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Tracing the dynamics of competition: Evidence from company profits*

Jesús Crespo Cuaresma† Adelina Gschwandtner‡

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Abstract

This paper proposes a simple approach to analyzing profit dynamics which allows for time-varying persistence of profits. The time series model is a simple autoregressive process where the dynamics of the persistence parameter follow an autoregressive or random walk process. Using the longest time series available on profits for six US firms (Archer-Daniels-Midland , Avon, Coca Cola, Johnson & Johnson, WHX Corporation and Wrigley), we analyze the dynamics of profit persistence for the second half of the twentieth century.

JEL classification: L00; C22.

Keywords: Profit persistence; competition; time series models .

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1 Introduction

Since the seminal contributions of Mueller (1977, 1986), there is a fruitful and steadily growing literature aimed at investigating empirically the persistence of company profits. While the competitive environment hypothesis predicts that profit differentials across firms should disappear in the long run, the empirical evidence tends to give little support to this theory. Several studies analyze the question of competition within the frame of profit persistence across different economies, industries and time periods.

Mueller (1990) presents a comprehensive international comparison of profit dynamics. In his study the dynamics of company profits were analyzed and compared for seven developed economies - US, UK, Japan, France, Germany, Sweden, Canada - during the 1960s to 1980s. Kambhampati (1995) analyzes and compares the profits differentials in 42 Indian industries over the period 1970-85 and shows that competition is less intense in fast growing, concentrated industries. Glen *et al.* (2001) analyze and compare the dynamics of competitive forces in seven emerging markets - India, Malaysia, South Korea, Brazil, Mexico, Jordan and Zimbabwe - during the 1980s and early 1990s and concludes that the intensity of competition is, if anything, greater in emerging than in advanced countries. Odagiri and Maruyama (2002) analyze the intensity of competition in Japan during the period 1964-97 and still find a considerable degree of profit persistence. Yurtoglu (2004) analyzes the persistence of firm-level profitability for the largest 172 manufacturing firms in Turkey during the period 1985 to 1998 and concludes that the intensity of competition in Turkey is no less than in developed countries. Gschwandtner (2005) analyzes the differences in profit persistence between surviving and exiting firms in the US for the second half of the twentieth century.

The empirical literature on profit persistence uses two different but interrelated definitions of persistence of profits. The persistence measure related to long-run deviations from normal profits is given by the unconditional expectation of the stochastic process that profit rates are assumed to follow (usually, an autoregressive process). Short run persistence (which corresponds to the context in which "persistence" is usually used in time-series analysis), on the other hand, is given by the size of the autoregressive parameter in the dynamic representation of the profit rate. If the time series span a long period of time, considering persistence (whichever its definition) constant might be

very restrictive, since the degree of overall competition in the economy or sector under study may be expected to change over time. There is evidence for example, that competition increased in the US after the opening to international competition in the 1960s and structural breaks of this kind could have taken place also afterwards. Recently, Gschwandtner (2004), using data for US companies in the period 1950-1999, finds evidence of significantly different profit dynamics when dividing the sample into different subperiods.

In this paper we study the dynamics of profit rates making use of an unobserved components model with a time-varying persistence parameter. This allows us to trace the dynamics of competition for any given company and thus assess the validity of the competitive environment hypothesis without constraining the persistence parameter to be constant. The advantages of this methodology are exemplified by analyzing profit data from six US companies.

The structure of the paper is as follows. The time series model used in the study is discussed in section 2 and the results of the estimation of the model for the profit data are reported and commented in section 3. Section 4 concludes and indicates potential future paths of research using the methodology put forward in this paper.

2 Modelling time varying persistence

Since Mueller (1986) and Odagiri and Yamawaki (1986), the autoregressive process of first order (AR(1)) has been the most widely used representation of the dynamics of profits and has become the modelling workhorse for evaluating the adequacy of the competitive environment hypothesis empirically. Let $\pi_{i,t}$ be the profit rate of firm i in period t, eventually normalized by taking the difference to the sample average profit rate in period t. The dynamic behaviour of $\pi_{i,t}$ is assumed to be given by

$$\pi_{i,t} = \alpha_i + \lambda_i \pi_{i,t-1} + \varepsilon_{i,t}, \tag{1}$$

where $\lambda_i \in (-1, 1)$ and $\varepsilon_{i,t}$ is white noise with constant variance $\sigma^2_{\varepsilon,i}$. Notice that the specification given by (1) can be justified theoretically (see Geroski, 1990, for example) as a reduced form of a two-equation system where profits are assumed to depend on the threat of entry in the market, and the threat is itself assumed to depend on the profits observed in the last period.

The unconditional expectation of $\pi_{i,t}$ in (1) is given by $\alpha_i/(1-\lambda_i)$. The empirical literature on profit persistence usually compares the estimates of the unconditional expectations from (1) (or alternative AR(p) generalizations) and tests the equality of unconditional expectations – long run projections of the series – across companies. However, this procedure is appropriate only for stationary AR processes, as $\alpha_i/(1-\lambda_i)$ is not defined for unit root processes, where $\lambda_i = 1$.

Evidence of nonstationary (unit root) behaviour in company profits is often reported in the empirical literature dealing with the competitive environment hypothesis. Kambhampati (1995), using the Dickey-Fuller (DF) test, could reject non-stationarity of profits in only 13 out of 42 cases for Indian industry-level data. Goddard and Wilson (1999) employing data for 335 U.K firms over the period 1972-91 likewise report non-stationarity in 76-81 % of firms in the sample. Gschwandtner (2003) fails to reject the unit root hypothesis in 69 out of 187 cases (36,9%) for US companies.

We aim at modelling profits in a framework of time-varying persistence (leading thus to a constant long-run projected profit rate only if the dynamics of the persistence parameter converge to a constant value). The model specification we propose and implement is given by

$$\pi_{i,t} = \alpha_i + \lambda_{i,t}\pi_{i,t-1} + \varepsilon_{i,t}, \tag{2}$$

where the persistence parameter $\lambda_{i,t}$ can be specified as an AR(1) process itself,

$$\lambda_{i,t} = \phi_{i,0} + \phi_{i,1}\lambda_{i,t-1} + \nu_{i,t}, , \tag{3}$$

where $\nu_{i,t}$ is assumed to be a white noise process with constant variance $\sigma^2_{\nu,i}$, uncorrelated with $\varepsilon_{i,t}$. In principle, the persistence of profits may have increased or decreased in certain sectors (or firms) continuously for the sample available, so a random walk specification (with or without drift) might as well fit the development of the persistence parameter better for certain firms in the sample. We will thus also consider dynamics of $\lambda_{i,t}$ of the type

$$\lambda_{i,t} = \phi_{i,0} + \lambda_{i,t-1} + \nu_{i,t}, , \tag{4}$$

where $\nu_{i,t}$ is defined as above. The characteristics of an AR(1) where the autoregressive parameter follows an AR(1) process itself have been studied in Weiss (1985). Equation (2) with either (3) or (4) is a conditionally Gaussian

model, which can thus be estimated using maximum likelihood methods (see for example Harvey, 1989).

The model given by (2) with (3) or (4) will be the specification used in our application with profit data from six US firms in the period 1950-1999. This method will alow us to draw conclusions on the development of competitive pressures in the period considered.

3 The dynamics of profit persistence in selected US firms

This section presents the results obtained from the estimation of the AR(1) model with time-varying autoregressive parameter using profit data ranging from 1950 to 1999 for six US firms: Abbott laboratories, Archer-Daniels-Midland, Avon, Coca Cola, Johnson & Johnson, WHX Corporation and Wrigley.

3.1 Estimation results

The relevant variable used for the analysis ($\pi_{i,t}$) will be defined as the percentage deviation from company i's profit rate from the average profit rate in a sample of 156 firms for which data is available in the period 1950-1999 (see Crespo Cuaresma and Gschwandtner, 2003).[1] This normalization has two aims. On the one hand, it should remove business cycle fluctuations and common shocks. Furthermore, the literature tends to interpret the average profit as a measure of the competitive profit, and thus $\pi_{i,t}$ as deviations from the competitive norm. The profit rate is given by a firm's profits after taxes (Compustat's *Income Before Extraordinary Items*, which represents the income of a company after all expenses, including special items, income taxes and minority interests-but before provisions for common and/or preferred dividends) divided by total assets (Compustat's *Assets-Total*). The main source for the profit data is Compustat, while for the most recent years (1977-99) Global Vantage was employed as a data source. The dataset was completed using "Moody's Industrial Manual" (Messner, 1950-1999) for those years for which Compustat

[1] The companies in the sample belonged to the largest 500 (in terms of sales) in 1950 and managed to survive until 1999.

and/or Global Vantage did not provide data.

For all firms in our dataset, the modelling strategy is the following. A simple AR(1) model with a constant persistence parameter is estimated for the sample available. Initiating the maximum likelihood algorithm by setting the long-run average of the time-varying λ parameter ($\phi_{i,0}/(1-\phi_{i,1})$ equal to the estimate in the model with constant persistence, estimates for the model with an AR(1) coefficient will be obtained. Maximum likelihood estimates for the model with random walk dynamics of λ (both with and without drift) will also be obtained, and the three models will be compared in terms of AIC. The model with significant time-varying persistence and minimum AIC will be chosen as the preferred specification. The dynamics of the profit rate (relative to average profit) for the firms in our sample are presented in Figure 1, and the parameter estimates of AR(1) processes with constant persistence such as (1) are presented in Table 1, together with the test statistics of Augmented Dickey-Fuller (ADF) tests applied to the profit rates.[2] The unit root tests give evidence supporting the existence of a unit root in the autoregressive dynamics for three of the six profit rate series under study: Coca Cola, Johnson & Johnson and Wrigley. It should be noticed that the existence of a unit root in the profit rate series would invalidate inference based on the long-run projected profit rate, since the unconditional variance of the profit rate would be asymptotically infinite if the autoregressive root was equal to one. All of the series studied present positive persistence (in the sense of a significantly positive estimate of λ), although clear differences can be found in terms of the long-run projected profit rate. The unconditional expectation of the data generating process of the profit rate is not significantly different from zero for Avon and Johnson & Johnson, while Avon, Coca Cola and Wrigley present persistent profits above the norm in the sense of a significantly positive long-run projected profit rate. The case of WHX is especially interesting, since it presents positive short-run persistence (an estimated positive λ) together with a long run projected profit rate significantly below normal profits. Actually, as can be seen in Figure 1, the profit rate of WHX stayed below normal profits for most of the period being studied.

[2]No evidence of autocorrelation was found in the residuals of the original Dickey-Fuller test specification for any of the series under study, with the exception of Archer-Daniels-Midland. For this series, the test specification was augmented with three lagged differences of the profit rate in order to get rid of the autocorrelation in the residuals of the Dickey-Fuller regression.

Table 2 presents the estimates of the specification with time-varying persistence. The preferred specification for the dynamics of the persistence parameter is indicated in the last row of the table. The random walk specification (without a drift) for λ is chosen in all cases but one, Archer-Daniels-Midland's profit rate, for which an AR(1) process is estimated for the persistence parameter. The estimates of the time-varying persistence models allow us to recover the dynamics of λ for the whole period considered. In particular, the smoothed estimate of $\lambda_{i,t}$, $\lambda^s_{i,t}$ is given by the expected value of $\lambda_{i,t}$ given all observations of $\pi_{i,t}$, that is

$$\lambda^s_{i,t} = \mathsf{E}(\lambda_{i,t}|\{\pi_{i,t}\}^T_{t=1}),$$

where T is the total number of observations in the sample of profit rates for company i. The corresponding variance of the smoothed estimate is given by $\mathsf{var}(\lambda_{i,t}|\{\pi_{i,t}\}^T_{t=1})$.

3.2 Profit persistence dynamics in selected US companies

We now turn to analyzing the dynamics of persistence in profit rates for six US companies: Archer-Daniels-Midland, Avon, Coca Cola, Johnson & Johnson, WHX Corporation and Wrigley, making use of the smoothed estimates obtained from the time series model with time-varying persistence. The aim of the section is not to carry out an in-depth analysis of the evolution of profits in these six companies, but rather to demonstrate the virtues of the method proposed as compared to the approach based on fixed persistence parameters to trace the dynamics of profit persistence in these selected companies. Figure 2 presents the smoothed estimates of λ for each company, together with (twice) their standard deviation. As it is evident from Figure 2, the dynamics of persistence are relatively different across the companies under study, as is the uncertainty surrounding the time-varying estimates of λ. There are, furthermore, substantial difference in the persistence parameter both across firms and, most importantly for our application, in time.

Archer-Daniels-Midland

Archer-Daniels-Midland Company (ADM) was founded in 1902 and is today one of the largest agricultural processors in the world. The dynamics of the

point estimate of λ present two peaks located in the mid-sixties and mid-eighties. The first peak corresponds with the opening of ADM to direct trade with the Gulf coast, after the opening of its grain export terminal at Destrehan (Louisiana) and with the beginning of the production of textured vegetable protein at the Decatur East Plant. At the beginning of the eighties, ADM Industrial Oils is established, with production of ethanol starting up in the beginning of the decade. The smoothed persistence parameter for these two periods appears significantly higher than the estimate obtained with the simple AR(1) model with constant λ in Table 1. On the other hand, the time-varying persistence parameter is insignificant for most of the fifties and seventies, where our model therefore concludes that the dynamics of profits for ADM can be described as a random uncorrelated changes around a constant profit rate, given by the estimate of α in Table 2.

In the summer of 1995, ADM was involved in a price-fixing federal antitrust lawsuit which was recently settled by the company having to pay $400 million. This explains the dramatic fall in both profits and profit persistence by the end of the sample. The smoothed estimates of λ cycle around zero for the last part of the sample, reproducing closely the pattern of deviations of the profit rate of ADM from normal profits for the last observations available.

Avon Company

The birth of Avon dates back to 1886, when David McConnell founded a cosmetics firm aimed at door-to-door selling. In 1897 the first Avon laboratory opens, and starting in the 1950s the expansion of the Avon company has been enormous (first to South America, then to Australia, central Europe and South-East Asia and recently to central and eastern European emerging markets such as Slovenia, Bulgaria and Russia). While Avon enjoyed a rather protected position in the US market as being one of the world's first global cosmetics companies during the 1950s and 1960s, in the last four decades Avon faced high competition from both domestic and foreign products. The path of the estimated persistence of profits for Avon remains basically constant for the whole sample available, and is obviously similar to the value obtained by estimating the simple AR(1) process presented in Table 1.

The results for Avon therefore support the use of the classical modelling strategy based on a constant persistence parameter.

Coca Cola

Since its origin as a soda fountain beverage in 1886, the development of the Coca Cola company in the second part of the twentieth century has been extremely successful, with net income in 1999 almost 80 times higher than in 1950. The introduction of new bottle sizes in 1955 and the acquisition and launching of brands starting in the sixties (Fanta, acquired in 1960, Sprite, launched in 1960 and Tab, in 1963, for example) are accompanied by relatively low values of the persistence parameter in the beginning of the period under study. The smoothed estimate of λ fluctuates in the post-1970 sample in the band roughly defined by 0.6 and 1, a period that coincides with the worldwide expansion of Coca Cola in the seventies and eighties. The overall trend in the λ estimates for the period 1950-1998 is increasing, and the estimated data generating process reaches parameter values implying nonstationarity of profits by the end of the sample. In the very last years of the sample, the fall in profits observable in Figure 1 is mirrored in a significant decrease of the estimated persistence parameter, most probably caused by the Asian and Russian crises, together with the withdrawal of Coca Cola beverages from Belgium following a case of sudden illness on children after consuming Coca Cola products.

Johnson & Johnson

Johnson & Johnson is one of the world's largest health care product makers. Starting as a producer of antisepsis instruments by the end of the nineteenth century, Johnson & Johnson expanded during the fifties of the twentieth century to the field of pharmaceuticals. Since the seventies, Johnson & Johnson has followed a relatively aggressive policy of acquisitions, which however has resulted in below-norm profits for most of the post-1970 period. Since the sixties, the smoothed estimate of the persistence parameter for Johnson & Johnson's profit rate has followed a downward trend, reaching a minimum in 1982, the year when the Tylenol scandal broke out.[3] It should be noticed that the uncertainty surrounding our estimate of λ increases dramatically in the period considered, making it thus extremely difficult to make inference on the persistence parameter at the end of the sample, where all plausible positive values for λ are included in the interval formed by two standard deviations around the smoothed estimated of λ.

[3]Tylenol, a product of a subsidiary of Johnson & Johnson, caused the death of seven patients after being altered by unknown individuals. The product was voluntarily recalled and Johnson & Johnson took a $100 million charge against earnings.

WHX Corporation

Wheeling Steel Corporation was born in 1920 to consolidate the operations of three steel companies (Wheeling Steel and Iron Company, Whitaker-Glasner Company and La Belle Iron Works). In 1968, Wheeling Steel Corporation and Pittsburgh Steel Company merged into Wheeling Steel Corporation (WHX), which is currently the sixth largest steel producer in the US.

The profit rate of WHX has been systematically below average profits for most of the sample under study, and the estimates of the constant persistence AR(1) process presented in Table 1 reveal a significantly negative long run projected profit rate. The smoothed estimate of λ, however, is only significant (and significantly higher than the constant persistence estimate) for the subsample corresponding to the mid-eighties. The period of significant positive persistence starts with the bankruptcy filing by WHX and seven of its subsidiaries in 1985, and ends with the filing of a reorganization plan in 1988. The estimated process for the last part of the sample is not significantly different from a constant (significantly negative) profit rate plus a white noise disturbance.

Wrigley

Wrigley is the world's leading chewing gum manufacturer. The company has remained basically a chewing gum manufacturer throughout its 110 years of existence. Three clear regimes emerge from the smoothed estimates of the persistence parameter, whose limits coincide with the breakpoints that Cable and Mueller (2005) identify using simple autoregressive models. Until 1980, the smoothed estimate of λ tends to be relatively constant around a negative value and not significantly different from zero, while between 1980 and 1988 a systematic increase of the persistence parameter takes place. The smoothed estimate converges to a significantly higher level, and remains fluctuating mildly around 0.8 for the last part of the sample. Cable and Mueller (2005) tentatively explain the increase of profit persistence during the eighties as an effect of the aggressive television advertising campaign carried out by the company during the eighties. As opposed to, for example, the smoothed estimates for Johnson & Johnson, the standard deviation attached to our estimates of the persistence parameter in Wrigley tends to diminish in time, and thus the smoothed estimates for the last part of the sample are more precise than for the period ranging until 1980.

Our results for Wrigley enhance the conclusions put forward in Cable and Mueller (2005) concerning the evolution of the profit rate for this company, and represent a relevant example for the dangers of modelling the degree of persistence in profits as a constant for long time intervals. The results presented in Table 1 for the AR(1) process with constant persistence parameter render a very high λ, which is not significantly different from unity according to the ADF test, thus implying that shocks to the profit rate have a permanent effect in the level of the variable. The estimation of our simple time-varying persistence model, however, reveals strong differences in this parameter across time, with extremely high λ estimates appearing only in the last part of the sample.

4 Conclusions

This paper presents a simple time series model with a time-varying persistence parameter aimed at modelling the dynamics of profit rates. Until now, the empirical literature on profit persistence has relied on single measures of persistence for the whole sample of profits available, thus abstracting away from the dynamic nature of competition. We propose a simple way of modelling changes in the persistence of company profits by generalizing the autoregressive process used in the literature to an autoregressive process where the dynamics of the autoregressive parameter itself follow an autoregressive or random walk process. We exemplify the method using profit data from six US companies, and show that this simple model can give interesting insights to the dynamics of profits.

The model put forward in this piece of research can be easily expanded to include explanatory variables of the persistence parameter and to account for asymmetric profit rate (and profit persistence) dynamics or regime shifts in the autoregressive parameter governing the autocorrelation in profit rates.

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Company:	Archer-Daniels-Midland	Avon	Coca Cola	Johnson & Johnson	WHX	Wrigley
α	0.0028 (0.0686)	0.3404** (0.1364)	0.1891 (0.1162)	0.0167 (0.0396)	-0.6726** (0.2521)	0.1313 (0.0990)
λ	0.3254** (0.1441)	0.7643*** (0.0887)	0.8566*** (0.0728)	0.8500*** (0.0732)	0.3695*** (0.1327)	0.9332*** (0.0531)
$\alpha/(1-\lambda)$	0.0042 (0.0995)	1.4444*** (0.2507)	1.3189** (0.5162)	0.1115 (0.2383)	-1.0668*** (0.3408)	1.9675* (1.1198)
Sum sq. resid.	10.7837	8.3063	13.0184	2.8090	1.5027	10.8846
ADF test, profit rate	-3.1528**	-2.6561*	-1.9701	-2.0467	-4.7497***	-1.2573

Standard errors in parenthesis. * (**) [***] stands for 10% (5%) [1%] significant.

Table 1: AR(1) estimation for profit rates

Company:	Archer-Daniels-Midland	Avon	Coca Cola	Johnson & Johnson	WHX	Wrigley
α	-0.0782* (0.0453)	0.3408** (0.1492)	0.2980*** 0.0919	-0.0158 (0.0364)	-0.7338** (0.3401)	0.7585** (0.3062)
ϕ_0	0.0521 (0.0727)	–	–	–	–	–
ϕ_1	0.7324*** (0.1568)	–	–	–	–	–
σ^2_ε	0.0172	0.1725	0.0086	0.0488	1.3974	0.0552
σ^2_ν	0.1239	0.0001	0.1339	0.0067	0.1457	0.0378
Model for λ	AR	RW	RW	RW	RW	RW

Standard errors in parenthesis. * (**) [***] stands for 10% (5%) [1%] significant. AR stands for an AR(1) process for the persistence parameter, RW stands for a random walk process without drift for the persistence parameter.

Table 2: Estimation for profit rates with time-varying persistence

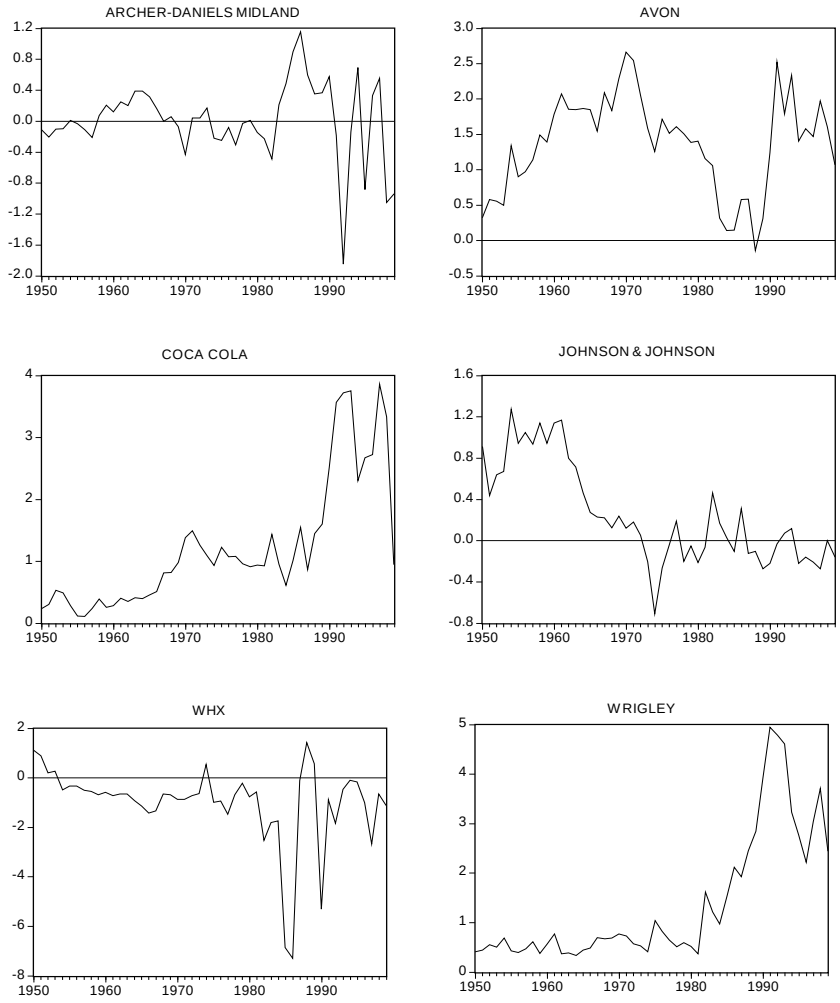

Figure 1: Profit rates: percentage deviation from average profits

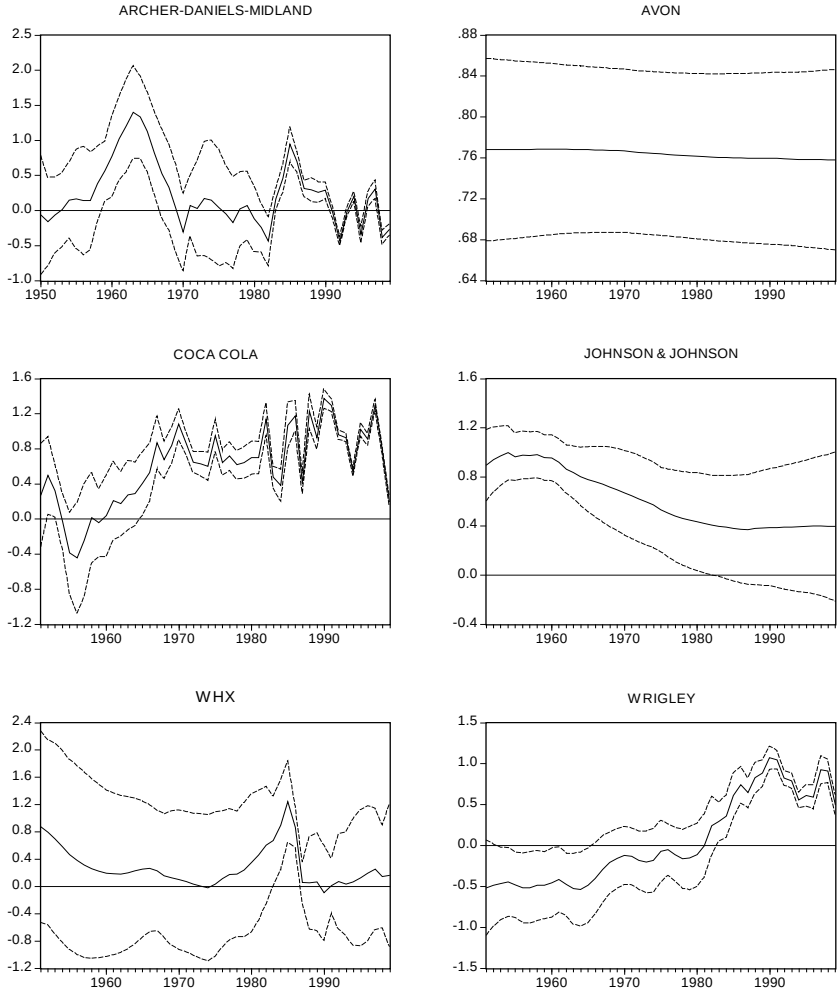

Figure 2: Smoothed persistence parameter estimates (± twice their standard deviation)