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PERSISTENCE OF PROFITS AND THE SYSTEMATIC SEARCH FOR KNOWLEDGE

- R&D links to firm above-norm profits

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Abstract

Economic theory tells us that abnormal firm and industry profits will not persist for any significant 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.

However, a substantial amount of research has found evidence of persistent profits above the norm. Barriers to entry and exit, is an often put forward 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 we explore the links between the systematic search for knowledge and the persistence of profits. 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 may, by doing this, offset the erosion of profits and thereby have persistently high profits which diverge from the competitive return.

We argue 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 in a competitive milieu attract entrants and this competitive process will erode profits.

If firms are persistently making profits that deviate from the competitive, normal return, this 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 firms may succeed in creating products or services that are preferred by the market, or find a more cost efficient method of production.

Depending on the specific market conditions, regulations, patents, cost structure etc., profits will gradually be eroded. Corporations that systematically invest in research and development may, by doing this, offset the erosion of profit and thereby have persistently high profits that even diverge from the competitive return. This lies at the very core of what Joseph Schumpeter understood by creative destruction and "*the fundamental phenomenon of economic development*" (Schumpeter, 1911, 1934 and 1950). Basically that the competitive process that drives economic development is fueled and propelled by the quest for profits[1].

In this paper we explore the links between the systematic search for knowledge, through R&D efforts, and the persistence of profits. We argue 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.

We continue this presentation in section 2 with an overview of previous studies related to the persistence of profits phenomenon. Section 3 discusses the nature and convergence of profits. From this discussion we raise our hypotheses regarding R&D efforts and the persistence of profits. The methodology is accessible in section 4. In section 5 we analyze and discuss the results of the study, followed by concluding remarks 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. For example equation (1);

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

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

here, the equilibrium level of profits Π 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^1 is an error term with the standard properties.

The reason for estimating the model and the parameters *β* is then to draw conclusions regarding the influence of the explanatory variables on the equilibrium level of profits within the firm or industry.

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). Firstly, 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. See appendix 1.

Another reason why cross-sectional studies are inappropriate when designing antitrust policies is that the data may 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 very 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 an interest in extending cross-sectional empirical analysis to include 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.

Mueller (1990) finds, using a sample of nearly 600 firms for the period 1950 to 1972 (23 years) that firms tend to converge to the industry-average profit rate, but that the convergence process is incomplete.

Geroski and Jacquemin (1988) compare in total 134 large German, French and British firms, they present evidence that the British firms have less variation in profits and that these profits persist over time. In contrast the German and French firms have larger variation in profits and also tend to converge more quickly to the industry-average profit rate. 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.

Schwalbach, Graßhoff and Mahmood (1988) find converges of profits for German firms. Connolly and Schwartz (1985) find an asymmetry in the convergence process between firms, where less successful firms (below an industry-average profitability), did converge to the competitive return, whilst more profitable firms (above industry-average profitability) showed more persistent returns.

Waring (1996) examines industry aggregates for some 12 000 American firms over a 20 year period. Waring provides evidence that the convergence process is industry specific and that industry specificities, such as R&D, has a significant impact on the speed of convergence.

The profit dynamics thus seem to differ depending on whether one look at industry aggregates or at firm level returns. Bentzen, Madsen, Smith and Dilling-Hansen (2005) provide empirical evidence for this from a sample of Danish firms. Their results show that, in contrast to firm, industry aggregate returns display persistence.

For a summary of previous studies se table 1 in section 4.2.

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 transitory disequilibria phenomenon. In a stylized manner this process can be illustrated as in figure 1; profits above (under) the long-run equilibrium implies entry (exit)[2].

[2] Possibly only the threat of entry.

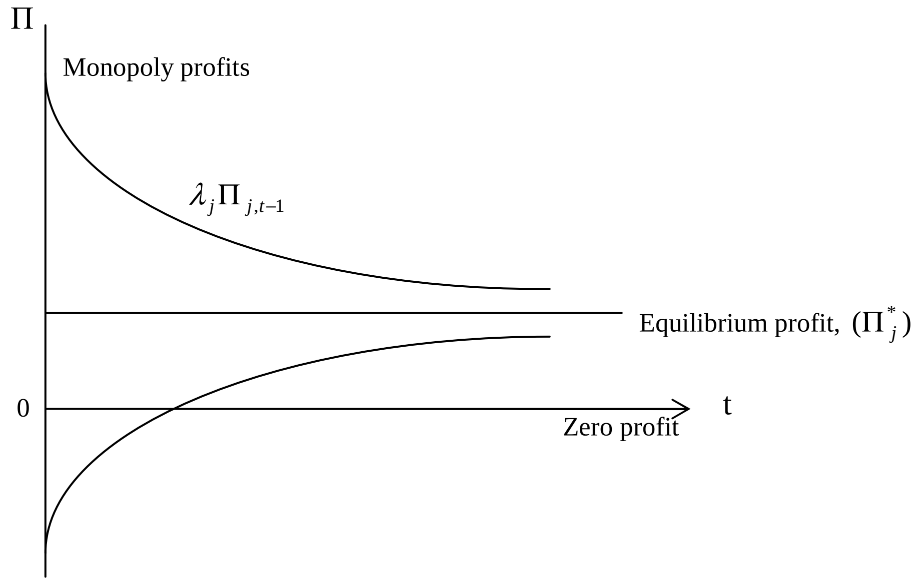

Figure 1, Process of profit convergence (source: Schwalbach et al. (1989))

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, due to sustained investments in R&D, maintain a profitability rate persistently above the industry average. 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 (1990, 1986) has suggested that profits (Π) can be decomposed in the following way[3]:

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

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, i.e. 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 working in a competitive market. We refer to the long-run equilibrium return as Π_j^*. The transitory component $s_{j,t}$, is assumed to decline in the following way:

[3] 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.

$$s_{j,t} = \lambda_j s_{j,t-1} \quad (3)$$

The λ-parameter shows the speed of the profit decay[4]. Assuming that $-1 \leq \lambda \leq 1$ profits will converge to the equilibrium rate of return as time passes. By substitution this gives the following first-order autoregressive function:

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

This reduces to the following empirically testable model:

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

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:

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

Consequently a test of the hypothesis that competition drives all profit rates to a common competitive level would be to test whether the $\hat{\Pi}_{jp}$ differs 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.'

A summery of previous studies and their average estimated λ_i is provided in table 1. As can be seen from table 1 few previous studies look at profitability persistence in relation to R&D investments.

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

Table 1, Previous studies

Authors	Country	Period	Years	Number of 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.
** R&D measured as patenting intensity.
***Not firms specific R&D, but R&D-intensity on industry level.

3.2 Research and Development 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. However, it is very likely that a lot of firms actively engage in product-R&D without ever applying for a patent. Therefore, this study will be restricted to profitability and to 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 (1911, 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) made the assertion that large corporations had standardized/routinized the search for knowledge and that this in itself was an important innovation which characterized the modern large corporations.

Research and development may thus slowdown 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, deals 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 research and development expenditures. Hypothesis three is that research and development intensive firms will have higher profits and that the convergence to normal profits will be solver.

3.3 Data and Method

The data used in the regressions are all taken form the Bureau van Dijk OSIRIS-database. From the database 293 large European firms where collected, for which data was available for a 21 year period between 1984 until 2004. The reason for choosing large firms is that they both report and invest systematically in R&D.

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. As a measure of profits we use return on total assets before taxes, and as a proxy for innovative effort reported R&D expenditures.

In order to remove business cycle effects from the profit data the profit measure is defined as: $\overline{\Pi}_{j,t} = \Pi_{j,t} - \sum_{j=1}^{n} \Pi_{j,t} \Big/ n$. Where $\Pi_{j,t}$ is profit for firm *j* at time *t*. 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[5]. In order to reduce heteroscedasticity we normalize R&D by dividing by gross sales.

4. Results and Analysis

Separate regressions for the 293 firms were estimated following equation (9). For each firm there are 21 annual observations. The results are summarized and reported for seven subgroups in Table 2. The seven groups have been constructed by ranking firms by their 1984 profit rates and then splitting them in to groups.

[5] To see why profit persistence is a relative term; see e.g. Jacobsen (1988).

The average convergence parameter, $\hat{\lambda}_j$, is estimated to approximately 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.

Table 2, Profit dynamics

	(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.

In column (1) the estimated absolute deviation of each group from the average equilibrium profit rate is reported. From this we can see 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 averages returns. For example, group 1 with the highest initial profit rates in 1984 had an average profit rate that was 13.4 percentage points above, as seen from column (3). The estimated equilibrium profit for group one is projected to be 4.9 percentage points above the average.

Column (2) shows the average convergence parameters for each group and column (4) the number of firms in each group.

In order to detect possible autocorrelation a Breusch-Godfrey test was performed. At five percent significance only 10 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 $\leq$ 0.1).

Among all firms in our sample 28 percent reported to have made investments in R&D in 2004, and the average R&D to Sales ratio was about 4 percent (see table 3).

Table 3, Research and Development 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.

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. 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 R&D is included the convergence parameter $\hat{\lambda}_j$ is lower for the panel data estimations than for the individual OLS estimations.

Table 4, Regression results

Dependent variable: $\Pi_{j,t}$	(1)	(2)	(3)
Constant	-0.192*	-0.136	-0.106
	(0.111)	(0.115)	(0.117)
$\hat{\lambda}_j$	0.346***	0.322***	0.313***
	(0.013)	(0.013)	(0.013)
$R\&D_{j,\ t-1}$	25.05***		
	(7.164)		
$R\&D_{j,\ t-2}$		17.73**	
		(7.619)	
$R\&D_{j,\ t-3}$			13.81*
			(7.832)
No. obs.	5856	5563	5270
R^2	0.29	0.28	0.28
F - value	370	320	282

*, ** and *** indicates significance at 10, 5 and 1 percent.

A central question is also how to specify the lag periods for the R&D variable. In most cases it can reasonable to assume that the time between the R&D investment and the revenues it generates is fairly long. Pakes and Schankerman (1984) have found that it on average 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 years 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.

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. As can be seen from table 4 all estimations proved to be significant[6]. Moreover the R&D coefficient seems to be economically significant.

[6] Two outlying observations have been excluded.

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 reason why some firms succeed in maintaining profits persistently above average.

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 we find evidence 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 20 years ago are still presenting profits above (below) the average.

One explanation for this persistent profit divergence and particularly for profits above the norm, is sustained investments in R&D. Using several estimation methods the importance of R&D investments relative to profit persistence was 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 thought there might be no significant barriers to entry and exit.

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Appendix 1

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).