‘Oscillate Wildly’: asymmetries and persistence in company-level profitability

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Abstract

This paper examines company-level persistence in profitability over the period 1975-98. The competitive forces that act to compete away abnormal returns need not act symmetrically and may differ at different points in the distribution of profitability. This suggestion is tested empirically on an unbalanced panel of 2,129 companies. First, evidence for both asymmetries and non-linearities in the persistence of company profitability is found. The results are consistent with the notion that competitive forces act less swiftly to eliminate superior returns than inferior returns and/or that companies attempt to allocate a positive result to more years than they would allocate a poor result. Second, by imposing a linear specification, previous studies are likely to have understated the extent of persistence of superior profitability. Third, industry variation in the extent of profit persistence is considered. Under the standard linear model such variation across industries is quite small. A greater degree of variation between industries is found when allowing for persistence in a non-linear fashion. But the finding that high profitability persists more than low profitability is common across each industry.

Key words: Company profitability, persistence, asymmetries.
JEL classification: G30, L10.

Summary

Competition is central to an understanding of the corporate sector. Such competitive forces are best viewed in the dynamic sense of how quickly high rates of profit are competed away by entry and the threat of entry, and how quickly less profitable companies that survive improve their financial health. If profits persist from one year to the next this indicates that competitive forces do not act especially swiftly in removing such abnormal returns.

In this context, most of the existing literature has focused on those companies with high returns, motivated by concerns about market power. For financial stability it is the low-performing companies that are of special interest. A low rate of profitability is one indicator of financial distress. But the extent to which it is an indication of the company's profitability the following year and its ability to withstand any adverse shock depends on the degree of persistence in profits. Moreover, the emphasis in such financial stability surveillance work concerns the most vulnerable companies in any year. For this reason, the degree of persistence of profitability amongst the weakest companies is especially important. But previous studies of profit persistence have not attempted to distinguish between the experiences of this set of companies from others.

More generally, the motivation for a study of the persistence in profits is based on the notion that examining rates of return of companies, even with disaggregated data, provides only a snapshot of the financial position of a company. Mobility between points in the distribution of returns over time is also of interest. To this end, the paper employs panel data methods using data constructed from the company accounts of 2,129 quoted UK companies over the period 1974 to 1998, making it the most comprehensive study of its kind for the United Kingdom.

A useful precursor to the main empirical analysis is to study the relative position of companies' profit rates and how this varies from one year to the next. This reveals a number of stylised facts. The level of persistence in companies' positions in the distribution is quite high. Moreover, this persistence differs across different parts of the distribution of profitability. Almost three quarters of companies in the top quintile of companies in one year remain there in the following year, on average. This compares with two thirds of companies in the lowest quintile remaining in that part of the distribution the following year.

The more detailed analysis focuses on the extent to which the profit rate of a company deviates from its rate the previous year. The paper finds that persistence in profits is less strong for companies with low rates of profitability in a particular year. The results indicate that surviving companies are able to recover from periods of relatively poor performance more rapidly than previous linear models of profit persistence would suggest. One other possible explanation for this finding is that companies favour a conservative approach to accounting, preferring to report good performance over more years than they would allocate any poor performance. At the same time, the results indicate that previous studies of the persistence of profits are likely to have understated the degree of persistence of high returns.

Only a modest degree of variation among industries has been found on the basis of the standard linear models for persistence, with an increase in the extent of this variation between industries being found on the basis of the non-linear models. The asymmetries in the persistence of profits are estimated to be stronger in ‘energy and water supply’, a heavily regulated sector in which regulators have had a responsibility for ensuring that companies can finance their functions. The result that high profitability persists more than low profitability is estimated to be present in each industry.

Companies are far from passive to the shocks that they experience. They respond by adopting strategies that involve financial and/or real implications for outcomes such as employment, dividends, wages, productivity and investment. This suggests that future work could explore the strategies available to companies in times of financial distress, the factors that will lead a company to favour one option over another and the implications of each for the wider economy.

1 Introduction

Persistence in profits represents a key aspect of the dynamics of the corporate sector. Competition is best viewed in the dynamic sense of how quickly non-competitive profits are eliminated (eg Geroski (1991)). If profits persist from one year to the next, then this indicates that competitive forces do not act especially swiftly in removing such excess returns. In an economy (or industry) where profits do not persist, such profits are playing the efficient role of providing incentives for resources to be reallocated to meet demand. Where they do persist, profits instead indicate resource misallocation (Mueller (1977)).[(1)]

In this context, most of the existing literature that has examined profit (ie return on physical capital) persistence has focused on those companies with *high* returns. In the context of financial stability it is the low-performing companies that are perhaps of special interest. A low rate of profitability is one possible indicator of financial distress. However, the extent to which it is an informative indicator of such distress is largely determined by the extent to which profits persist. If, for instance, there is considerable mobility from one year to the next at low rates of profit, then the importance to be attached to an individual year's rate of profit for an individual company is weakened.[(2)] This paper quantifies such mobility, ie the tendency for a company's rate of profit to deviate from its rate in the previous year.

Competitive forces imply that high rates of profitability should be competed away through new entry and the emulation of successful products and technologies. Conversely, the threat of takeover or failure should prompt companies with low rates of profitability to reallocate resources accordingly with actual takeover and failure representing additional mechanisms. Whilst these equilibrating mechanisms for those companies performing relatively well and those performing relatively poorly are clearly related, they remain distinct. There need be no presumption that they should act in a symmetric fashion, ie be of equal magnitude for those companies with rates of profitability above and those below the typical level. This paper assesses the extent to which such mechanisms are symmetric and finds evidence that they are not. More specifically, it appears that mobility of profitability is stronger for less successful companies, with persistence of profits being stronger for the more profitable companies. In addition to this asymmetry, evidence of further non-linearities in the relationship is presented.

More generally, the motivation for a study of the persistence of profits is based on the notion that examining rates of return of companies, even with disaggregated data, provides only a snap-shot of the financial position of a company. Mobility between points in the distribution of returns across companies over time is also of interest. At an empirical level, the analysis presented in this paper also benefits from a larger dataset than has been employed in previous studies of the corporate sector in the United Kingdom—particularly in terms of the cross-sectional dimension

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(1) This interpretation rests on the notion that persistent profits are derived through firms restricting output levels to less than their competitive level, with actual and potential entry failing to discipline their behaviour in a competitive sense. For a discussion of the costs of market power in a static context, see Harberger (1954) and Posner (1975).
(2) Geroski and Gregg (1997) present evidence indicating that the probability of corporate failure is a function of pre-failure profitability.

of the panel data employed. This allows a number of additional testable hypotheses to be considered.

The remainder of the paper is organised as follows. Section 2 provides some further economic background to the study. Section 3 describes the estimation strategy employed in examining persistence in company profit rates. Section 4 describes the dataset employed, derived from the statutory accounts of quoted UK non-financial companies. Estimation results are presented in Section 5 with concluding remarks given in Section 6.

2 Economic background

The persistence in profits literature is based on a relatively dynamic notion of competitive forces facing firms. Rather than an emphasis on high or low profits *per se*, the emphasis is on the extent to which any profits persist. In this way the literature emphasises the notion that in a competitive product market companies may enjoy high profitability, but the more competitive the system, the greater the expected tendency that such profits will attract new entry. Indeed, in keeping with the literature on contestability (Baumol *et al* (1982)), actual entry may not be necessary. The threat of entry may be sufficient to prevent companies from enjoying persistently high returns.

Following Cubbin and Geroski (1987), define a company's 'excess' profit rate, r_{it} as its return $(p\ /K)_{it}$ over and above its long-run equilibrium level, $(p\ /K)^*_{it}$. This excess of profits over the long-run equilibrium is assumed to decline in response to the competitive effects of 'entry' (actual and potential). Firms may observe high rates of return and enter the market or incumbent firms may expand (perhaps in part to pre-empt new entry), but both factors are expected to reduce rates of return. Such effects will combine industry-level (ie common across firms in an industry) and firm-level effects (ie specific to an individual firm within the industry). The precise means through which such entry affects profitability is not explicitly modelled but follows from a large number of industrial organisation models (see Weiss (1989)). Competitive effects or entry respond to a high level of profitability *vis à vis* its equilibrium level (see equation **(1)** below). Competition affects both the level of profitability and the speed with which profitability converges on that level. For convenience, normalise $(p\ /K)^* = 0$.

$$E_t = d\left(\frac{p}{K}\right)_{it-1} + m_{it} \qquad \textbf{(1)}$$

$$\Delta\left(\frac{p}{K}\right)_{it} = l\,E_t + q\left(\frac{p}{K}\right)_{it-1} + v_{it} \qquad \textbf{(2)}$$

with $d > 0$ and l , $q < 0$; E denotes entry. The terms m_{it} and v_{it} are assumed to be orthogonal to the other terms on the right-hand side of equations **(1)** and **(2)**. This produces a 'latent (ie unobserved) variables problem': actual and potential entry may be unobserved but their effects are captured through looking at the degree of persistence of profitability. Substituting **(1)** into **(2)** and re-arranging gives:

$$\left(\frac{p}{K}\right)_{it} = (d\,l + q + 1)\left(\frac{p}{K}\right)_{it-1} + m_{it} + v_{it} \qquad \textbf{(3)}$$

thereby giving rise to the autoregression in profitability. The parameters concerning the responsiveness of entry to profitability (d), the effect of entry on profitability (l), and the speed with which profitability converges to its long-run level (q), are not separately identified but their combined role is assessed by estimating models of the autoregression in company-level profitability.(3) This discussion provides the rationale for the study of persistence in profitability. On the issue of asymmetries in persistence, theory is of little guide as the matter is really an empirical one. Section 3 describes the estimation strategy employed to address this issue.

Most of the motivation for this study has been provided in terms of understanding the dynamics of competition. This is clearly important in understanding the UK corporate sector. Further motivation for the study is provided by the Bank of England's surveillance work on company financial health (eg Benito and Vlieghe (2000)). It is common in such work to use profitability as a measure of financial health. However, the extent to which profitability in one year is an indication of the company's profitability the following year and its ability to withstand any adverse shock is heavily dependent on the degree of persistence in profits. Moreover, the emphasis in such surveillance work connected with financial stability concerns the most vulnerable companies in any year. For this reason, the degree of persistence of profitability among the weakest companies is of special interest. Whether the degree of persistence of this set of companies is the same as for all companies is an empirical matter considered below.

3 Estimation strategy

The issue being considered is perhaps best conveyed by a description of the conceptual experiment in mind. Essentially, the experiment would be to subject companies, selected at random, to shocks to their profitability (through a technology or demand shock), and estimating how much of the profit shock carries over to the subsequent year. If competitive forces act instantaneously, this will be zero. The more slowly such forces operate, the greater the amount of the shock to profitability that will carry over to the following year. Of course, such experimental data do not exist and Section 5 discusses some of the empirical issues that arise in attempting to make inferences regarding the conceptual experiment described, on the basis of our company panel data approach.

In a panel data framework, models of persistence can be represented by the following estimating equation:

$$\left(\frac{p}{K}\right)_{it} = a_i + b\left(\frac{p}{K}\right)_{i\,t-1} + g_t + e_{it} \qquad \textbf{(4)}$$

(3) An estimate of q could be obtained by running a regression of the annual change in profit rate on the lagged level of profit rate.

where 'i' indexes companies, n = 1…N and 't' time, t = 1…T; $(p\ /\ K)$ represents return on capital employed; a_i are firm-specific fixed effects that control for all time-invariant differences in profits between companies; and g_t denotes time effects that will pick up common (ie macroeconomic) shocks to profitability across all companies in a particular year. So it is through the inclusion of g_t that it is possible to control for the economic cycle. e_{it} is assumed to be a serially uncorrelated (but possibly heteroskedastic) error term.

In equation **(4)**, b is the measure of persistence in profits. The closer b is to 1, the greater the degree of persistence, and the longer it takes for profits to be competed away. Of course, a more general specification could add additional lags of the dependent variable and this will be considered.

In order to preserve degrees of freedom, the fixed effects, a_i, are removed from the estimating equation by considering equation **(4)** in deviations from the company-specific time means.[(4)] In this way, those effects that are constant over time (which the fixed effects are, by definition) are removed from the estimating equation. The transformation of the data in this way still means that the role of the fixed effects is incorporated by the estimation strategy.

One further issue that should be noted is that Nickell (1981) shows that eliminating the fixed effects in this way gives rise to a (downward) bias in the coefficient on the lagged dependent variable as the variable becomes correlated with the transformed error term. Instrumenting the lagged dependent variable (perhaps with lags of itself) can overcome this problem but at the cost of losing observations, if lags are used as instruments and may be sensitive to the precise choice of instruments. Nickell (1981) derives analytically an expression for the size of this bias (under the standard case of $N \to \infty$) as a function of the number of time series observations and the actual coefficient on the lagged dependent variable (T is assumed to be the same across the companies). The size of this downward bias becomes quite small for T > 15 under the case of $b = 0.5$; in the present context of T = 25 (for the balanced panel), the size of the bias is evaluated as -0.062.[(5)] The results presented in Section 4 should be interpreted in the light of this although estimates which use an instrumental variable approach designed to correct for the Nickell (1981) bias are also presented. The results confirm that with a panel of this size any such bias is quite small.

As has been mentioned above, a more general version of equation **(4)** would allow for asymmetries and non-linearities in the persistence of profits. In this context, an asymmetry refers to the reaction of profitability to last year's profit rate being different at different points in the distribution of rates of profit. The asymmetries are considered in two different ways. First, consider the following estimating equation:

$$\left(\frac{p}{K}\right)_{it} = a_i + \sum_{j=1}^{5} b_j \left(\text{Quintile}_j \frac{p}{K}\right)_{it-1} + g_t + e_{it} \qquad \textbf{(5)}$$

(4) Estimating the models in differences has a very similar effect.
(5) See Nickell (1981, page 1,422), equation 17.

in which $\left(\text{Quintile}_j \frac{p}{K}\right)_{it-1}$ is the 'j'th quintile of the lagged profitability term. The quintiles separate the distribution of profitability in each year in to five groups of companies depending on their profit rate. Equation **(5)** is therefore equivalent to equation **(4)** but the lagged profits term becomes five corresponding lagged profit terms which are equal to $(p / K)_{it-1}$ if $(p / K)_{it-1}$ lies in the jth quintile and zero otherwise. Equation **(5)** is therefore equivalent to equation **(4)** but with the linear lagged profits term in the former being replaced by five terms allowing the coefficients to vary according to the rate of profit, with 'knots' at the 20th, 40th, 60th and 80th percentiles. The thresholds that define these groups vary across years depending upon the profit rates in year 't' represented by these percentiles. In equation **(5)**, the absence of both asymmetries and non-linearities implies that $b_1 = b_2 = b_3 = b_4 = b_5$, a restriction that can be tested in the usual way.

An alternative formulation allows for a quadratic in the return on assets while also allowing this to be separately defined for companies with rates of profitability above and below the median level in a particular year.

$$\left(\frac{p}{K}\right)_{it} = a_i + b_1\left(high\frac{p}{K}\right)_{it-1} + b_2\left(low\frac{p}{K}\right)_{it-1} + b_3\left(\left(high\frac{p}{K}\right)_{it-1}\right)^2 + b_4\left(\left(low\frac{p}{K}\right)_{it-1}\right)^2 + g_t + e_{it} \qquad \textbf{(6)}$$

where $\left(high\frac{p}{K}\right)_{i\,t-1}$ denotes the company return on assets in year 't' if this is greater than or equal to the median return in that year (zero otherwise); and $\left(low\frac{p}{K}\right)_{i\,t-1}$ denotes the company return if it is less than the median (zero otherwise). In this estimating equation, symmetry implies that $b_1 = b_2$ and $b_3 = b_4$. While the additional hypothesis of linearity (but with a possible 'kink' at the median profit rate) implies that $b_3 = b_4 = 0$. The absence of the 'kink' implies that $b_1 = b_2$ and $b_3 = b_4 = 0$. The signs of the b_3 and b_4 coefficients determine whether persistence increases (b_3, $b_4 > 0$) or decreases (b_3, $b_4 < 0$), the further one moves away from the median in either direction. Of course, the models considered remain linear in parameters.

A number of additional candidate measures of persistence or mobility in profitability are available. Standard measures of correlation such as the linear correlation coefficient are obvious possibilities. These correlation measures continue to focus on the relationship between successive years' profit rates for companies, but are likely to produce larger estimates of the degree of persistence than the fixed-effects methods outlined above. Such measures do not control for differences between firms to the same extent as the fixed-effects approach. This is the main strength of the fixed-effects panel estimation method.[(6)] Section 4 also presents results based on a transition matrix looking at movement from different points in the distribution of profitability, although greater emphasis is attached to the panel data methods described previously.

The existing literature on the persistence of profitability, such as Geroski and Jacquemin (1988), employs time series regressions for the individual companies, and takes the average coefficient

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[(6)] Note, for instance, that such differences in profitability between companies that are stable over time may include profit-reporting differences between companies such that issues of measurement error may also be addressed by fixed-effects analysis.

on the lagged dependent variable as the indicator of persistence. By allowing for different intercepts in the estimations of separate equations by each company, this approach can be thought of as allowing for fixed-effects differences in profitability. In their analysis for the United Kingdom, based on 51 companies over the period 1949-77, Geroski and Jacquemin (1988) arrive at a measure of persistence of 0.49 (rising to 0.52 when correcting for small-sample bias).[7] Restricting the analysis to companies with a relatively long run of time series data is, however, likely to accentuate problems of survivor bias.

The analysis conducted in this paper is also relevant in terms of the accounting and finance literature on the predictability of earnings and, to a lesser extent, of profitability. Little (1962) suggested that successive changes in earnings were independent. This implies pure persistence in earnings. Ball and Watts (1972) also suggest that corporate incomes follow a martingale process. A more thorough statistical approach is the recent contribution of Fama and French (2000). They consider the issue of mean reversion in profitability (and hence whether there is predictability in profitability as well as earnings). Their approach, applied to US companies, involves two stages. First, to estimate expected profitability (as a function of the ratio of dividends to book value of equity, whether the company is a dividend-payer at all, and the market-to-book ratio). Second, to estimate the relation between profitability and the deviation of profitability from its expected value (obtained from the first-stage regression) and the previous period's change in profitability. Significant evidence of mean reversion is found. Fama and French (2000) also emphasise the importance of allowing for non-linearities in this relationship.

4 The data

The data are derived from the company accounts of all UK quoted non-financial companies held on the Datastream database, over the period 1974-98.[8] This includes companies that subsequently failed or de-listed. Use of the (single) lagged profit term as a regressor means that the period 1975-98 is available for estimation purposes. The data are also restricted by the requirement that each company records at least four time series observations during this period. This is to ensure that there are a reasonable number of time series observations to estimate the autoregressive parameters. Further details regarding the structure of the panel are provided in the data appendix. Table A records the number of companies in the sample per year as well as some other basic summary statistics.

These are disproportionately large companies compared with the population of non-financial companies in the United Kingdom. The average sales across the companies in 1998 is £580.5 million. The smallest company (by turnover) in 1998 has sales of £135,000 and the largest £41 billion. It is an unbalanced panel with the number of firms per year at its maximum of 1,180 in 1980 and minimum of 996 in 1998. A balanced panel subset exists with 391 companies present in the dataset for all 25 years. The combined turnover of the set of companies in 1998 is £650 billion. Of course, for many companies a significant proportion of these sales will be derived from overseas markets.

[7] More recent studies for the United States include McGahan and Porter (1999) and Waring (1996).
[8] A year refers to the accounting year-end.

The measurement of the return on (physical) assets, before interest and taxes are deducted, warrants further comment. Financial performance is measured on a pre-tax basis since taxes are drawn from post-interest profits and are not therefore an indication of financial performance or financial pressure facing the firm. The estimate of persistence is unlikely to be sensitive to this point and to the extent that companies face similar tax schedules in each year, this should be taken into account through the time effects.(9) The issue of taking earnings on a pre versus post-interest payments basis also needs to be considered. Interest payments represent an important financial pressure on firms (see Nickell and Nicolitsas (1999) for an analysis) but the aim in this paper is to consider the underlying financial performance of companies, irrespective of the chosen financing structure. Use of post-interest profits conflates the two and the use of pre-interest profits has therefore been adopted. Similarly, since interest payments are tax-deductible, taking profits on a post-tax basis would also make the profits measure affected by the chosen financing structure of the firm. The pre-tax measure has therefore been adopted even though it is more common to think of firms as maximising post-tax profits. Nevertheless, equation **(5)** was estimated using a post-tax measure of profits and produced results very similar to those reported below.

One further measurement issue is that associated with the effects of inflation. With inflation, historic cost measures of profits tend to overstate profit levels for two reasons. First, historic cost depreciation understates current cost depreciation. Second, a measured nominal gain on inventories is counted as profit (eg King (1975)). The issue in the present context is whether this should lead to any persistence in measured profitability, and there may be such a tendency as the effects could be serially correlated. To the extent that industries differ in how much they hold inventories or are highly geared, then this further motivates the assessment of whether such effects vary across industries. A second method was also employed to assess the likely importance of this factor. The sample was split between broadly high and low-inflation periods. The average inflation rate (GDP deflator) 1975-84 was 13.0% per annum while in the period 1985-98 it was 4.4%. If inflation affects the estimate of persistence, this should lead to a difference in the degree of persistence between these two periods. Separate estimates of equation **(5)** for the two sub-periods did not suggest this to be the case. The point estimates of profit persistence by quintile were marginally higher for the lower-inflation period. Note that these measurement issues apply equally to previous studies using company-level data of this kind.

A key measurement issue concerns the capital stock. In order to estimate the company capital stock at replacement cost, the procedure described in Nickell *et al* (1992) has been employed (see the data appendix). This essentially involves the application of a perpetual inventory approach. The value of stocks and work-in-progress has been added to this measure of physical assets. Capital stock is measured at year-end. The issue of intangibles on which companies expect to earn a return is a significant measurement issue in this context. Much investment in intangible assets (eg research and development and advertising) is expensed against current-period profits rather than being capitalised (see Lev and Zarowin (1999) who suggest that the importance of

(9) Note that tax asymmetries, such as loss ‘carry-forwards’, would affect estimates of profit persistence on a post-tax (but not pre-tax) basis. Some behavioural consequences at the firm level may also result but for the most part in terms of capital expenditures, thereby affecting cash flow rather than profits (for an analysis, see Auerbach (1986)), although this will have consequences for the capital stock.

such factors has increased over time). This raises some potentially difficult issues for studies using company accounts data and a full consideration of these issues is beyond the scope of this paper. Nevertheless, it is natural to infer that the importance of such intangibles will vary in importance across sectors (eg Bond and Cummins (2000)). Intangibles are likely to be less important for utilities and manufacturing than for service sector firms, for instance. This suggests examining whether any pattern of high or low profitability persistence is robust across sectors. This is pursued in Section 5.

Data description

It is clear from Table A that across the sample of companies, there is a decline in the return on assets throughout the mid to late 1970s, reaching a low point of 7.9% in 1981. A recovery is then experienced until 1988 when the average company's return on assets stood at 18.9%. The recession of the early 1990s is associated with a decline in the average return to 10.8% in 1992, from which point it has increased steadily.

Some initial indication of the extent of persistence is given by the correlation coefficient between successive years' profit rates. This linear correlation coefficient stands at 0.82. In a similar vein, but considering the rank position of companies' rates of profit, the Spearman correlation coefficient between successive profit rates is 0.80 (p-value = 0.00). The addition of year dummies to a pooled cross-sectional OLS model of persistence produces a coefficient (White standard error) on the lagged dependent variable of 0.79 (0.017). Given that these results do not control for many of the differences that exist between firms, they are taken to represent an upper bound on the extent of persistence in profits.

An additional approach that will act as a useful introduction to the analysis of mobility or persistence in company profitability is presented in Table B. The table presents the one-year transition matrix of moves between different quintiles of the cross-sectional distribution. The $(j, k)^{th}$ element of the (5 x 5) transition matrix gives the probability that a company in state or quintile 'j' will move to quintile 'k' the following year.[10] Note that this analysis therefore pertains to the relative position in the distribution of profitability rather than persistence in the absolute profit rate *per se.* The diagonal elements in the matrix reveal the level of persistence of relative profitability for companies in the different quintiles.

The level of persistence in companies' position in the distribution seems quite high. Moreover, this persistence does appear to differ across the quintiles of the distribution. Almost three quarters of companies in the top quintile in one year remain in that top quintile of companies in the following year, on average. This compares with approximately 50% of companies remaining in the same quintile for those in the quintile groups two, three and four. The degree of mobility from a position in the lowest quintile, with two thirds remaining in the same quintile, also appears to be slightly lower than that for the middle quintiles.

[10] Analysis of this kind, applied to the distribution of real income per capita at the economy-wide level, is carried out by Quah (1993).

There is therefore some evidence that companies in either the top or bottom quintile have a greater propensity to remain in that quintile than those in the middle of the distribution. To some extent this would be expected, since the companies in the bottom and top quintiles can only move in one 'direction'. Table B also conveys some sense of the 'distance' of mobility ie the extent to which companies move to the contiguous quintiles. Not surprisingly, there is a clear tendency for this to be the case. Of those companies in the bottom quintile, only 3.2% and 1.9% transit to the fourth and fifth quintiles respectively, compared with 22.4% moving to the second quintile. More than 90% of companies in the top quintile of rates of profitability remain in either the fourth or fifth quintile in the following year, with approximately 2% moving to the first and second quintiles. Finally, one may note that estimating two separate such transition matrices for the periods 1974-85 and 1986-98 produces a very similar pattern.

5 Estimation results

This section focuses on the estimation of the fixed-effects panel data models represented by equations **(4)** to **(6)**.

Table C reports the results from estimation of equation **(4)** in column [1].(11) These are the key results for the linear model with some alternative experiments concerning the use of deeper lags reported in columns [2] and [3]. A highly significant degree of persistence is seen, with a coefficient (standard error) on the single lagged dependent variable of 0.497 (0.025). The coefficients on the deeper lags decline quite rapidly, with the coefficient for the model with the second lag being 0.187, although it remains statistically significant. Not surprisingly, the year effects, which will incorporate the influence of the macroeconomic cycle, are significant in all specifications reported (in the case of column 1, $\chi^2(23) = 629.07$; p-value = 0.00). The reported standard errors are robust to general forms of heteroskedasticity; a comparison of the standard errors with and without this correction suggested that this was an important adjustment to make. This is not surprising using company-level data, where the variance of shocks to profitability is likely to be related to company size, among other things.

Controlling for profits lagged one year, there is no sign of persistence carrying over from previous years. The addition of the deeper lags when the single-period lag is included attracts a negative coefficient. Consequently, in the remainder of the paper, I concentrate on the issue of asymmetries and non-linearities and how this varies across industries, employing a single lag on the profits term, as in previous (linear, symmetric) studies.

Table D reports estimation results, reporting the two alternative types of estimating equation, allowing for variable coefficients in the profits term and the quadratic with an asymmetry at the median profit rate in each year. Both sets of results provide evidence of asymmetries and non-linearities in the persistence of company profitability, neither of which have been allowed for in previous studies. More specifically, there is evidence of greater persistence of profits at higher rates of profitability, suggesting that reversion is a stronger phenomenon at lower rates of

(11) Estimation is carried out using DPD98, a program written in GAUSS for estimation of dynamic unbalanced panels (see Arellano and Bond (1998)).

profitability. In the variable coefficients model, the null hypothesis of linearity and symmetry is easily rejected by the data ($\chi^2(4) = 58.69$; p-value = 0.00), with the hypothesis of linearity in the quadratic model also rejecting the null, although the restriction that the coefficients on the two quadratic terms are equal to zero is not rejected.

The degree of persistence has been estimated to be monotonically increasing in the degree of profitability.(12) The analysis of the transition matrix in Table B indicates that persistence tends to be greatest at the top quintile but also appears to be slightly greater for the bottom quintile than the three central quintiles. Note that the latter result is not necessarily in conflict with the results of the econometric exercise, suggesting that the degree of persistence is higher at higher rates of profitability. Persistence is being defined in different ways in the two approaches. In the transition matrix, persistence is defined as continuing membership of the same quintile of the distribution (regardless of what is happening to the company's absolute rate of profit aside from whether it remains in the same quintile). The econometric analysis has considered the relationship between successive absolute rates of profit. This difference in the pattern of results can be interpreted as suggesting that there is a relatively high degree of persistence in membership of the bottom quintile but that within this quintile rates of profit can still vary to a relatively high degree from one year to the next. The results from the two methods are consistent in showing that persistence is greatest at higher rates of profitability.

Variation by industry

The analysis goes on to consider whether there is variation in the above results by industry. Note that estimating the models separately by industry will also allow the role of aggregate or macroeconomic effects to differ between industries, acknowledging the fact that different industries may be at different stages in the economic cycle in any particular year. To this end, the Datastream industry codes are used and matched with one-digit SIC 1980 classifications. Unfortunately however, there are a significant number of non-reported cases on this industry variable. The combined sample size declines from 26,458 to 20,247 (before allowing for the use of a lagged dependent variable). Nevertheless, it will still allow an analysis of how the results vary by industry. There is no indication that the missing values on industry affiliation occur non-randomly. Re-estimating our previous models on the requirement that the industry group information is available provides very similar results.

Estimating the basic linear model separately by industry indicates only a minor degree of variation in persistence by industry. The smallest degree of persistence is estimated for the 'transport and communications' sector (a coefficient of 0.45), with profitability being most persistent in the 'distribution, hotels and catering sector' (a coefficient of 0.54). However, for most industries the measure of persistence lies in the range 0.48 to 0.53, indicating that overall

(12) A similar pattern (ie higher levels of persistence for higher rates of profitability) is observed when estimating separate equations for the different quintiles. However, this of course involves the loss of observations when a company's profit rate moves from one quintile to another, which is partly why equation **(5)** is the preferred specification. It is also apparent from the results that the standard error of the estimated degree of persistence is higher for the lower quintiles. This is not observed when not correcting for heteroskedasticity, suggesting that the pattern occurs because the variance of shocks to profitability varies more across companies in the least profitable group.

there is little apparent variation by industry in this regard. This may, however, disguise variation when allowing for asymmetries.

Tables F1 and F2 report the results allowing for asymmetries and non-linearities in the persistence of profits, considering the estimating equation separately by industry. These results define the thresholds for the quintiles separately for each industry (and for each year). Evidence of a greater degree of variation among industries is now found. For parsimony, I report the results for the variable coefficients model, the results for the quadratic specification being much the same in interpretation.

The result that persistence is greater at higher rates of profitability is common across the industry regressions. At the highest quintiles the degree of persistence is less similar across the different industries than under the linear models, ranging from 0.47 in ‘other manufacturing’ to 0.58 in ‘distribution, hotels and catering’. In terms of persistence at low rates of profitability, mean reversion or recovery appears to be strongest in the ‘energy and water supply’ sector for which there is no evidence of persistence in profitability below the second quintile. This is quite an intuitive result in the sense that this is a highly regulated sector and, to date, regulators have possessed a primary duty to ensure that regulated businesses can finance their functions.[13] The highest degree of persistence for the lowest quintile occurs in the ‘other services’ sector, suggesting that mean reversion is slowest at low rates of profitability in this sector.

Robustness checks

Before going on to discuss the results further, three issues of robustness of the results are considered. The first issue concerns the possibility of non-random entry and exit in the dataset. Companies with low rates of profitability may be more likely to leave the dataset (through liquidation, takeover, etc) than is likely to be the case for companies with high rates of profit. There is the possibility of some sample-selection bias. The main implication of this is that one can only make inferences about persistence of profits conditional on company survival. An indication of the extent to which such sample-selection problems are likely to be present is also provided by re-estimating our models on a balanced panel subset of the data, ie using those companies that are present in each and every year between 1974 and 1998. The results display the same pattern to that previously reported with persistence being greater at the higher points in the distribution. The coefficients (White standard errors) on the five quintiles, taken in ascending sequence are: 0.293 (0.069); 0.463 (0.055); 0.548 (0.042); 0.600 (0.033); 0.628 (0.038). The linear model for the balanced panel produces a coefficient (standard error) of 0.618 (0.038). Therefore this suggestion of non-random exit and entry does not appear to account for the pattern of asymmetries that has been estimated.[14]

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[13] The regulatory duty to ensure that companies can finance their functions will not account for this result entirely, since not all companies in SIC1 are regulated. However, the number of companies in SIC1 rises from 30 in 1989 to 62 by 1992 as the privatisations of the electricity and water sectors takes place.

[14] Bond and Meghir (1994) also note that under certain conditions the fixed effects can control for non-random exit, or attrition bias. The necessary conditions are that the duration of company lifetimes is distributed exponentially and the covariance between the exit process and innovations (to profitability) is fixed over time.

The discussion presented in Section 3 noted the presence of a (downward) bias on the coefficient in the lagged dependent variable under the within-groups estimates, although this is not expected to be large in the case of T = 25 (Nickell (1981)). Nevertheless, the issue merits further analysis through instrumenting the lagged dependent variable to account for this bias. In the light of this, the Generalised Methods of Moments (GMM) estimator due to Arellano and Bond (1991) (see also Arellano and Bover (1995)) was used to consider the issue. The method estimates equations such as **(4)** and **(5)** in differences or orthogonal deviations (this is an alternative way of removing the fixed effects from the estimating equation by subtracting from the value of each company in a particular year that company's average until the end of the sample period). It then uses the lagged levels of the variable dated $t - 2$ as an instrument. As one proceeds through the panel (ie as 't' increases) deeper lags become available as instruments and are added to the instrument set. Consistency of the estimator requires the absence of second-order serial correlation.

The results confirm our priors that any Nickell (1981) bias in a panel with T = 25 is small. When estimating by GMM in orthogonal deviations (first differences are very similar), the coefficients (standard errors) for each quintile of the lagged dependent variable in ascending order are 0.322 (0.056), 0.437 (0.066), 0.562 (0.041), 0.557 (0.031) and 0.615 (0.018). The restriction of linearity is rejected ($\chi^2(4) = 35.88$ (p-value = 0.00)).[15]

Blundell and Bond (1998) propose a system GMM estimator for a situation of highly persistent data (ie the coefficient on the lagged dependent variable is close to 1, such that the lagged level at $t - 2$ has a low correlation with the first difference). Employing this estimator, the results again indicate that high profitability persists more than low profitability. This is not surprising, since the coefficient on the lagged dependent variable at about 0.6 is not as high as is necessary for the (weak instruments) problem to be a significant one.

A third issue is to consider an alternative estimation strategy. As noted in Section 3, the approach of Geroski and Jacquemin (1988) is to estimate time series regressions for each company and use the average coefficient on the lagged dependent variable as the indicator of persistence. Adopting a time series approach for each of the 391 companies that present data for each year during our sample period produces an average coefficient on the lagged dependent variable of 0.65. In 312 of the 391 regressions the 't-value' on the lagged dependent variable exceeds 3. These results provide a useful robustness check and, to a significant extent, confirm our earlier findings of persistence based on the linear model. Examining non-linearities and asymmetries in the persistence of profits based on this time series approach seems ill-advised, however, given the relatively small sample sizes involved in each regression. It is for this reason that the panel data approach, controlling for fixed effects, is our preferred methodology.

Two economic hypotheses would appear to be consistent with the finding that there is greater persistence of profits from higher rates of profitability. The first, in the tradition of Mueller (1977), is that companies with higher rates of profitability use such resources as a means of

(15) These are the two-step estimates (see Arellano and Bond (1991)). The robust one-step estimates suggested a similar pattern for the point estimates but were somewhat less well-determined and did not reject the null of linearity (p-value = 0.15). Neither set of results suggested the presence of serial correlation.

setting up barriers to entry, making both actual entry and the threat of entry more difficult. They may also benefit more from exogenously given entry barriers. Mueller (1977) suggests that such companies have a greater incentive to protect such returns and greater resources with which to do so.

The second possible explanation is that companies may possess some discretion over the timing of their reported returns, whether good or bad. Basu (1997) suggests that they will be inclined to exploit any such potential in the direction of reporting good performance over more than one year's results while allocating any poor performance to a single year. In this way, companies will favour a conservative approach to accounting. This, too, would imply greater persistence at higher rates of profitability, such that something of an observational equivalence problem is present. The present analysis is not able to discriminate between these two hypotheses.

6 Conclusions

This paper has examined the persistence of profitability in the UK non-financial corporate sector over the period 1975-98. The motivation for the analysis lies in the fact that persistence in company profits represents a key dimension of the dynamics of the corporate sector. Persistence in profits has frequently been interpreted as an indication of the extent of competition, emphasising the dynamic nature of such forces and without imposing priors about structural indicators of competition based on actual (as opposed to potential) incumbents. Moreover, from the perspective of financial stability, an analysis of the persistence of profitability provides a context for assessing how quickly surviving companies that are financially vulnerable are able to recover from a period of low profitability.

A key finding of this paper has been that persistence in profits is less strong for companies with low rates of profitability in a particular year. Such companies' rates of return therefore appear to revert to the mean more quickly than that of companies with high rates of return. This is 'good news' from the perspective of financial stability, in particular to the extent that such outturns deviate from previous expectations. Our results indicate that companies are able to recover from such periods of relatively poor performance more rapidly than previous linear models of profit persistence would suggest. Indeed, the quantitative importance of the difference in estimates is quite large, with a coefficient on the lagged dependent variable of 0.26 for companies whose rates of profitability lie in the bottom quintile compared with one of 0.56 in the top quintile of profitability. In keeping with the extant literature on profit persistence, it needs to be borne in mind that these results are conditional on company survival. Significantly, however, the same pattern of results was obtained when the analysis looked at the balanced panel subset of firms present at each and every year between 1974 and 1998.

Persistence in the rate of profit is therefore estimated to be lowest in the bottom quintile than elsewhere in the distribution. In addition, inspection of the one-year transition matrix of moves between quintiles indicated that the proportion of companies transiting from a particular quintile was lowest from the highest quintile followed by the lowest quintile. This suggests that while the *rate* of profitability is less persistent at the bottom quintile, the *position* of companies in the bottom fifth of companies between successive years remains highly persistent.

At the same time, the results also indicate that previous studies of the persistence of profits are likely to have understated the degree of persistence of high returns. This naturally gives rise to the interpretation that competitive forces act less swiftly in competing away such excess returns than such studies would suggest.

The present paper also examined variation between industries in the extent of profit persistence. Only a modest degree of variation among industries has been found on the basis of the standard linear models, with an increase in the extent of this variation between industries being found on the basis of the non-linear (in variables) models. The asymmetries in the persistence of profits were estimated to be stronger in ‘energy and water supply’ than in the ‘other services’ sector. For instance, low profitability (ie rates of profitability in the lowest quintile) does not persist in the ‘energy and water supply’ sector, whereas high profitability does. Future research might attempt to consider the features of these industries that appear to account for such differences, which might be due to differences in cost structures. The result that high profitability persists more than low profitability was estimated to be present in each industry.

Table A: Summary statistics

Year	Mean nominal sales (£ million)	Mean return on assets (before interest and taxes) (%)	Number of companies
1974	71,486	18.6	1,152
1975	82,125	14.9	1,158
1976	103,617	14.0	1,160
1977	120,124	14.0	1,170
1978	132,249	13.0	1,162
1979	151,465	11.9	1,175
1980	168,583	9.5	1,180
1981	189,293	7.9	1,175
1982	211,329	8.3	1,169
1983	241,352	10.1	1,170
1984	211,347	12.9	1,172
1985	226,824	14.3	1,167
1986	241,576	15.9	1,161
1987	266,269	18.0	1,169
1988	297,301	18.9	1,179
1989	341,700	17.6	1,176
1990	371,899	16.1	1,154
1991	399,713	11.5	1,102
1992	421,983	10.8	1,073
1993	453,811	11.5	1,079
1994	461,527	12.5	1,115
1995	484,860	11.3	1,167
1996	521,868	10.6	1,127
1997	536,512	12.3	1,083
1998	580,259	12.7	996
Total	287,390	13.2	28,591

Table B: Transition matrix for one-year transitions between quintiles of distribution of company profitability

		Subsequent quintile				
		Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Initial quintile	Quintile 1	66.0	22.4	6.6	3.2	1.9
	Quintile 2	21.5	51.2	22.0	4.5	0.8
	Quintile 3	7.8	22.7	47.8	19.3	2.5
	Quintile 4	4.3	6.2	22.0	54.8	12.8
	Quintile 5	2.9	1.9	4.0	18.0	73.3

Note: Quintile 1 is the lowest of the five groups of profit rates.

Table C: Fixed-effects linear models of persistence

	[1]	[2]	[3]
Return on assets $_{it-1}$	0.497 (0.025)		0.548 (0.034)
Return on assets $_{it-2}$		0.187 (0.035)	-0.071 (0.029)
Year dummies	Yes (23)	Yes (22)	Yes (21)
Fixed effects	Yes	Yes	Yes
M_2	-0.586 [p-value = 0.56]	-5.235 [p-value = 0.00]	2.043 [p-value = 0.04]
Companies	2,129	2,129	2,129
Observations	24,329	22,200	22,200

Notes: Within-groups estimates. Standard errors robust to heteroskedasticity reported in parentheses; M_2 is a test of second-order serial correlation as in Arellano and Bond (1991), and is asymptotically distributed as a standard normal.

Table D: Fixed-effects estimates with asymmetries and non-linearities

	[1]	[2]
Quintile$_1(\pi / K)_{it\text{-}1}$	0.257 (0.099)	
Quintile$_2(\pi / K)_{it\text{-}1}$	0.418 (0.030)	
Quintile$_3(\pi / K)_{it\text{-}1}$	0.502 (0.024)	
Quintile$_4(\pi / K)_{it\text{-}1}$	0.547 (0.020)	
Quintile$_5(\pi / K)_{it\text{-}1}$	0.564 (0.022)	
High$(\pi / K)_{it\text{-}1}$		0.550 (0.026)
Low$(\pi / K)_{it\text{-}1}$		0.354 (0.049)
(High$(\pi / K)_{it\text{-}1})^2$		-0.003 (0.036)
(Low$(\pi / K)_{it\text{-}1})^2$		0.042 (0.119)
Year dummies	Yes (23)	Yes (23)
Fixed effects	Yes	Yes
Hypothesis test		
Linearity	$\chi^2(4) = 58.69$ [p-value = 0.00]	$\chi^2(3) = 65.44$ [p-value = 0.00]
M_2	-0.660 [p-value = 0.51]	-0.600 [p-value = 0.55]
Companies	2,129	2,129
Observations	24,329	24,329

Note: Standard errors robust to heteroskedasticity reported in parentheses.

Table E: Results summary for fixed-effects estimates by industry

	$(p/K)_{i\,t-1}$	Companies	Observations
Energy and water supply	0.513 (0.165)	74	538
Extraction, metals and chemicals	0.470 (0.114)	84	1,031
Metal goods, engineering	0.534 (0.034)	327	4,226
Other manufacturing	0.449 (0.144)	216	2,627
Construction	0.480 (0.047)	169	2,435
Distribution, hotels and catering	0.536 (0.057)	289	3,890
Transport and communications	0.445 (0.038)	244	2,423
Other services	0.525 (0.044)	155	1,593

Note: Industry classifications are matched from Datastream codes to 1980 Standard Industrial Classifications (SIC 1980).

Table F1: Fixed-effects results by industry with non-linearities

	Energy and water supply	Extraction, metals and chemicals	Metal goods, engineering	Other manufacturing
Quintile$_1(p/K)_{it-1}$	0.101 (0.184)	0.161 (0.216)	0.126 (0.088)	0.381 (0.344)
Quintile$_2(p/K)_{it-1}$	0.001 (0.281)	0.185 (0.098)	0.350 (0.041)	0.254 (0.113)
Quintile$_3(p/K)_{it-1}$	0.232 (0.128)	0.223 (0.076)	0.444 (0.031)	0.379 (0.093)
Quintile$_4(p/K)_{it-1}$	0.274 (0.100)	0.343 (0.076)	0.501 (0.025)	0.411 (0.070)
Quintile$_5(p/K)_{it-1}$	0.536 (0.173)	0.552 (0.052)	0.574 (0.030)	0.465 (0.074)
Year dummies	Yes (23)	Yes (23)	Yes (23)	Yes (23)
Fixed effects	Yes	Yes	Yes	Yes
Hypothesis test				
Linearity	$\chi^2(4) = 5.48$ [p-value = 0.24]	$\chi^2(4) = 12.46$ [p-value = 0.01]	$\chi^2(4) = 37.22$ [p-value = 0.00]	$\chi^2(4) = 10.63$ [p-value = 0.03]
M_2	-1.345 [p-value = 0.18]	-1.190 [p-value = 0.24]	-2.108 [p-value = 0.04]	-1.294 [p-value = 0.20]
Companies	74	84	327	216
Observations	538	1,031	4,226	2,627

Table F2: Fixed-effects results by industry with non-linearities

	Construction	Distribution, hotels & catering	Transport and communications	Other services
Quintile$_1(p/K)_{it-1}$	0.108 (0.099)	0.159 (0.077)	0.260 (0.132)	0.294 (0.102)
Quintile$_2(p/K)_{it-1}$	0.320 (0.061)	0.284 (0.075)	0.285 (0.119)	0.255 (0.110)
Quintile$_3(p/K)_{it-1}$	0.397 (0.045)	0.390 (0.056)	0.340 (0.091)	0.410 (0.072)
Quintile$_4(p/K)_{it-1}$	0.437 (0.036)	0.508 (0.053)	0.417 (0.075)	0.460 (0.056)
Quintile$_5(p/K)_{it-1}$	0.529 (0.040)	0.580 (0.056)	0.522 (0.056)	0.546 (0.044)
Year dummies	Yes (23)	Yes (23)	Yes (23)	Yes (23)
Fixed effects	Yes	Yes	Yes	Yes
Hypothesis test				
Linearity	$\chi^2(4) = 22.81$ [p-value = 0.00]	$\chi^2(4) = 68.27$ [p-value = 0.00]	$\chi^2(4) = 8.84$ [p-value = 0.06]	$\chi^2(4) = 11.17$ [p-value = 0.03]
M_2	-0.632 [p-value = 0.53]	0.664 [p-value = 0.51]	-0.180 [p-value = 0.86]	0.151 [p-value = 0.88]
Companies	169	289	244	155
Observations	2,435	3,890	2,423	1,593

Data appendix

The data are an unbalanced panel over the period 1974-98, consisting of the following number of observations per company.

Table A1: Structure of the unbalanced panel

Records per co.	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Companies	175	144	100	93	97	114	159	148
Records per co.	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
Companies	134	115	92	85	54	52	37	19
Records per co.	**20**	**21**	**22**	**23**	**24**	**25**		
Companies	23	17	19	15	46	391	**Total**	2,129

Variable definitions

Profits

Profits are defined as the sum of pre-tax profits (Datastream item 157) and total interest paid (item 153) less interest income (item 143). A post-tax measure of profits was also employed, subtracting the total tax charge (item 172) from the preferred measure of profits.

Capital stock

Capital stock is measured on a replacement cost basis. The procedure employed to convert the historic cost/book value measure in company accounts to replacement cost with a perpetual inventory method has been used in a number of company accounts panel data studies (eg Nickell *et al* (1992) and Blundell *et al* (1992)).

The raw data provide cost of plant and machinery (Datastream item 328), buildings (item 327) and other assets (item 329) separately in gross historic cost terms. Investment is obtained as the sum of the change in the gross historic cost of each category of asset plus depreciation of fixed assets (item 136). This is used rather than total new fixed assets (item 435) as the latter is not available on Datastream from 1992 onwards.

Changes in the gross fixed assets of each asset type are used to estimate the proportion of investment in each category of asset. In a company's first year, its proportion of investment in plant and machinery is taken to equal the ratio of plant and machinery to total book value of assets.

$$PMR_{it} = \frac{GFP_{it}}{GFP_{it} + GFB_{it} + GFOT_{it}}$$

For subsequent years the annual difference in each of the terms on the right-hand side of this expression is used to obtain PMR_{it}. Investment in a particular type of asset is then given by

$$NFAPM_{it} = I_{it} * PMR_{it}$$

Replacement cost capital stock is estimated using the perpetual inventory formula

$$K_{it+1} = (1+P_t)K_{it}(1-d) + IJ_{it}$$

where P_t is the inflation rate for the particular asset type in year t; d is the rate of depreciation of the asset. This is assumed to be equal to 0.025 for buildings, 0.08 for plant and machinery and 0.05 for other assets; *IJ* is investment in a particular asset type (ie *NFAPM* in the case of plant and machinery as defined above). Similar calculations are done for the other asset types (buildings and 'other'). Total stocks and work in progress (item 364) is then added for each company in a particular year to obtain the company capital stock in that year.

For the company's first observation, the replacement cost is assumed equal to the gross historic cost. In a fixed-effects framework, this should not matter (ie any measured difference in rate of return between companies as a result of this will be quite stable over time for the company).

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