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SOME ECONOMIC DETERMINANTS OF TIME-SERIES PROPERTIES OF EARNINGS

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The earnings 'time-series literature' in accounting focuses on the statistical characteristics of the processes which generate corporate earnings. In order to further our understanding of earnings behavior, this study investigates the question whether inter-firm differences in these statistical characteristics (autocorrelations and variances of earnings changes) can be explained by economic factors. Various relationships between economic factors and earnings behavior are derived from the economic literature and examined empirically in this study Findings indicate that autocorrelations and variability of annual earnings and earnings over equity changes are systematically associated with the following factors: the type of product, the height of industry barriers-to-entry (a surrogate for degree of competition), the degree of capital intensity ('operating leverage'), and the firm size.

1. Introduction

Understanding the nature of processes which generate corporate earnings has in recent years become a major objective of accounting research, since such an understanding is essential for the study of many positive and normative accounting, finance and economic issues.[1] A common conclusion of the research on the time-series properties of annual earnings is that successive changes in earnings appear to be serially uncorrelated for the majority of the sampled firms [Little and Rayner (1966), Ball and Watts (1972), Lookabill (1976) and Watts and Leftwich (1977)]. This suggests that the process generating annual earnings of the 'average' or 'representative'

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[1]Among these are the effects of alternative accounting techniques on the behavior of accounting numbers [e.g., Dopuch and Watts (1972)], the design of optimal earnings expectation models required for tests of information content of accounting numbers [Lev and Ohlson (1982, section 2)], the estimation of expected earnings and growth rates used in the construction of equity valuation models and cost of capital estimates [such as in Glenn and Litzenberger (1979)], industrial organization research in which inferences from the time-series behavior of accounting numbers bear upon the degree of competition and economies of scale issues, among others [Gonedes and Dopuch (1979)].

firm can be well described as a random walk, possibly with a drift (submartingale).[2] However, when earnings processes of individual firms were identified, they differed in many cases from the random walk behavior of the 'representative' firm. Moreover, cross-sectional rankings of accounting rates of return were found to exhibit considerable stability over time [Mueller (1977)], suggesting persistencies (nonrandomness) in earnings behavior. Such persistent differences among firms in earnings processes may result from substantive economic factors, such as firm size and capital intensity, as well as from the use of different accounting techniques in the computation of earnings.

The objective of this study is to investigate the relationship between various economic factors relating to the firm and its environment and some properties (autocorrelation and variability) of earnings processes, thereby furthering our understanding of earnings behavior. The importance of such understanding is demonstrated by the following example. Accounting policy makers are obviously interested in the effect of alternative measurement techniques on reported accounting numbers. Operationally, Dopuch and Watts (1972) suggested that time-series analysis could be used to assess the impact of accounting techniques, by examining the effects of such techniques on the parameters of the time-series model which best describes the firm's earnings generating process. It should be noted, however, that if substantive economic factors systematically affect the time-series properties of earnings, such factors should be explicitly accounted for in the examination of the possible impact of accounting techniques on the time-series model. Suppose, for example, that a change in depreciation method is generally associated with a change in capital intensity (e.g., a large investment in fixed assets leads managers to a switch from straight-line to the accelerated depreciation method). If the degree of capital intensity affects the time-series properties of earnings, it would be erroneous to attribute an observed change in the earnings time-series model to the switch in depreciation method. Accordingly, assessing the impact of accounting techniques on the time-series properties of accounting numbers should be conditional on known relationships between environmental and firm-specific economic factors and the time-series properties of accounting numbers.[3]

[2]The main exception to the random walk findings occurs for deflated earnings series (i.e., earnings divided by equity or total assets), where a moving average process appears to better describe earnings behavior, see Lev (1969), Beaver (1970) and Lookabill (1976).

[3]One approach suggested by Gonedes and Dopuch (1979) to examine the effect of different accounting techniques on the properties of accounting numbers is to group firms by industries ('cross-sectional assessment') as a means of holding substantive economic factors constant However, if some of the substantive factors affecting the time-series properties of accounting numbers differ cross-sectionally *within* industry grouping (e.g., factors related to firm size or capital intensity), then the industry grouping suggested by Gonedes and Dopuch will obviously be a poor device for holding these substantive factors constant Thus, the effects of substantive economic factors on the properties of accounting numbers must be dealt with explicitly, rather than indirectly by devices, such as industry groupings

In general, given the well-known difficulties in identifying time-series models for annual earnings, due particularly to the paucity of available observations [Dharan (1981)], knowledge of the substantive economic factors affecting earnings behavior will strengthen the researcher's prior beliefs regarding the specific time-series model consistent with the firm's earnings behavior. The empirical tests reported below confirm that various economic factors, such as product type, barriers-to-entry, firm size and capital intensity are associated with time-series properties of earnings.

2. Possible economic determinants of earnings behavior

Whereas net income is viewed by accountants primarily as a *residual* of matching the basic variables, such as sales and costs of sales, economists assign to income a much more fundamental role — that of a *driving force for change*. Net income, or return on invested capital, signals, among other things, the desirability of entry into or exit from the industry, thereby affecting the industrial structure. 'Excessive' earnings relative to some norm might call for public intervention, such as anti-trust action or a change in public utility rate setting. On the intra-firm level, current earnings changes often affect operating decisions by signalling a change in future cash flows. Thus, for example, an earnings decline might signal management a decrease in future cash flows, leading to a lower optimal level of capital investments, advertising and R&D outlays. Given this central role of earnings as a signal for change, an association can be expected between earnings properties and economic factors. The following factors provide a framework for an empirical examination of the economic determinants of time-series properties of earnings. This nonexhaustive list of factors is mainly derived from the industrial organization literature in economics.

2.1. The effect of product type: Durables vs. nondurables and services

It is well known and documented that demand for nondurable goods and services exhibits a generally stable (low variance) pattern over time, while demand for durable goods is much more volatile and difficult to predict. On the conceptual level, this is implied by Friedman's 'permanent income' theory which postulates that consumption of nondurables and services is a function of *permanent* income, while spending on durables is related to the more volatile *transitory* income component. This implication was indeed confirmed by empirical studies, such as Darby (1972). Consumption series of nondurables and services are therefore expected to be more stable over time than consumption of durable goods. Empirical findings support this expectation. Zarnowitz (1967, p. 38), who analyzed the performance of various forecasters of macroeconomic series, concluded that 'within aggregate

consumption, the (prediction) errors are much larger for durable goods than for either nondurables or services'.[4] The relatively stable consumption pattern of nondurables and services is also evidenced by the predictive superiority of trend extrapolation models applied to these series relative to simple no-change models (the latter are optimal for a random walk series). For durables, on the other hand, there is no appreciable difference in predictive performance between trend extrapolation and no-change prediction. This finding led Zarnowitz (1972, p. 193, emphasis supplied) to conclude that 'the consumption aggregates (*except for durable goods*) are *smoothly* growing series that could have been predicted very well by simple trend projections'.

Given the smooth demand pattern for nondurables and services relative to durable goods, and assuming no offsetting differences in cost structures of durables and nondurable goods manufacturers, we can expect the earnings series of nondurables and service producers to behave generally in a more systematic manner, reflected by lower variability and/or by more pronounced autocorrelations in earnings series.[5] On the other hand, the volatile demand for durable goods will probably induce a large random element into the earnings of durable goods producers, causing earnings series to exhibit frequent sign reversals and thus to be largely uncorrelated over time.

2.2. *The effect of competition*

It has been long believed that the persistence over time in the behavior of accounting rates of return for individual firms and industries is related to the degree of competition. Stigler (1963, p. 70), for example, notes:

> The final hypothesis to be considered here is the stability of the industrial pattern of rates of return. . . . Competitive industries will have a volatile pattern of rates of return, for the movement into high-profit industries and out of low-profit industries will — together with the flow of new disturbances of equilibrium — lead to a constantly changing hierarchy of rates of return. In the monopolistic industries, on the other hand, the unusually profitable industries will be able to preserve their preferential position for considerable periods of time.

Thus, many factors can disrupt the pattern of earnings; unexpected shifts in demand and technology changes are but a few examples. However, one source of disruption — entry of new firms and exit of incumbent ones — is

[4]Evaluation of forecasters' performance on more recent data yielded similar results; namely, forecast errors for consumption of durable goods are substantially larger than those of nondurables; see McNees (1975).

[5]It is, of course, unrealistic to assume that cost conditions are uniform across producers of durables and nondurables However, to the best of my knowledge, there is no empirical evidence suggesting systematic differences in cost conditions that could offset the hypothesized impact of differences in the behavior of demand (revenues) on earnings

characteristic of competitive, low-barriers-to-entry industries.[6]

The empirical evidence in the industrial organization area supports the hypothesis concerning the relatively stable pattern of rates of return in noncompetitive industries. Thus, for example, Stigler (1963), examining correlation coefficients for a cross-section of industries' return on total assets over various periods of time (from one to ten years), concluded that for the concentrated (less competitive) industries the correlation coefficients remain relatively stable as the interval between two cross-sections increases, while the correlation coefficients for the competitive industries decrease sharply with time. This led Stigler (1963, p. 70) to conclude:

> On the whole, the pattern of (correlation) coefficients agrees remarkably well with the hypothesis. The industrial pattern of rates is extremely stable in the concentrated industries. . . . The industrial pattern is much more volatile in the unconcentrated industries.[7]

The instability of the industrial structure and the price wars sometimes waged by incumbent firms to ward off entry will induce a substantial random element into the earnings series of firms operating in competitive industries relative to those of monopolistic firms. Thus, for example, the impact on earnings of a favorable event, such as a cost-saving technological change, or an introduction of a new product, will be short lived for competitive firms, yet might persist for firms operating in high-barriers-to-entry industries. In the latter case, such persistence will probably be reflected by some serial correlation of earnings. Therefore, monopolistic firms can be expected to exhibit more persistent patterns, or serial correlation, in their earnings series (as well as lower volatility of earnings), relative to those of competitive firms.[8]

2.3. *The effect of firm size*

It has been empirically established that the variability of growth rates in sales and earnings is negatively related to firm size [Scherer (1973, p. 129), emphasis supplied]: 'With few exceptions, statistical studies have shown that the variability of growth rates of large firms is lower than for small firms; that is, large firms seem to enjoy *more stable growth.*' The relationship

[6]Young (1979), in a stochastic context, has shown that demand uncertainty facing a given firm is a direct function of, among other things, the extent of market competition

[7]The relationship between degree of competition and the stability (persistence) of accounting rates of return was also investigated by Brozen (1971) and Ellert (1974). Brealey (1969, p. 80) also relates the degree of competition to earnings persistence, as well as Van Breda (1981)

[8]It should be noted that this relationship is stated in terms of conventionally computed earnings. If, for example, an Hicksian definition of economic profit is employed, where profit is defined as the change in the market value of equity including the change in capitalized rents, then the economic profits of monopolists will follow a random walk (if the returns distribution is stationary) Under such an Hicksian definition of profit it is possible to construct scenarios where monopolist earnings will be more variable than those of competitive firms

between inter-temporal variability of earnings and firm size was examined by Whittington (1971, p. 71, emphasis supplied) for public British companies and found to exhibit 'a clear tendency for smaller companies to have a greater variability of profitability through time than the larger companies ... large size seems to add an unexpected degree of *inter-temporal stability* to the profitability of quoted companies'. The relatively stable growth pattern of large firms probably results from, among other things, diversification into largely independent operations which is typical of many large firms.[9] The stable growth pattern of large firms relative to smaller ones might be manifested by a lower degree of volatility as well as a higher serial correlation in the earnings of large firms.

2.4. *The effect of capital intensity*

Earnings volatility is positively related to the degree of capital intensity, reflected by the share of fixed to total cost, which is often termed the 'operating leverage'. Specifically, given demand fluctuations, the higher the firm's capital intensity, the larger the volatility of earnings; see Lev (1974). This well-known relationship results, of course, from the lumpiness of fixed costs relative to demand fluctuations, or from the higher adjustment costs involved in capacity modifications to demand, for capital intensive firms. Thus, for example, Scherer (1973, p. 193) notes: 'Where demand falls below levels which will sustain capacity output, the profit-maximizing enterprise with high fixed costs cuts prices more sharply and suffers more severe erosion of profits than a similarly-inclined firm with low fixed costs.' The relatively high earnings volatility of capital intensive firms will cause disruptions of earnings series patterns and might be reflected in a lower degree (or absence) of serial correlation in earnings changes, relative to the smoother earnings series of low capital intensive firms. Accordingly, a relationship is hypothesized between the degree of firms' capital intensity and the time-series properties of earnings.

The preceding expected relationships between economic factors and earnings time-series properties raise two issues. First, while these relationships are grounded on economic reasoning, the empirical tests reported below were based on accounting earnings. Consequently, the examined relationship between economic factors and earnings time-series

[9]Watts and Zimmerman (1978) provide an additional, interesting explanation for the relationship between earnings stability and firm size. Large firms are more susceptible than small ones to political pressure and government intervention (e.g., anti-trust). Large firms can, therefore, be expected to engage in less risky production and investment activities in order not to draw the attention of public policy makers to large variations in earnings 'For example, government intervention costs may lead the firm to select less risky investments in order to eliminate the chance of high returns which then increase the likelihood of government intervention.' (p. 131).

properties may be blurred by the confounding effects of both substantive (real) factors and accounting measurement techniques on earnings properties. An attempt will therefore be made to distinguish between the effects of substantive vs. those of accounting factors on earnings properties. Second, the somewhat heuristic nature of the preceding relationships makes it difficult to distinguish *a priori* between the effect of the economic factors (e.g., competition within the industry) on variability as opposed to the effect on the autocorrelation of earnings series. Therefore, such a distinction will be made in the empirical tests reported below by considering separately the effects of the economic factors on earnings variability and on autocorrelation.

3. Sample characteristics and variable definition

The sample for this study was selected from Standard and Poor's Compustat tape.[10] Candidates for inclusion in the sample were required to have at least 15 years of consecutive data required for this study (e.g., earnings, sales, and common stockholders' equity).[11] The final sample consisted of 385 firms classified by 77 four-digit industries.

First and second order autocorrelation coefficients were computed for the following three series of each firm:[12] (a) the annual *change* (first difference) in net earnings, (b) the annual change in 'return on equity', namely earnings divided by the average balance of common stockholders' equity outstanding during the year, and (c) the annual change in sales. Table 1 presents the distributions of estimated autocorrelation coefficients. It is evident that most correlation coefficients are rather small, consistent with previous findings about the independence of earnings changes of the 'average firm'. However, the range of the estimated autocorrelation coefficients is quite large, suggesting considerable heterogeneity in generating processes, and the correlation coefficients for about 15–20 percent of the firms are statistically significant at the 0.05 percent level.

The variables representing the various economic factors discussed in the previous section were defined and measured as follows:

1. *Product type*: The sampled industries were classified into two groups,

[10]The general qualification concerning the 'survivorship bias' of Compustat firms applies to our case Specifically, firms on the Compustat tape are relatively large, and most of them survived for the last 30 years Consequently, such firms might exhibit a somewhat different earnings behavior (a larger degree of earnings persistence?) than non-Compustat firms.

[11]The minimum 15-year restriction on earnings and equity series was placed to secure a reasonably meaningful autocorrelation coefficient. Most firms included in the final sample of 385 firms had longer earnings series. 290 firms (about 75 percent of the sample) had consecutive earnings series of 20 years or longer, and 252 firms (about 65 percent of the sample) had the maximum number of 27 years. The full 27-year period was 1947–1973

[12]Higher order autocorrelation coefficients were not examined because of the relatively short length of the series.

Table 1
Distribution of estimated autocorrelation coefficients (385 firms)

	Mean	Standard deviation	Decile 1	2	3	4	5	6	7	8	9
Earnings											
1st order	−0.0023	0.3107	−0.4679	−0.3081	−0.2249	−0.1521	−0.0760	0.0024	0.0874	0.1839	0.3195
2nd order	−0.0738	0.3118	−0.5386	−0.3828	−0.2919	−0.2070	−0.1427	−0.0781	0 0010	0.0907	0.2482
Earnings to equity											
1st order	−0.0980	0.2834	−0.5155	−0.3933	−0.3094	−0.2268	−0.1579	−0.0916	−0.0140	0 0704	0.1978
2nd order	−0.0900	0.2474	−0.4898	−0.3518	−0.2602	−0.1857	−0.1328	−0 0735	−0.0172	0.0673	0.1664
Sales											
1st order	0.1736	0.3202	−0.3372	−0.1805	−0.0600	0.0233	0.1167	0.1996	0.3085	0.3988	0 5226
2nd order	0.0443	0.3477	−0.4915	−0.3023	−0.2127	−0 1321	−0.0434	0.0552	0.1479	0.2943	0.4448

namely producers of nondurables and services (41 industries) and producers of durable goods (36 industries), according to the classification of the *Survey of Current Business.*[13]

2. *Competition — barriers-to-entry*: The above reasoning underlying the possible relationship between degree of competition and earnings behavior was mainly stated in terms of barriers-to-entry (*BTE*). *BTE* provide an appealing, though somewhat subjective, measure of the degree of competition since, as opposed to the often used concentration ratios, *BTE* account for *potential competition.* Specifically, it is generally recognized that competition is not only a function of the number of firms operating within an industry and their sales distribution (reflected by concentration measures), but also, or rather mainly, the result of potential competition which depends on the existence of *BTE.* Competitive behavior of firms can prevail even in highly concentrated industries if entry is not blocked.[14] *BTE* are defined as 'a cost of producing (at some or every rate of output) which must be borne by a firm which seeks to enter an industry but is not borne by firms already in the industry' [Stigler (1968, p. 67)].[15] The sampled industries were classified in this study according to 'high' and 'low' *BTE*, using Palmer's (1973) four-digit industry classification.[16] Palmer's classification was mainly based on four sources: Bain, Mann, Shepherd and a 1967 Federal Trade Commission study.[17]

3. *Size*: Was measured by the 1960 sales value of each firm (1960 was roughly the midperiod for the earnings series of most sampled firms).

4. *Capital intensity*: Was approximated by the ratio of depreciation and fixed capital charges (mainly interest expenses) to sales in 1960.[18]

5. *Inventory level*: Measured as the 1960 ratio of the average inventory balance (beginning and ending of year) to sales. This ratio was incorporated in the test in an attempt to partially capture the possible effect of accounting techniques on the time-series properties of earnings. Consider, for example,

[13]A monthly publication of the Bureau of Economic Analysis, US Department of Commerce.

[14]In this case, existing firms will charge prices which are close to marginal costs in order to deter further entry.

[15]See Bain (1956) for elaboration on *BTE*. Barriers-to-entry were also found in various studies to be more strongly correlated with industry profitability than were concentration measures, e.g., Kamerschen (1968)

[16]Among the 'high' *BTE* industries are: crude petroleum, packaged food, brewers, distillers, soft drinks, cigarettes, chemicals, tire and rubber, steel, machinery, electronic computing equipment, household appliances, motor vehicles, trucks, aircraft, air transportation, telephone and finance. Among the 'low' *BTE* industries are: mining, construction, meat packers, dairy products, canned food, textiles, home furnishings, containers, publishers, paint, building materials, plastic, shoes, nonferrous materials, metal work, auto parts and accessories, engineering equipment, shipping, retail, hotels and motion pictures.

[17]Palmer's classification consists of three classes: very high, substantial, and low *BTE*. Since the number of industries in our sample with very high *BTE* was small, the first two classes (very high and substantial) were grouped in the current study into one class — high *BTE*.

[18]Cost of sales would have been a more appropriate denominator, but this item was missing for many firms in the sample

the 'absorption costing' method for inventory valuation, which is uniformly required for financial reporting. Under reasonable real-world conditions (i.e., sales and inventory changes are negatively associated over time in order to buffer production from external shocks), the 'absorption costing' method will yield a smoother (lower variance) earnings stream than the more economically meaningful method of 'direct (variable) costing'.[19]

This is an example of a uniform accounting technique of inventory valuation ('absorption costing') which might exert a systematic effect on earnings behavior. Similar arguments can be made with respect to other uniform inventory valuation techniques, such as 'the lower of cost or market'. It stands to reason that if such systematic effects due to inventory valuation rules exist, they will bear a cross-sectional relationship to the relative level of inventories — the higher the inventory level relative to the firm's operations, the more pronounced will be the effects of such uniform inventory valuation techniques on earnings behavior. Additional attempts to distinguish between the effects of substantive factors vs. those of accounting techniques on earnings behavior will be reported below.

4. Test results — autocorrelations

The association between the various economic factors and earnings and sales autocorrelation coefficients postulated above was cross-sectionally examined by means of the following least squares regressions:

$$P^k(Y)_i = \alpha_0 + \alpha_1 PT + \alpha_2 BTE + \alpha_3 S_i + \alpha_4 CI_i + \alpha_5 I_i + \varepsilon_{1i}, \tag{1}$$

$$P^k(Y/E)_i = \beta_0 + \beta_1 PT + \beta_2 BTE + \beta_3 S_i + \beta_4 CI_i + \beta_5 I_i + \varepsilon_{2i}, \tag{2}$$

$$P^k(S)_i = \gamma_0 + \gamma_1 PT + \gamma_2 BTE + \gamma_3 S_i + \gamma_4 CI_i + \gamma_5 I_i + \varepsilon_{3i}, \tag{3}$$

where

$P^k(Y)_i$, $P^k(Y/E)_i$ and $P^k(S)_i$ = the kth order ($k = 1, 2$) autocorrelation coefficient of change in earnings (Y), change in earnings/equity (Y/E) and change in sales (S), respectively, for firm i,

PT = a dummy variable representing *product type*; 1 = durables, 0 = nondurables and services,

BTE = a dummy variable representing *barriers to entry*; 1 = high BTE, 0 = low BTE,

S_i = size of firm i,

[19]For elaboration, see for example Dopuch et al. (1982, pp. 408–412).

CI_i = capital intensity (depreciation plus interest expenses to sales) of firm i,
I_i = inventory level to sales.

Regression results are exhibited in table 2 and summarized thus:

(a) Of the above hypothesized economic factors, *product type* was found to be significantly associated with the autocorrelation coefficients of the earnings, earnings/equity and sales series. *Barriers-to-entry* were also found to be significantly associated with all the examined series (except for 2nd order earnings/equity). Note that the coefficients of both the product-type and barriers-to-entry variables also have the expected sign. The *firm-size* coefficient was found to be statistically insignificant in all the regressions except for 1st order earnings/equity and in that regression its sign is not as predicted. The *capital intensity* coefficient was found to be statistically significant only for the 1st and 2nd order earnings series, with the expected sign of coefficients.

(b) The F-values of all the regressions (except 2nd order earnings/equity) are statistically significant at the 0.05 level or higher. The R^2's are rather small indicating that the hypothesized factors combined 'explain' only a relatively small part of the cross-sectional variance of autocorrelation coefficients. The Durbin–Watson statistics of the earnings and earnings/equity regressions are above the d_u limit indicating no correlation in the residuals. The Durbin–Watson statistics is meaningful in this cross-sectional regression since the sampled firms were ordered by industry in an attempt to examine for the existence of cross-sectional correlation in the estimated autocorrelation coefficients due to industry-wide effects. This absence of residual correlation increases the confidence in the inferences derived from the regression estimates reported in table 2, since there apparently does not exist a significant cross-sectional (across firms) correlation in the estimated autocorrelation coefficients.[20]

We turn now to the distinction between the effects of substantive (economic) factors and those of accounting techniques on the autocorrelation coefficients. The following observations can be made:

(a) Given that sales figures are much less affected by accounting

[20]Firms' earnings were found in other studies to be cross-sectionally correlated, due to common industry- and economy-wide factors, see Magee (1974) However, in our sample of *autocorrelation coefficients*, despite the fact that the sampled firms were grouped by industries, cross-sectional correlation apparently does not cause a serious problem. In an attempt to further examine the cross-sectional correlation issue, we have computed autocorrelation coefficients of the *residuals* from index models, where the various earnings series were regressed on economy-wide indexes. Regression estimates of these residual autocorrelation coefficients on the four economic factors (product-type, etc) yielded similar results to those reported in table 2, for the autocorrelation coefficients of the earnings series. Thus, the Durbin–Watson statistics, industry grouping of firms and the results of the removal of economy-wide factors by index models all suggest the absence of a significant cross-sectional correlation in the estimated autocorrelation coefficients.

Table 2
Coefficient estimates for regressions (1) through (3) with t-values in parentheses.

Variables	Predicted sign	Earnings (1)		Earnings/equity (2)		Sales (3)	
		1st order	2nd order	1st order	2nd order	1st order	2nd order
Product type	−	−0.150	−0.175	−0 118	−0.064	−0.233	−0.247
		(−4 55)	(−5 26)	(−3.91)	(−2.37)	(−7 08)	(−6.89)
Barriers-to-entry	+	0.086	0 061	0 039	−0 024	1.00	0 079
		(2.51)	(1 87)	(2.22)	(−0.85)	(2.90)	(2.13)
Size[a]	+	0.006	−0.074	−0 264	0.119	−0 006	0.197
		(0.04)	(−0 45)	(−1.68)	(0 89)	(−0.03)	(1.12)
Capital intensity[b]	−	−0.863	−0 697	−0.054	0.148	−0.413	0.474
		(−2 08)	(−1.87)	(−0 14)	(0.44)	(−0 99)	(1.05)
Inventory[b]	+	0.033	−0 057	−0.004	0 038	−0.246	0.127
		(0.30)	(−0.52)	(−0 04)	(0 426)	(−2 25)	(1 07)
R^2		0 08	0 09	0 05	0 03	0.14	0.13
F-statistic		5 14	5 98	3.36	1 90	11.59	11.08
Durbin–Watson		1.75	1.93	1.96	1 97	1 55	1 58

[a]Coefficients should be multiplied by 10^{-6}
[b]Coefficients should be multiplied by 10^{-3}

techniques than earnings numbers, the finding in table 2 that the two factors — product-type and barriers-to-entry — are associated with *both* earnings and sales autocorrelations in a very similar manner suggests that this association is a substantive one, rather than induced by accounting techniques.

(b) The finding that inventory level is not associated with earnings autocorrelations lends additional support to the conclusion that the association between the hypothesized economic factors and earnings autocorrelations is not induced by accounting techniques, at least those concerned with some inventory valuation rules. Specifically, to the extent that inventory valuation techniques which are applied uniformly across firms (e.g., 'absorption costing', 'lower of cost or market') affect the systematic behavior of earnings, such effects should be related to the relative level of inventories (e.g., the higher the relative level of inventories to sales, the more pronounced the systematic effect on the characteristics of the earnings time-series model). Accordingly, the statistical insignificance of the inventory coefficient in regressions (1) and (2) suggests that such inventory valuation techniques do not affect systematically the autocorrelations of earnings.[21]

(c) The capital intensity variable mainly includes depreciation expenses. If, as often argued [e.g., Beaver (1970)], depreciation is an earnings' 'smoother', capital intensity should be *positively* related to earnings autocorrelation. This is inconsistent with the negative sign of the significant capital intensity coefficients in table 2.

(d) As hypothesized in section 2 above, capital intensity should be associated with earnings autocorrelations but not with sales autocorrelations, given that the operating leverage effect is induced by cost structure. This indeed is consistent with the results reported in table 2.

(e) Finally, it has been argued [e.g., Smith (1976)] that managers of 'management controlled' firms (i.e., firms whose stocks are thinly spread across investors) use accounting techniques to smooth earnings to a larger extent than managers of 'owner-controlled' firms (firms in which large blocks of shares are owned by individuals). In order to examine this possible smoothing effect of accounting techniques on earnings behavior we have classified 181 firms in our sample, for which information on control was available, by type of control — management vs. owner control. Regressions (1) to (3) were then rerun for this subsample of firms, incorporating the type-of-control as an additional independent (dummy) variable. The estimated coefficient of this firm control variable was found to be statistically insignificant in all the regressions, suggesting that to the extent that

[21]Note our emphasis on inventory techniques which are applied uniformly by all firms The inventory level variable would not capture the possible effects on earnings behavior of nonuniform techniques, such as FIFO and LIFO. However, such effects might be captured by the earnings vs. sales comparisons, discussed in the preceding point (a).

accounting techniques are used by 'management controlled' firms to smooth earnings, these techniques do not affect earnings autocorrelations.

It can be concluded, therefore, that the observed relationships in table 2 between the economic factors and earnings autocorrelation coefficients are not due to 'missing' accounting technique variables.

5. Autocorrelation and earnings variability

As mentioned above, the heuristic nature of the relationships set forth in section 1 makes it difficult to distinguish *a priori* between the effect of the various hypothesized economic factors on earnings variability as distinct from the effect on the autocorrelation of earnings series. Such a distinction will therefore be made on empirical grounds, where the effect of the economic factors on variability is examined in this section.

Given the large size of our sample and the relatively short length of earnings series, an identification of a specific time-series model for each firm is, of course, ruled out. Based on a finding in Watts and Leftwich (1977) that the annual earnings series of a substantial number of large US firms can be characterized by a first order autoregressive process, we hypothesized that the following first order autoregressive process characterizes reasonably well our sampled firms:

$$u_t = \theta_1 u_{t-1} + \delta + e_t, \tag{4}$$

where u_t represents earnings or earnings/equity of a given firm in year t. Denoting by $\tilde{u}_t$ the deviation of the process from its mean, the variance of the earnings processes is

$$\sigma^2(\tilde{u}_t) = \theta_1^2 \sigma^2(\tilde{u}_t) + \sigma^2(e_t). \tag{5}$$

Thus, the variance of the earnings series, $\sigma^2(\tilde{u}_t)$, is decomposed in (5) into two components. The first, $\theta_1^2\sigma^2(\tilde{u}_t)$, involving the first order autocorrelation coefficient of the original earnings series, θ_1. The second, $\sigma^2(e_t)$, is the variance of residual earnings. Accordingly, since the residual variance, $\sigma^2(e_t)$, is an earnings variability measure 'net of autocorrelation', it can serve our purpose in this section — to examine the effect of the hypothesized economic factors on variability, as distinct from their effect on autocorrelation (which has been examined in the preceding section).

Three variability measures have been computed for the two earnings series (i.e., changes in net earnings and in earnings/equity ratios) of each sampled firm:

(i) $\sigma(u_t)$ = standard deviation of the (raw) earnings series,

(ii) $\sigma(e_t^1)$ = residual standard deviation of a first order autoregressive process (4),

(iii) $\sigma(e_t^2)$ = residual standard deviation of a second order autoregressive process.[22]

The following *six* cross-sectional regressions were then run over the 385 sampled firms:

$$\sigma(\cdot)_i = \alpha_0 + \alpha_1 PT + \alpha_2 BTE + \alpha_3 S_i + \alpha_4 CI_i + \varepsilon_i, \tag{6}$$

where $\sigma(\cdot)_i$ are the three variability measures outlined above, each applied to the earnings and the earnings/equity series of each firm, and PT, BTE S_i and CI_i are product type, barriers-to-entry, size and capital intensity variables, respectively, as described in section 4.

As expected, the three regressions in which the variability measures were computed from the earnings changes series were largely dominated by the size variable, S_i (having t-values of about 23 and R^2's of about 0.60), indicating nothing more than a strong scale effect on earnings variability. The next three regressions, examining the variability of the earnings/equity series, yielded more meaningful results, reported in table 3. Coefficient estimates indicate that two economic factors, product-type and size, are significantly associated with all three variability measures of earnings/equity series. The direction of association is as expected: We hypothesized that the earnings variability of durable goods producers will be larger than that of nondurables and service producers, which is confirmed by the positive product-type coefficients in table 3 (recall that product-type is a dummy variable, taking the value of 1 for durable producers and 0 for nondurables and services). With respect to firm size, a negative association with earnings variability was hypothesized and confirmed by the sign of the estimated size coefficients.

Comparing the findings in table 3 with those of table 2 it can be concluded that the effects of the economic factors on earnings autocorrelation can be clearly distinguished from the effects on variability. Earnings/equity autocorrelations are affected by product-type and barriers-to-entry, while variability is affected by product-type and firm size. Furthermore, the direction of product-type effect on autocorrelation, is, as expected, opposite to that of the product-type effect on variability. The two variables that are not significant, barriers-to-entry and capital intensity, have opposite signs to those hypothesized.

[22]This was done to allow for the possibility that a second order autoregressive system fits better the actual earnings series of some sampled firms

Table 3
Coefficient estimates for regressions (6) — earnings/equity series (t-values in parentheses)

Variable	Predicted sign	$\sigma(u_t)$	$\sigma(e_t^1)$	$\sigma(e_t^2)$
Product-type	+	0.022	0 017	0 015
		(2 94)	(3 28)	(3.03)
Barriers-to-entry	−	0 009	0 006	0 005
		(1 12)	(1.16)	(0.92)
Size[a]	−	−0 759	−0.584	−0.516
		(−2 03)	(−2 26)	(−2 14)
Capital intensity[b]	+	−0 421	−0 742	−0.641
		(−0.54)	(−1.37)	(−1 27)
R^2		0.04	0 06	0 05
F-statistic		4.42	5.95	4.98
Durbin–Watson		1 93	1 82	1 82

[a]Coefficients should be multiplied by 10^{-7}.
[b]Coefficients should be multiplied by 10^{-4}.

6. Concluding remarks

Ball and Foster (1982, p. 55) in a recent survey concluded: 'At present, our knowledge as to why certain statistical properties are found for the annual earnings series of firms is very meager indeed.' The outlined relationships and empirical tests reported above constitute a first step in furthering our understanding as to why certain statistical properties are found for annual earnings series. It appears that earnings autocorrelations are systematically affected by type-of-product, barriers-to-entry (competition) and by capital intensity (operating leverage), while earnings variability is affected by product-type and firm size. Furthermore, these relationships appear to exist independently of the accounting techniques employed by the sampled firms. The possibility of 'missing variables' should, as always, be recognized. Thus, for example, the relationship between earnings autocorrelation and degree of competition might also be due to some (nonaccounting) smoothing efforts by monopolistic firms concerned with government intervention [Watts and Zimmerman (1978)].

The above findings are obviously relevant to various issues investigated in the industrial organization area. Economists investigating effects of competition or economies of scale, generally restrict themselves to one aspect of the earnings distributions — cross-sectional differences (among firms or industries) in mean return-on-capital ratios. This study expanded the scope to autocorrelation and variability of earnings. Particularly relevant might be the finding (table 2) that 1st order autocorrelation coefficients of return on equity ratios are significantly associated with barriers-to-entry.

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