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Persistence of Profits and the Systematic Search for Knowledge

- R&D and profits above the norm

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Persistence of Profits and the Systematic Search for Knowledge - R&D and Profits Above the Norm[1]

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Abstract

Economic theory tells us that abnormal industry and firm profits will not persist for any length of time. Any industry or firm making profits in excess of the normal rate of return will attract entrants and this competitive process will erode profits. A substantial amount of research however, has found evidence of persistent profits above the norm. Barriers to entry and exit are often put forward as explanation to this anomaly. In the absence of, or with low barriers to entry and exit, this reasoning provides little help in explaining why these above-norm profits arise and persist.

In this paper the association between profits and the systematic search for knowledge is investigated. The results show that by investing in research and development firms may succeed in creating products or services that are preferred by the market and/or find a more cost efficient method of production. Corporations that systematically invest in research and development are, by doing so, offsetting the erosion of profits and thereby have profits which persistently diverge from the competitive return. It is argued that even in the absence of significant barriers to entry and exit profits may persist. This can be accredited to a systematic search for knowledge through research and development.

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1. Introduction

In a competitive milieu abnormal firm and industry profits will not persist for any length of time. Any firm or industry making profits in excess of the normal rate of return will attract entrants and this competitive process will erode profits.

If firms are persistently making profits that deviate from the competitive, normal return, it implies a continuous misallocation of resources (Mueller, 1977). One would expect any economic activity that yields excess profits or is unprofitable to stimulate either entry or exit. This dynamic process will eventually restore profits to a normal level. However this does not explain why some firms' profits persist nor does it explain how these profits arise in the first place.

One set of explanations are of course various types of entry and exit barriers as suggested in the industrial economics literature. Another explanation for abnormal returns, even in a competitive environment, might be varying levels of innovation efforts made by the firms. By investing in research and development (R&D) firms may succeed in creating products or services that are preferred by the market, or find a more cost efficient method of production. This lies at the very core of what Joseph Schumpeter means by creative destruction and "*the fundamental phenomenon of economic development*" (Schumpeter, 1911, 1934 and 1950). Basically, the competitive process that drives economic development is fueled and propelled by the quest for profits[3].

The purpose of this paper is therefore to investigate the links between the systematic search for knowledge, through R&D efforts, and the persistence of profits. It is argued that even in the absence of significant barriers to entry and exit, profits may persist, and this can be accredited to the systematic search for knowledge through R&D.

The rest of the paper is outlined as follows. Section 2 provides an overview of previous studies related to the persistence of profits issue. Section 3 discusses the nature and convergence of profits. From this discussion, hypotheses regarding R&D efforts and the persistence of profits are formulated followed by a description of the data used. The methodology is described in section 4, followed by empirical results and analysis in section 5. Concluding remarks end the paper in section 6.

2. Previous Studies

Within industrial organization there is a large body of research on the determinants of profits. However, most studies are static and rely on cross-sectional analysis. Usually these models are structured in a way that a vector of various estimated parameters, explains the present level of profits within industries, as illustrated in equation (1):

$$\prod_{ip} = \beta x_i + \mu_i \qquad (1)$$

Here, the equilibrium level of profits $\prod$ of some firm *i* (or average level of profits for some industry *i*) is explained by a vector x of explanatory variables (such as, patents, market share, industry concentration, etc.) with associated unknown parameters β. In this formulation μ_i is an error term with the standard properties.

[3] This is often referred to as the profit motive.

Although this is a very common way of formulating these kinds of cross-sectional studies, two major problems arise due to the neglect of market dynamics (Mueller, 1990). First, even though equation (1) intends to describe long run equilibrium, the data used in estimation of the model may not have been generated from a long run equilibrium relationship. This discrepancy between theory and data can, if not controlled for, generate biased estimates of the unknown parameters, which in turn leads to incorrect conclusions.[4]

A second reason why cross-sectional studies are inappropriate, especially when antitrust policies are designed, is that the data might not have been generated from long run equilibrium (Geroski, 1990). Using the results from static, cross sectional models to recommend intervention policies may consequently be misleading since this effect may already be occurring. Markets have intrinsic error correction mechanisms that eliminate excess profits, and the alternative to policy action is therefore to allow competition from entry and intra-industry mobility to erode the monopolistic profits that high concentration apparently induces (Geroski, 1990).

In other words, static structure-performance models must comprise considerations of both long-run equilibrium configurations and the systematic motion around them that is induced by market forces. This automatically creates a need to extend cross-sectional empirical analysis towards including a time series dimension (Geroski, 1990).

In contrast to the static structure-performance literature there is a relatively small but growing literature that empirically looks into the dynamics of profits from a time series perspective. This branch of research was initiated by a number of studies made by Mueller (1977, 1986, 1990) and Geroski and Jacquemin (1988). Most of the studies make use of some type of autoregressive formulation of the time path of profits, and use accounting measures of profits. The findings from these time series studies differ a great deal from the cross-sectional studies.

Using a sample of nearly 600 US firms for the period 1950 to 1972, Mueller (1990) finds that firms tend to converge to the industry-average profit rate, but that the convergence process is incomplete. Geroski and Jacquemin (1988) investigate a sample of 134 large German, French and British firms. Their results show that the British firms have less variation in profits and that these profits persist over time. The German and French firms on the contrary have larger variation in profits and also tend to converge more quickly to the industry-average profit rate. Schwalbach, Graßhoff and Mahmood (1988) also find support for profit convergence in German firms. In a similar study, using a sample of 241 American firms over a 20 year period, Jacobsen (1988) finds that industry concentration has no significant effect on the level of profitability. Jacobsen also observes that the abnormal profit rates vanish over time.

Connolly and Schwartz (1985) find an asymmetry in the convergence process between firms, where less successful firms (below industry average profitability), converge to the competitive return, whilst more profitable firms (above industry average profitability) show more persistent returns.

In a study of particular interest to this paper, Waring (1996) examines industry aggregates for some 12 000 American firms over a 20 year period. Waring finds that the convergence process is industry specific and that industry specificity, such as R&D, has a significant

[4] For extended discussion see Appendix A.

impact on the speed of convergence. In consequence R&D investments appear to have a direct relation to the persistence of profits. The profit dynamics seem to differ however depending on whether one looks at industry aggregates or at firm level returns. This is also supported by the findings in a more recent study by Bentzen et al. (2005). Studying a sample of Danish firms there results show that, in contrast to firm, industry aggregate returns display persistence.

Focusing on heterogeneity within industries Caves and Porter (1977) have, by stressing the importance of barriers to intraindustry mobility, pointed out the possibility of observing persistent profitability differences between firms in the same industry. This observation (see also Scott and Pascoe, 1986) is enough to raise the suspicion that the fortunes of various firms in particular industries may diverge from each other considerably, and this in turn leads to the suspicion that the intraindustry variation in excess profits (or in the time paths of excess profits) may be more interesting to examine than between-industry variations in profitability.

A summery of previous studies and their average estimated convergence parameters (λ_i) is provided in Table 1. As can be seen from Table 1 few previous studies have looked at the persistence of profitability in relation to R&D investments.

Table 1, Previous studies on the persistence of profits

Authors	Country	Period	No. Years	No. firms	Average λ_i	R&D effect on persistence
Yurtoglu (2004)	Turkey	1985-98	14	172	0.380	n.a.
Maruyama and Odagiri (2002)	Japan	1964-97	34	357	0.543	n.a.
Glen, Lee and Singh (2001)	Brazil	1985-95	11	56	0.013	n.a
	India	1982-92	11	40	0.229	n.a.
	Jordan	1980-94	15	17	0.348	n.a.
	Korea	1980-94	15	82	0.323	n.a.
	Malaysia	1983-94	12	62	0.349	n.a.
	Mexico	1984-94	11	39	0.222	n.a.
	Zimbabwe	1980-94	15	40	0.421	n.a.
McGahan and Porter (1999)	US	1981-94	14	4488	0.537	n.a.
Goddard and Wilson (1999)	UK	1972-91	20	335	0.590	n.a
Waring (1996)	US	1970-89	20	12,986	0.540	yes*
Kambhampati (1995)	India	1970-85	16	42	0.484	n.a.
Schohl (1990)	Germany	1961-81	21	283	0.509	n.a.
Odagiri and Yamawaki (1990)	Japan	1964-82	19	376	0.465	yes**
Jenny and Weber (1990)	France	1965-82	18	450	0.367	n.a.
Khemani and Shapiro (1990)	Canada	1964-82	19	129	0.425	n.a.
Cubbin and Geroski (1990)	UK	1948-77	30	243	0.482	n.a.
Mueller (1990)	US	1950-72	23	551	0.183	yes***
Schwalbach et al. (1989)	Germany	1961-82	22	299	0.485	n.a.
Yamawaki (1989)	Japan	1964-82	19	376	0.486	yes
	US	1964-82	19	413	0.475	yes
Geroski and Jacquemin (1988)	UK	1947-77	29	51	0.488	n.a.
	France	1965-82	18	55	0.412	n.a.
	Germany	1961-81	21	28	0.410	n.a.

*Finds indirect positive effects of R&D intensity through market share.
** Not firms specific R&D, but R&D-intensity on industry level.
***R&D measured as patenting intensity.

3. The Competitive Process and Profit Convergence

Microeconomic theory predicts that the dynamic process of competition will restore profits to a normal return. This is mainly achieved through entry and exit. From this point of view profits in excess of the opportunity cost of capital are nothing more than a transitory disequilibrium phenomenon. In a stylized manner this process can be illustrated as in Figure 1; profits above (under) the long-run equilibrium imply entry (exit)[5].

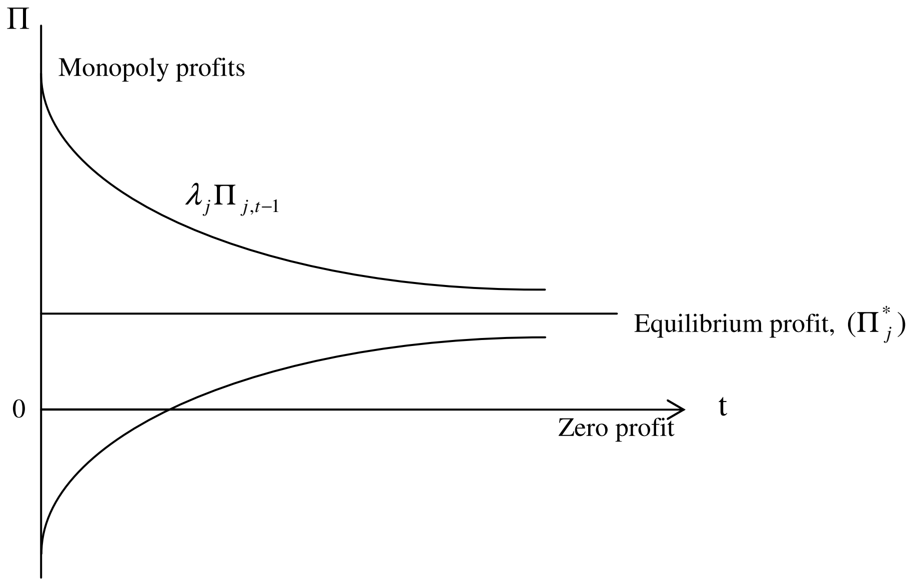

Figure 1, **Process of profit convergence** (source: Schwalbach et al. (1989))

As time progresses, firms' profits will move towards the equilibrium profit level, that is the industry average. Depending then on the firm structure in a particular industry this convergence process will take a certain amount of time, if it converges at all. Using time-series analysis, it is thus possible to measure if firms converge towards a common industry average, and also at what speed this adjustment process takes place. As previously mentioned, it might even be the case that certain firms maintain profits above the industry average even in the absence of significant barriers to entry and exit. One reason for this might be the sustained investments in R&D. For firms and industries signified by little or no R&D, the opposite case may be true, i.e. persistent profitability below the industry average.

3.1 Measuring Persistent Profitability

In order to capture the long-run dynamics of a firm's profitability a decomposition of the firm's profits is necessary. Mueller (1986, 1990) has suggested that profits (Π) can be decomposed in the following way[6]:

$$\Pi_{j,t} = c + r_j + s_{j,t} \tag{2}$$

Where $\Pi_{j,t}$ is the profit for firm j at time t, c is the normal competitive return, r_j is a firm specific permanent rent for firm j, e.g. a premium for risk, and $s_{j,t}$ is a transitory rent. In the long-run the equilibrium profit will be equal to the competitive return $(\Pi_{j,t} = c)$, for a firm

[5] As Mueller (2003) points out it is presumably enough with the threat of entry for incumbent firms to lower prices and subsequently move above-norm profits down to the industry average or norm.
[6] Several alternative formulations have been suggested. Waring (1996) has for example suggested that the transitory rent should be decomposed into industry rent and firm specific rent.

working in a competitive market. Hereafter this long-run equilibrium return, of any firm j, is referred to as Π_j^*. The transitory component $s_{j,t}$, is assumed to decline in the following way:

$$s_{j,t} = \lambda_j s_{j,t-1} \tag{3}$$

The λ-parameter shows the speed of the profit decay. Assuming that $-1 \leq \lambda \leq 1$ profits will converge to the equilibrium rate of return as time passes.[7] By substitution this gives the following first-order autoregressive function:

$$\Pi_{j,t} = (c + r_j)(1 - \lambda_j) + \lambda_j \Pi_{j,t-1} \tag{4}$$

This reduces to the following empirically testable model:

$$\Pi_{j,t} = \alpha_j + \lambda_j \Pi_{j,t-1} + \varepsilon_{j,t} \tag{5}$$

Where $\alpha_j \equiv c + r_j \equiv \Pi^*$, and $\varepsilon_{j,t}$ is an error term. The long-run projected profits of firm j, Π_{jp} can then be derived and estimated as:

$$\hat{\Pi}_{jp} = \frac{\hat{\alpha}_i}{1 - \hat{\lambda}_j}. \tag{6}$$

A test of the hypothesis that competition drives all profit rates to a common competitive level would consequently be to test whether the long-run projected profits ($\hat{\Pi}_{jp}$) differ significantly across firms. If firm j possesses some monopoly power the long-run equilibrium rate of return will be $c + r_j$. That is, due to the monopoly market conditions the profitability level is not the same as the competitive market equilibrium.'

3.2 R&D and the Persistence of Profits

The way patents provide an opportunity for monopoly profits and thereby also create incentives for innovative effort, is a good example of how R&D-efforts may bring about abnormal profit rates in firms. It is very likely however, that a lot of firms actively engage in product-R&D without ever applying for a patent. Therefore, this study will concentrate on profitability and reported R&D investments per se. Subsequently we are not forced to make any assumptions regarding measurements of profitable innovations, productivity, innovation-output, etc.

In "*The Theory of Economic Development*" Schumpeter (1934) argued and emphasized the entrepreneur as the actor who introduces radical innovations and thereby drive economic development. In this view profits are created by the innovations made by the entrepreneurs, which in turn attract imitators. Later, in "*Capitalism, Socialism and Democracy*", Schumpeter (1950) argued that the role of the entrepreneurs to some extent had been replaced by routinary innovative efforts by the rise of modern large corporations. In fact, Schumpeter (1950) asserts that large corporations have standardized/routinized the search for knowledge and that this in itself is an important innovation characterizing the modern large corporations.

[7] Most studies on the persistence of profit find that the λ-parameter is in the region of 0.5 (Mueller (2003)).

R&D may thus slow down the decay of profits towards the normal return. Radical innovations or sustained innovative activity, such as R&D, might then lead to a divergence of profit levels. The successfully innovating firms get a return above the industry average, and less successful firms fall behind.

From this reasoning we form three testable hypotheses. Hypothesis one, the competitive process erodes profits and causes them to converge towards a normal level. Hypothesis two and three, deal with relative R&D intense firms and their profitability. As mentioned before it is likely that sustained R&D investments above average bring about persistent above average profitability levels, on both firm and industry level. Hypothesis two therefore is that there is persistence in R&D expenditures. Hypothesis three is that R&D intensive firms will have a positive effect on profits and that the convergence to normal profits will be slower.

3.3 Data and Method

The data used in the regressions is provided by the Bureau van Dijk OSIRIS-database. From the database 293 large European firms were collected, for which data was available for a 21 year period between 1984 until 2004. The sample is homogenous in the sense that all firms are listed and multinational with a substantial market share in their respective industries. The reason for choosing large firms is that they systematically report on and invest in R&D[8].

Since this type of studies require long time series it puts a restriction on the number of firms that are possible to include in the sample. A larger sample of firms comes at a cost of shorter time series. Nevertheless, the sample covers firms in 44 (two-digit SIC-code) industries spanning over 14 European countries[9]. As a measure of profits we use return on total assets before taxes[10]. More specifically the profit considered is the return on assets around the sample mean. This methodology was previously applied by Waring (1996) in a study which combines time series estimates of the persistence of industry and firm profits with a cross-sectional study of the determinants of above norm profitability. As a proxy for innovative effort we use reported R&D expenditures.

In order to remove business cycle effects from the profit data the profit measure is defined as:

$$\overline{\Pi}_{j,t} = \Pi_{j,t} - \frac{\sum_{j=1}^{n} \Pi_{j,t}}{n} \qquad (7)$$

Where $\Pi_{j,t}$ profit for firm *j* at time *t* and *n* is the number of firms. In other words the term $\overline{\Pi}_{j,t}$ measures firm *j*'s profit deviation from the sample mean. This means that profit is measured as the deviation from the overall sample mean[11]. The dependent variable in the structural equation should consequently be nearly free of cyclical influences. If firm specific

[8] The sample firms are included regardless of the extent of their merger activity and thus include many firms with radically different product structures in 2004 than they possessed in 1984.
[9] The countries are; Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom.
[10] The use of return on total assets before tax mitigates problems related to country bias due to differences in tax structure.
[11] To see why profit persistence is a relative term; see e.g. Jacobsen (1988).

effects are important, then it is in explaining differences in permanent rents that one is most likely to observe them. Furthermore the reported R&D expenditures are normalized by dividing them with gross sales in order to reduce heteroscedasticity.

Among all firms in our sample 28 percent reported to have made investments in R&D in 2004[12], and the average R&D to Sales ratio was about 4 percent, see descriptive statistics in Table 2.

Table 2, Descriptive statistics of R&D-expenditures

Year	R&D/Sales[a]	Nr of firms reporting R&D investments	Share of firms reporting R&D investments	All firm R&D/Sales
2004	0.039	81	0.276	0.011
2003	0.038	87	0.297	0.011
2002	0.037	85	0.290	0.011
2001	0.036	76	0.259	0.009
2000	0.039	67	0.229	0.009
1999	0.040	62	0.212	0.008
1998	0.038	67	0.229	0.009
1997	0.036	71	0.242	0.009
1996	0.039	65	0.222	0.009
1995	0.037	66	0.225	0.008
1994	0.040	70	0.239	0.009
1993	0.043	66	0.225	0.010
1992	0.043	59	0.201	0.009
1991	0.046	57	0.195	0.009
1990	0.043	57	0.195	0.008
1989	0.038	56	0.191	0.007
1988	0.039	46	0.157	0.006
1987	0.038	27	0.092	0.003
1986	0.027	10	0.034	0.001
1985	0.025	10	0.034	0.001
1984	0.023	4	0.014	0.000
Average	**0.037**	**57**	**0.193**	**0.007**

[a] Average for firms reporting R&D sales.

Requiring that the firms provided data for each of the 21 years implies that the sample is a collection of survivors. The sample firms are by definition more successful than other firms over the 21 year period, substantial differences within the sample may however subsist.

4. Results and Analysis

Separate regressions for the 293 firms were estimated following equation (5)[13]. For each firm there are 21 annual observations. The results are summarized and reported for seven subgroups in Table 3. The seven groups have been constructed by ranking the firms by their 1984 profit rates.

[12] There might be an element of selection bias related to the firms reporting R&D. This bias is however expected to be small or even negligible due to the homogenous set of firms in the sample.

[13] Equation (5) can be interpreted as a restricted version of a general finite distributed lag model. It is thus important to determine the appropriate lag length on the profit coefficient. Testing different lag lengths Yurtoglu (2004) show the superiority of a first order auto-regressive model formulation. Consequently, only the estimated parameters of a first-order model are reported in this paper.

In column (1) of Table 3 the estimated absolute deviation of each group from the average equilibrium profit rate is reported. Column (2) shows the average convergence parameters for each group. Column (3) display the group average profit 1984 and column (4) the number of firms in each group. Column (5) represents the number of firms in each group who suffer from autocorrelation according to the Breusch-Godfrey test:

Table 3, Estimates of profit dynamics and the speed of adjustment

	(1)	(2)	(3)	(4)	(5)
Groups	$\hat{\Pi}^*$ (a)	$\hat{\lambda}_j$	$\overline{\Pi}_{1984}$	No. of firms	Autocorrelation (b)
1	4.900	0.543	13.404	42	1
2	3.452	0.544	4.815	42	2
3	1.686	0.468	1.022	42	0
4	-1.007	0.378	-1.565	42	1
5	-2.500	0.439	-3.711	42	3
6	-1.802	0.505	-5.581	42	2
7	-2.837	0.446	-8.588	41	1

a) Average absolute deviation from sample mean: $\hat{\Pi}_j^* = \hat{\alpha}_j / (1 - \hat{\lambda}_j)$.

b) Breusch-Godfrey test indicating autocorrelation at the 5% significance level.

The average convergence parameter, $\hat{\lambda}_j$, is calculated to be 0.475, which is in line with previous studies. This means that profits are reduced each year by $1 - \hat{\lambda}_j^n$, and that on average 0.525 percent of the firms' profit "difference" had disappeared by the second year. This implies that profits do converge towards the average profit rate, but the convergence process is incomplete. Both firms with high initial profits and firms with relatively low initial profits converge. However, the process is partial and the estimated equilibrium profit rates for each of the seven groups deviates from the average returns. For example, group 1 with the highest initial profit rates in 1984 had an average profit rate that was 13.4 percentage points higher, as seen from column (3). The estimated long-run equilibrium profit for group one is projected to be 4.9 percentage points above the average.

In order to detect possible autocorrelation, a Breusch-Godfrey test was performed. At five percent significance only 10 (out of 295) regressions suffered from autocorrelation, see column 5). Given that this only corresponds to about three percent of the firms, there is no reason to believe that the model is incorrectly specified. Despite the fact that the regressions only have 20 degrees of freedom, about 70 percent (201) of the regressions are significant at 10 percent (p-values ≤ 0.1).

To test the effects of R&D investments on the persistence of profits above the norm, a panel data model with fixed effects was estimated. The panel data model is constructed to follow the same individual firm over the entire period. The major motivation for using a panel data model in this way is the ability to control for possibly correlated, time-invariant heterogeneity without observing it. A fixed effect model is the most appropriate since it considers both time and firm specific effects.

The regression results are reported in Table 4. Interestingly, when lagged R&D is included as an explanatory variable the convergence parameter $\hat{\lambda}_j$ is lower for the panel data estimations than the average for the individual OLS estimations.

Table 4, Fixed effects estimations with deviations from firm means lagged R&D and firm plus time effects.

Dependent variable: $\Pi_{j,t}$	(1)	(2)	(3)
Constant	-0.192	-0.134	-0.106
	(-1.54)	(-1.13)	(-0.96)
$\hat{\lambda}_j$	0.346***	0.311***	0.313***
	(5.76)	(5.40)	(5.18)
$R\&D_{j,\ t-1}$	25.05***		
	(2.80)		
$R\&D_{j,\ t-2}$		17.75***	
		(2.88)	
$R\&D_{j,\ t-3}$			13.81***
			(2.45)
No. obs.	5856	5561	5269
R^2	0.29	0.28	0.28
F - value	25.75	17.59	17.22

Notes: *, ** and *** indicates significance at the 10, 5 and 1 percent level.
Numbers in parenthesis represent heteroscedasticity consistent t-statistics.
Two outlying observations have been excluded due to obvious errors in the data.

As expected the estimated coefficient on lagged R&D investments is positive and significant at 1% level. The constant, α_j in equation (5), is negative. This is also reasonable to assume, realizing that an unconcentrated industry achieves at best a Cournot equilibrium (Mueller, 1990).

A central question is how to specify the lag periods for the R&D variable. In most cases it can be assumed that the time between the R&D investment and the revenues it generates is fairly long. Pakes and Schankerman (1984) have found that on average it takes two years. However, statistically, the R&D lag might be of less importance because firms engaging in R&D presumably do so persistently over longer periods of time and consequently the effects will be detected anyhow in the 21 year series. It is likely that it is this persistence in R&D efforts that is important for the persistence of profits, rather than individual years' spending on R&D which to a large extent is more of an accounting quantity. So, in addition to the lagged R&D investments, a five-year moving average of R&D investments was also tested. This was also found to have a significant effect on profits. Again, it is likely that it is continuous and sustained R&D strategies that induce persistence in profits, rather than single or scattered R&D investments. Having 21 observations for each firm nevertheless puts a constraint on the number of R&D lags that can be used. Up to third order lags have been tested (column 2 and 3). As can be seen from Table 4 all estimations proved to be significant. Moreover the R&D coefficient seems to be economically significant.

The size of the R&D parameter declines as the length of the lag increases, which is an indicator of reversed causality. Meaning that high profits are used to invest even more in

R&D. This two-way relationship is thus one possible reason for why some firms succeed in maintaining profits persistently above average. And also, as certain firms recurrently carry out R&D, this brings about a “knowledge barrier to entry”, relative to new and less research intense firms.

As suggested by Waring (1996) the transitory component ($s_{j,t}$ in equation (2)) can be decomposed into industry rents and firms specific rents. To test this notion more formally with regard to how the persistence of firm specific profits might vary across industries, the empirical model of equation (5) is modified by adding industry dummies. These industry dummies, based on two-digit SIC codes, are then interacted with the lagged profit variable.

Table 5 provides the results of this fixed effect estimation with interacted industry effects. The convergence parameter $\hat{\lambda}_j$ and the positive effect of R&D investments on profitability are remarkably consistent when industry is accounted for. This indicates that the systematic persistence of profitability that is observed arises primarily from the firm specific component of above average profits rather than from the industry specific component. This result is in accordance with the findings of Yurtoglu (2004).

Table 5, Fixed effects estimations with deviations from firm means lagged R&D and industry plus time effects.

Dependent variable: $\Pi_{j,t}$	(1)	(2)	(3)
Constant	-0.350 (-2.52)	-0.291 (-2.24)	-0.290 (-2.33)
$\hat{\lambda}_j$	0.550*** (2.72)	0.591*** (2.96)	0.563*** (2.75)
$R\&D_{j,\ t-1}$	23.91*** (2.63)		
$R\&D_{j,\ t-2}$		17.53*** (2.71)	
$R\&D_{j,\ t-3}$			13.68** (2.34)
No. obs.	5856	5561	5269
R^2	0.32	0.31	0.28
F - value	23.33	20.61	17.22

Notes: *, ** and *** indicates significance at the 10, 5 and 1 percent level.
Numbers in parenthesis is heteroscedasticity-consistent t-statistics. Estimated coefficients of industry interaction terms upon request, F-test of industry interaction terms are equal to zero rejected, $F_{[68,\ 5518]}$=4.30 Prob > F=0.000.
Two outlying observations have been excluded due to obvious errors in the data.

An F test is used to verify whether the coefficients of the industry interaction terms are all equal to zero (i.e., $d_1 = d_2 = \ldots = d_I = 0$). Based on the F-test results[14], the null hypothesis that persistence of firm-specific profits is equal across firms is soundly rejected. This test is valid

[14] $F_{[68,\ 5518]}$=4.30 Prob > F=0.000

although the data also comprises multiproduct firms, which blur the measurement of industry-level variables. In effect these multiproduct firms make the test less likely to reject the null hypothesis of no differences across industries. This is because multiproduct firms add more noise to the estimate of industry persistence, and thus raise the standard error of the estimate. The rejection of the null hypothesis is consequently even stronger since it also needed to overcome the effect of multiproduct firms making acceptance more likely.

The robustness of the fixed effects estimates in Table 4 and 5 are consistent with results obtained from pooled OLS regressions, although for brevity reasons these results are not reported. Furthermore, the estimations have been made with country effects, which again did not alter the results[15]. To the extent that tax rates differ across industries, the estimates of α_j in equation (5) will differ across companies, which suggest the existence of firm or industry specific rents that are not due to differences in the competitive environment, but to the tax treatment of profits. This bias will thus influence the long run projected profit rates; the speed of adjustment parameter will remain unbiased (Yurtoglu, 2004). Since the data on the firms return on assets, R&D expenditures and sales are all accounting numbers, the usual caveats associated with accounting measures apply. This withstanding the results shows that profit rates persist between as well as within-industries. In addition, R&D-investment is found to have a significant and positive effect on firm-specific above norm profits.

5. Conclusions

Although economic theory tells us that profits above the industry norm cannot persist in the absence of significant barriers to entry and exit, evidence continues to accumulate contrary to this supposition. This study joins up with the growing literature that emphasizes dynamic analysis when trying to estimate the determinants of firm and industry profits.

In line with previous dynamic studies evidence is found of firms with profit levels which persistently diverge from the industry average. The empirical analysis show that although there is a convergence towards industry normal profit levels the convergence process is incomplete. The best (worst) performing firms of 20 years ago are still presenting profits above (below) the average. The results also show that the observed systematic persistence of profitability arises primarily from the firm specific component of above average profits rather than from the industry specific component.

One explanation for this persistent profit divergence and particularly for profits above the norm is sustained investments in R&D. By utilizing a fixed-effects model which accounts for time and firm effects the importance of R&D investments relative to profit persistence is demonstrated. Not only do firms with sustained R&D investments exhibit higher profit levels, the relative level of R&D is also positively related to the persistence of the firms' profits. By investing in R&D firms may thus maintain higher levels of profits even though there might be no significant barriers to entry and exit.

[15] The results from the OLS- and FE-estimation with country effects are available upon request from the author.

References

Bentzen, J., Madsen, E. S., Smith, V. & Dilling-Hansen, M., (2005), Persistence in Corporate Performance? Empirical Evidence from Panel Unit Root Tests, *Empirica,* vol. 32, No. 2, 217-230.

Caves, R. & Porter M., (1977), From Entry Barriers to Mobility Barriers: Conjectural Decisions and Contrived Deterence to New Competition. *Quaterly Journal of Economics*, vol. 91, No. 2, 241-262.

Cubbin, J. & Geroski A., (1990), *"The Persistence of Profits in the United Kingdom."* in The Dynamics of Company Profits: an International Comparison, edited by Dennis C. Mueller, Cambridge University Press.

Geroski, P. A., (1990) *"Modeling Persistent Profitability"*, in The Dynamics of Company Profits: an International Comparison, edited by Dennis C. Mueller, Cambridge University Press.

Geroski, P. A. & Jacquemin, A., (1988), The Persistence of Profits: A European Comparison, *The Economic Journal,* vol. 98, No. 391, 375-389.

Glen, J., Lee, K. & Singh, A., (2001), Persistence of Profitability and Competition in Emerging Markets, *Economic Letters*, vol. 72, No. 2, 247-253.

Goddard, J. A. & Wilson J. O. S., (1999) The Persistence of Profit: A New Empirical Interpretation, *International Journal of Industrial Organization*, vol. 17, No. 5, 663-687.

Grabowski, G. H. & Mueller, D. C., (1978), Industrial Research and Development, Intangible Capital Stocks, and Firm Profit Rates, *The Bell journal of Economics,* vol. 9, No. 2, 328-343.

Jacobsen, R., (1988), The Persistence of Abnormal Returns, *Strategic Management Journal,* vol. 9, No. 5, 415-430.

Jenny, F. Y. & Weber A. P., (1990), *"The Persistence of Profits in France."* in The Dynamics of Company Profits: an International Comparison, edited by Dennis C. Mueller, Cambridge University Press.

Kambhampati, U. S., (1995), The Persistence of Profit Differentials in Indian Industry, *Applied Economics*, vol. 27, No. 4, 353-361.

Khemani R. S. & Shapiro D. M., (1990), *"The Persistence of Profitability in Canada.."* in The Dynamics of Company Profits: an International Comparison, edited by Dennis C. Mueller, Cambridge university Press.

Maruyama, N. & Odagiri, H., (2002), Does the 'Persistence of Profits' Persist?: A Study of Company Profits in Japan, 1964-97, *International Journal of Industrial Organization*, vol. 20, No. 10, 1513-1533.

McGahan, A. M. & Porter, M. E., (1999), The Persistence of Shocks to Profitability, *The Review of Economics and Statistics*, vol. 81, No. 1, 143-153.

Mueller, D. C. & Tilton, J. E., (1969), Research and Development Costs as Barrier to Entry, *The Canadian Journal of Economics*, vol. 2, No. 4, 570-579.

Mueller, D. C., (1977), The Persistence of Profits above the Norm, *Economica,* vol. 44, No. 176, 369-380.

Mueller, D. C., (1986), *Profits in the Long Run*, Cambridge: Cambridge University Press.

Mueller, D. C., (1990), *"The Persistence of Profits in the United States."* in The Dynamics of Company Profits: an International Comparison, edited by Dennis C. Mueller, Cambridge University Press.

Mueller, D. C., (2003), *The Corporation, Investments, Mergers, and Growth*, Routledge.

Nelson, R. & Winter, S. G., (1982), *An Evolutionary Theory of Economic Change,* Cambridge, Harvard University Press.

Odagiri, H. & Yamawaki, H., (1990), *"The Persistence of Profits in Japan."* in The Dynamics of Company Profits: an International Comparison, edited by Dennis C. Mueller, Cambridge University Press.

Pakes, A., (1987), Mueller's Profits in the Long Run, *The RAND Journal of Economics,* vol. 18, No. 2, 319-332.

Pakes, A. & Schankerman, M., (1984), *"The Rate of Obsolence of Patents, ResearchGestation Lags, and the Private Rate of Returns to Research and Development."* in: R&D, Patents and Productivity, edited by Zvi Griliches, Chicago: University of Chicago.

Schohl, F., (1990), The Persistence of Profits in the Long Run – A Critical Extension of Some Recent Findings, *International Journal of Industrial Organization*, vol. 8, No. 3, 385-404.

Schumpeter, J. A., (1934), *The Theory of Economic Development*, Cambridge, MA: Hardvard University Press; first published in German, pp.1911.

Schumpeter, J. A., (1950), *Capitalism, Socialism and Democracy*, New York: Harper and Row.

Schwalbach, J., Graßhoff, U. & Mahmood, T., (1989), The Dynamics of Corporate Profits, *European Economic Review,* vol. 33. 1625-1639.

Waring, G. F., (1996), Industry differences in the Persistence of Firm-Specific Returns, *American Economic Review,* vol. 86, No. 5, 1253-1265.

Winter, S. G., (1984), Schumpeterian Competition in Alternative Technological Regimes, *Journal of Economic Behavior and organization,* vol. 5, 287-320.

Yamawaki, H., (1989), A Comparative Analysis of Intertemporal Behavior of Profits: Japan and the United States, The Journal Of Industrial Economics, vol. 37, No. 4, 389-409.

Yurtoglu, B. B., (2004), Persistence of firm-level profitability in Turkey, *Applied Economics*, vol. 36, No. 6, 615-625.

Appendix A

This section basically follows Geroski (1990).

Suppose profit-equation (1), $\prod_{ip} = \beta x_i + \mu_i^1$ has only one explanatory variable say patents, denoted *P*, so it can be written as

$$\prod_{ip} = \beta_0 + \beta_1 P_i + \mu_i^1 \qquad (2A)$$

The problem with estimating β_1, the parameter of interest in equation (2A), is that long run equilibrium profits $\prod_{ip}$ are not observable. Current period profits $\prod_i$ are observable but unfortunately not the same as $\prod_{ip}$ unless every industry is in long run equilibrium when observed. If, as is commonly the case, one nevertheless uses $\prod_i$ as a proxy of $\prod_{ip}$, the empirical model equation (3A) will differ from the model derived from theory.

$$\prod_i = \beta_0 + \beta_1 P_i + \mu_i^2 \qquad (3A)$$

If equation (2A) is the "true" model as assumed, then μ_i^2 contains a measurement error $\prod_i - \prod_{ip}$ in addition to any stochastic term inherent in equation (2A), thus

$$\mu_i^2 = \mu_i^1 + \left(\prod_i - \prod_{ip}\right). \qquad (4A)$$

The existence of this additional noise inflates standard errors and so biases t-statistics downward. What is worse, it can introduce bias if $\prod_i - \prod_{ip}$ is correlated to P_i; that is, if P_i not only explains the level of equilibrium profits $\prod_{ip}$, but also helps to govern dynamic movements around equilibrium. Suppose that this is true and, for example, that the deviation from equilibrium at any given time is proportional to P_i,

$$\left(\prod_i - \prod_{ip}\right) = \alpha P_i + \mu_i^3 \qquad (5A)$$

where μ_i^3 summarizes all other determinants orthogonal to P_i. Then, neglecting equation (5A) in the estimation of (3A) yields an estimated slope coefficient of $\alpha + \beta_1$, clearly a biased estimate of the parameter of interest in equation (3A), β_1. The only way to recover estimates of α and β_1 separately is to analyze equation (3A) and (4A) together. To put it in another way, one can only have confidence in estimates that claim to measure β_1 if either the hypothesis that all units *i* are in equilibrium ($\prod_i = \prod_{ip}$ for all *i*) or the hypothesis that x_i has no effect on disequilibrium motion (α =0) cannot be rejected by the data or if a control variable (like market growth) captures the non-random variation that causes bias. For a more thorough discussion see Geroski (1990).