-645.517	-2.33		dint21	17.35808	1.45		int98_21	33.99425	2.59
RevGr	.6683363	1.93		dintsq21	-.7837887	-1.62		intsq98_21	-.8084331	-1.67
ΔTC/R	.3802608	0.37		dint24	-8.832999	-7.36		int98_24	-8.445688	-12.89
$\Delta(TC/R)^2$	-.0033815	-2.46		dintsq24	.0178609	8.59		intsq98_24	.0140934	9.14
Cons	-9.870558	-2.56		dint25	-7.091507	-0.39		int98_25	-6.925905	-0.39
				dintsq25	-.6706409	-0.59		intsq98_25	-.6740384	-0.59
				dint26	-44.41096	-0.90		int98_26	112.4733	2.25
				dintsq26	-24.26446	-3.82		intsq98_26	-40.22493	-4.92
				dint27	34.41804	6.77		int98_27	35.6137	7.09
				dintsq27	-1.288874	-16.83		intsq98_27	-1.29226	-16.88
				dint28	-19.71224	-2.59		int98_28	-15.88047	-2.15
				dintsq28	-.5591291	-2.04		intsq98_28	-.5726481	-2.09
				dint29	37.85551	7.62		int98_29	41.35713	8.02
				dintsq29	-.907019	-6.90		intsq98_29	-.9144851	-6.95
				dint30	-4802.085	-14.03		int98_30	-4715.743	-13.99
				dintsq30	(dropped)			intsq98_30	-1.900117	-4.10
				dint31	-28.57739	-3.00		int98_31	-22.63122	-2.63
				dintsq31	1.286667	4.03		intsq98_31	1.175959	3.92
				dint32	-81.36869	-3.19		int98_32	-29.87775	-0.80
				dintsq32	19.42132	5.42		intsq98_32	13.15381	2.72
				dint33	-23.15801	-1.56		int98_33	-30.84296	-2.08
				dintsq33	1.037244	1.05		intsq98_33	1.042926	1.05
				dint34	13.53773	2.27		int98_34	125.0719	0.94
				dintsq34	-.3237712	-2.88		intsq98_34	-64.14786	-0.84
				dint35	-24.42918	-1.84		int98_35	-23.97626	-0.76
				dintsq35	.1347651	0.21		intsq98_35	.560938	0.09
				dint36	-1.654557	-0.33		int98_36	-.3692035	-0.07
				dintsq36	.0140453	0.20		intsq98_36	.0094083	0.13

$adjR^2 = 0.462$ N = 7350
Intercept dummies not reported
Omitted dummy = SIC22 (N=972)
intxy = (TC/R)*dummy(SICxy)
intsqxy = $(TC/R)^2$*dummy(SICxy)
Δintxy = change in intxy over the interval 1998-03.
Δintsqxy = change in intsqxy over the interval 1998-03.
int98_xy = 1998(TC/R)*dummy(SICxy)
intsq98_xy = 1998$(TC/R)^2$*dummy(SICxy)

Table 8

OLS regressions: dependent variables TC/R

Half normal						Exponential			
	Coeff.	t stat		Coeff.	t stat	Coeff.	t stat	Coeff.	t stat
K/L	.0025586	13.63	kl20	-.000644	-0.18	.0040443	9.19	-.004652	-0.57
$(K/L)^2$	-9.65e-08	-5.44	klsq20	-1.69e-06	-0.41	9.66e-09	0.23	4.73e-07	0.05
Share	-7.576942	-1.65	kl21	.001156	0.59	-34.21613	-5.08	-.0026016	-0.57
$Share^2$	71.5979	3.96	klsq21	4.53e-06	2.34			5.16e-06	1.14
RevGr			kl24	-.0020242	-10.60	-.0045517	-2.42	.0066409	14.63
(K/L)*RevGr			klsq24	9.61e-08	5.42	.0000527	13.42	-2.48e-08	-0.60
$(K/L)^2$*RevGr	-5.23e-10	-0.84	kl25	.0046796	4.78	-6.89e-08	-22.28	.0014957	0.65
(K/L)*Share	-.0509997	-5.99	klsq25	-3.98e-07	-1.73	.1661742	8.27	-3.54e-07	-0.66
$(K/L)^2$*Share	-5.78e-06	-6.69	kl26	-.0023207	-6.75	-.0000925	-41.53	-.0035238	-4.37
Cons	.208718	2.98	klsq26	1.01e-07	4.38	-.1952635	-1.19	-1.08e-08	-0.20
			kl27	-.0020587	-3.01			-.0021377	-1.33
			klsq27	1.35e-06	10.63			1.23e-06	4.15
			kl28	-.0003202	-0.75			-.0012982	-1.29
			klsq28	2.04e-07	3.42			1.29e-07	0.92
			kl29	.0082811	23.64			.0033845	4.12
			klsq29	-6.00e-07	-20.72			-3.58e-07	-5.28
			kl30	.0006473	0.61			-.0065345	-2.62
			klsq30	4.83e-08	0.80			1.76e-06	12.40
			kl31	-.0033503	-6.59			-.0045363	-3.80
			klsq31	1.04e-06	14.24			7.09e-07	4.12
			kl32	.0036282	3.63			-.003783	-1.61
			klsq32	-3.84e-07	-3.86			8.91e-07	3.82
			kl33	-.0021938	-2.53			-.0128494	-6.32
			klsq33	1.56e-06	11.41			.0000136	40.54
			kl34	-.0048084	-2.25			-.0101419	-2.03
			klsq34	.0000164	13.05			.000016	5.43
			kl35	.0040274	4.12			.0047649	2.07
			klsq35	-8.07e-07	-3.69			-1.05e-06	-2.05
			kl36	.0048051	7.85			.002993	2.08
			klsq36	-5.12e-07	-3.07			-5.77e-07	-1.48

adj $R^2 = 0.502$ N = 7350 adj$R^2 = 0.694$

Intercept dummies not reported

Omitted dummy = SIC22 (N=972)

klxy = (K/L)*dummy(SICxy)

klsqxy = $(K/L)^2$*dummy(SICxy)

Table 9

OLS regressions: predicted TC/R, dependent variable π/L

	Half normal		Exponential	
	Coeff	t stat	Coeff	t stat
K/L	.124214	53.46	.1991262	43.07
$(K/L)^2$	-6.19e-07	-33.10	-3.44e-06	-15.51
RevGr	-.2276305	-1.40	.0835901	1.44
$(RevGr)^2$	.0000537	1.23	-.0000151	-1.28
Share	-259.0483	-1.95	-1128.51	-4.61
$Share^2$			2998.329	2.92
TC/R	-46.17087	-7.44	-53.53056	-18.78
$(TC/R)^2$	9.073467	12.65	-.2549716	-4.97
(TC/R)*(K/L)	-.0109711	-15.92	.0022837	10.46
$(TC/R)^2$*(K/L)	-.0000825	-2.29	1.36e-06	2.48
(TC/R)*RevGr	.3632501	1.77	-.022357	-0.69
$(TC/R)^2$*RevGr	-.2524741	-6.35	-.0813704	-10.85
(TC/R)*Share	202.1798	2.46	-17.98297	-0.29
$(TC/R)^2$*Share	-25.57002	-3.29	8.257962	1.57
Cons	14.66159	3.29	.4706244	0.13

$adjR^2 = 0.630$ N = 7350 $adjR^2 = 0.513$

Slope and intercept industry dummies not reported

Table 10

Transaction cost impacts on profitability

	Half normal	Exponential
Monotonic +ve	7 industries	3 industries
Monotonic -ve	7 industries	12 industries
Inverted U	1 industry	1 industry
U	1 industry	

Notes

Calculations based on regression results in table 9.

The quadratic effects are measured over an assumed relevant range of TC/R < 1.

Table 11
OLS regressions: dependent variable 2004 π/L

	Half normal		Exponential	
	Coeff	t stat	Coeff	t stat
K/L	.1358017	20.73	.0574698	7.13
$(K/L)^2$	-1.09e-06	-3.17	3.15e-06	7.16
RevGr	.1015026	1.23	.0924621	1.13
Share	-352.3438	-1.58	29.68352	0.13
TC/R	80.07234	8.31	-1.370505	-0.14
$(TC/R)^2$	-5.885251	-23.47	.2104742	1.34
(TC/R)*(K/L)	-.0337521	-34.47	-.0066859	-10.20
$(TC/R)^2$*(K/L)	.0014102	28.22	-8.88e-06	-1.56
(TC/R)*RevGr	-.4373179	-1.77	-.6040144	-1.56
$(TC/R)^2$*RevGr	.1590676	4.73	.1528811	3.88
(TC/R)*Share	788.765	2.09	-147.7611	-0.24
$(TC/R)^2$*Share	-272.7659	-5.29	89.86727	1.25
Cons	-45.22331	-6.44	1.565658	0.26

$AdjR^2 = 0.317$ N = 4680 $AdjR^2 = 0.357$
Slope and intercept industry dummies not reported.

Table 12
Transaction cost impacts on profitability

	Half normal	Exponential
Monotonic +ve	10 industries	4 industries
Monotonic -ve	5 industries	8 industries
Inverted U		2 industries
U	1 industry	2 industries

Notes
Calculations based on regression results in table 11.
The quadratic effects are measured over an assumed relevant range of TC/R < 1.

Table 13
Transaction cost impacts on profitability: industry characteristics

		N	1/H	π/L	Rev Gr	TC/R
TC half normal	Positive	8	22.15	2.06	1.06	0.32
	Negative	7	32.03	4.03	1.16	0.43
TC exponential	Positive	6	15.43	2.25	1.06	0.23
	Negative	9	38.18	2.48	1.14	0.26

Data taken from results reported in tables 5 and 6.
Number of industries sum to 15 because of the non-monotonic result in one industry as reported in table 6.
Values for 1/H, π/L, RevGr and TC/R are median values for the industries in each category taken from table 1.