

Testing for Persistence of Profits' Differences Across Firms

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A fundamental premise underlying normative arguments for market systems is that competition drives profits to zero, and thus that the price system maximizes social welfare by equating the marginal social benefits and costs of each economic activity. There are essentially two underlying logics for this – one based on a static view of competition, the other on a dynamic view. Under the static view, competition among an existing set of firms suffices to produce zero profits at each point in time. Under the dynamic view, the entry and exit of firms drives profits to zero *in the long run*, and is thus consistent with there being non-zero economic profits at different points in time.

Testing whether the static view of competition is consistent with observed patterns of profits is fairly straightforward. Not surprisingly such tests were the first to be performed and the preponderance of studies to date still fall into this category. Beginning with Mueller (1977) a by now rather large literature has also developed, which tries to test the dynamic view of competition.¹ Since the dynamic view allows for the possibility of differences in profits across firms at any given point in time, the literature testing it has concentrated on determining whether these persist. The key methodological issue in this literature is, therefore, how to define and test for the persistence of profit differences.

This methodological issue is the main concern of our paper. We begin, however, by reviewing the premises and inferences of the static view of competition. As we shall see, much of the dynamic literature has built assumptions from the static literature into its modeling of the dynamic process. Thus to understand the logic underlying the dynamic models it is useful to review the logic underlying static models of the competitive process. Accordingly Section I reviews the logic and implications underlying both types of model.

In Section II we discuss the methodological issues that arise when trying to test the various models outlined in Section I. The thrust of this section is to point out that models tested in much of the existing literature may be open to more than one interpretation, and that the results reported may not always support the inferences drawn by the authors.

Section III extends the discussion by considering complications that can arise due to innovation, mergers and cyclical factors. The points raised in II and III are then illustrated in Section IV with estimates of various dynamic models of firm profitability using data from both the United States and the United Kingdom. This work differs from that of previous studies in that we test a larger set of possible models than have been used in previous work, and we conduct these tests using longer time series on company profits, thereby increasing their power.

The main conclusions drawn from our research are that the patterns of firm profits observed over time in both countries are consistent with a much larger and more complicated set of models of the competitive process than has been assumed in the literature until now. These conclusions are brought together in the final section of the article.

I. Two Views of the Competitive Process

The two views of the competitive process are an essentially static view that we can associate with the names of Cournot and Bain, and a dynamic view attributable to Schumpeter. We begin with the static view.

1.A A Cournot/Bain Model of the Competitive Process

Assume that an industry's product is homogeneous, all firms have the same, constant average costs, c , the number of firms in the industry is fixed at n , and each firm is identical to all others and acts to maximize profits as a Cournot quantity-setter. The equilibrium for the industry is then one in which each firm's price/cost margin satisfies

$$(p - c)/p = H/\eta \tag{1}$$

where H is the Herfindahl index of concentration for the industry ($H = 1/n$ in this special case of a symmetric equilibrium), and η is the industry elasticity of demand (see, e.g., Cowling and Waterson, 1976). Multiplying both numerator and denominator on the left-hand-side of (1) by output, the equilibrium condition implies that the profit-to-sales ratio of a firm equals H/η . If profitability is measured as the ratio of profits to assets, then (1) implies that firm-level profitability varies with the level of concentration, demand elasticity and capital-to-sales ratio of its industry.

A slight degree of dynamics can be added to the simple Cournot model by assuming that entry into an industry is free and continues until there are n firms in the industry with the profits

of the n 'th firm, π_n , nonnegative, and $\pi_{n+1} < 0$. Except where demand and cost conditions result in an equilibrium n , which is very small, free entry in a Cournot world should lead to long-run equilibria in which the profits of all firms are positive but small. When entry barriers exist, the entry process can stop at values of n that lead to profits substantially above zero. This is the world of Joe Bain (1956). Bain's implicit model of the competitive process can be viewed as one in which entry has run its course in each industry, and thus industry and firm profits are a function of concentration, demand elasticity, the capital-to-sales ratio (K/S), and a vector of industry entry barriers (BE) such as sunk costs, scale economies, and so forth:

$$\pi/K = f(H, \eta, K/S, BE) \quad (2)$$

In such a world, tests for persistent differences across *firms* amount to tests for persistent differences across *industries*, since all firms within an industry are presumed to have the same level of profits, and this level is entirely dependent on the characteristics of the industry. Moreover, a test for the existence of persistent profit differences across firms can be made by simply comparing differences in profit *means* across industries. Appropriately, Bain (1956), Mann (1966) and other early tests for the existence of profit differences across firms simply calculated and compared industry mean profit rates. The vast number of studies that followed, regressing industry profits on industry characteristics, implicitly assumed that Bain's static view of the world held, and that all industries were in long run equilibrium. The point of the exercise was then not to test for the existence of persistent differences in profits across firms, this was implicitly taken for granted, but to try to explain these differences by estimating the parameters of the function on the right-hand-side of (2).²

1.B The Schumpeterian Model of the Competitive Process

In Joseph Schumpeter's (1934, 1950) description of the competitive process, firms compete against one another by introducing innovations and copying one another's innovations. In the extreme case one firm's innovation creates an entirely new industry. The innovator starts off as a monopoly earning monopoly profits, but these attract imitators who erode the innovator's profits. Where the focus in a Cournot/Bain world is on the characteristics of industries, the focus in Schumpeter's world is on the characteristics of firms. In particular, an innovator and early imitators can be expected to earn substantial profits in the early phases of a product's life cycle, lower profits in the later phases. Recent work on product life cycles has established that early entrants often possess significant "first-mover advantages" over late entrants, and that these lead

to higher survival rates and higher market shares in the mature phases of a product's life cycle.³ These higher market shares can also be expected to be associated with higher profitability.⁴

Thus, in a Schumpeterian world there is no reason to expect that the profits of all firms in a given industry are the same, or that the profits of all firms at a given point in time are zero. Although the process of “creative destruction” brought about by the entry of imitators should drive all firms' profits toward zero, first-mover advantages and subsequent innovations may prevent at least some from ever arriving there. Where there are sequences of innovations and competitive responses, complex time paths of profits may then emerge, featuring phases or sub-periods of divergence from the competitive level, convergence to it, and stability around it. At any point in time, a cross-section of firms will contain both innovators and imitators. Some firms will be in the early phases of their product (or process) life cycles, others in the mature phase. Cross-sectional analyses of inter-firm and, *a fortiori*, inter-industry profits differences in this world reveal little of interest unless all this can be allowed for. As this is rarely practicable, to understand and evaluate how the competitive process works in a Schumpeterian world, one must focus on firms and not industries, and one must follow the firms over time.

II. Modeling the Persistence of Profits

II.A In a Static World

In a static world in which all firms are in long-run equilibrium, the profits of any firm i might simply be written as

$$\pi_{it} = \pi_{ip} + \mu_{it}, \quad (3)$$

where π_{ip} is a constant representing the *permanent* profits of firm i , possibly zero, and μ_{it} is a random shock to these profits, which is assumed to have a normal distribution with zero mean. A firm's profits are thus stochastic, but are essentially constant over the observation period (i.e. with constant mean). Most of the existing literature has measured firm-level profits as a percentage deviation of a firm's profits-to-assets ratio from the sample/population mean, and we follow this convention in this paper.⁵ Thus, a π_{ip} of 0.55 implies that i 's profits-to-assets ratio is on average permanently 55 percent above, or equal to 1.55 times the sample/population mean. A plot of π_{it} against time would reveal a scatter of points around a horizontal straight line as in Figure 1, while a phase diagram, with π_{it-1} on the horizontal axis and π_{it} on the vertical axis, would reveal a symmetric cluster of points centered on $\pi_{it} = \pi_{it-1} = \pi_{ip}$, as in Figure 2. The

existing literature has tended to assume, often implicitly, that long run competition would drive all economic profits to the mean, and thus a test for the existence of persistent, non-zero economic profits would consist simply of testing whether all $\pi_{ip} = 0$, or, in terms of Figures 1 and 2, whether the horizontal line in Figure 1 coincides with the horizontal axis, or the cluster of points in Figure 2 is centered on the origin.

II.B In a Dynamic World

In the Schumpeterian world, an innovating firm sees its initially high profits eroded over time by the entry of imitators into the industry until, absent further, offsetting innovations, they eventually disappear. Today's profits are related to yesterday, but are expected to be converging onto the competitive norm, unless further innovation occurs. Alternatively, if one assumes that a firm somehow began with profits below the norm, one might envisage a dynamic process in which profits moved up toward the norm, or the firm vanished. Assuming that a permanent profit rate exists for each firm,⁶ possibly zero, this dynamic process can be modeled by writing the deviation of a firm's profits from the norm in any period as a function of the previous period's deviation

$$\mu_{it} = u_i(\mu_{it-1}) + \varepsilon_{it} \quad (4)$$

where ε_i is now a random error term with an expected value of zero. Specifying and estimating (4) then becomes the challenge of modeling the dynamics of Schumpeterian competition.

Much of the literature on profits persistence has assumed that (4) takes on a simple, autoregressive form:

$$\mu_{it} = \lambda_i \mu_{it-1} + \varepsilon_{it} \quad (5)$$

If we assume that (3) holds in every period, then μ_{it-1} can be written as

$$\mu_{it-1} = \pi_{it-1} - \pi_{ip} \quad (6)$$

Substituting (6) into (5), and then (5) into (3) and rearranging yields

$$\pi_{it} = (1 - \lambda_i)\pi_{ip} + \lambda_i\pi_{it-1} + \varepsilon_{it} \quad (7)$$

Thus the key parameters of the dynamic model, π_{ip} and λ_i , can both be estimated from a simple, first-order, autoregressive profits equation (AR1).⁷

Equation (7) has been the workhorse of the persistence of profits literature. It allows one to formulate an alternative notion of profits persistence from that implied by equation (3). The speed with which profits converge on π_{ip} is measured by the parameter $(1-\lambda_i)$. For convergence

to take place, λ_i must lie between zero and one.⁸ The closer λ_i is to one, the longer will any initial deviation of profits from their long run value persist. Thus, λ_i can and has been interpreted as a measure of profits persistence. Indeed, more attention has generally been given in the literature to λ_i as a measure of persistence than to π_{ip} . Figure 3 plots π_{it} against time using a simulation of equation (7) assuming that $\pi_{ip} = 0$, $\lambda_i = 0.95$, ε_{it} has a mean of 0 and standard deviation of 0.05, and the profits of the firm in the initial time period are 1.0, i.e., double the norm. A fairly slow convergence of profits on the norm is observed with the curve first crossing the zero line at $t_0 = 34$. From then on it drops below the zero line. The phase diagram for the same data is presented in Figure 4. The curve spirals in on the origin, and produces a cluster slightly below it. With enough observations, the curve in Figure 3 should return to the zero line, but Figures 3 and 4 illustrate that when λ_i is very large, convergence on the long run profit rate may be quite slow. Indeed, in a non-negligible fraction of the 100 simulations that we ran using these parameters, the curve in Figure 3 failed to reach the zero line within the 50 time periods.

II.C Interpreting Persistence

The discussion so far has revealed two alternative interpretations of profits persistence – a component of a firm’s profits that constitutes a permanent deviation from the norm, and a slow process of convergence of profits to this permanent level, whether it is zero or not. Equation (3), which captures the first notion of profits persistence, can be regarded as a special case of (7) with $\lambda_i = 0$. Thus, estimates of (7) can be used to determine the existence of both types of persistence. Since $-1 < \lambda_i < 1$ is a necessary condition for the convergence of the time series, $(1 - \lambda_i)$ must differ from zero, and the existence of profits persistence in the sense of a $\pi_{ip} \neq 0$ can be inferred, if the estimated intercept from (7) is nonzero. Persistence under the second interpretation obviously exists if $\lambda_i > 0$, and rises as λ_i itself does. Thus, the intercept and slope from (7) are the key parameters for interpreting whether persistence in the two senses exists.

A second issue with respect to interpretation arises when one considers whether one is speaking of *within sample period persistence*, or *out of sample persistence*. When thinking of within-sample-period persistence, it seems to us that the π_{ip} notion of persistence has an advantage over the λ_i measure. When one looks at Figure 1, it seems pretty clear that this firm had a profit rate that was persistently above the norm throughout the entire period. When one looks at Figure 3, one sees profits above the norm for only a part of the period. To speak of profits persistence in this case, one must argue that the time interval over which profits were

above the norm was sufficiently long that it is legitimate to make such an interpretation. But how long is long? Five years? Ten? Twenty? The notion of profits persistence is inherently more subjective when one uses λ_i to represent it than when one uses π_{ip} .

π_{ip} also has an advantage when one is thinking of persistence in terms of out-of-sample projections. With a long time series, if we observed a profit pattern as in Figure 1, we might feel reasonably confident in predicting that (a) firm i is likely to have above normal profits for years beyond the sample time period and, more tentatively perhaps, that (b) $\pi_{it} = \pi_{ip}$ in some future period t .

Now consider making out-of-sample-period projections with data generated by the process that produced Figure 3. The first obvious point to make is that the accuracy of one's projections is much more likely to depend on the length of one's sample period in the second case than in the first. In the first, one makes the same prediction *regardless* of the length of the sample period. In the second one's prediction might be quite sensitive to the length of the time series that one had. For example, if one's data stopped at or before t_0 , by simply eyeballing the data one quite likely might project negative profits for the firm in the future. Estimates of the parameters of the model might pick up the curvature in the relationship and accurately predict $\pi_{it} = 0$ in the future, but the pattern of errors could easily hide this curvature and lead one to estimate a negative trend or, if one searched for it, a long cycle, with the data up to t_0 revealing just the first phase of the cycle. Even with data beyond t_0 and projected profits of zero, one might be less confident of one's projection than for the data pattern in Figure 1. What event caused the large deviation of profits from the norm in the first period of Figure 3, and the slow return to normalcy? How can one be sure that the same event will not recur?

We conclude from this discussion that one's confidence in discovering a persistent profit deviation from the norm is likely to be much higher, if one has estimated a $\pi_{ip} = 0$, than if one has estimated a large λ_i .

III. Complications

As Geroski and Jacquemin (1988) have shown, equation (7) can be derived as the reduced-form of a two equation structural system in which profits drive entry up, and entry drives profits down. Thus, in the first structural equation "entry", defined in a very broad sense, responds to past profit. In the second, excess profit is reduced by the force of competition that entry exerts. Solving for the reduced form enables "entry", which is largely unobservable, to be treated as a latent variable, and takes us back to equation (7). However, the intercept and slope

terms can now be interpreted as combinations of the parameters of the underlying structural equations capturing, in particular, the level of entry (and mobility) barriers; the permanent advantage enjoyed by firm i relative to a competitive firm; and the alertness of individual entrants, the size of the potential ‘entry pool’, and the ability of entrants to penetrate (Geroski, 1990).

All this seems to capture Schumpeter’s idea of the process of creative destruction. But Schumpeter is even better known for the emphasis he placed on innovation, which we may again think of, in very general terms, as any form of new rent-generating activity. How might one introduce innovation in this sense into the foregoing dynamic process, and what effect would this have on modeling the dynamics?

The simplest way to answer these questions is to argue that innovation has already been captured in the error term of equation (7). The process of imitation and creative destruction is then modeled by the rest of the equation. This interpretation may be reasonable for small innovations, but for large innovations – the kind that one generally associates with the name of Schumpeter – this modeling seems inadequate. One problem is that most estimates of λ from equation (7) imply a very rapid erosion of the profits from innovation. An average estimate of $\lambda = 0.5$ is fairly common in the literature and implies that only six percent of the profits initially generated by an innovation remains after four periods. Even a λ of 0.9 implies that 65 percent of the profits initially generated by an innovation are gone after ten periods. If the gains from innovations dissipate so rapidly, the incentive to introduce them will not be very large and they will not be the driving force behind growth that Schumpeter and many of his followers assume them to be.⁹

A second problem with using equation (7) to model the innovation process is that innovations may not have their largest impact on profits in year one followed by a continuous erosion as (7) implies. One might expect that the profits from an innovation grow, possibly for several years, before the erosion process begins. To model this process one would need to estimate an autoregressive equation with several lags, and with e.g. an Almon lag structure. To our knowledge this has not so far been attempted, and the omission is likely to mean both that there is dynamic misspecification, and that the residuals from OLS estimates of (7) are prone to (possibly higher-order) serial correlation.

Schumpeter (1934, 1950) claimed that the monopoly rents generated from one innovation provide the means by which the innovator can survive the process of creative destruction by

funding new innovations, and numerous studies have found company cash flows to be significant determinants of R&D expenditures.¹⁰ To the extent that the Schumpeterian hypothesis cannot be ruled out, lagged profits in an autoregressive equation such as (7) therefore may not be independent of the error term, if this captures the innovation process. If so, we have a further violation of the standard assumptions, and potential bias. Moreover, the coefficient λ can no longer be interpreted as *solely* a measure of the strength of dynamic competition in eroding excess profits; it becomes a measure of the *net* effects of two, opposing forces: the rent-generating force of innovation, and the rent-eroding force of “entry”.¹¹

Whilst most previous estimates of λ imply that the effects of shocks to company profits erode rather quickly, estimates of π_{ip} in all studies imply that a significant fraction of companies have permanent profits that differ from the mean. These permanent differences might be due to past innovations and suggest that the innovation process in the persistence of profits literature has been *implicitly* captured not by the error term in the model and/or λ , but in the intercept, that is the average error over the time period of estimation. Under this interpretation, the literature has, again implicitly, assumed that the innovations that lead to permanent rents have taken place *prior* to the estimation period. While such an assumption seems reasonable for short time periods, its reasonableness obviously declines as the length of the data series expands. How might one then model innovations that create permanent rents that occur *during* the sample period?

Let us define π_c as the competitive return on capital, the rate of return all firms would earn in a world of perfect competition.¹² We can then specify the effect on π_{ip} of an innovation in period t as

$$\begin{aligned}\pi_{ip} &= \pi_c \quad \text{for periods } 0 \text{ to } t-1, \text{ and} \\ \pi_{ip} &= \pi_c + R_t \text{ for periods } t \text{ to infinity,}\end{aligned}$$

where R_t is the permanent rent created in t . If the innovation occurs during the sample period, its effects will appear as a shift in the intercept of equation (7) in period t . It is also possible that an “innovation” has a long-lasting *negative* effect on profitability as, for example, when a patent expires. In this case $\pi_{ip} = \pi_c$ after the patent expires, and $\pi_{ip} > \pi_c$ up until that point. More generally, we recognize that, whether patented or not, the new products and processes that innovation brings – and indeed the strategic entry barriers erected or franchises secured (for these too fall under the broad definition of innovation that we employ) – may last not for ever but only for some finite period. In this case the effect on π_{ip} of an innovation in period t becomes

$\pi_{ip} = \pi_c$ for periods 0 to $t-1$, as before, but

$\pi_{ip} = \pi_c + R_t$ for periods t to τ ,

where τ defines the life-span of the innovation. Rents are now ‘durable’ rather than strictly permanent, though the possibility of a truly permanent rent still exists as a special case where $\tau \rightarrow \infty$.

These considerations suggest that innovations might be modeled within the framework of (7) as shifts in the intercept term. Assuming that only one or two such innovations occur during the sample period, identifying such innovations is fairly straightforward econometrically. As the number of innovations occurring during the sample period increases, however, it becomes increasingly difficult to separate shifts in the intercept from the shocks introduced via the error term and we are back to modeling innovations as such shocks, with all the difficulties that entails.

Searching for shifts in the intercept is also a natural way to account for the effects of mergers. Assume two companies i and j merge. Let π_{ip} be the permanent profits of i and π_{jp} of j , $\pi_{ip} \neq \pi_{jp}$. Then if the merger has no effect on the permanent profits of the two companies, the permanent profits of the merged company, π_{mp} , will be merely a weighted average of π_{ip} and π_{jp} , $\pi_{mp} = (K_i \pi_{ip} + K_j \pi_{jp}) / (K_i + K_j)$, where K_i and K_j are the total assets of the two firms. Should the merger produce some permanent rent beyond those earned by the two companies prior to the merger, this could be added to the weighted sum to produce the new permanent profits of the merged firm. If one were tracking the profits of the acquiring company over time, the effects of the merger would appear as a shift in the intercept of the equation estimated for this firm.¹³ Thus, mergers might be treated as forms of innovations and handled by testing for shifts in the intercepts of the basic autoregressive model. If there are too many shifts, that is, too many mergers, the search process will once again break down. Indeed, the question of what we mean by a firm becomes difficult, if it is continually modifying its product mix, and thus its identity, through mergers.

While the discussion in this section has been theoretically driven, we conclude by discussing two additional econometric problems of potential importance. First, equation (7) contains a lagged dependent variable and estimates of λ_i will be seriously biased for small time series of the type usually employed in the persistence literature. This is less of a problem in our work, since we use time series of 32 and 50 years.

A second problem occurs when $\lambda_i \geq 1.0$ and $\alpha_i \neq 0$. An $\alpha_i > 0$ implies that the profits’

time series wanders off to higher and higher values, an $\alpha_i < 0$ implies a negative drift. In the many studies of persistence that have been conducted only a handful of point estimates of $\lambda_i \geq 1.0$ have been reported. Estimates above 0.9 are not uncommon, however. When they occur it is typically not possible to reject the null hypothesis of non-stationarity, and some authors have expressed concern about this (e.g. Geroski and Jaquemin, 1988). The practice of testing for non-stationarity arose in econometric studies using macro data, where some time series can drift off indefinitely. Non-stationarity seems far less likely to be a problem for profits time series. A continual downward drift in profits must eventually produce either a firm's bankruptcy or a replacement of management and new policies to correct the cause of the decline. Likewise, competitive forces must surely bring an end to any continuous upward spiral in profits at some point. For profits time series we think, therefore, that the proper null hypothesis is one of stationarity. Tests of this hypothesis are still important however, not least because, as we show below, apparent violations can signal the kind of breaks in the data that we expect when innovations occur.

IV. Uncovering Profits Persistence

This section uses long time series for eight UK and US firms to illustrate some of the points raised above, and to explore further the issues of identifying profits persistence. Previous studies have tended to use rather short time series – usually 15 to 25 years of data. We have 50 years of data for the US companies discussed below, and 32 years for the UK companies. Rather obviously, if one can identify persistence of above or below normal profits over a 30 - 50 year time interval, one has much more confidence about its existence than for a 20-year interval.

We limit our focus to eight companies so that we can examine each one in some depth. The idea is to see how well the results and insights obtained from the statistical analysis stand up when the events lying behind the observed statistical series are at least to some extent known. Moreover by testing the models, we also explore their general robustness, and how misinterpretations can arise if this is not done. So far as we are aware, this approach is novel, at least to the extensive literature on persistence of profits. Given the small number of cases we cover, we naturally make no strong claims on generalization, save to note that, as a matter of logic, existing generalizations sometimes, and in principle, can be refuted by a single, well established counter-observation. The general implications of our findings, both for previous

results and for future inquiry, are drawn in the concluding section.

We begin with histories of the eight companies. We then test for persistence. To this end we first apply the standard AR1 model of equation (7), proceeding to an AR2 in one case where there are strong indications of cycles (Rank). We employ Wald tests for the significance of estimated ‘permanent’ profits π_{ip} (or ‘long-run projected profits’), and Chow tests for structural breaks / shifting means. We test for stationarity using the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) procedure, which employs a null of stationarity, in preference to the ADF unit root test. This is primarily on theoretical grounds, advanced earlier, but there is an added, practical advantage in that KPSS is less prone to loss of power in small samples, and we wish to apply tests for subperiods within our sample period as well as overall. Both the dw and LM tests for serial correlation are reported, along with the JB test for non-normality. Estimation is carried out with the aid of *E-views*.

We also apply structural time series (STS) analysis, proposed elsewhere as an alternative method for analysing persistence of profits issues (Cable and Jackson, 2003; Cable and Gschwandtner, 2004). We regard the two approaches as essentially complementary, in that the AR1 framework models the adjustment process, while STS *inter alia* estimates the underlying trend. The graphics output of the STS application program, *Stamp* (Koopman *et al.* 2000) incidentally provides a powerful tool for interpreting individual series, and identifying potential outliers and structural breaks.¹⁴

IV.A Case Histories¹⁵

IV.A.1 WM. WRIGLEY JR. COMPANY

The Wrigley Company is over 110 years old. It first went public in 1919. Although a public company listed on the New York Stock Exchange, it can also be categorized as a conservative, family-run firm. It has been controlled by the Wrigley family throughout its history, and today its top manager is a fourth generation William Wrigley. Wrigley is the world’s leading chewing gum manufacturer. It was an early innovator in producing and advertising a quality chewing gum. An important part of its marketing strategy over most of the first century of its life was to hold price down; a pack of Wrigley’s gum cost 5 cents over a 50-year period ending in 1971. During the 1970s Wrigley faced intense competition in terms of price and the introduction of new products by its competitors – particularly sugar-free gums. In the 1980s it resorted to heavy television advertising to increase sales and

profits. Its advertising slogan “pure chewing satisfaction” embodied the principle put forward by the first Wm. Wrigley: “Tell ’em quick, tell ’em often.” The company also had great success in advertising chewing gum as an alternative to smoking. During the 1990s Wrigley successfully expanded into Asia and Europe, and by 1994 international sales exceeded domestic sales.

Wrigley has remained basically a chewing gum manufacturer throughout its history. This stability, along with the continuity of family leadership, makes Wrigley an ideal candidate for identifying profits persistence. The current leader of Wrigley who took over in 1999 has begun an acquisition and diversification program, however, so that the continuity of product line has now been broken. Fortunately for analytical purposes, this development comes after our time series ends.

IV.A.2 WEYERHAEUSER COMPANY

The Weyerhaeuser Company has some things in common with Wrigley. It also is over 100 years old, incorporated as Weyerhaeuser Timber Company in 1900 following the merger of two timber companies. It was controlled by the Weyerhaeuser family until 1963. Weyerhaeuser is the world’s largest producer of softwood lumber and market pulp. It produces a variety of paper products and is also involved in real estate development and the construction of single-family housing and master-planned communities.

Weyerhaeuser confined its activities largely to the lumber and timber business until after World War II, when it began to expand into various other paper products through acquisitions. The 1970s were a period of rapid growth through diversification some of which was fairly far from its traditional lines of business (e.g. diapers). While the 1970s was a boom decade in the lumber and paper business, the tight credit conditions of the 1980s led to a collapse of the housing market and a depression in the lumber industry not seen since the 1930s. Weyerhaeuser responded to the slow growth of the 1980s with spin-offs of unrelated firms, further acquisitions in the lumber and paper industries, and in general a return to its core areas.

IV.A.3 THE GOODYEAR TIRE & RUBBER COMPANY

The Goodyear Tire & Rubber Company, like Weyerhaeuser and Wrigley, is over 100 years old, incorporated in Akron, Ohio in 1898. It is named after Charles Goodyear, the inventor of vulcanization - the process that converts raw rubber into a strong and flexible product that can be

molded into tires and other uses. Charles Goodyear played no part in the company's founding, however, having died some 38 years earlier.

Goodyear quickly grew to be the world's largest tire producer by 1916 and its largest rubber producer by 1926. It maintained its world leadership position in tire manufacturing until 1990, when Michelin surpassed it through its acquisition of Goodrich's tire business.

Although Goodyear entered the post-World War II period as the world's leading tire manufacturer, and remained near the top throughout the next 50 years, its profitability suffered over this period due to intense competition in the tire and rubber business; to its having undertaken some acquisitions that were unprofitable; and to random events like labor disputes and law suits against it. In many ways, Goodyear became a typical conglomerate over the 1960s and '70s diversifying into oil pipelines and other markets unrelated to the rubber business. And as happened with many underperforming conglomerates, it became the target of a hostile takeover bid in 1986. It thwarted this bid by selling off most of its non-rubber industry assets. In the early 1990s Goodyear introduced several newly developed tires. Once again it chose to use some of the profits stemming from these innovations to acquire other firms.

IV.A.4 AVON PRODUCTS

Avon Products is the oldest beauty company in the United States. It began as the California Perfume Company in 1886. David H. McConnell, its founder, had been a door-to-door book salesman, but discovered that he could make more money selling perfumes. The company expanded at the end of the 19th and beginning of the 20th centuries by adding new product lines. One of these was Avon Products, a toothbrush, cleanser and vanity set. The name became popular and the company itself adopted it in 1939.

Avon's early success rested in large part on its marketing strategy. The cultural constraints on women during the first half of the 20th century greatly restricted their choice of occupations. Going door-to-door selling cosmetics to other women was more socially acceptable and could be more easily combined with being a housewife and mother than was true of many other occupations. Avon's sales force of door-to-door saleswomen continued to expand even through the Great Depression.

During the first 25 years after World War II most American women continued to stay at home during the day, and could be easily reached by door-to-door saleswomen. Avon expanded greatly. By 1970, however, the trend toward two career families was beginning to take hold, and

fewer and fewer women could be found at home when the “Avon ladies” called. Combined with the economic recession of the 1970s, this development produced a crisis for the company.

Like many other companies faced with a fall in demand for its main line of products, Avon responded by undertaking acquisitions – Tiffany in 1979, Foster Medical Corporation in 1984, Retirements Inns of America and The Mediplex Group of nursing homes in 1985, Parfums Stern and Giorgio, Inc. in 1987. As has been true for many other companies also, most of these mergers were unsuccessful. At the end of the 1980s, Avon itself was fighting off a series of hostile takeover attempts. It responded by selling off its unsuccessful acquisitions and expanding its main cosmetics business both in the United States and around the globe. It entered Poland in 1992 and Russia in 1993. From the mid-nineties onward it has attempted to improve its image with younger buyers by heavy investments in advertising.

IV.A.5 THE BOOTS COMPANY PLC

From humble beginnings, the company formed by Jesse Boot in 1883 went on to become a leading UK retailer, and major manufacturer and marketer of cosmetics, toiletries, non-prescription drugs and pharmaceuticals. Manufacture of pharmaceuticals began during the First World War. After World War II this extended to the production of antibiotics and, from 1953, cortisone products. In 1967 the company adopted a divisionalised structure, and in 1968 it acquired Timothy Whites and Taylor, a long-standing competitor with over 600 branches. Several further acquisitions marked the late 1970s and '80s, including Optrex (opticians), Halfords (autoparts), and Payless and FADS, owned by A.G. Stanley (DIY).

This diversification into other areas of retailing encountered problems in the 1990s and the company acquired high levels of debt. The pharmaceuticals unit also faced difficulties in competing due to its small size, and in 1993 had to abandon a major heart treatment product due to negative side effects. As the 1990s progressed, Boots pulled back from its other retailing operations while the core retail chemists' business (accounting for about two thirds of the company's sales) continued to keep the company profitable. Despite expansions into Ireland, Continental Europe, the Far East and elsewhere, more than 95% of sales continued to be generated in the UK.

IV.A.6 GLAXO WELLCOME PLC

Originally a trading company, Glaxo emerged as an infant food producer in the early twentieth

century. By the 1960s the expanded Glaxo Group Ltd had also developed a strong presence in pharmaceuticals, including penicillin and corticosteroids, as well as in vitamins and other food supplements. However, the group's fortunes declined in the 1970s due to inflation, dependence on export trade, and a failure to develop outside British and Commonwealth markets. Stock market expectations at this point were low, but prospects were transformed by the spectacular success of an anti-ulcer drug, Zantac. Introduced first into European markets, and then into the US in 1981, Zantac captured 25 per cent of the new prescription market by 1984 and sales nearly tripled between 1980 and 1988.

Profitability in the 1990s was hit by the effects of a wave of mergers amongst other drug companies in 1989, the leveling-out of Zantac sales in the face of rival new products, and growing competition from Wellcome plc. Wellcome had launched more than a dozen drugs during the 1980s and early 1990s, including Zovirax (a herpes treatment) and Retovir (a drug to combat AIDS). A successful bid for Wellcome by Glaxo in 1995 led to immediate post-merger reductions in R&D expenditures, and in 1996 various consumer business ventures were sold off to focus on prescription medical development. Though the Zantac patent expired in 1997, Zyban, the first prescription anti-smoking drug that did not contain nicotine, was launched the following year, and the merged company embarked on an ambitious, R&D-based strategy.

IV.A.7 THE RANK ORGANISATION PLC

Founded in 1935 by J Arthur Rank, son of a Yorkshire flour miller, the company built up a large film production, distribution network and cinema chain prior to World War II. After 1948 it suffered from the sharp decline in UK cinema attendances (whereas 1.6 billion tickets were sold in 1946, sales were only 400 million in 1963). The redeployment of vacated theatres as real estate, bowling alleys and bingo halls in the 1950s and '60s did not yield lasting returns, nor for Rank did excursions into TV and the record industry. However, entry into a partnership with Xerox in 1956 produced a spectacular turn-around. Under the deal Rank owned 48.8% of the equity of Rank-Xerox (RX), received one third of the profits above a certain minimum, and had the rights to manufacture and sell or lease machines using the new dry-copy, all paper 'xerography' process everywhere except in the Americas. Xerox sales rose from \$7m in 1962 to \$276m in 1969. Whereas RX and Rank's other profits were equal in 1965, by 1968 they were in the ratio 4:1. Attempts to bolster returns in other areas meanwhile met with little success. Then at the end of the 1970s the world copier market caught up with RX, eroding the latter's market

share and profits due, in particular, to strong Japanese competition.

In 1983 there was speculation of a bid by corporate raiders. But Rank had recovered by 1988, with all but one division in profit, and with the RX/Rank balance of earnings back to parity. Additional investments in core leisure, recreation and holiday operations up to the mid 1990s included partnership with MCA to build the Universal Studios Florida theme park in Orlando (opened in 1990 and attracting 7 million visitors a year by 1994) and the acquisition of the Mecca Leisure Group, also in 1990. Sales revenue surged, but profits from RX again surpassed 50% by the mid-90s. To reduce the imbalance, Rank sold 40% of its interest in RX to Xerox in January 1995, intending to use the funds to invest further in leisure and recreation businesses.

IV.A.8 SCOTTISH & NEWCASTLE PLC

S&N is a UK brewing ‘major’ with a 2,800-strong chain of branded restaurants and pubs and 60,000 employees. In its present form it was created via the 1960 merger of Scottish Brewers (which included Youngers, McEwan’s and others) and Newcastle Breweries. Both companies had long previous histories including many acquisitions. The ten years or so after the merger saw a continuing restructuring of the brewing industry in the UK, with intense merger activity – entirely horizontal up to 1971 – leading to a dramatic decline in the number of independent brewers, and a marked increase in seller concentration. According to the Brewers’ Society there were 247 brewing companies in 1960 (already less than half the number of thirty years previously), and by 1973 this had fallen to only 88. Meanwhile, the five-firm concentration ratio, only 18% in 1954, rose to 62% in 1968 and an estimated 71% by the mid-1970s.¹⁶

Compared with most other brewing majors of the time (Bass Charrington, Allied, Whitbread, Watneys and Courage), S&N had comparatively few ‘tied’ houses, but produced a number of leading brands in the free trade sector, including Newcastle Brown and McEwan’s Export.¹⁷ This gave the company a strong competitive edge in the off-licence and, in particular, the burgeoning supermarket trade for home consumption.¹⁸ Over the period 1965 to 1975 the company’s sales nearly doubled, those to the free trade sector increasing by 150%. The period 1966 to 1995 saw an expansion into the leisure industry, with the acquisition of Thistle Hotels (1965, subsequently sold on in 1989), Thorn EMI’s hotel group (1979), 65% of Center Parcs (1989), the rest of Center Parcs (1991), and Chef & Brewer (1993). A bid for Cameron (1984) was blocked by the regulators, but S&N went on to acquire Nottingham’s Home Brewery (1986),

Matthew Brown (1985) and the major Courage Ltd (1995). A retail division was formed in 1990 to manage the pubs and restaurants business separately from brewing activities.

IV.B Persistence of Profits

Plots of the excess profit time series for our companies are set out in Figure 5, and their associated phase diagrams in Figure 6. As inspection will reveal, many of the events in the preceding case histories stand out clearly in these figures. The phase diagrams also give preliminary, but rather strong, visual impressions of the persistence category to which the companies belong. In the case of Wrigley, Boots, Glaxo and, with two exceptions, Avon, all data points lie in the first quadrant, i.e. profits are consistently above the norm. The Rank scatter strays occasionally into the other quadrants as, rather more frequently, does Scottish & Newcastle. Weyerhaeuser and Goodyear likewise occupy all quadrants, but with clusters centring roughly on the 0-0 point in the first case, and below it in the second. Thus, by inspection, we would identify the first four as putative cases of (long run) persistence above the norm, Weyerhaeuser as a firm apparently earning normal profits, Goodyear as a case of persistence below, albeit not far, the norm, and Rank and Scottish & Newcastle as intermediate cases. We return to these initial assessments after carrying out the formal analysis, which begins by estimating the standard AR1 model.

IV.B.1 ARI ESTIMATES

OLS estimates of equation (7) for our eight cases are reported in Table 1. Explanatory power is quite high except for Goodyear, where it is very low. However, the F -score shows that this regression is nevertheless significant overall at the 5 per cent level, as are all the others at one per cent. All the λ coefficients are significant, mostly highly so. With one exception they indicate moderate to high levels of persistence due to short run rents, with values between 0.57 and 0.67 in four cases and between 0.74 and 0.92 in three others.¹⁹ The exception is again Goodyear, where λ is just under 0.3. Intercepts are of mixed sign and significance but, taken with the λ s, yield six π_{ip} estimates that are significantly different from zero, four at the one per cent level, two at ten per cent.

Overall, the estimates are fairly typical of those found in previous work except, perhaps, that the λ s are somewhat higher. Interpreted in the usual way, they produce the classification of the companies in terms of short- and long-run persistence shown in the matrix in Table 2.A. In

passing, we note that the long-run classification is consistent with the visual judgments drawn earlier from the phase diagrams. Note also that all entries are in the diagonal boxes: high persistence in the long run sense (π_p) is associated with high short run persistence.

The associated diagnostics are generally satisfactory. Though the dw statistics for the UK cases all come fairly close to the indeterminate regions,²⁰ and there are indications of higher order autocorrelation in the LM statistics for Glaxo and Rank, reference to robust standard errors confirms that, while significance levels do drop, the interpretation as stated still stands. The other principal diagnostic failure is the evidence of non-normality in the residuals in the JB statistics for three of the US companies. Inspection of the relevant histograms and kurtosis statistics suggests outlier problems.

Diagnostics like these are probably common in persistence studies and would not, we suspect, lead researchers to reject the present estimates. These, as we have seen, also conform closely to the general pattern of previous work. However, the historical evidence from our case studies, the complex trends observed in the data for some companies, and certain indications from the graphics output from preliminary STS runs, all lead us to test, selectively, for structural breaks.

Significant breaks, identified in this manner, turn out to be present in five cases (Table 3). Their effect on subsequent stationarity testing is interesting. Where we do *not* find significant structural breaks (Goodyear, Boots and Rank), there are no rejections of the null of stationarity at the 5 per cent level (Table 4). In three of the remaining cases where we do, evidence of non-stationarity for the overall period disappears when we apply the test for subperiods that are defined by the breakpoints (Wrigley, Weyerhaeuser and Scottish & Newcastle). The Glaxo case we cannot examine in the same way because the (three) subperiods are all too short; and the Avon case goes the other way. Here, stationarity is not rejected overall, even though this also is a case with significant breaks, but it is rejected (without trend) in the two subperiods that we can analyse (the third being too short).

That structural breaks can induce spurious evidence of non-stationarity is in general well known. From the results in the present case one could almost make a case for using stationarity tests to diagnose breaks, though the method may not be foolproof; in the present case it would not have picked up Avon. In any event, and given the evidence of breaks we have, we partition our cases for further discussion, dealing first with the more straightforward ones where breaks do not occur.

IV.B.2 STRAIGHTFORWARD CASES: BOOTS AND GOODYEAR

Tests for structural breaks in 1972 and 1988, prompted by inspection of the Boots time series, were both non-significant, vindicating the simple AR1 in this case. As we have seen, this model identifies Boots as an example of moderate persistence in both the senses we employ. The STS model produces a similar picture. It fits a linear, almost horizontal long-term trend (Figure 7.B), the level of which in the final vector state (0.47) is very close to the π_{ip} estimate of 0.49. Introducing outliers for 1972 and 1988 raises R^2_D dramatically but has minimal impact on the estimates otherwise. Slope interventions at these points produce a trend composed of non-linear line segments that tracks the series closely, but convergence becomes very weak and R^2_D falls to only 0.37. We therefore again regard the initial, standard specification as preferred in this case.

Thus Boots represents a case where the standard AR1 and STS models appear to be unproblematic and robust, and to produce essentially the same results. The only caveat would be that the results would no doubt differ had we analysed only the subperiod up to 1988; a glance at Figure 5.B indicates that up to that point the time series has all the appearances of convergence on the norm. Thus, though analytically straightforward *for our period*, the Boots case also illustrates the potential sensitivity of results to the choice of observation period.

In the case of Goodyear, the simple AR1 model survived Chow tests at observations 12, 30, 40, 42 and various combinations, again adding robustness to the original interpretation as a case of rather weak persistence in terms of short run rents, but slightly below normal profits in the long run. Again, too, STS results largely concur: the standard STS model produces an almost horizontal, linear trend, the level of which in the final vector state is -0.26, again not far from the (AR1) π_{ip} estimate of -0.20 and, like that estimate, significant at better than one per cent.

It is, however, possible that Goodyear's profitability may have risen to resemble that of an average firm during the last decade of the period. A level intervention for 1991 produces a trend consisting of two negatively sloped, linear segments, with a step up between them almost to the zero line in 1991 (Figure 7.A). The final vector state level is now only -0.11 (Table 6.A), which just fails to achieve significance at 10 per cent (while the negative slope, though very small, is now highly significant). While this might be discounted on grounds of over-fitting, particularly in view of the marked increase in volatility around the time of the putative break, it happens that 1991 was the year in which the firm introduced four new tire models, and this strengthens the argument for intervening. On the other hand, the simple AR1 and earlier STS

characterization of Goodyear as a company with essentially below normal profits over the 50 year period as a whole do not seem to violate the data unduly. Moreover, this interpretation too has historical backing, in so far as the record highlights the intensely competitive international market in which the firm has been operating throughout the period.

IV.B.3 AR(2) MODELS AND CYCLES: THE RANK ORGANISATION

Strong visual evidence of cyclicity in the excess earnings series for Rank (Figures 5 and 6), coupled with evidence of higher order autocorrelation under AR1 estimation (Table 1), suggest that a higher order auto-regressive process may be called for. The lowest order process capable of accommodating cycles is an AR2:

$$\pi_{t+1} = a + 2b\pi_t - c\pi_{t-1} + \mu_t. \quad (8)$$

Cable, Jackson and Rhys (2003) set out the parametric restrictions for harmonic behaviour. From the complementary function and the particular solution of (8), if $b^2 < c$, then

$$\pi_t = \alpha + \beta c^{\frac{t-1}{2}} \cos [(t-1)\delta + \phi]$$

for α , β , δ and ϕ constant. π_t will then evolve harmonically, in damped form if $c < 1$, explosive if $c > 1$.²¹ The estimates of a , b and c they report for Rank are 0.10, 0.78 and -0.37 respectively, all of which are significant at 5 per cent or higher. Testing the parametric conditions for cyclicity reveals that the estimate of c is significantly less than unity at better than 1 per cent (thus meeting the condition for damped harmonics, if present) but b^2 is less than c (as is required by the first condition) at only 12 per cent.²² Thus the AR2 specification comes close, but strictly just fails, to capture harmonic motion in this case.²³ Compared with the AR1 results (Table 1), however, adjusted R^2 increases and, more importantly, neither the dw nor the LM statistics now arouse concern. Thus the higher order equation appears to correct the misspecification and dominate the AR1 model. In passing, we note that the intercept is now significant at 5 per cent, while the π_{ip} implied by the AR2 model, 0.17, is numerically identical to the AR1 estimate (to two decimal places), but is now significant at better than 1 per cent.

STS analysis throws light on why the AR2 may have been unable to capture the cyclical behaviour fully in this case, showing that the overall cyclical pattern is a composite of three underlying cycles (Figure 8). These have periods of around 5, 8 and 28 years respectively, and the associated test statistics indicate that the first and third are stationary and deterministic.²⁴ After allowing for the cycles, the STS model fits a linear trend, sloping down towards zero, but

not yet reaching it (Figure 7.B). On this basis, we obtain a clear illustration of convergence towards the norm, from innovation-driven high levels of profit in the late 1960s and '70s. The inclusion of outlier interventions for 1969 sharpens significance levels, but leaves the estimates otherwise unaffected.²⁵ Both outliers are themselves significant at close to 1 per cent, and under this specification the trend level and slope are significantly positive and negative respectively in the final vector state (Table 6.B).

Somewhat surprisingly, rich harmonics also emerged in the case of Boots, and lesser evidence of cycles was also uncovered for some of the other firms. However, their profit histories seem to be well accounted for with the AR1 model appropriately modified to allow for structural breaks. While we therefore do not pursue the cyclical aspect further in this paper, we note this as an avenue for further research and also that, where cycles exist, STS appears to have a definite edge over the AR1 in detecting and describing them.

IVB.4 SHIFTING MEAN SCENARIOS: WRIGLEY, WEYERHAEUSER, AVON, GLAXO AND S&N

To allow for structural breaks in the five cases where we find them, we augment the basic AR1 model with binary shift and slope terms for the relevant subperiods. The coefficients reported in Table 5 are combinations of the raw parameters; i.e. they take into account the shift and slope terms in the second (and third) subperiods (where present). The accompanying standard errors are likewise combinations of those for the raw parameters. Though not all the reported coefficients are significant, levels are generally quite high for interactive models of this type. Diagnostics are satisfactory except that outlier problems apparently remain in the cases of Wrigley and Weyerhaeuser, and there are indications of higher order autocorrelation in Avon, and possibly also in Glaxo where the LM statistic is borderline at 5 per cent. As we saw earlier, stationarity issues largely recede.

The results bring out dramatic differences in parameter values between the subperiods. For Wrigley, the intercept doubles and doubles again, acquiring significance on the way. Weyerhaeuser and Scottish & Newcastle both change from significant positive to even more significant negative values (S&N then going to zero in the third period). Avon falls by a factor of four, and then rebounds to six times its original value, while Glaxo nearly triples and then quadruples again. In the two latter cases, intercepts which are not significant in the first two periods become highly so in the third.

There is more continuity in the short-run adjustment parameter λ , though large variations

occur here too. Thus short-run persistence is roughly the same in the second two periods for Wrigley and Scottish & Newcastle, and the first two for Avon, and it is exactly the same (to two decimals) for Weyerhaeuser. But it also doubles from first to second period for Wrigley, increases by 50 per cent for Glaxo, falls to one sixth of its first period value in the second period for Scottish & Newcastle; and in the case of both Avon and Glaxo it goes to zero in the third.

When all these effects combine in the π_{ip} calculations, these too become volatile. Wrigley triples and doubles again. Weyerhaeuser and Scottish & Newcastle change sign once more. Avon falls by a factor of five and then rises fourfold. Glaxo increases nine times over before falling back to a little over half its peak value.

Table 2B shows that these changes are sufficient to produce marked alterations in the cross-classification of companies in terms of short- and long-run persistence. The positive correlation between λ and π_{ip} is broken. Estimates of π_{ip} that are significantly above zero are now associated with low, moderate and high estimates of λ . The same is true for estimates of π_{ip} that are insignificantly different from zero. Wrigley, Weyerhaeuser, Glaxo and S&N *never* occupy the category assigned to them from the full-period estimates (Table 2A). Several of the high λ estimates in this table were obviously produced by significant *shifts* in π_{ip} during the time period.

Visual support for these shifts is added by the STS trends for these cases in Figure 7. Thus the estimated long-term trend for Wrigley is approximately a linear spline, with a zero gradient up to 1981 and a steep rise to 1989, after which it essentially levels off. Glaxo is somewhat similar, and up- or downward shifts in essentially horizontal trends are clearly seen for Weyerhaeuser and S&N. Avon differs, the main contrast between periods one and two being the strikingly opposed trends though, again, there is fairly clear step up in average levels in the third period. Whether the post-1990 slope in this case is genuinely negative is, however, debatable, and an alternative reading might see the series falling back in 1994 after three exceptionally high years, to oscillate around a lower, though still quite high level. Otherwise, the fitted trends appear to accord closely not only with their respective statistical series, but also their histories. Interestingly, the levels of the STS trends in the final vector state: 3.87, -0.29, 1.52, 1.30 and -0.03 respectively for the five companies in the order we treat them (Table 5) match rather closely their corresponding AR1 estimates of 3.95, -0.31, 1.99, 1.36 and -0.02 (Table 6). In particular we note that S&N, with a very small (negative) trend level and zero slope under STS, and tiny, non-significant π_{ip} under AR1 estimation, has apparently converged on the norm under both approaches.

IV.B.5 LONG-RUN PREDICTIONS

The fact that π_{ip} can be interpreted as the steady state equilibrium of the relevant dynamic system is an attraction of the AR1 approach, and in persistence studies tempts in the direction of out-of sample forecasts of ‘long run projected profits’. Out-of-sample projection is of course always hazardous beyond a few periods, and the hazards compound when, as in five of our eight cases, both the estimated π_{ip} values and the fitted trends are themselves unstable. In these circumstances one could take some form of average. But, in the AR1 case, this merely leads back to the original, unaugmented specifications and their attendant problems. In long-run terms it is also tantamount to comparing means – which is probably what one subconsciously does when assessing persistence categories by inspection of phase diagrams, as we did earlier.²⁶ While useful up to a point, the subsequent analysis has revealed this to be too broad-brush and to obscure important detail.

All this having been said, and wielding our largest brush, Weyerhaeuser, Goodyear and, after 1973, Scottish & Newcastle do look different from the others, and to be firms usually earning at best normal returns. Unless something dramatic happens, Rank seems set to join them (or disappear in one way or another). Wrigley, Avon, Glaxo and Boots have all managed to weather the ups and down in the past, and turn in above average returns every year (except once in Avon’s case). It is hard not to rate their chances of doing so in future higher than the others.²⁷ The difficulty, perhaps, is to decide how far judgments like these derive from background knowledge of their industries, strategies and management, as opposed to analysis of their past profit records.

V. Conclusions

In a static world in which all firms and industries are in equilibrium, one could test for the presence of persistent differences in profits across firms or industries by comparing differences in profit means. The early structure-conduct-performance literature implicitly assumed such equilibria and concluded that there were persistent differences in profits across firms/industries that were related to industry concentration or firm market shares, and various measures of entry barriers.

When industries are out of equilibrium, profits will be driven down by entry, up by exit,

and will be affected by the innovation activity of individual firms and their competitors. Profit means calculated over short time periods will give a misleading picture of the long-run profits of a firm or industry. To identify these long-run profits one must model the dynamics of profits over time.

A now large, and still growing, literature on ‘the persistence of profits’ has modeled these dynamics as a simple, first-order autoregression in profits. Using this framework, two types of persistence can be distinguished: a permanent deviation of a firm’s profits from the norm, and the speed of convergence to the permanent level. The existence of persistent differences in profits across firms in both senses has been confirmed – with remarkable consistency for empirical work in industrial organization – across both different countries and time periods. Even those who have criticized the methodology for testing for persistence, like Goddard and Wilson (1999), have not challenged the conclusion of profits’ persistence, but rather have come up with different estimates of the *relative* importance of the two forms of persistence.

Due to data limitations, previous studies have typically worked with time series of around 20 years. Such short time series present certain econometric problems, and raise the question of whether one can really infer *long-run* persistence from such short time series. On the other hand, they have the advantage of being less likely to be subject to the kinds of innovative shocks that would change the very nature of a firm, and quite possibly its profits dynamics. Our paper alleviates the first type of problem by our use of long time series, but heightens the second one. The histories of the eight companies, which we examine, reveal important “shocks” in the form of technological innovations, mergers, changes in advertising strategies, and the like, which would seem likely to have important effects on the profit dynamics of the companies. Our econometric analysis reveals that in many cases they did. For only two of the eight companies, Boots and Goodyear, did we find that the AR1 estimates of persistence for the full sample period gave the best description of the data. For five companies one had to allow for various parameter shifts during the sample periods, in one case (Rank) the data were best described by a cycle. Thus, our first conclusion is that with long time series, one should allow for structural breaks in the parameters of the AR1, if that is the model used to test for persistence, and that in some cases one is better off abandoning the model entirely.

For those who wish to test for persistence using large samples of companies, this is, of course, not a happy conclusion. Few scholars working with samples of 200 or more companies will be willing to invest the time per company that we have in our analysis of only eight

companies. Fortunately for these scholars our study suggests that such an investment in time may not be necessary, *if* one is primarily interested in simply answering the question of whether there are persistent differences in profits across firms as measured by π_{ip} . The answer that we would give to this question using the AR1 estimates over the full sample period would be yes – Wrigley, Avon, Boots and Glaxo have π_{ip} s significantly above zero, Rank modestly so, Weyerhaeuser and Scottish and Newcastle have π_{ip} s that are insignificantly different from zero, and Goodyear’s π_{ip} is slightly, but significantly below zero (see Table 1). The full STS analysis forces us to revise our answer only slightly – Wrigley, Avon, Boots and Glaxo have estimated profit levels significantly above zero, Rank somewhat less so than based on the AR1 estimates of π_{ip} , and Scottish and Newcastle is again insignificantly different from zero. Weyerhaeuser and Goodyear are again both slightly below zero, but now only the estimate for Weyerhaeuser is significant at conventional levels (see Table 1).

Making judgments about persistence in the second sense based on the AR1 estimates of Table 1, on the other hand, would be quite dangerous. The estimates of λ in Table 1 for the five companies for which we identified structural breaks exceed the estimates of λ for the individual time periods (Table 6) in 11 of 14 cases. The high λ estimates in Table 1 appear to be due to *shifts* in π_{ip} rather than to a slow adjustment to an unchanging π_{ip} .

That π_{ip} should be superior to λ as a measure of persistence for long time series is perhaps not surprising. π_{ip} is an estimate of the mean of the time series, and as the time series grows in length it becomes a more accurate estimate. The need to model short-run dynamics arises in short time series, because a single shock to profits could severely bias an estimate of the mean, if it takes several years for the effects of the shock to dissipate. With long time series the effects of individual shocks will cancel out, and the mean – or π_{ip} – becomes an accurate measure of *within* period persistence.

Of course, using the profit mean or π_{ip} to make out-of-sample predictions becomes more hazardous when the data contain the kinds of structural breaks reported in Table 5, or cycles as in the data for Rank. Here it is perhaps comforting to note that in at least one case, estimates of π_{ip} from an AR1 did provide quite good out-of-sample predictions.²⁸ If asked to bet on whether Wrigley or Weyerhaeuser would have the higher return on capital over the next decade, we would not hesitate to bet on Wrigley. It is, perhaps, also worth recognizing that to answer the questions about the competitive process of most interest to economists, we do not have to be able

to make accurate out-of-period estimates. It suffices to answer the question of whether market competition drives all company profits to the same competitive level to know that it has not done so for the last 35 years in the UK and 50 years in the USA.

What lessons have we learned for future research? In industrial organization, like every other field, more data are better than less. As the availability of long time series of company data increases, these data sets should be used to test for the persistence of profit differences across firms. If one is only interested in the question of whether such differences existed for the time period available, estimates of π_{ip} from an AR1 or simply comparison of sample means will suffice. If, on the other hand, one wishes to obtain a more accurate picture of the profit dynamics of individual firms with a view, perhaps, to gaining a better understanding of the causes of these dynamics, a more arduous econometric approach will be needed. In this paper we have suggested one form this approach might take.

Table 1: AR1 Estimates (OLS)

| | Wrigley | Weyer- haeuser 1950 – 1999 | Goodyear | Avon | Boots | Glaxo 1968 - 1999 | Rank | Scottish & Newcastle |
|-------------|-------------------|----------------------------------|--------------------|---------------------|-------------------|----------------------|-------------------|-------------------------|
| α | 0.16 (0.12) | -0.01 (0.04) | -0.14** (0.06) | 0.41**(*) (0.16) | 0.16** (0.07) | 0.16 (0.11) | 0.06 (0.05) | -0.02 (0.02) |
| λ | 0.92*** (0.06) | 0.57*** (0.12) | 0.29** (0.14) | 0.74*** (0.09) | 0.67*** (0.13) | 0.84*** (0.11) | 0.62*** (0.15) | 0.65*** (0.14) |
| \bar{R}^2 | 0.84 | 0.30 | 0.06 | 0.56 | 0.44 | 0.67 | 0.36 | 0.40 |
| F | 257.97*** | 21.82*** | 4.21** | 61.67*** | 24.86*** | 62.60*** | 18.01*** | 20.73*** |
| dw | 1.97 | 1.90 | 1.82 | 2.25 | 1.55 | 2.41 | 1.53 | 1.53 |
| LM | 1.01 | 1.67 | 0.72 | 2.37(*) | 0.87 | 3.65**(*) | 4.59*** | 1.94 |
| JB | 29.15*** | 10.76*** | 3.29 | 8.90**(*) | 1.52 | 2.85 | 0.52 | 0.18 |
| π_{ip} | 2.09* (1.18) | -0.01 (0.10) | -0.20*** (0.07) | 1.55*** (0.27) | 0.49*** (0.09) | 1.03*** (0.37) | 0.17* (0.09) | -0.07 (0.06) |
| n | 49 | 49 | 49 | 49 | 31 | 31 | 31 | 31 |

Notes: (i) Figures in parentheses are standard errors. ***, **, * denote significance at 1, 5 and 10 per cent; (*) denotes within 1-2 per cent of level shown.
(ii) LM is from the Breusch-Godfrey serial correlation test, JB from the Jarque-Bera test for non-normality in the residuals.

Table 2: Classification to Long- and Short-Run Persistence Category

A. Preliminary Estimates (8 cases)⁽ⁱ⁾

| | | $\Pi_{ip} < 0$ | Long Run Π_{ip} n.s. | $\Pi_{ip} > 0$ |
|-----------|---|----------------|---|--|
| Short-Run | High $0.68 < \lambda < 1.0$ (High) | | | Avon Glaxo Wrigley ⁽ⁱⁱ⁾ |
| | Moderate $0.34 < \lambda < 0.68$ (Moderate) | | Weyerhaeuser (-) Rank (+) S & N (-) | |
| | Low $0 < \lambda < 0.34$ (Low) | Goodyear | | |

B. After Allowing for Structural Breaks (5 cases)

| | | $\Pi_{ip} < 0$ | Long Run Π_{ip} n.s. | $\Pi_{ip} > 0$ |
|-----------|---|---------------------------------------|-------------------------------|--|
| Short-Run | High $0.68 < \lambda < 1.0$ (High) | | Avon (71-89) Glaxo (80-85) | Avon (50-70) |
| | Moderate $0.34 < \lambda < 0.68$ (Moderate) | | Glaxo (68-79) | Wrigley (81-88) Wrigley (88-99) S & N (50-72) |
| | Low $0 < \lambda < 0.34$ (Low) | Weyerhaeuser (80-99) S & N (73-89) | S & N (90-99) | Wrigley (50-80) Weyerhaeuser (50-79) Avon (90-99) Glaxo (86-99) |

Notes: (i) Signs in parentheses indicate $\Pi_{ip} \leq 0$ in non-significant cases
(ii) Significant at 10 per cent.

Table 3: Structural Break and STS Intervention tests

A. AR1 (Chow) Tests

| Case | Years | F |
|----------------------|-------------|---------|
| Wrigley | 1981 & 1989 | 2.96** |
| Weyerhaeuser | 1980 | 6.82*** |
| Avon | 1971 & 1990 | 5.85*** |
| Glaxo | 1980 & 1986 | 5.02*** |
| Scottish & Newcastle | 1973 & 1990 | 8.67*** |

B. STS Intervention Coefficients (and t-values)

| Case | Year | Level | Slope |
|----------------------|------|------------------|------------------|
| Wrigley | 1981 | | 0.42 *** (6.23) |
| | 1989 | | -0.39*** (-3.92) |
| Weyerhaeuser | 1980 | -0.49*** (-2.38) | |
| Goodyear | 1991 | 0.32*** (3.29) | |
| Avon | 1971 | 2.51*** (10.02) | |
| | 1990 | | -0.18*** (-3.07) |
| Glaxo | 1980 | | 0.23*** (4.64) |
| | 1986 | | -0.26** (-5.19) |
| Scottish & Newcastle | 1973 | -0.34*** (-9.08) | |
| | 1990 | 0.11*** (3.18) | |

Table 4. KPSS Stationarity Tests (LM statistics)

| US Companies | | | | UK Companies | | | |
|--------------|---------|----------|------------|----------------------|---------|----------|------------|
| | | No Trend | With Trend | | | No Trend | With Trend |
| Wrigley | 1950-90 | 0.64** | 0.15** | Boots | 1968-99 | 0.13 | 0.13* |
| | 1950-80 | 0.43* | 0.09 | | | | |
| | 1981-99 | 0.34 | 0.14 | | | | |
| Weyerhaeuser | 1950-99 | 0.67** | 0.09 | Glaxo ⁽ⁱ⁾ | 1968-99 | 0.57** | 0.10 |
| | 1950-79 | 0.12 | 0.12* | | | | |
| | 1980-99 | 0.07 | 0.07 | | | | |
| Goodyear | 1950-99 | 0.09 | 0.09 | Rank | 1968-99 | 0.48* | 0.07 |
| Avon | 1950-99 | 0.10 | 0.11 | S & N | 1968-99 | 0.20 | 0.16** |
| | 1950-70 | 0.62** | 0.13* | | 1973-89 | 0.16 | 0.11 |
| | 1971-89 | 0.58** | 0.07 | | | | |

Note: (i) Sub-periods too short for testing (see text).

Table 5: AR1 Estimates: Structural Breaks⁽ⁱ⁾

| Case | Period | α | λ | π_{ip} | \bar{R}^2 | F | dw | LM | JB |
|-------------------|---------|-------------------------------|-------------------------------|-------------------------------|-------------|----------|------|---------------------|---------------------|
| Wrigley | 1950-80 | 0.42 (0.36) | 0.30 (0.58) | 0.60*** (0.14) | 0.87 | 62.57*** | 1.89 | 1.14 | 16.07*** |
| | 1981-88 | 0.76 ^(*) (0.46) | 0.62 ^(*) (0.32) | 1.98 ^(*) (0.76) | | | | | |
| | 1989-99 | 1.70*** (0.57) | 0.57*** (0.14) | 3.95*** (0.39) | | | | | |
| Weyer- haeuser | 1950-79 | 0.15** (0.06) | 0.27 ^(*) (0.13) | 0.21*** (0.07) | 0.45 | 20.88*** | 1.83 | 1.10 | 24.53*** |
| | 1980-99 | -0.23*** (0.07) | 0.27 ^(*) (0.13) | -0.31*** (0.09) | | | | | |
| Avon | 1950-70 | 0.33 (0.24) | 0.86*** (0.15) | 2.39 ^(*) (1.20) | 0.69 | 22.10** | 2.51 | 3.29** | 4.41 ^(*) |
| | 1971-89 | 0.08 (0.18) | 0.83*** (0.12) | 0.46 (0.81) | | | | | |
| | 1990-99 | 1.82*** (0.35) | 0.09 (0.17) | 1.99*** (0.15) | | | | | |
| Glaxo | 1968-79 | 0.10 (0.22) | 0.63 (0.51) | 0.27 (0.28) | 0.79 | 23.48*** | 1.86 | 2.75 ^(*) | 1.52 |
| | 1980-85 | 0.27 (0.19) | 0.89*** (0.26) | 2.42 (4.57) | | | | | |
| | 1986-99 | 1.37** (0.44) | -0.004 (0.23) | 1.36*** (0.07) | | | | | |
| S & N | 1950-72 | 0.14 ^(*) (0.07) | 0.58* (0.33) | 0.34** (0.16) | 0.71 | 15.47*** | 1.88 | 2.15 ^(*) | 0.48 |
| | 1973-89 | -0.14*** (0.03) | 0.10 (0.17) | -0.15*** (0.02) | | | | | |
| | 1990-99 | -0.02 (0.02) | 0.11 (0.26) | -0.02 (0.03) | | | | | |

Note: (i) Figures in parentheses are standard errors.

Table 6: Structural Time Series Estimates, 1950-99 (US Cases), 1968-99 (UK Cases)

| Case | Estimated Trend Coefficients in Final Vector State | | | | Diagnostics | | | | | |
|--------------|--|---------|-------------|---------|-------------|-----------|-------|------|-------|---------|
| | Level | | Slope | | -2 log L | Normality | H | dw | Q | R_D^2 |
| | Coefficient | (t) | Coefficient | (t) | | | | | | |
| Wrigley | 3.87*** | (10.56) | 0.01 | (0.19) | -48.73 | 12.69 | 16.42 | 2.05 | 12.45 | 0.36 |
| Weyerhaeuser | -0.29** | (-2.53) | 0.3 (E-3) | (0.04) | -107.59 | 13.90 | 4.93 | 1.89 | 22.53 | 0.38 |
| Goodyear | -0.11*(*) | (-1.62) | -0.01*** | (2.63) | -106.13 | 1.20 | 16.92 | 1.97 | 18.80 | 0.66 |
| Avon | 1.52*** | (10.06) | -0.11** | (-2.37) | -86.09 | 0.43 | 1.56 | 2.09 | 6.57 | 0.61 |
| Boots | 0.47*** | (9.18) | 0.2 (E-2) | (0.74) | -114.11 | 1.35 | 0.30 | 1.86 | 19.16 | 0.62 |
| Glaxo | 1.30*** | (14.43) | 0.01 | (0.33) | -80.80 | 0.46 | 4.32 | 2.17 | 8.92 | 0.65 |
| Rank | 0.07** | (2.10) | -0.01*** | (4.09) | -100.23 | 3.87 | 0.85 | 2.02 | 21.45 | 0.73 |
| S & N | -0.03*(*) | (-1.97) | -0.6 (E-3) | (-0.28) | -133.09 | 0.76 | 0.70 | 21.6 | 14.18 | 0.78 |

- Notes: (i) Normality is the Doornik-Hansen (1994) statistic, distributed as approximately χ_D^2 .
- (ii) H(h) is a test for heteroscedasticity, distributed approximately as F (h,h).
- (iii) Q(P,d) is the Box-Ljung Q-statistic based on the first P residuals, distributed approximately χ_D^2 .
- (iv) R_D^2 is the R^2 in differences, most suitable of three alternatives in the present application.

Figure 1: Illustrative Times Series for $\pi_{ip} = 0.55$

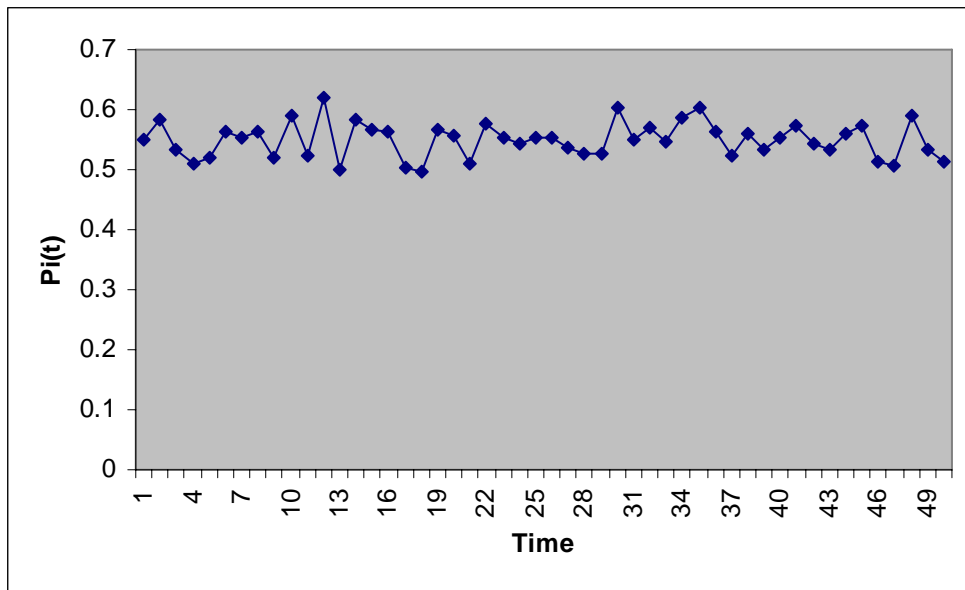


Figure 2: Phase Diagram for $\pi_{ip} = 0.55$

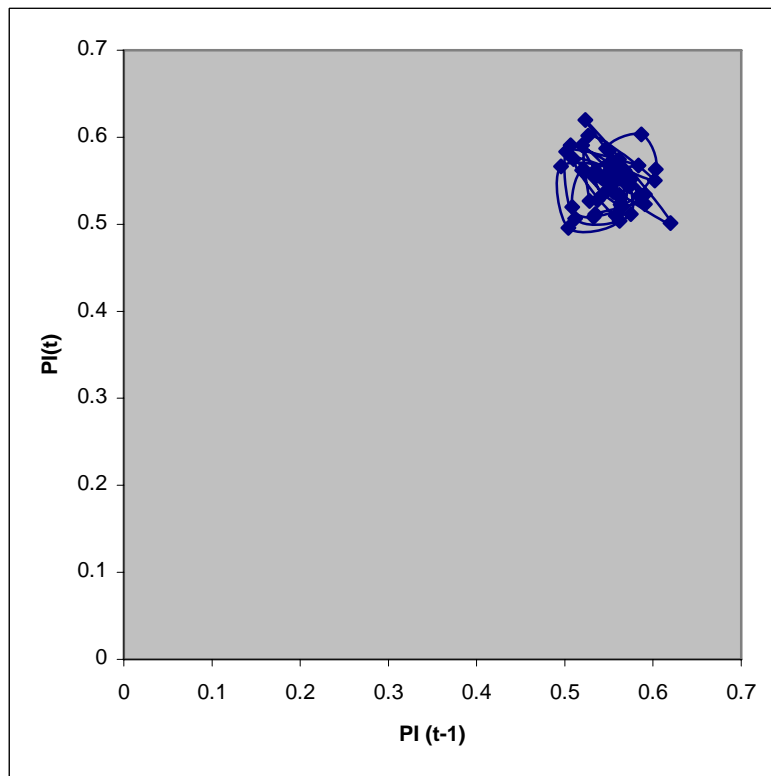


Figure 3: Time Series Simulation for $\pi_{ip} = 0, \lambda = 0.95$

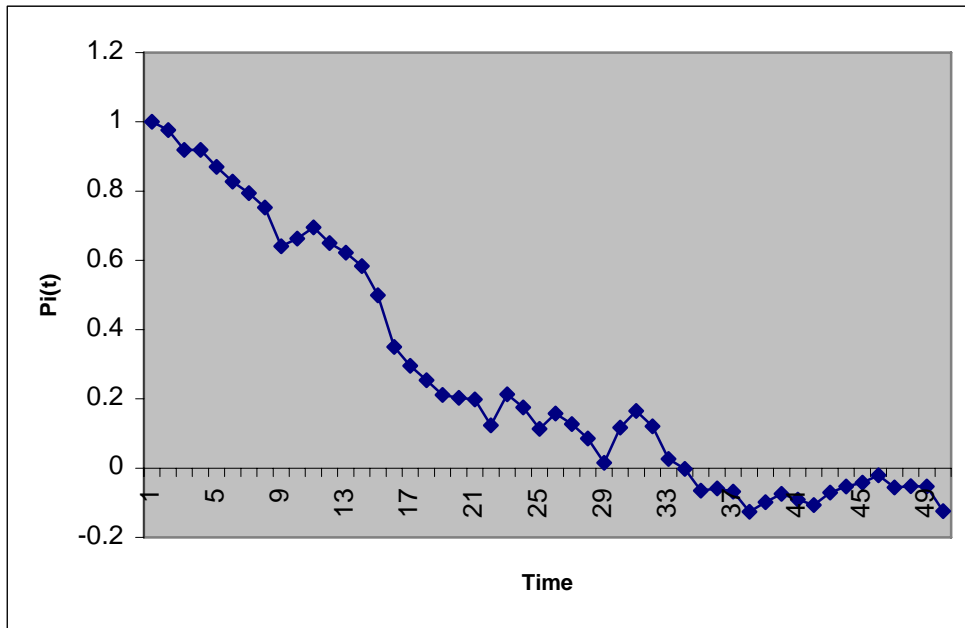


Figure 4: Phase Diagram, Simulated Series

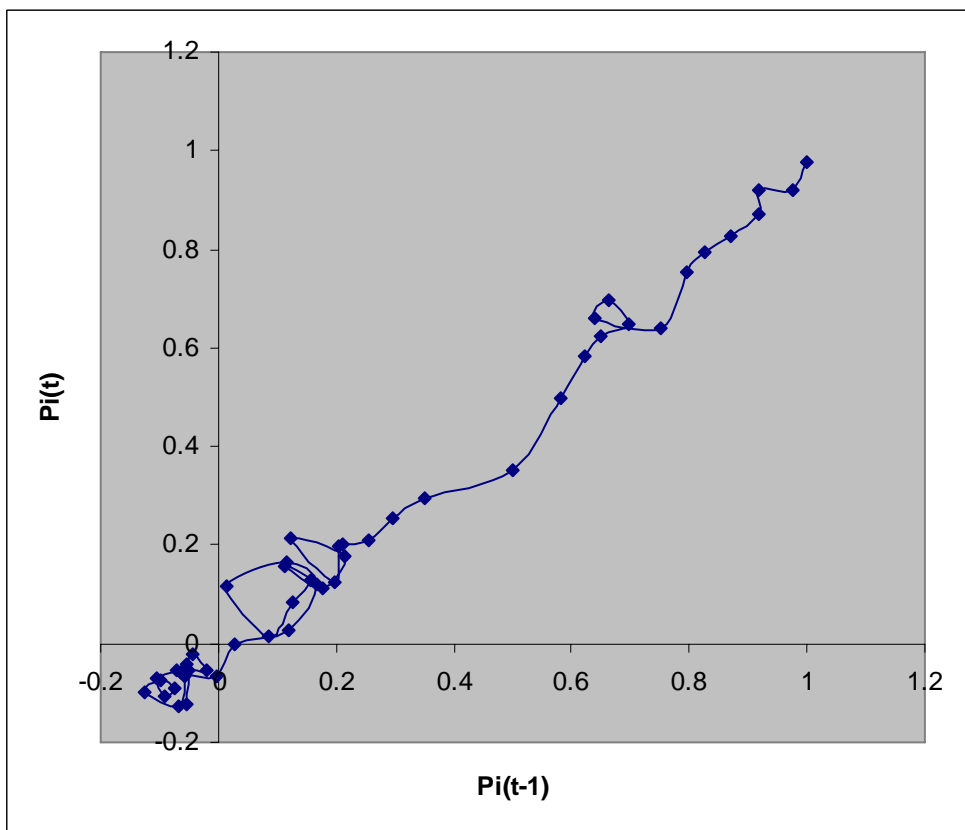
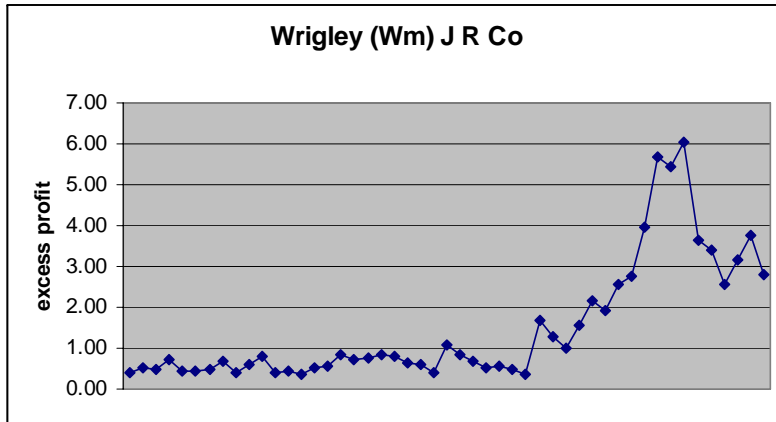


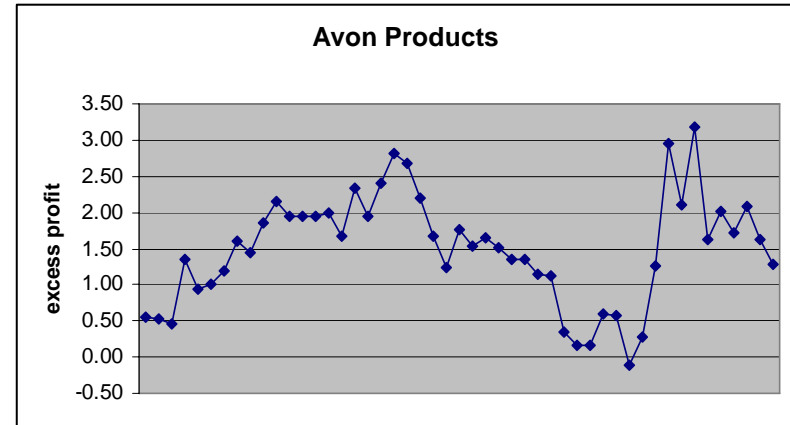
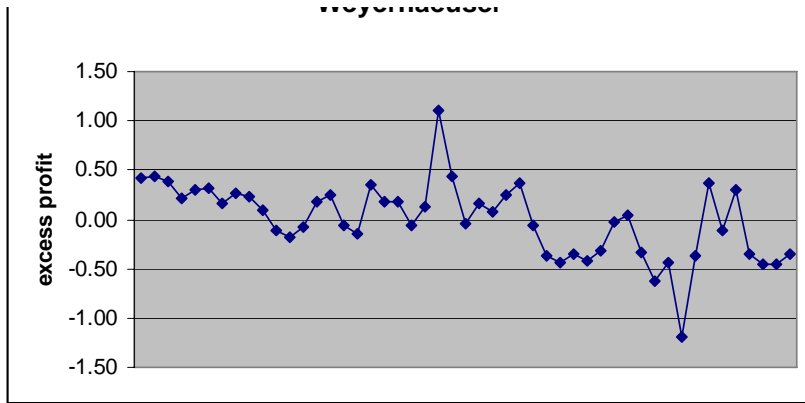
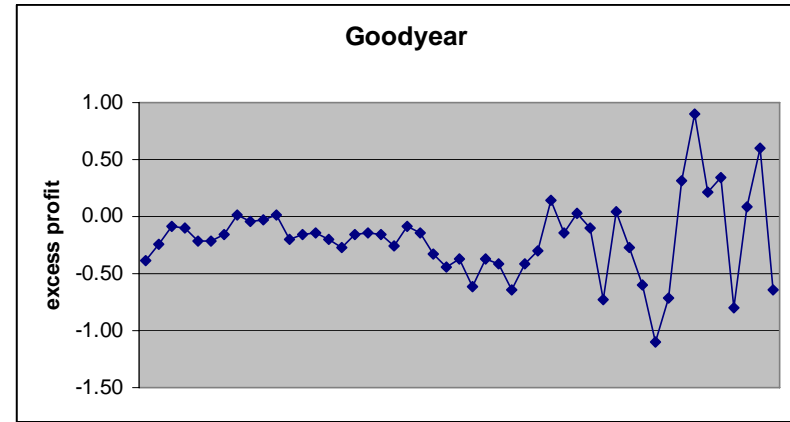
Figure 5: Excess Profit Time Series

(a) US Companies 1950-1999

(i)

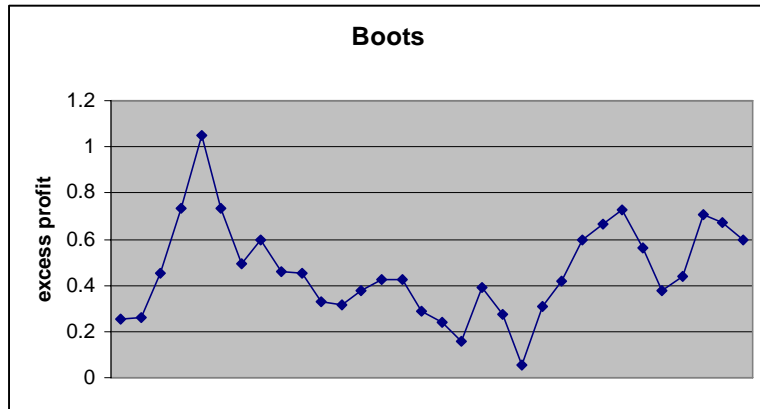


(iii)



(b) UK Companies 1968-1999

(i)



(iii)

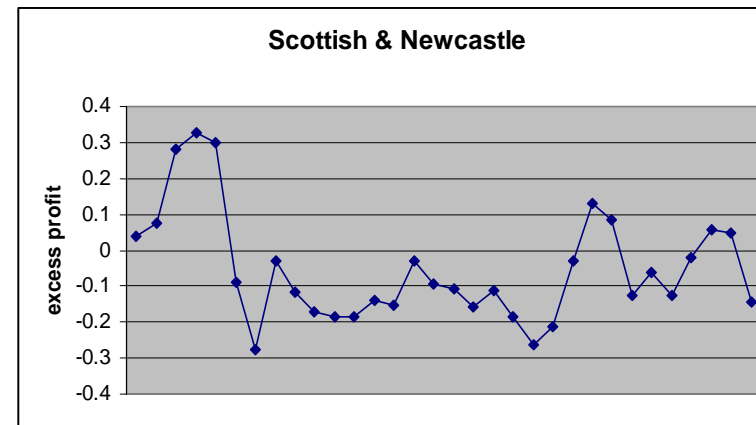
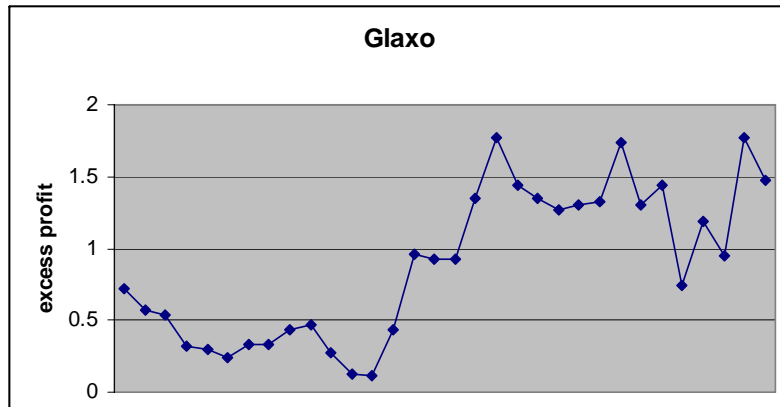
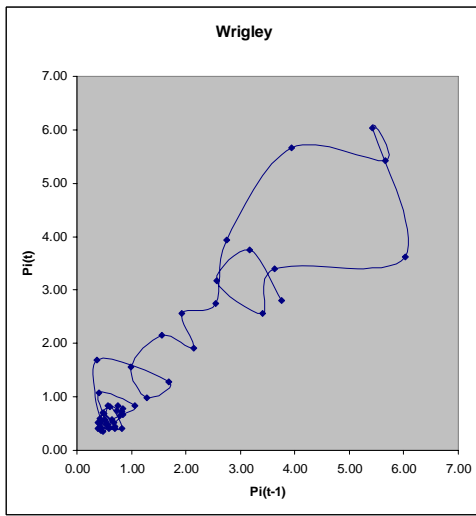


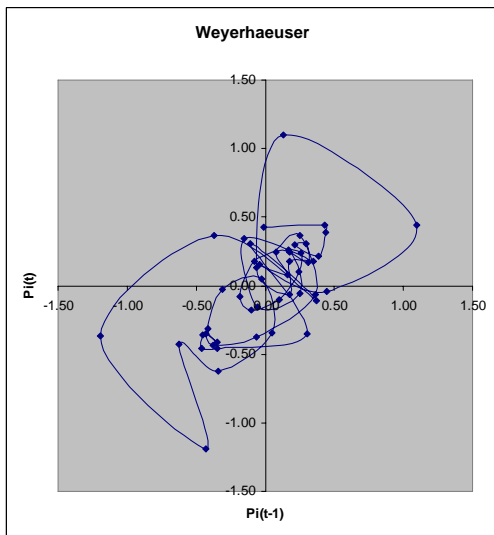
Figure 6: Phase Diagrams

a) US Companies 1950-1999

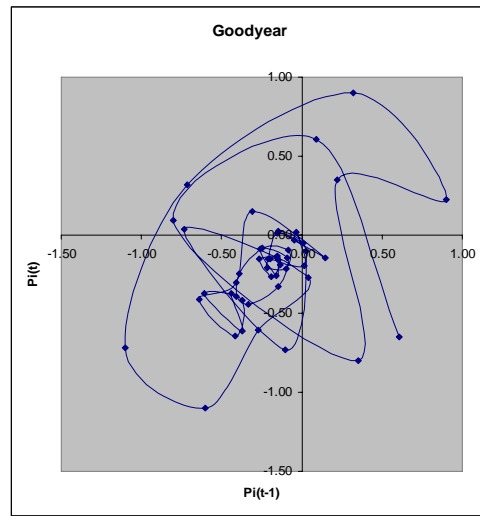
(i)



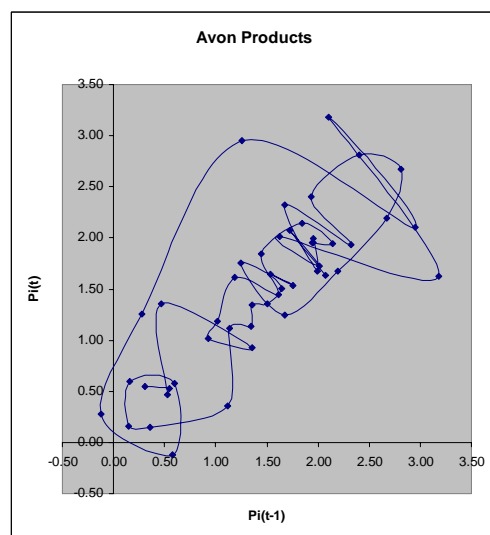
(ii)



(iii)

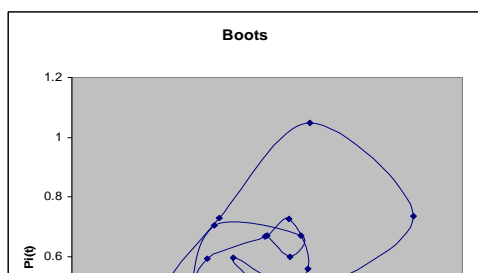


(i)

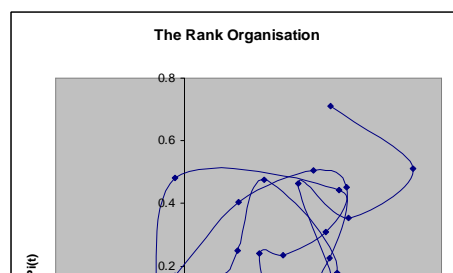


(b) UK Companies 1968-1999

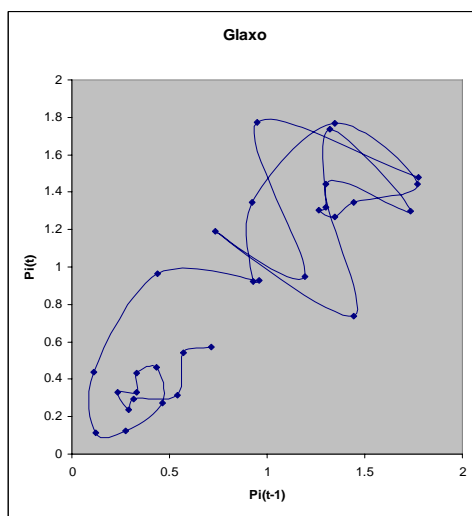
(i)



(iii)



(ii)



(iv)

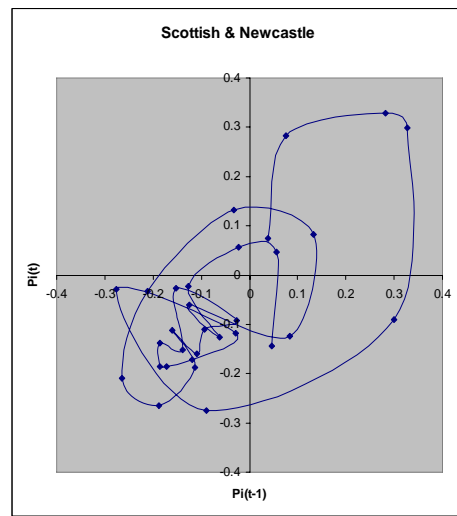
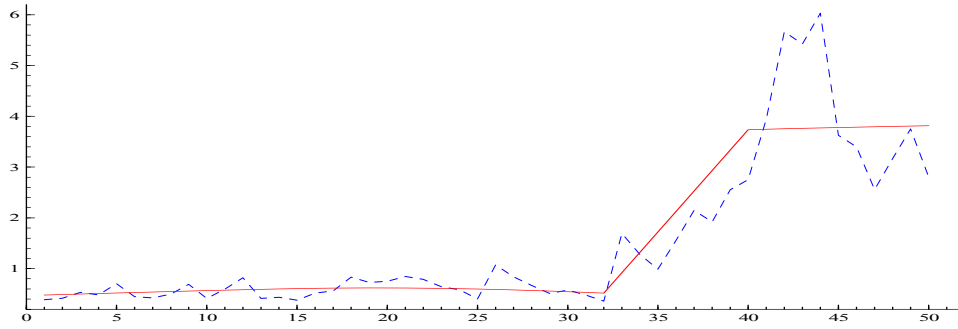
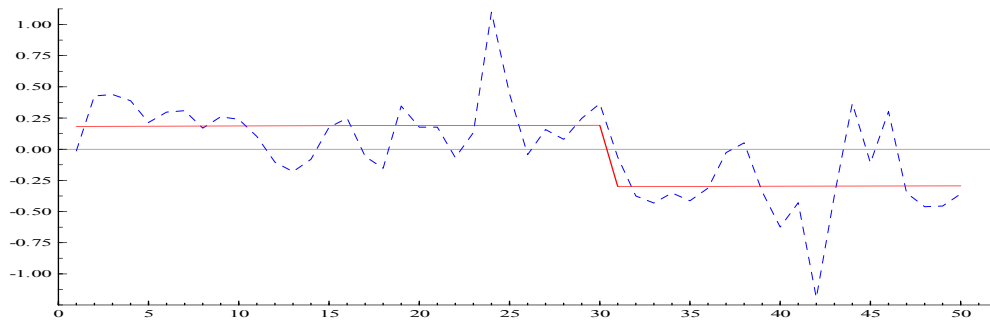


Figure 7(a) Structural Time Series Trend Estimates: US Companies

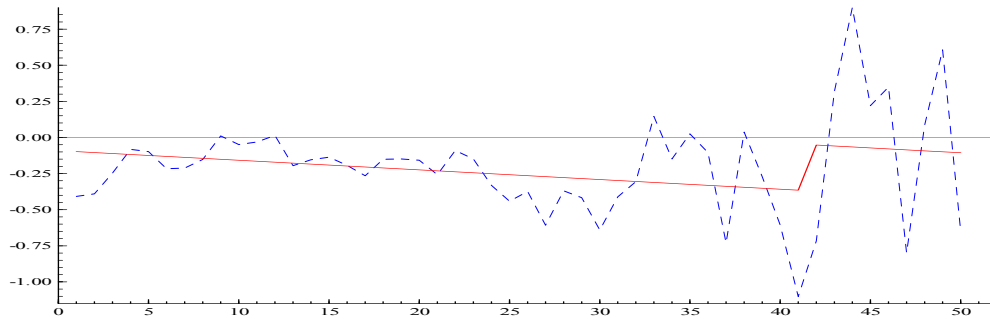
(i) Wrigley



(ii) Weyerhaeuser



(iii) Goodyear



(iv) Avon Products

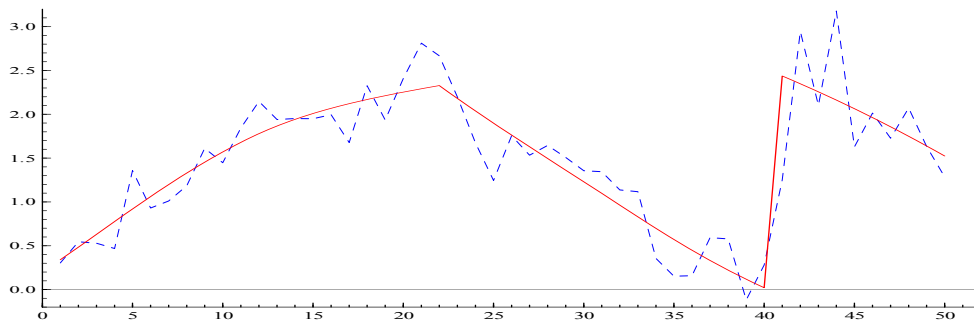
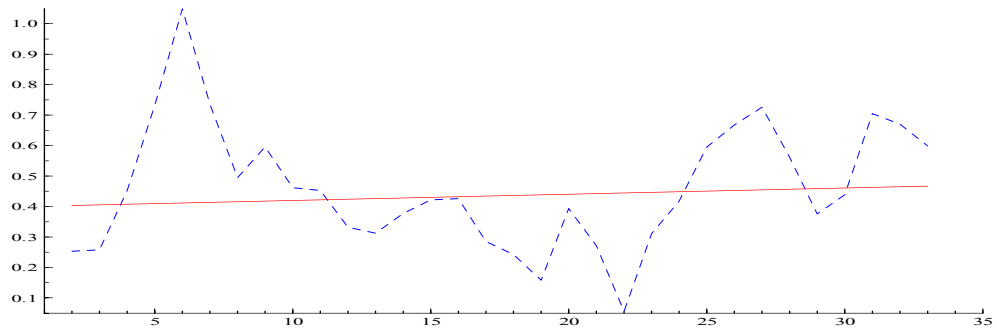
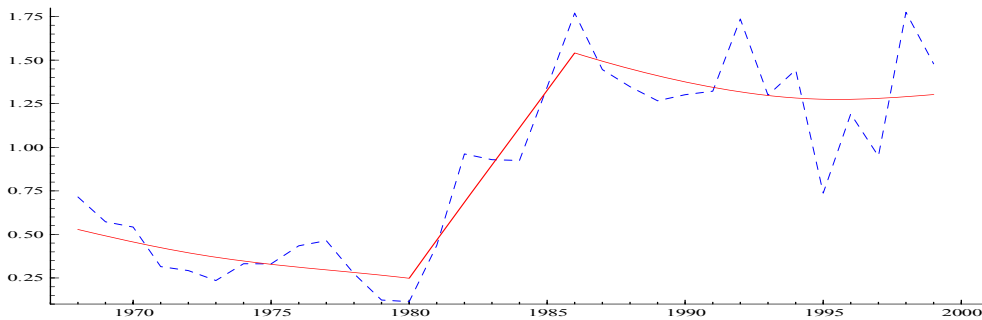


Figure 7(b) Structural Time Series Trend Estimates: UK Companies

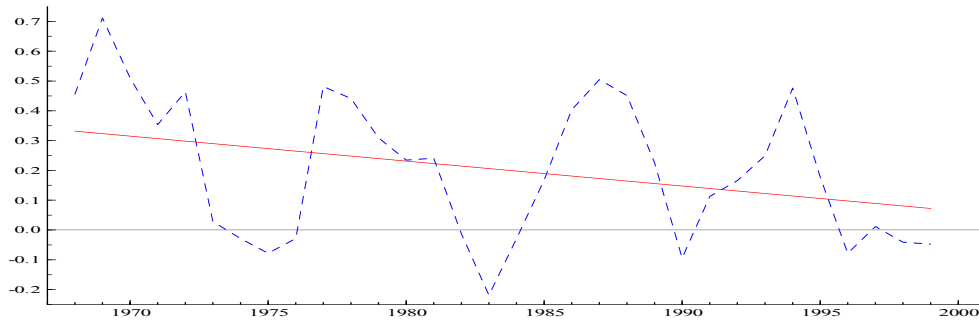
(i) Boots



(ii) Glaxo



(iii) The Rank Organisation



(iv) Scottish & Newcastle

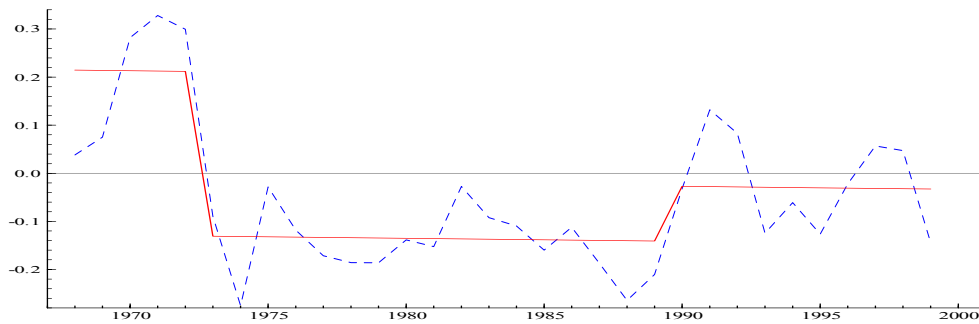
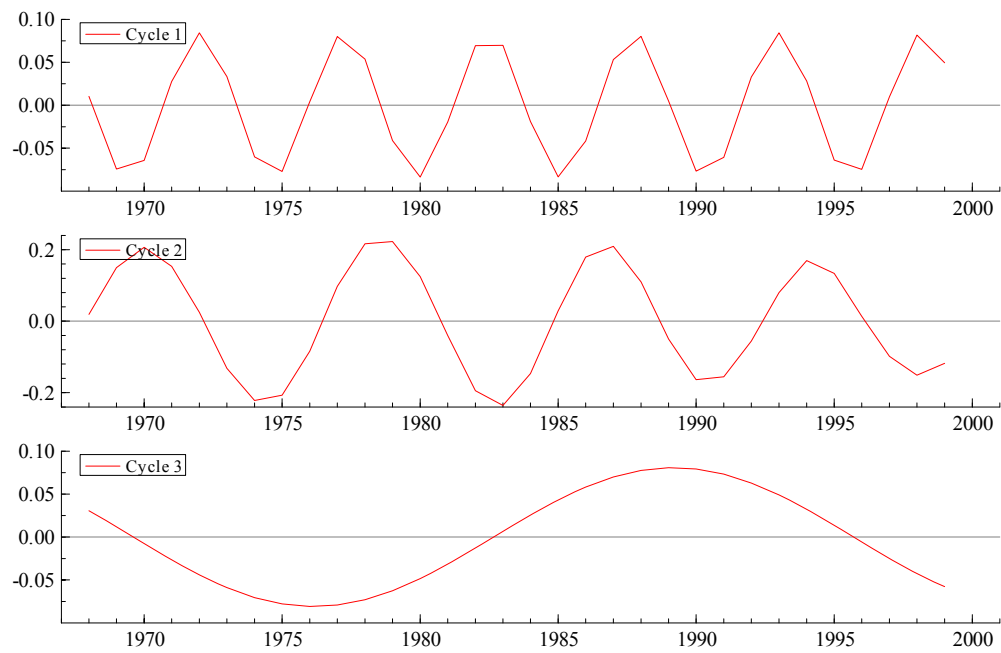


Figure 8: Cyclical Components, The Rank Organisation



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Endnotes

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- ¹ See, for example, Geroski and Jacquemin (1988), Mueller (1990), Kambhampati (1995), Goddard and Wilson (1999), Glen and Singh (2001), Maruyama and Odagiri (2002), Cable and Jackson (2003), and Gschwandtner (2005).
- ² For a survey of this literature, see Schmalensee (1989).
- ³ See Klepper and Simons (1996, 1997), Sutton (2004).
- ⁴ Numerous studies have found a strong correlation between firm market shares and profitability. See, for example, Ravenscraft (1983) and Mueller (1986, ch. 4).
- ⁵ Though Odagiri and Yamawaki (1986) and Maruyama and Odagiri (2002) for example work in terms of absolute deviations.
- ⁶ The idea that returns to firm-specific rents may be ‘durable’ (or ‘quasi-permanent’ over the observation period), with truly permanent rents as a limiting case, is discussed in section III.
- ⁷ The derivation and interpretation of this equation is discussed further in section III.
- ⁸ Strictly speaking convergence is ensured if $-1 < \lambda_i < 1$, but negative values of λ_i make no economic sense in the context of a Schumpeterian model.
- ⁹ One might add that for the error process to have zero mean, in accordance with the classical assumptions required for OLS validity, there would need to be as many innovation failures as successes, a rather strong further disincentive.
- ¹⁰ See Mueller (1967), Grabowski (1968), Kathuria and Mueller (1995), Hall et al. (1999), Gugler, Mueller and Yurtoglu (2004).
- ¹¹ See Cable and Jackson (2003) for a formal demonstration. Essentially, the problem is that $\pi_{t,l}$ is representing both “entry” and “innovation” (i.e. more than one latent variable) so that the AR1 speed-of-adjustment parameter scrambles their effects together.
- ¹² Throughout the paper we abstract from the effects of risk differences on firm profit rates. These can and have been explicitly introduced in some of the empirical work, and do not account for all of the observed differences in estimates of π_{ip} (Mueller, 1986, Ch. 4).
- ¹³ If the two firms had different λ s, then one would also have to allow for a change in this parameter at the time of the merger.
- ¹⁴ For technical details of structural time series methods and *Stamp*, see Harvey (1990, 1997) and Koopman, et al. (2000).
- ¹⁵ The brief histories draw on the following sources: Smiley and Stansell, 2004 (Wrigley); Lawson, Covell and Salame, 1999 (Weyerhaeuser); Belisto and Salame, 1998 (Goodyear); Keeley, Whiteley and Stansell, 2002, (Avon); Slinn and Salame, 1999 (Boots); Tucker, Salame, Dougal and Stansell, 2002 (Glaxo); Martin and Salame, 1996 (Rank); and Ingram and Brynildsen, 2001 (Scottish & Newcastle).
- ¹⁶ Cowling, et.al. (1980).
- ¹⁷ Tied houses were typically owned by a brewery and run by tenants or managers under exclusive trading arrangements, thus providing significant forward vertical integration with security of market and varying degrees of control over prices for the brewer.
- ¹⁸ Off-licences are specialist outlets, now mainly national chains, with a licence to sell beer, wines and spirits for consumption off the premises only.
- ¹⁹ Recall that a λ of 0.6 implies only 20% of rents surviving after three years and less than 10 %

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- after five, with comparable figures of 3% and less than 1% for $\lambda = 0.3$.
- ²⁰ $d_L = 1.373$ and $d_U = 1.502$ in these cases.
- ²¹ While proceeding to autoregressive processes of order three or higher is easy from the point of view of estimation, and might in theory accommodate more complex cyclical patterns, deducing the parametric conditions for cyclical behaviour becomes increasingly complex.
- ²² The relevant χ^2 statistics under Wald tests are 14.72 and 2.41 respectively.
- ²³ However, the Rank case was the third most successful instance among the 53 cases analysed. In only fifteen of these was b^2 *numerically* less than c , and in only one of those was the difference significant at 5 per cent, with one other at 10 per cent, Rank being the only other case approaching significance at that level. For our other UK illustrative cases, Glaxo was one of those for which the estimate of b^2 was numerically *greater* than c , thus failing the first condition for harmonic behaviour. While this condition was met in the cases of Boots and S&N, the differences were significant at only 29 and 28 per cent respectively.
- ²⁴ The relevant χ^2 values are 5.24 and 28.09 respectively. The preferred STS specification in this case is the local linear trend model, in which both level and slope are stochastic, as opposed to fixed and stochastic respectively in the 'smooth trend' model which is our usual STS starting point.
- ²⁵ Further slope and/or outlier interventions, e.g. for 1969, 1976 and 1983, are not significant and produce generally less satisfactory results, indicating a degree of robustness in the preferred model.
- ²⁶ The essence being to gauge how far the scatter is located away from the origin on the 45° line.
- ²⁷ As long as, in the cases of Glaxo and Boots, difficulties at the time of writing again prove transitory - Boots having posted profit warnings for the current year, and Glaxo (now Glaxosmithkline, after the merger with Smithkline Beecham in 2000)) having encountered problems in the last two to three years over executive compensation; over litigation concerning the reporting of research findings; and in discovering replacements for major drugs going out of patent.
- ²⁸ Mueller (1997) used π_{ip} estimates from the period of 1950 to 1972 to predict profit deviations from the mean in 1993-94. He found that the sample of firms with estimated π_{ip} s ≥ 0.5 had a much higher probability of surviving until 1994, and had a mean π of 0.45. Firms with estimated π_{ip} s ≤ -0.5 had a lower probability of surviving until 1994, and a mean π of -0.72.