A. I. IGNATIADIS
M. Sc. (Manag. Sc.), Ph. D. (Bus. Adm).

THE EMPIRICAL EVIDENCE ON THE SIZE, GROWTH, AND PROFITABILITY OF FIRMS

SYNOPSIS

The objective of this paper is to present some of the major empirical findings available in the relevant literature which bear on the relationship between size, growth, and profitability of firms.

As the extant literature appears quite voluminous nowadays, the paper in hand has been confined to cover only those studies which deal rather directly with the above mentioned variables.

In the first chapter there are considered the various size measures, their advantages, disadvantages, limitations and the correlation between some of them. At the end of the chapter the conclusion is drawn that although on theoretical grounds the various size measures are open to some criticisms, the empirical findings suggest that the measures in question are on the whole most closely correlated with each other and consequently any reasonable technique for measuring size will be sufficient for many practical purposes. Nevertheless, it is also mentioned that this statement is not universally accepted.

Since most empirical studies bearing on the relationship between size and growth make an attempt to test the empirical validity of the law of proportionate effect or refer to it in some way or another, chapter two is devoted to the theory underlying this law, its versions, and its economic implications. This chapter also deals with the attempts by some writers to associate Gibrat's law - as the law of proportionate effect has become known in the relevant literature - with the question of existence of ecconomies of scale.

Chapter three deals with the empirical evidence on the relationship between size and profitability which has long been of interest both to economists and investors. The survey revealed that the extant evidence is inconclusive, the findings ranging from a positive or negative correlation to a parabolic relationship and to lack of any significant relationship; hence, some possible explanations of this inconsistency in findings are advanced.

The evidence on the variability of profit rates both over time and

within size-classes is also dealt with in the third chapter; in this respect the empirical evidence turned out to be fairly conclusive; it was found on the whole, that variability was inversely related to size, this in turn being consistent with a priori expectations. The implications that the empirical findings could have for investors and managements are considered in the concluding remarks of the chapter.

In chapter four the empirical evidence bearing on the relationship between profitability and growth is surveyed. It was found that the association between the two variables was fairly strong with profitability explaining on the whole a large proportion of the variation in growth and that the relationship in question may change substantially over time and within industries. It was found that the post-tax rate of return on equity assets provided a much better explanation of growth than the pre-tax rate of return on net assets. Another feature which was borne out of the studies was that the relationship profitability-growth did not vary significantly among large firms but it did vary significantly as between large and small firms.

Finally, chapter five is devoted to the empirical evidence on the relationship between size and growth. In essence, the majority of studies dealing with these two variables make an attempt to test the empirical validity of the law of proportionate effect. It was revealed that although this law is considered by researchers exceedingly useful tool, especially as a first approximation to the growth process of firms, not all of its properties apply to the firm's growth process.

INTRODUCTION

About twenty years ago W. Leontief [1] suggested that in economics there has been a surfeit of theory with little or no factual support and, on the contrary, too many facts which simply have not been related or cannot, as they stand, be related to any theory.

Since then notable strides have been made in drawing together theories with facts. In recent years published accounts of public companies have turned out to be a considerable source of data for illuminating a variety of economic problems. The early econometric studies based on exploitation of data derived from the above mentioned accounts were mainly American. So far as G. Britain is concerned such data effectively became utilisable with the passing of the Companies Act, 1948; before that, published accounts were of very limited relevance and use as a source for economic analysis, mainly due to the fact that there was an inadequate degree of standardisation and disclosure as between different companies of the itemisation and matters that constituted the conceptual basis of or underlay published accounts.

In addition to this, the absence of consolidated statements was a much more serious hindrance in any attempt to utilize published financial data. For, without such consolidated statements there is very little scope for any analysis, given that a substantial proportion of public companies conduct a considerable part of their transactions through subsidiaries which in turn do not themselves publish accounts; on the other hand, the nature of activities of such subsidiaries is not clear from the parent company's accounts. One could not tell from published accounts what the company earnings were or how they grew. One needed accounts related to "business units" in the economic sence of the term and not simply to "firms" in the legal sense of the term.

The 1948 Companies Act laid down fairly detailed minimum re-

1. *Leontief W. et al.*: "Studies in the Structure of the American Economy", Oxf. Univ. Press, New York, 1953.

quirements concerning the specific items to be shown in published statements and first forced companies to consolidate their accounts with those of their subsidiaries. It was owing to this Act that it was for the first time possible to draw up a standard form with which most public companies' group accounts would comply. Then several years had to lapse before there were enough adjusted consolidated statements and accumulated evidence to permit a statistical analysis.

In the present paper an attempt is made to survey the literature bearing on the empirical evidence on growth, size, and profitability of British and American firms. A large number of the studies under survey have been conducted with the aim to attempt to confirm or refute theories that were advanced several years ago (e.g. Gibrat's Law or the Law of Proportionate Effect). It should be noted, however, that some studies suffer from incomparability, owing to the fact, amongst others, that some factors which might affect the conclusions were ignored or at least it is not clear from these studies how the factors in question were dealt with, e.g. revaluations, mergers etc.

CHAPTER ONE

FIRM SIZE AND ITS MEASUREMENT

1. 1. THE MEASUREMENT OF SIZE OF FIRMS AND ITS INHERENT DIFFICULTIES

The definition and measurement of firm size is an area of economics in which there has been a great deal of debate and controversy over the years. The debate resulted from the fact that there are several dimensions of size and it is conceivable that the measures that can be advanced will vary accordingly. It was argued that no single measure is ideal nor can be used confidently to measure firm size in all its bearings and that the use and usefulness of a particular measure of firm size depend closely on the purpose for which the relevant measure is used. A measure suitable for a certain purpose may be irrelevant for other purposes. In extreme cases, one can think of a firm "big" in terms of turnover but "very small" in terms of value-added; or of a firm "very big" in terms of total or net assets but "small" in number of employees.

Despite these considerations it has been found in recent years that although there are several theoretical reasons why certain size measures are less than ideal and several arguments may be advanced against the use of any measure, in practice it does not seem to matter very much which measures are used since they are mostly highly correlated with each other[2,3,4]. It should be noted, however, that this proposition is not universally accepted and it is argued that the apparent size of a firm depends largely on the measure chosen: Harris and Solly, for example, claim that "except when attention is confined to a small number

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2. *Bates J.*: "Alternative Measures of the Size of Firms" (in *P.E. Hart*: Studies in Profits, Business Saving and Investment in the U.K. 1920-1962. Vol. I Allen & Unwin) London, 1965.

3. *Hart P.E. & Prais S.J.*: "The Analysis of Business Concentration: a Statistical Approach". The Journal of the Royal Statist. Society, Ser.A,Part II 1956,p.p. 150-81.

4. *Samuels J.*: "Size and the Growth of Firms". The Review of Econ. Studies, 1965 p.p. 105-12.

differing greatly in size..... companies appear "greater" or "smaller" according to the yardstick applied" [5].

There are a number of reasons why we need to know the size of firms:

1. A distribution of firms by size is often required when research is conducted and a great deal of field work has been carried out in recent years in order to test whether the best known theory concerning this distribution (i.e. the so-called "Gibrat's Law") holds or not in practice. On the other hand, in econometric studies size is thought to be an important variable which accounts for differing behaviour and attitude of firms towards various aspects of business life, some of these aspects usually referred to being efficiency, profitability, variability of profits, rate of growth or decline, rate of mortality etc.

2. Knowledge of firm size is also necessary whenever measures are specifically devised in order to provide aid to firms of a particular size. It is known, for instance, that small firms have their own problems many of which result from their "smallness" and are peculiar to them; e.g. they may have problems in the field of finance, survival, management recruitment and training, technical change, taxation etc.

Given the social, economic and political importance of the small firm sector, governments often try to help them weather their difficulties. In the U.S.A. the Small Business Administration was set up in order to give specific aid to small concerns and so far as G. Britain is concerned one of the "possible recommendations" of the Committee of Inquiry on Small Firms was directed "towards aiding recruitment and establishing a more satisfactory market of small firm managers" [6]. It is plain that if the intended assistance is to be effective or if specific legislative measures are to be taken, some sort of size criteria have to be laid down in order for a particular firm to qualify for the assistance to be extended.

3. Size of firms may be important in making public policy. The fraction of an industry's or sector's output or investment or employment or economic power which is accounted for by the three or four largest firms in the industry or sector concerned may be of primary importance in an economic, political and social sense. Such matters as monopolistic tendencies and concentration which may call for a certain public policy

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5. *Harris R. and Solly H.*: "A Survey of Large Companies", London Institute of Econ. Affairs (1959).

6. *Committee of Inquiry on Small Firms* (Research Report No. 12): "Dynamics of Small Firms" - HMSO 1971 p. 41.

(anti-trust legislation e.t.c.) are to a large extent problems of size.

There are a number of snags and difficulties in dealing with matters of firm size; when one is using published frequency distributions as a source of information one is often faced with the problem of how one is to treat the top open-ended class interval. The decision may be important and may affect the conclusion to be reached in that while firms may move from one size-class to another, they cannot graduate out of the top class. This problem is particularly serious when long-run differences between small and large firms are considered, for it is known that in most cases the only readily available information turns out to be in the form of grouped data. Surely the above-mentioned problem is not peculiar to the measurement of firm size nor does it result from any definitional or conceptual difficulty; it is a common problem whenever grouped data are dealt with and can be overcome by rearranging the original data in a more meaningful way.

A more serious difficulty arises when one is considering inter-industry differences; no matter what measure of size is used, comparisons are sometimes extremely erroneous and no sound judgement can be made before further considerations are taken into account. This type of difficulty is due to the fact that industries differ sometimes so greatly with respect to several variables, that inter-industry size comparisons may have little relevance. Differences in capital intensity, the ratio of material cost to total cost, the composition of labour force and a host of other variables are usually mentioned to illustrate the foregoing statement.

Other difficulties which are peculiar to particular size measures will be dealt with when considering the individual measures of firm size.

1. 2. MEASURES OF FIRM SIZE

The measures that have at times been suggested and used in research can be classified in two broad categories:

a. Qualitative measures and

b. Quantitative measures

The measures of the first category are susceptible to different interpretation or misunderstanding and this makes them of little practical value, their use being limited. Nevertheless, such measures have been used in some cases: it has been suggested[7] for example, that in consi-

7. *Federal Reserve System*: "Financing Small Business", Report to the Commi

dering matters of credit availability the relevant criteria might be:

— "too small to float securities in the public market,or

— "unknown to lenders and investors outside one area" etc.

The measures of the second type can be divided into:

ba. physical measures and

bb. financial measures

1.2.1.*Physical measures*

The main measures falling into this type are volume (not value) of output (or productive capacity) and employment.

The main disadvantage of volume of output as a measure of size is that its use in practice is limited to industries whose outputs lend themselves to some sort of physical measurement,i.e. measures of length, surface, weight etc. Another disadvantage is that this type of measure does not allow for qualitative differences amongst outputs of firms in the same industry. In addition, such measures may be totally inappropriate for inter-industry comparisons, as no common denominator exists. These disadvantages are in practice overcome by converting physical output to some kind of value-of-output measure.

Employment also is a frequently used physical measure of size. Studies in which there are considered such matters as the social and political aspects of industrial concentration or employment policies and other features closely related to labour rely mainly on numbers of employees as a measure of size. M. Adelman claims that in such cases "the distribution of employees is probably the most relevant single measure"[8].

The main argument for the use of employment as a measure is that employment is not affected by monetary factors and hence can be used for international comparisons or for comparisons over periods of considerable movements which do affect other measures.

The measure in question is not free of difficulties. Disagreement can arise as to what should be included in "employment", or how special categories should be treated (e.g. male and female staff, managers, part-timers etc.); in all these and related matters the answer will depend heavily on arbitrariness.

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tees on Banking and Currency by the Federal Res. System, Washington D.C.: U.S. Government Printing Office, 1958.

8. *Adelman M.A.*: "The Measurement of Industrial Concentration".The Rev. of Econ. & Statistics, Nov. 1951 p. 272.

The measure also presents problems when inter-industry comparisons are to be made, since different industries may have different labour intensity and capital intensity; if, for example, firms of an industry pertaining to the labour-intensive type (clothing industry is usually mentioned as an example) employ large numbers of workers but a small volume of fixed assets, can we conclude that these firms are larger than firms of another industry, which being of the capital-intensive type, employ smaller numbers of employees but larger assets? The answer will of course depend on the angle from which one is viewing the problem. If financial considerations are preponderant the former may be smaller than the latter.

The Oxford Small Business Survey revealed that turnover tended to be proportionately higher than employment the larger the firm (this was attributed mainly to the higher labour productivity of larger firms) and also that employment tended to be proportionally higher than assets the larger the firms (both findings refer to the smaller size ranges).

As for the availabilty of data on employment it cannot be said that in Britain such data were readily available for private purposes before the 1967 Companies Act and this was perhaps the reason why employment as a measure was not extensively used in private studies, since publication of information by companies was optional. In Britain, however, the half-yearly Earnigs Inquiries of the Ministry of Labour ask firms to specify the number of people in their employment; hence, information was available for government research. The Census of Production also utilizes employment as the measure of size of establishments, classifying size of establishments (not firms) by persons employed. (It should be noted however, that Leak and Maizels [9] based on Census data were able to calculate the proportion of total output and persons in every industry accounted for by its largest three business units.) Since the passing of the Companies Act, 1967, Companies under certain conditions, are required to disclose the average number of employees per week; thus employment may become a more readily available measure of size in future studies.

Employment is also one of the measures used by the American Small Business Administration and it was used in the Oxford Small

9. *Leak H. and Maizels A.:* "The Structure of British Industry". The Journal of the Royal Stat. Society 1945, p.p. 142-207.

Business Survey and partly in the Research Report No. 18 of the Committee of Inquiry on Small Firms (by partly we mean that employment was the measure used to define the whole small size group, whereas net assets was the measure for the definition of the whole large size group).

1.2.2. *Financial size measures*

They fall into two main types:

a. stock measures and

b. flow measures

The measures of the first type concern amounts that are presented or recorded at a given moment of time. The most commonly used measures of this type are total assets, net assets, working capital and market value of stocks.

The flow type of measures are usually in terms of sales (turnover), value added (or net output) profit and payroll (or cost of labour).

a. Stock measures of size

aa. Assets

They provide the most readily accessible measure of size, but it is also one that involves considerable difficulties. The fact that all firms value their assets at balance sheet dates renders this measure relatively readily ascertainable particularly as regards public companies which, in addition, have to publish their accounts. What makes such measures somewhat slippery and difficult to handle in research is the fact that companies differ considerably in the way they present their financial data and unless these data are brought on to some comparable and common basis, the conclusions may be misleading and erroneous. Thus although assets are an important and easily accessible dimension of business size, their use presents certain problems which have been at times discussed exhaustively in the relevant literature and some of which are set out below.

Tangible fixed assets make up a major item in most companies' balance sheets and one which is a typical case of undervaluation due, inter alia, to principles and concepts long ingrained in the minds of accountants[10]. Fixed assets are the result of accumulation over time;

10. See for example the concept of conservatism in: *Hendriksen E.S.* "Accounting Theory" (Revised Edit.) - R. Irwin, Homewood, Illin. 1970 p. 118.

given that the most common valuation method is historic cost less depreciation to date, if prices have changed to an appreciable degree, comparisons among firms or groups of firms are blurred by the variations in the time pattern of accumulation: the longer the time period over which the fixed assets have been accumulated, the greater the discrepancy amongst companies owning similar assets and the greater the difficulty of comparisons.

In certain European countries firms have been encouraged by their Governments to revalue their fixed assets by the use of price indices, the encouragement being additional taxation allowances[11]. In Britain, however, no such tax benefit exists, which means that extra sums set aside to meet increased replacement costs are treated as disallowable charges for taxation purposes.

Undervaluation of fixed assets will tend to result in bias in studies in which assets are involved in one way or another, e.g. in studies concerning rates of return on assets, the rates will tend to be overstated first because the denominator (i.e. assets) of the relevant ratio is understated, and second because the numerator (profits) is overstated as depreciation charges are too low owing to the fact that depreciation is calculated on original (historical) cost of the assets concerned. In their study Singh and Whittington[12] found the average profitability in the period 1954-60 to be lower than in the period 1948-54 and concluded that this difference "may be largely due to the more realistic accounting valuation of fixed assets in the second sub-period as compared with the first". More generally, it has been argued that the extent of undervaluation has been diminished since the introduction of the Companies Act in 1948.

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11. It is common place however, to say that revaluation is not an easy affair; cf: *The Inst. of Chartered Accountants in England & Wales*: "Recommendations on Accounting Principles (1970 edition) Rec. No. 12: "the writing-up of the fixed assets itself involves practical difficulties, including, inter alia, those which arise because relative stability of prices on a new level has not yet been attained, the invalidation of comparisons with figures of previous periods and in many cases the lack of data on which satisfactory revaluations could be achieved", and (in recommendation made in amplification of recomm. 9 & 10): "For Balance sheet purposes fixed assets should not, in general, be written-up on the basis of estimated replacement costs, especially in the absence of a measure of stability in the price level".

12. *Singh A. & Whittington G.*: (in collaboration with *Burley H.T.*) "Growth, Profitability, and Valuation", Cambridge Univ. Press, Cambridge, 1968.

The following table shows the number of companies which revalued during the periods 1948-54 and 1954-60.

Table 1.1 Revaluations
Four industries: continuing companies only

Opening size range (£'000)	1948 – 54			1954 – 60		
	(1) Number of contin. companies	(2) No. of compan. which revalued	(3) Col. (2) as % of col. (1)	(4) No. of contin. companies	(5) No. of companies which revalued	(6) Col. (5) as % of col. (4)
< 250	117	10	8.5	65	11	16.9
< 500	103	5	4.8	79	10	12.7
< 1,000	102	8	7.8	94	11	11.7
< 2,000	67	5	7.5	81	10	12.3
< 4,000	42	1	2.4	54	7	13.0
< 8,000	14	2	14.3	38	6	15.8
< 16,000	13	1	7.7	16	6	37.5
< 32,000	4	1	25.0	7	2	28.6
> 32,000	2	1	50.0	5	1	20.0
Total	464	34	7.3	439	64	14.6

Source: Singh - Whittington, op. cit.

The table shows that in both sub-periods studied some companies in all size-classes revalued. During the first sub-period (1948-54) the proportionate distribution of firms between size-classes which revalued was fairly even, except for the two largest size-classes in which the proportions of firms were 25% and 50% (but this was due to the fact that these classes consisted of four and two firms only respectively). During the second sub-period, however, there appeared to be a tendency for the incidence of revaluation to vary positively with size. This in turn suggests that, as we said, revaluations can be a possible source of bias in studies of growth, profitability etc., based on assets figures. In fact Samuels[13] found the parameter b which related the log of opening

13. *Samuels J.*, op. cit.

size to the log of closing size to be greater than unity in the period 1955--60. The fact that $b>1$ implied that the large firms grew proportionately faster than the small ones, but this outcome could be due to the bias mentioned.

ab. Fire insurance values of assets

It has been said in the foregoing paragraphs that a major difficulty in dealing with assets as a measure of size, is that they are shown in balance sheets on an original cost basis. A way to overcome this difficulty is to use fire insurance values of assets.

It is maintained that there are strong incentives for firms to ensure that valuations for insurance purposes are made on a realistic basis, since if assets are overvalued premiums will be unduly high and recompense for loss will be on market value; if, on the other hand, assets are undervalued, premium may be low, but the firm may incur a loss since insurance companies will not pay more than the insured values.

It is recognised, however, that under-insurance is probably more common in practice than over-insurance, particularly in periods of rising prices during which firms tend to allow insured values to be lower than current prices, but even so, it is argued that insured values of assets will provide a better and closer approximation to current situation than will book values.

Fire insurance values were used by T. Barna[14] who made an estimate of the replacement cost of fixed assets in the manufacturing industry for 1955. The book value of fixed assets of the same industry for the same year was estimated to be between £ 8,000 million and £ 9,000 million approximately, while Barna's figure of replacement costs of the same industry and year was £ 15,000 million.

Another instance of study, in which insured values of assets were used, is the Oxford Small Business Survey; respondents to this survey were asked to state the insured value of their physical assets (fixed assets plus stocks). The correlation between book values of physical assets and insured values turned out to be high (in fact the r^2 coefficient was found to be as high as 0.80).

Table 1.2 shows the differences between book values and insured values of companies covered by the Oxford Survey.

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14. *Barna T.*: "The Replacement Cost of Fixed Assets in British Manufacturing Industry in 1955". The Journal of the Royal Stat. Society, 1957 p.p. 1-36.

Table 1.2 Balance sheet values of physical assets expressed as percentage of insured values.

Percentage	Number of firms	Percentage of firms
0 - 49.9	77	26.2
50 - 74.9	61	20.8
75 - 99.9	58	19.7
100 and over	98	33.3
	294	100.0

ac. Market valuation

Despite the fact that insured values provide a better approximation to current values or replacement costs of assets, there are opponents who claim that replacement cost is not an ideal figure for the size of assets because it does not relate to the earning capacity of the firm which reflects the efficiency with which the assets are utilized. They suggest that market valuations can possibly be considered to reflect the earning power of the firm, given that such valuations should ideally be based on discounted future earnings of the firm.

It is plain, however, that if one were to assess this alternative, one would say that all these assertions might be true if stock exchanges were perfect markets and if earning capacity were the only variable affecting market values. In real every-day economic life these assumptions are said not to hold. Stock markets are far from perfect[15,16] and shareholders can hardly be said to behave rationally always; earning capacity on the other hand is only one factor influencing market values, which in fact reflect the outcome of a number of interacting forces[17].

Another sort of criticism against market valuations is that they do not relate to a business as such but to its shares, and unless a firm is to be sold as a going concern shares cannot be said to reflect the value of the firm.

Further limitations of the measure in question are first, that market

15. *Amey L.R.*: "The Efficiency of Business Entreprise", Allen & Unwin Ltd., London, 1970 p. 34.

16. Cf. *E. Fama* distinguishing between informed and uninformed investors: *Fama E.*: "The Behaviour of Stock-market Prices». The Journal of Business, Jan. 1965, p.p. 34-106.

17. Cf. *Samuels J.M. & Wilkes F.M.*: "Management of Company Finance", Nelson 1971, p. 488.

values fluctuate considerably over time[18] and this renders the measure less useful and second, that this type of measure can only be applied to quoted public companies since these are the only companies whose shares change hands in stock exchanges. Finally, it is maintained that earning capacity is not necessarily a good measure of size for all purposes, since it reflects subjective judgement, it depends on market forces and does not necessarily provide a reliable indication of the economic weight or significance of a firm.

Despite the above mentioned theoretical arguments against the use of the measure in question, Hart and Prais[19] found that it was highly correlated with other measures of size: r^2 (of logarithms) of market valuation with total fixed assets was found to be as high as 0.86[20]; with nominal value of share capital and debentures it was 0.92; with net assets 0.93; with profits for the same year 0.87 and with average profits for five years 0.86.

b. Flow measures of size

ba. Turnover or sales

It is one of the most often used measures of the flow type. Some time ago it was less readily available in Britain, as firms were often reluctant to divulge turnover figures and details. The Companies Act, 1967 made it compulsory for most companies to show their turnover[21]

18. See the controversy on the random-walk hypothesis in *Fama E.*: "Random Walks in Stock-market Prices" (in *Lishan J.M. & Crary D.T.*: The Investment Process, Int. Textbook Co, Scranton, Penns., 1970). *Weintraub R.E.*: "On Speculative Prices and Random Walks: a Denial (in the same book by Lishan - Crary). *Little I.M.D. & Rayner A.C.*: "Higgledy-Piggledy Growth Again". Blackwell, Oxford, 1966.

19. *Hart P.E. & Prais S. J.*, op. cit.

20. See, however, *S. Florence* who claims that "little correlation is shown between rank in asset growth and rank in market value growth.The disconcerting contradiciton ..... in the two measures of the growth of firms is probably not just a chance accident but a logical consequence of the basis of the stock-market valuations. The price of an ordinary share appears to depend more on the rate of dividends paid out on it, less on the assets accumulated ..... the increase in the market value of its stocks and shares can be a very unsatisfactory measure of growth of a firm": *Florence S.* "New Measures of the Growth of Firms".The Econ. Journal, June 1957, p.p. 244-8.

21. Exemption from disclosure is given to companies not being holding or subsidiary companies, if turnover which would be required to be stated does not exceed £50,000.

and the method by which it is arrived at; in 1960 the number of firms publishing information concerning turnover was as small as 116.

The use of turnover figures as a measure does not involve major difficulties but this does not imply that the relevant term is completely free from ambiguities or minor difficulties, e.g. the question might arise as to whether turnover relates to sales gross or net of discounts, also whether turnover includes only sales made by a firm as principal or whether it includes the amount of sales made by the firm in its capacity as agent, on which it only earned commission. The treatment of inter-company sales may present another problem. Table 1.3 shows the treatment of such sales followed by 300 British companies.

Table 1.3 Method of arriving at turnover

Treatment of inter-company sales:	No. of companies 1969-70	1968-69
Excluded	213	215
Included	20	14
Not mentioned	66	69
No turnover disclosed	1	2
	300	300

Source: Survey of Published Accounts 1969-70 (The Inst. of Chartered Acc. in England and Wales)

The main arguments against the use of turnover as a measure are as follows:

1. Such a measure does not allow for inter-industry differences and differences in input-output structure between firms in the same industry; the wholesaling industry, for instance, appears to have high turnover, but wholesaling firms may be small if ranked in terms of other measures, the reason being that a high proportion of total costs consists of purchases, while net output and wages are low.

This problem, however, may not be so serious, if industries or firms of similar capital and output structures are considered, although it is maintained that net output, employment and turnover are not by necessity in any constant relationship even within the same firm.

2. The measure under consideration does not allow for vertical integration, although such a factor may be extremely important in con-

sidering the economic significance and contribution of individual firms. Consider, for example, two firms A & B both having equal shares of total sales in the industry but differing in that A buys components and adds a little to them, while B makes its own components; if the two firms are ranked in terms of sales, they will appear to have the same size whereas in terms of other measures, e.g. net output, employment etc, B will appear much larger.

Some of the above points have been considered by Harris and Solly, who showed that the successive utilization of turnover, employment and net assets as measures of size resulted in nationalised industries' appearing as having different sizes[22].

bb. Value added

Value added is another flow type measure which appears to be the one that is more likely to be accepted by most economists. Value added consists of the difference between sales and cost of purchased materials and represents the true contribution to national output of individual firms, or, put another way, it describes the incomes that arise from the production processes of firms.

If problems of depreciation (which is part of value added) are disregarded, this measure is free from valuation difficulties, but it is not free from difficulties of comparability arising from price changes, if longer time spans are to be considered.

Specific items included in value added may present other problem areas, e.g. given that in small firms directors are also managers the directors' remuneration in such concerns may pose a problem, since such remunerations may constitute a large part of value added (in fact J. Bates found that directors' remuneration typically accounts for about 4 per cent of total sales of small firms)[23]. Ideally part of this item should be allocated as salaries and part as earnings of the firms from which distributions are made, but this would inevitably involve some element of arbitrariness; in the standardised accounts prepared for the Oxford Small Business Survey this item was somewhat arbitrarily treated as a cost.

The major disadvantage of value added as a measure is that it is extremely difficult to ascertain on an individual firm basis, since firms do not have to disclose such information.

22. *Harris R. & Solly H.*, op. cit.
23. *Bates J.*, op. cit. p. 201.

bc. Measures based on profits

Profits provide a further example of the flow type size measures and constitute part of a firm's income flow. If differences in efficiency are ignored, profits are said to be influenced by similar factors in similar firms, but since such differences cannot be ignored, it is maintained that most measures of size based on profits ultimately turn out to be measures of efficiency[24].

An objection to this type of measure is that profits are a flow that may fluctuate violently from year to year and for this objection to be overcome in practice there are taken averages over a period of years during which such variations might be expected to cancel out.

Another difficulty arises from the fact that there is little agreement on the precise profits measure to be used. Even if one accepts the statement often made that accounting conventions tend to be fairly similar between firms within the same industry, differences could arise when inter-industry or inter-temporal comparisons are made due, for instance, to such factors as differing depreciation practices followed by firms in different industries, or to the fact that the taxation system may differ at different points in time. To overcome these difficulties most of the researchers employ the measure in question as gross as possible (e.g. gross of depreciation and taxes).

A further complication arises in practice when small and large firms are compared due to the fact that small firms are usually owned by one, two, or three officers who are also full-time workers in their concern and hence such firms tend to misclassify part of their profits. As a matter of fact, J.L. McConnell found that this was true of 70 per cent of the non-financial corporations with assets under 50 thousand dollars and 50 per cent of the non-financial corporations with assets between 50 thousand dollars and 250 thousand dollars[25]. S. Alexander[26] also states that the reported profit figures of many closely held corporations differ from a theoretically desirable definition of profits because of the

24. Cf. *Blair J.M.*: "The Relation Between Size and Efficiency of Business". The Rev. of Econ. & Stat. 1942 p.p. 125-135. Also *T.N.E.C.*: "Relative Efficiency of Large, Medium-sized, and Small Firms" Monogr. No. 13, Washington D.C., 1941.

25. *McConnell J.L.*: "Corporate Earnings by Size of Firm", Survey of Current Business, May 1945, p.p. 6-12.

26. *Alexander S.S.*: "The Effect of Size of Manufacturing Corporation on the Distribution of the Rate of Return". The Review of Econ. & Statistics, Aug. 1949, p.p. 229-35.

treatment of the compensation of officers: he found that such corporations in attempting to minimize tax liability tended to pay out profits as salaries rather than as dividends, since the latter would be taxed both as income of the corporation and of the recipient. It is plain, therefore, that unless some sort of suitable adjustment is made, measures based on profits may lead to wrong conclusions. In fact such adjustments have been attempted by J.L. McConnell and S. Alexander[27,28].

The major problems with all flow measures are first, that some of them are not easy to ascertain and second, that all of them are closely related to each other, e.g. turnover includes value-added and the latter in turn includes profits and payroll. This disadvantage is said to be important in the sense that if one wished to consider, for example, the effects of size on profits (where size is measured in terms of one of the flow measures) one could expect a high correlation between profits and the measures in question and this might suggest the use of other size measures. Nevertheless, it is equally maintained that since in practice profit on turnover varies a great deal from firm to firm and over time, the above mentioned disadvantage may be less serious than it is claimed to be in theory.

1.3. CONCLUSIONS

Although it is maintained on theoretical grounds that the various size measures are open to some criticisms because they suffer from several defects and are far from ideal, it was found in practice that these measures are on the whole most closely related to each other (J. Bates, Hart & Prais, J. Samuels), a fact which means that they will tend to provide similar results and using any reasonable technique for measuring size will be sufficient for many practical purposes.

Therefore choice or preference of any size measure will ultimately depend on the relative convenience and availability of the relevant data. Nevertheless, the statement that it does not matter very much which particular measure is chosen is not universally accepted. (Harris & Solly, S. Florence).

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27. *McConnell J.L.* op. cit. and also: *McConnell J.L.*: "1942 Corporate Profits by Size of Firm", Survey of Current Business, Jan. 1946, p.p. 10-16.

28. *Alexander S.S.*,op. cit. p. 233.

CHAPTER TWO

THE LAW OF PROPORTIONATE EFFECT

2.1.THE THEORY UNDERLYING THE LAW

In recent years there has been a growing body of economic literature bearing on the relationship between size and growth of firms. In this context the law of proportionate effect is often given pride of place. Since most relevant empirical studies to which we refer in Chapter 5 attempt to give an answer as to whether the above law and its economic implications do hold, we think a brief mention of the underlying theory is in order.

The law of proportionate effect – or Gibrat's law[29] as has become known – implies that the proportionate change in the size of the firm is independent of its absolute size,i.e. in its strongest form the law asserts that a firm randomly selected from a certain size-class has the same probability of growing, say, 10 per cent as a firm randomly selected from any other size-class. Such a law of growth generates a lognormal size distribution of firms and such distributions have often been observed in practice, the typical size distribution of firms being positively skew, i.e. with few large firms and many small firms. This skewness can often be removed by plotting the frequencies against the logarithms of size so that the original distribution may be deemed to be lognormal[30].

A lognormal curve can be generated when a large number of small independent random forces act on a variate in multiplicative manner, just as a normal curve is generated when they act additively. This means that the factors determining the growth of firms tend to change their sizes by randomly selected proportions, i.e. some factors make for an increase some for a decrease, but all act in a random way so that there

29. *Gibrat R.*: "Les inégalités économiques". Sirey, Paris 1931.

30. It is true, though, that some size distributions of firms do not fit this simple model but are merely positively skew.

is no tendency to favour or disfavour firms of any particular size. The law in question can be expressed as follows:

$$X_t - X_{t-1} = \varepsilon_t X_{t-1} \qquad (2.1)$$

where X_t denotes the absolute size of a firm at time t and ε_t denotes a proportion drawn atrandom from a set of proportions which are mutually independent and also independent of X_{t-1}. Aitchison and Brown[31] treat this theorem as follows: equation (2.1) can be rewritten as:

$$(X_t - X_{t-1}) / X_{t-1} = \varepsilon_t \quad \text{from which we get:}$$

$$\sum_{t=1}^{n} (X_t - X_{t-1}) / X_{t-1} = \sum_{t=1}^{n} \varepsilon_t$$

and then supposing that each time interval is small:

$$\sum_{t=1}^{n} (X_t - X_{t-1}) / X_{t-1} \sim \int_{X_0}^{X_n} (1 / X)dX = \Big[\log X \Big]_{X_0}^{X_n} =$$

$$= \log X_n - \log X_0$$

$$\log X_n - \log X_0 = \sum_{t=1}^{n} \varepsilon_t$$

$$\log X_n = \log X_0 + \varepsilon_1 + \varepsilon_2 + \ldots\ldots + \varepsilon_n \qquad (2.2)$$

By the additive form of the central limit theorem, the variate log X_n is normally distributed and equation (2.2) is simply a formal statement of the theory that firms grow by randomly distributed proportions and thus tend to be lognormally distributed. Gibrat's law can be formulated in at least three ways depending on the treatment of the death of firms as well as on the comprehensiveness claimed for the law.

F i r s t, one can claim that it holds for all firms,i.e. including those that are driven out of the industry during the relevant period. Although we reserve the empirical tests of the law for the last chapter, it should be noted here in anticipation that some researchers maintain that this version of the law fails to hold, the reasoning being that the probability of a firm's death is certainly not independent of its size. Smaller firms are more likely than the larger ones to leave the industry.

S e c o n d, one can state that the law holds for all firms other than those that leave the industry [32].

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31. *Aitchison J. & Brown J.A.C.*: "The Lognormal Distribution" C.U.P., Cambridge,1957 p. 23.

32. *Hart P.E. & Prais S.J.*, op. cit.

T h i r d, one can say that the law holds only for those firms that exceed the minimum efficient size in the industry, i.e. the size below which unit costs rise sharply and above which they vary only slightly[33]. But here one is faced once again with the problem of how to treat firms that die.

The economic implications of the law in question are the following: F i r s t, large, medium and small firms have the same proportionate growth rate. S e c o n d, the dispersion of growth rates around the common average is also the same for all firms.

T h i r d, the distribution of growth rates is lognormal e.g. just as many firms halve as they double their sizes. The logarithms of proportionate growth are symmetrically distributed around the mean growth and since this applies to all firms we can postulate that if x per cent of small firms halve their sizes, x per cent of large firms double their sizes.

F o u r t h, the dispersion of the sizes of firms tends to increase over time despite the fact that large, medium and small firms have the same average proportionate growth. This in turn may have some important consequences for changes in industrial concentration over time. In its strong form the law implies increasing industrial concentration.

F i f t h, the rate of growth of the firm in one period has no influence on its growth in the subsequent periods.

Finally, some writers have stressed the implications of the law of proportionate effect for the question as to whether or not there are economies of scale. In this respect S. Hymer and P. Pashigian [34] claim that their findings are inconsistent with constant costs and imply instead that either unit costs decrease with size or that large firms are more monopolistic than small firms (it should be noted, however, that the above mentioned writers regard their conclusions as tentative). Hart and Prais (and Simon and Bonini in the U.S.A.) on the other hand, assert that the law of proportionate effect is more in keeping with the assumption that unit cost curves are horizontal (at least beyond some minimum size) than with the more usual assumption that unit cost curves are U-shaped.

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33. Cf. *Simon H. & Bonini C.*: "The Size Distribution of Business Firms". Amer. Econ. Review, Sept. 1958, p.p. 607-17.

34. *Hymer H. & Pashigian P.*: "Firm Size and Rate of Growth". The Journal of Polit. Econ., Dec. 1962, p.p. 556-69.

2.2.CONCLUSIONS

Attempts to explain the size-growth relationship make extensive use of the law of proportionate effect or Gibrat's law as has become known in the relevant literature. This law generates a lognormal size distribution of firms which has often been observed in practice: the typical size distribution of firms, like many other economic data, has been found to be positively skew and this skewness can often be removed by plotting the frequencies against the logarithms of size.

The lognormal curve is generated when a large number of small independent random forces act on a variate multiplicatively.

The law in question, were it to be supported by the empirical evidence would have important economic implications, e.g. firms of all sizes would have the same average proportionate growth rate, the dispersion of growth rates around the common average would be the same for all firms, the dispersion of the sizes of firms would tend to increase over time, thus leading to increasing industrial concentration and so on.

Some writers, on the other hand (Hymer - Pashigian, Simon - Bonini, Hart - Prais) have attempted to associate this law with the question of existence of economies of scale or falling costs, but their conclusions are in conflict with each other.

CHAPTER THREE

FIRM SIZE AND PROFITABILITY

In the following three chapters we discuss the empirical evidence bearing on the interdependence of profitability, size, and growth. In particular, the relationships to be examined are those between size and profitability, between growth and profitability, and between growth and size.

3.1. THE EMPIRICAL EVIDENCE ON THE RELATIONSHIP BETWEEN SIZE AND PROFITABILITY

One of the earliest studies in the field, which is now considered to have formed the corner-stone of subsequent work is that by W. Crum[35]. His findings are shown in diagram 3.1, which shows the form of the profitability relationship to size in almost all U.S. industries in the period 1931 - 36.

35. *Crum W.L.*: "Corporate Size and Earning Power". H.U.P., Cambridge, Mass 1939.

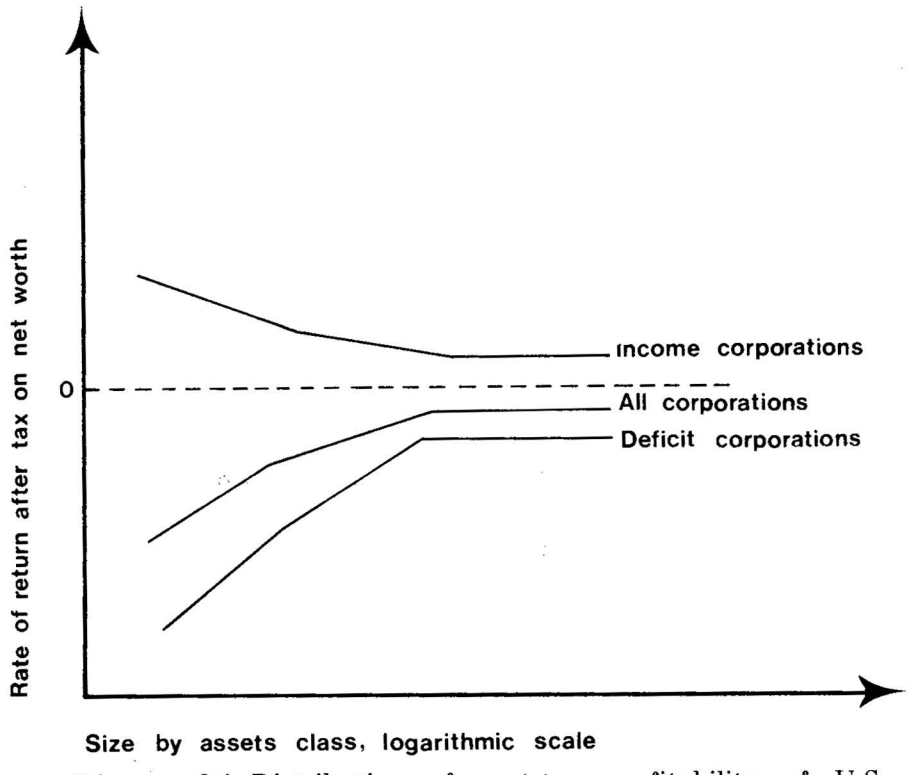

Diagram 3.1. Distribution of post-tax profitability of U.S. manufacturing corporations, 1931 - 36.
Source: J. Eatwell[36] quoting W. Crum.

From the above diagram it is clear that the correlation between profitability and size is negative when only income corporations are considered (i.e. corporations with positive income) and the same picture emerged from the more recent study by Sherman[37], whose findings are set out in Table 3.1.

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36. *Eatwell J.L.*: "Growth, Profitability,and Size" (in:*Marris & Wood*:The Corporate Economy).
37. *Sherman H.J.*: "Profits in the U.S.",Cornell Univ. Press, Ithaca, N.Y. 1968.

Table 3.1. Profit rates (profits before taxes on equity) in income and deficit corporations (all U.S. Corporations, 1949).

Assets class ($ 10,000)	All Corporations	Income Corpor.	Deficit Corpor.
0 – 5	–3.4	19.4	–59.5
5 – 10	7.4	17.1	–24.8
10 – 25	10.5	17.2	–21.1
25 – 50	12.9	18.0	–17.8
50 – 100	13.5	18.2	–16.3
100 – 500	14.3	17.4	–13.4
500 – 1,000	13.9	16.4	–11.9
1,000 – 5,000	14.6	16.2	–8.8
5,000 +	13.9	14.3	–9.5

Source: J. Eatwell[38], quoting H.J. Sherman

The relationship between size and profitability displayed by income corporations has been attributed to the possibility of increasing capital intensity of production in large firms but it was found that the assets / sales ratio reaches a maximum value in the $5 million to $10 million size-class and thereafter remains fairly constant with increasing size. Another explanation advanced was that small firms displayed greater variability of profit rates vis-à-vis large firms, that the positive correlation between size and profitability in diagram 3.1 was a characteristic of the 1930's when the mean profitability of all firms was low and small firms incurred heavy rates of losses.

S. Alexander also investigated the effect of size on the distribution of the rate of return[39]. He concluded that small corporations have greater variability of profits than do large in two different senses. F i r s t, for any given year the dispersion of profit rates is much greater among small corporations than among large. S e c o n d small corporations tend to misclassify a greater proportion of their profits as salaries of management than do large corporations and consequently the generalisation that might have been inferred from the experience of the thirties about the profitability of small corporations is not very reliable.

38. *Eatwell J.L.*, op. cit.
39. *Alexander S.S.*, op. cit.

Diagram 3.2 shows the variation of average rates of return (before taxes) in 1937 by assets size-classes[40].

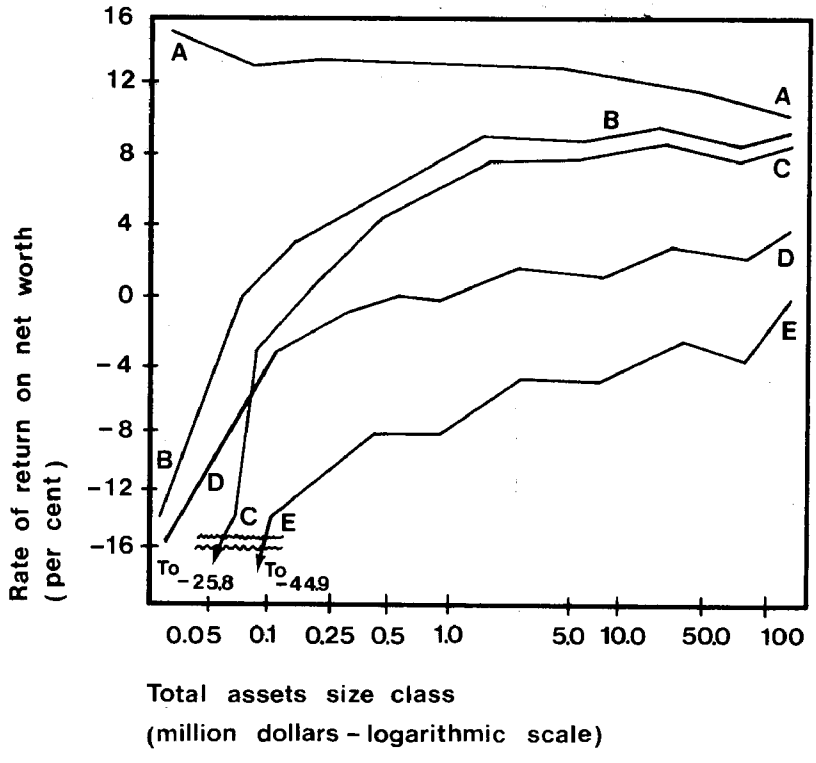

Diagram 3.2. Average rates of return on net worth, all manufacturing corporations, 1937, by assets size-classes.

Curve A. Income corporations, ratio of aggregate net income to aggregate year-end net worth.

Curve B. Average of A and E, weighted by net worth.

Curve C. Average of A and E, weighted by number of corporations.

Curve D. Average of A and E, weighted equally.

Curve E. Deficit corporations, ratio of aggregate deficit for the year to aggregate year-end net worth.

Source: S. Alexander, op. cit.

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40. It should be noted that Alexander's rates of profits are the ratio of net income or deficit (before taxes) to net worth; net worth, on the other hand, is the sum at year-end of capital stock, surplus (both capital and earned) and surplus reserves minus deficit. Crum's rates refer to net profits after taxes and the denominator is estimated average of equity at year-end and at beginning of year.

Curve B indicates the rate of return (on net worth) for the average dollar of net worth in each size-class, while curve C represents the estimated rate of return (on net worth) for the average corporation in each size-class. The two curves are similar in shape and rise very sharply from the very smallest size-class up to the range of corporations with 1 million dollars or more of total assets. The difference between the two curves is attributed to the fact that within a given size-class profitable corporations have greater net worth than deficit corporations so that we obtain different results when averaging rates of return, depending on whether the corporations are each weighted equally (as is the case with curve C) or each according to its net worth (as in curve B).

Another feature implicit in diagram 3.2. is that differences in profitability lead to smaller differences in net worth among large than among small corporations. This is inferred from the fact that curve C approaches curve B as the size of corporation increases.

Curve D shows the average rate of return that would be expected if the number of income corporations were equal to the number of deficit corporations in each size-class; its upward slope is attributed to the strong tendency for rate of loss of deficit corporations to be reduced with increasing size (curve E) combined with the weak tendency for rate of profit of income corporations to decline with increasing size (curve A). Another characteristic of the period studied was that the relative frequency of loss was much greater among small corporations (hence curve C is steeper than curve D).

Alexander also considered the tendency for the years 1941, 1942, and 1947 in which the curve of the rate of return turns downwards somewhere near the $ 5 million total assets mark (diagram 3.3) and he concluded that the rise of reported rate of return with size of corporation that was characteristic of the thirties is associated with the low levels of business activity of that period and that in very prosperous years (such as in 1941) the curve of reported rate of return takes on the traditional humped shape, frequently assumed by theorists.

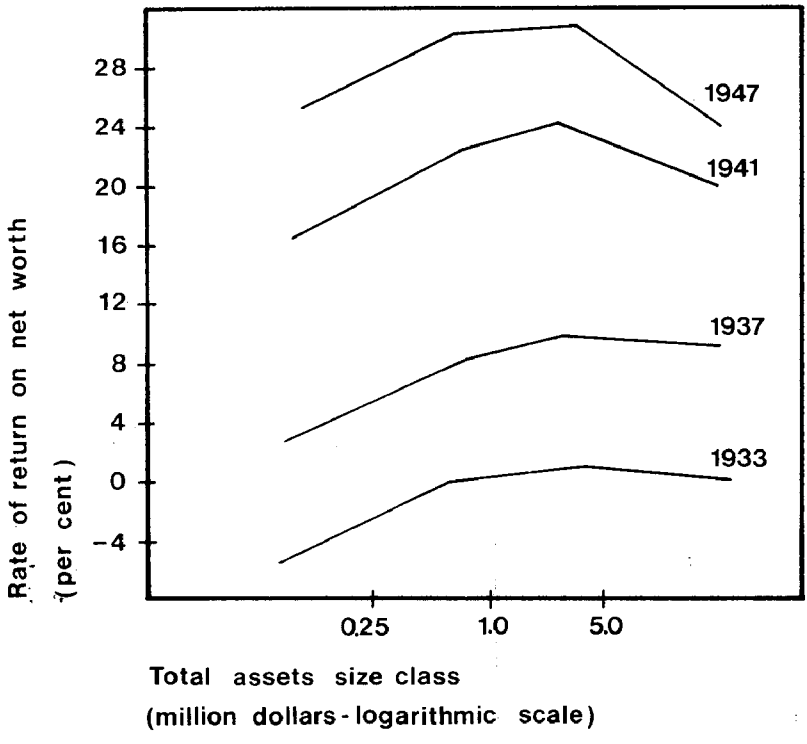

Diagram 3.3. Rates of return on Net Worth, all manufacturing corporations, by assets size-classes
Source: S. Alexander, op. cit.

As for the variation of rates of return it was found that for any given year the variation among small firms was greater than among large. The relative frequency of loss declined with size of corporation and this decline was especially strong with respect to losses of more than 10 per cent of net worth. With respect to profits it was found that the relative frequency of profits between 0 and 5 per cent did not differ significantly between different size-classes; the main differences were observed in the range between 5 and 20 per cent. Another feature was that the larger income corporations were much more concentrated in the range between 0 and 5 per cent than were the smaller income corporations; the relative frequency of losses was greater among the smaller corporations.

To test the tendency of corporations to show a greater concentration of rates of return around central values as size increases, Alexander used the ranges of rates of return from the medians to the quartiles

and to the extreme deciles as a measure of the dispersion of the distribution of rate of return within each size-class (diagram 3.4). Diagram 3.4 does not show any clear tendency for the inter-quartile range to narrow with increasing size (except for the very small and the very large size-classes); and only for corporations of roughly $ 5 million total assets or more was the inter-quartile range clearly smaller than for smaller corporations over the $ 50,000 mark. On the inter-decile range side there was a more marked tendency for this range to contract with increasing size.

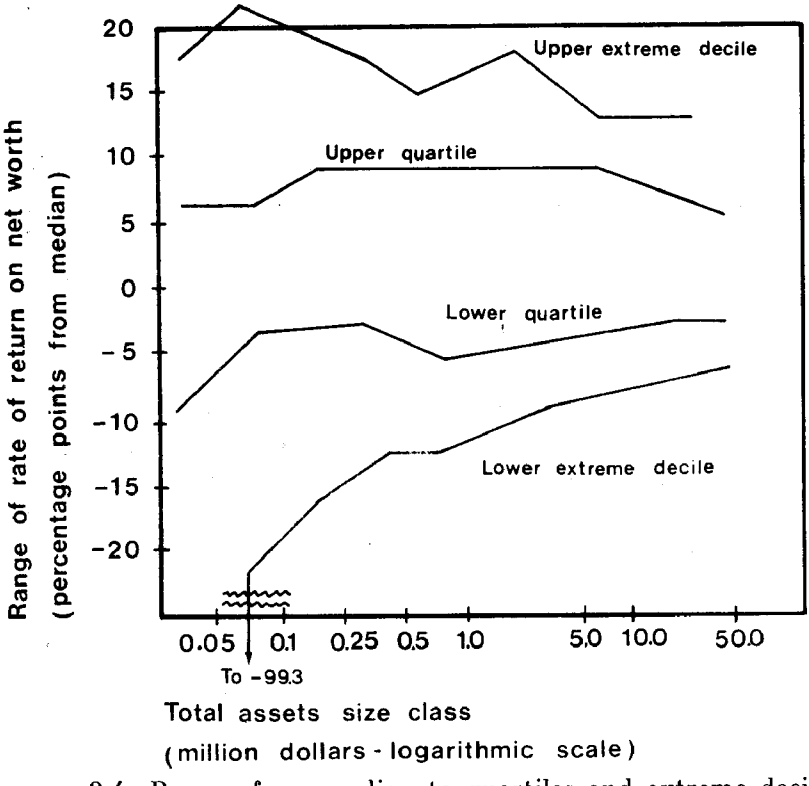

Diagram 3.4. Ranges from median to quartiles and extreme deciles in distributions of rates of return of manufacturing corporations within size-classes, 1937

Source: S. Alexander, op. cit.

Another feature emerging from diagram 3.4 was that the lower quartile approaches the lower extreme decile as firm size increases, implying that very few large corporations incurred losses in the period

covered. The same tendency is discernible with respect to the upper quartile and to the upper extreme decile, although not to the same extent as for the lower quartile and the lower extreme decile. In general, small corporations were spread wide beyond the quartiles, whereas large corporations tended to be more nearly free from extreme variations; the dispersion of rates of return tended to decline with increasing size of corporations.

Alexander also tested the hypothesis that the average large corporation may gain stability of earnings from the fact that such a corporation may be thought of as an aggregation of independent small ones, in which case the rate of profit of a large corporation may be regarded as the mean of the rates of profit of a number of smaller firms into which it could be decomposed. Thus if each $ 9 million corporation were in fact an aggregation of nine independent $ 1 million corporations, it should be expected that the dispersion of profit rates among the aggregations would be about one third of that among the corporations of the $ 1 million class, because the standard deviation of the mean of a sample is approximately $\frac{1}{\sqrt{n}}$ times the standard deviation of the original population (n = the number in the sample).

Alexander made the relevant calculations and found that the differences of dispersion were nowhere near as large as this, indicating the degree to which the individual operations of a large corporation were dependent on each other and on common circumstances.

The observed reduction of dispersion with that to be expected on the hypothesis that each large firm is merely an aggregation of independent smaller ones are set out in Table 3.2, whose construction rests on the assumption that the standard deviations of the distributions are proportional to the range from the upper to the lower extreme decile.

Table 3.2

Comparison	Estimated ratio of dispersion (a)	Hypothetical ratio on assumption of aggregation of independ. units (b)
$ 50,000 to $ 100,000 class with $ 250,000 to $ 500,000 class	1.17	2.24
$ 250,000 to $ 500,000 class with $ 500,000 to $ 1,000,000 class	1.09	1.41
$ 1 million to $ 5 million class with $ 10 million to $ 50 million class	1.31	3.16
$ 50,000 to $ 100,000 class with $ 5 million to $ 10 million class	1.88	10.-

(a) Ratio of range between highest and lowest deciles of smaller size-class to corresponding range for larger size-class.

(b) The square root of the ratio of the size of the larger corporations to the size of the smaller.

Source: S. Alexander, op. cit.

The above table shows that the decline of the estimated ratio of dispersion of rate of return with increasing size is far less than would be expected on the hypothesis of aggregation of smaller independent units. According to Alexander the differences in dispersion may probably be explained partly by the greater frequency of small corporations in risky industries and partly by the lesser security of position of the smaller firms within the relevant industries.

Alexander recognised that the conclusion described above may have been distorted by the fact that small, officer-owned corporations tend to misclassify profits (by subtracting from profits artificially high amounts as officers' compensation) in an attempt to minimize tax liability. He therefore attempted a suitable adjustment based on the assumption that there would be little or no tendency among deficit corporations for the executive-owners to take out larger amounts of compensation than the value of their services. Thus the adjustment made was based on the deficit corporations' ratio of officers' salaries paid to the value of assets used[41].

41. McConnell also devised an entirely different method for making adjustments; his method depended on the differences within a sample of 500 small corporations

The return curve after the adjustment for executive compensation was considerably changed. The difference between the two curves suggested a revision of the conclusions on dispersion. Since, if misclassified profits were added to reported profits, one should expect increased frequencies of high profit rates, especially in the smaller size-classes, the differences of dispersion between large and small corporations would be even greater than those depicted in diagram 3.4.

Another relevant study is that by H.O. Stekler[42], who found that the relationship between profitability and size is parabolic. As measures of the variability of profitability he used the standard deviation, the inter-decile ranges and finally the differences between the observed measures of variability and the theoretical values which would be expected if larger firms were a collection of independent profit centres.

The standard deviations of the profit rates of all manufacturing firms were found to be inversely correlated with size and this was true for both years studied (1955 and 1958). Since 1955 was a boom year but 1958 a recessionary one, Stekler also examined the differences of standard deviations between the two years. He states that one would expect the standard deviations of profit rates in a recessionary period to be larger than those of a prosperity period, provided that very much higher rates of loss would prevail in the recession and that no large rates of profit had prevailed in the boom. If, however the increase in the rates of loss were offset by a diminution of the exceedingly high profit rates of the previous period, the standard deviations would be virtually unchanged. If, on the other hand, there had been exceedingly high profit rates in the boom which were reduced but were not offset by subsequent very high loss rates, the standard deviations would decrease.

A class-by-class comparison of the 1955 and 1958 standard deviations yielded diverse results. The standard deviations were larger in

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between the average compensation of executives in executive-owned corporations and the average in corporations in which there is a 15% or more non-salaried ownership. Alexander's method includes in profit the return to superior entrepreunerial ability other than that reflected in difference of size of firms, while McConnell's method regards the reward of superior entrepreunerial ability within a size class as a cost.

42. *Stekler H.O.*: "The Variability of Profitability with Size of Firm 1947-58". The Journal of Amer. Stat. Association, Dec. 1964, p.p. 1183-93.

four classes, smaller in eight and unchanged in the other two; of the four increases only one occured in the medium or large size groups.

The mean firm profit rate and the standard deviations were also calculated for only those corporations which were profitable in 1955 and 1958. The standard deviations of the firms' profit rates were once again found to be negatively correlated with size. On the profit side, in all except the two smallest size-classes the 1958 rates of return were lower than those in 1955. This could be taken to indicate that recessionary periods affect adversely the profitability of all size-classes except the two smallest. In addition, the standard deviations were also smaller in 1958 in all size-classes except the second and third. This seems to indicate that the extremely high rates of return earned by some firms in 1955 were wiped out; nevertheless, the mean firm profit rates in some size-classes declined without a correspondingly significant decline in the standard deviation and this seems to suggest that recession affected the rates of return of all firms, not only of those that were extremely profitable.

The inter-decile range within each size-class was also used by Stekler as a measure of the variability of profitability. The results obtained are in line both with those obtained by Alexander (by using the inter-decile range approach), and with those by using the standard deviation approach, i.e. the variability of profitability declines with the size of firms.

Finally, the above mentioned variability was tested by comparing the observed measure of variability with the theoretical values which would be expected if larger firms were merely regarded as independent profit centres, in which case, as we have seen, the variability of the larger firm should be $\frac{1}{\sqrt{n}}$ times that of the smaller firms. Table 3.3 shows that in both years the ratios of the standard deviations of the smaller size-classes to that of the large size-classes are less than the predicted ratios, which means that the standard deviations of the larger size-classes are larger than the predicted.

Table 3.3 Ratios of the standard deviations of profit rates of various size-classes, actual vs. predicted, 1955 and 1958.

Size-class vs. size-class ('000 dollars)		Observed Ratios 1955	1958	Predicted Ratios
100–250	1,000–2,500	1.03	1.55	3.16
	10,000–25,000	1.78	2.04	10.00
	100,000–250,000	1.85	2.38	31.60
250–500	500–1,000	1.11	1.12	1.41
	2,500–5,000	1.20	1.08	3.16
	5,000–10,000	1.35	1.22	4.47
	25,000–50,000	1.46	1.35	10.00
	50,000–100,000	1.74	1.37	14.10

Source: H.O. Stekler, op. cit.

The hypotheses advanced to explain these results differ. We have already quoted Alexander who argued that the smaller firms might be in riskier industries. According to Hymer and Pashigian these results are due to either economies of scale or monopoly power; finally, Adelman maintains that they are due to incomplete independence of profit centres.

The sensitivity of each class ratios to the business cycle was also investigated by measuring the time variability of the rates of return for the period 1947-51, the range and s.d. of the yearly rates of return for each size-class being the measures of the time variability that were used. The size distributions of the two measures revealed no significant qualitative differences between the two distributions; both of them showed that the time variability of both the small and large firms was less than that of medium, i.e. the distributions were approximately inversely U-shaped.

The general conclusions from Stekler's paper are: first that the variability of profit rates of firms in a particular class is inversely correlated with size (this applying to both the profitable manufacturing firms and all manufacturing firms); second, the time variability of the average rate of return of both the smaller firms and larger firms is less than that of the medium-sized firms.

The behaviour of profit rates and the variability of profit rates relative to the size of firms were also examined by J.M. Samuels and

D.J. Smyth[43]. Their data consist of annual observations for the ten years 1954 to 1963 of profits and net assets for 186 U.K. companies (engaged in manufacturing, distribution and mining) classified in ten size-groups. Net assets were used as a measure of size and the ratio of profits (after depreciation but before taxation) to net assets as a measure of profitability. This measure of profitability is known to be to some extent sensitive to the method of financing; hence, differences in gearing provide part of the explanation for the observed effect of size of company on the rate of return. Nevertheless, it is maintained by the authors that they are not important enough to provide the complete explanation. The ratio of profitability would have been reduced by only one per cent in the event of a company financing 20 per cent of its assets with loan capital (the average reduction was in fact even less, given that on the average the ratio of long-term debt to the net assets of companies during the period studied had been 10.4 per cent).

Considering the differences in profit rates associated with firm size it is stated by the authors that certain economic pressures might be supposed to be working in the direction of higher rates of return for larger firms, owing, inter alia, to the technical and marketing opportunities open to them while in the opposite direction the usually higher capital-intensity in the larger firms should lead ceteris paribus to lower profit rates. As far as the behaviour over time of the profit rates is concerned it is generally assumed that there has been a pressure on profit rates over the more recent of the years covered, but the evidence is not clear as to whether it is the large or small companies that suffered more from the decline.

Average profit rates for each firm over the ten-year period were calculated and an analysis of variance performed. The variance between groups was found to be greater than that within groups, thus providing some evidence that a firm's size was a significant factor in the determination of its mean profits over the ten-year period, and this finding was further supported when similar analyses of variance were performed for each individual year: two of the F ratios (those for 1961 and 1962) were found to be significant at the 5 per cent level, three more (those for 1955, 1957 and 1958) were significant at the 10 per cent level and one more (that for 1963) was nearly significant at the 10 per cent level.

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43. *Samuels J.M. & Smyth D.J.*: "Profits, Variability of Profits,and Firm Size". Economica, May 1968.

The F ratios for the remaining four years were not significant. For three of these years (1956, 1959 and 1960) the variance within groups was found to be greater than the variance between groups.

Since an analysis of variance tests whether there are significant differences in the profitability of firms of different sizes but it does not indicate whether higher profit rates are associated with large or with small firms, Samuels and Smyth calculated rank-correlation coefficients between profit rates and size groups for each year. All of these coefficients turned out to be negative indicating that profit rates tended to decline with the size of firms. Of the ten coefficients calculated for individual years, four were significant at the 1 per cent level, two more at the 5 per cent level and another at the 10 per cent level, whereas the rank-correlation coefficient for the average of all years was significant only at the 10 per cent level. If the hypothesis was made that there is no correlation between size and profitability, negative and positive rank-correlation coefficients should be expected to be equal in number.

Another feature of the above analysis was that the six rank-correlation coefficients which were significant at the 5 per cent level referred to the last six years of the period covered, implying that the difference in the profit rates of large and small firms was becoming more marked over time. This hypothesis was tested by calculating the rank-correlation coefficient between the ten annual rank-correlation coefficients and time; the value of the new coefficient was found to be significant at the 5 per cent level, thus confirming the hypothesis advanced.

Throughout the period studied there was a pervasive tendency for profit rates to decline with time. The rank-correlation coefficient between the means of all observations and time was found to be –0.87, which was significant at the 0.1 per cent level. The trend in the rate of return was further tested by fitting linear trends for each of the 186 companies. Table 3.4 shows that 102 of the companies had trends that were significant at the 5 per cent level and 82 of these trends were negative. The significant positive trends, on the other hand, tended to be among the smaller firms(14 of the 20 significant positive trends were among firms with assets of less than £ 5 million).

Linear trends were also fitted to the mean profit rates of each size-group; it was found that all the trends were negative and significant at the 5 per cent level except that for the second smallest size-group.

Table 3.4 Trends in profit rates of individual companies

Size-group	Number of observations	Trends significant at the 5 per cent level		
		Positive	Negative	Total
Over £65m	11	0	6	6
£35m - £65m	15	1	14	15
£15m - £35m	20	3	7	10
£10m - £15m	20	1	13	14
£5m - £10m	20	1	6	7
£2.5m - £5m	20	4	7	11
£1m - £2.5m	20	3	10	13
£0.5m - £1m	20	1	11	12
£0.25m - £0.5m	20	5	3	8
Under £0.25m	20	1	5	6
Total	186	20	82	102

Source: Samuels and Smyth, op. cit.

Next the hypothesis that large companies have relatively smaller fluctuations in their profit rates than small companies was tested by comparing the variability of the profit rates of individual firms of different size, the residual variance about the linear trend in the firms' profit rates (rather than variance about means) being the measure of the variability that was used. The analysis of variance for the residual variances showed that the variance between groups is greater than that within groups and therefore the hypothesis that firms of different sizes have different variability of profit rates was not rejected.

The means of the residual variances about trends for the ten size-groups are set out in Table 3.5. The rank-correlation coefficient worked out at –0.56 which is significant at the 5 per cent level: thus the time variability of profit rates is inversely related to firm size.

Table 3.5 Mean residual variance of profit rates about trend

Size-class	Mean residual variance of profit rates about trend
£65m and over	7.73
£35m - £65m	7.61
£15m - £35m	6.44
£10m - £15m	8.76
£5m - £10m	7.90
£2.5m - £5m	9.26
£1m - £2.5m	16.82
£0.5m - £1m	15.78
£0.25m - £0.5m	15.25
Under £0.25m	15.22

Source: Samuels and Smyth, op. cit.

As Table 3.5 suggests that there is a marked difference in the variability of profit rates of firms with assets in excess of £2.5 million and those with assets less than that amount, the firms were classified in two groups (the dividing line being the amount mentioned) and the means of the residual variances of the profit rates of the individual companies in the two groups calculated. Application of the t test showed that the means were significantly different at the 0.1 level.

The hypothesis that investors demand a higher rate of return from those firms that have greater profit variability was tested by using data for all the 186 firms in the sample for fitting a regression between profit rates and residual variances, but since a value of r^2 equal to 0.011 was obtained the hypothesis was not accepted.

The variability of profit rates among the different firms in the same size-group for the same year was examined by calculating the intra-group variances and the rank-correlations between variability and firm size for each of the years. All the rank-correlation coefficients turned out negative, four of them were significantly different from zero at the 1 per cent level and another five at the five per cent level. Thus the variability among profit rates of firms of the same size was greater for small firms than for large firms.

The authors also made use of the model which rests on the assumption that large firms are composed of a number of small independent profit centres, each of which can be likened to a small firm. The

model was tested against the results of their study, but the authors state that the results are difficult to summarize, the conclusion being that the standard deviations declined as class-size increased, but at a rate slower than that predicted by the model[44].

The main conclusions of the paper by Samuels and Smyth are, first that profit rates and firm size are inversely related, second that both the time variability of profit rates and the intra-group variability of profits are inversely related to firm size.

The relationship between size and profitability was also studied by Singh and Whittington[45]. The firms included in their study were public companies whose stocks or shares were quoted on U.K. Stock Exchanges during the period 1948 to 1960, while the basis of the study was accounting and stock market data for approximately 450 of the above mentioned companies belonging to four industries: Shipbuilding and Non-Electrical Engineering, Food, Clothing and Footwear, and Tobacco.

The pre-tax rate of return on net assets and the post-tax rate of return on equity assets were used as measures of profitability, while the balance sheet or book value of net assets was used as a measure of size of the firm. Their analysis was conducted largely on an industry basis.

A comparison of average rates of return on net assets between size-classes for sub-period 1948-54 showed that for two industries (Clothing and Footwear, and Food) there was no systematic tendency for profitability to vary with size. However, in the largest industry, Engineering, and in the "all industries" group the average rate of return tended to decline with the size of firms.

In sub-period 1954 to 1960 profitability tended to increase with size in the Food industry and to a lesser extent in the Clothing and Footwear industry. As for the Engineering industry although there was a slight tendency for profits to decline with size, there were very small

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44. Another hypothesis examined in their study was that firms in the more highly concentrated industries have less variable profits than firms in less highly concentrated industries. The index of concentration used for each industry was the percentage share of the three largest firms in the total production of that industry. It was found that firms operating in highly concentrated industries had less variable profits than firms operating in less highly concentrated industries.

45. *Singh A.* & *Whittington G.*: (in collaboration with *Burley H.T.*): "Growth Profitability and Valuation", Univ. of Cambridge Dpmt. of Applied Econ., Occasional Paper 7, C.U.P. 1968.

variations in profitability with respect to size. It should be noted, however, that in both sub-periods the differences between means were found to be non-significant at the 10% level.

The pattern of profitability with respect to size described above was found to be consistent with that holding for the whole period (1948-1960), which is shown in Table 3.6. Hence, the authors' preliminary conclusion as to changes in average profitability with respect to size is negative, there being found to be no systematic tendency for average profitability to increase or decrease with changes in the size of firms.

T a b l e 3.6 Rate of return (on net assets) by opening size-class. Period 1948 - 1960.

Opening Size \ Industry	Clothing and Footwear			Food			Engineering			All (incl. Tobacco)		
	n	m	s	n	m	s	n	m	s	n	m	s
1. <£ 250,000	23	12.6	11.6	20	19.1	9.1	39	23.3	9.7	82	19.3	11.0
2. <£ 500,000	16	18.7	11.0	19	14.4	7.2	41	19.4	8.1	76	18.0	8.8
3. <£ 1,000,000	18	13.7	6.8	8	16.3	11.2	55	20.7	10.4	82	18.6	10.1
4. <£ 2,000,000	7	14.4	5.5	7	21.4	6.8	40	20.8	9.3	55	19.7	9.1
5. <£ 2,500,000	6	15.5	4.1	19	18.5	5.8	39	17.3	6.0	69	17.2	5.8
All companies	70	14.7	9.5	73	17.6	8.0	214	20.3	9.1	364	18.5	9.2

n = number of companies, m = arithmetic mean of rate of return (net assets), s = standard deviation, corrected for degrees of freedom.

Significant differences between means, at the 10% level

Industry groups	*Size-classes significantly different*
Clothing and Footwear	None
Food	1⟩2 2⟨4 2⟨5
Engineering	1⟩2 1⟩5 3⟩5 4⟩5
All four industries including tobacco	4⟩5

Source: Singh and Whittington, op. cit.

As for the dispersion of profitability within size-classes (as expressed by the standard deviation) it was found that, with minor exceptions, there was a tendency for the degree of dispersion of profit rates to decline with the size of firms and this was true of both of the two sub-periods

(1948-54 and 1954-60) and of the whole period (1948-60). However, only in the Clothing and Footwear industry was the tendency consistent between all size-classes.

The pattern of means and standard deviations of profit rates were found to be very similar when post-tax rates of return on equity assets were used instead of rates of return on net assets; the only systematic difference between the two distributions of the measures of profitability was that the mean of post-tax rate of return on equity assets tended to be relatively higher in the larger size-classes.

The relationship between size and profitability was further investigated by regressing profitability on size. The zero-order correlation coefficient showed a very weak linear relationship between size and profitability regardless of which measure of profitability was used; in fact the coefficients (for the full population for the whole period) were –0.06 and –0.01 when the rate of return on net assets and the rate of return on equity assets were used as measures of profitability respectively. It was found nevertheless that ten out of the twelve values of the regression coefficients (b) were negative meaning that profitability tended to decline slightly with size.

Since a low value of r for any two variables may arise not because the two variables are not related, but merely because the relationship is non-linear, a semi-logarithmic equation of the following form was fitted to the data:

$$P = a + b \log S + \varepsilon \tag{3.1}$$

where P = rate of return on net assets
S = opening size
ε = error term
and log indicates logarithms to the base e.

The above equation implies that a given proportionate change in opening size will cause the same absolute change in the rate of return for all sizes of firms. In most cases it was found that the degree of explanation of the variation of rates of return (indicated by r^2) was improved and that the regression coefficient (b) was more significant than was the case with the simple linear equation. These in turn imply that the logarithm of size seems to explain profitability better than does the absolute value of size, i.e. it is proportionate variations in opening size rather than the absolute amount of such variations that account for absolute changes in profitability. Nevertheless, despite the improvement in the degree of explanation, the values of r^2 remained low; so far as the

regression coefficients are concerned, eleven out of twelve turned out to be negative (eight of them being significant at the 5% level)[46].

Finally, to test the hypothesis that a given proportionate change in opening size causes the same proportionate change in profitability at all levels of size and profitability, the following fully logarithmic equation was fitted:

$$\log P = a + b \log S + \varepsilon \qquad (3.2)$$

A comparison of the regression results showed that the semi-logarithmic equation provides, in most cases, a better explanation of profitability in terms of size than does the double-logarithmic equation, although the authors admit that the goodness of fit of the two equations cannot be directly compared with each other.

To ascertain whether a more complex curvilinear relationship could be formed which would give a better fit to the data, the regression analysis was extended to the following equations:

$$P = a + bS + cS^2 + \varepsilon \qquad (3.3)$$
$$P = a + bS + cS^2 + dS^3 + \varepsilon \qquad (3.4)$$
$$P = a + bS + cS^2 + dS^3 + eS^4 + \varepsilon \qquad (3.5)$$
$$P = a + b\log S + c(\log S)^2 + \varepsilon \qquad (3.6)$$

It was then found that none of the above equations gave a better fit than the simple semi-logarithmic equation.

Fairly similar results were obtained when the rate of return on equity assets (rather than the rate of return on net assets) was regressed on size with the following remarks:

— the relationship between size and profitability was less strong and the simple linear equation yielded no values of the regression coefficients which were significant at the 5% level; in addition, only seven of the twelve coefficients were negative and the highest r^2 obtained was only 0.01.

- the semi-logarithmic equation again yielded the best results, the highest r^2 being 0.08 and eleven out of twelve regression coefficients being negative with five of them significant at the 5% level.

Thus the results of the regression analysis, outlined above, corroborated the authors' preliminary conclusion that the average rate of return is independent of the size of firm, if all companies are considered.

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46. It should be noted that Stekler using the same equation found the value of b to be positive and the value of r^2 equal to 0.68: *Stekler H.O.*: "Profitability and Size of Firm", Univ. of Calif. Press, Berkeley 1963.

The regression analysis, however, revealed that if non-growing and unprofitable firms are excluded there is a weak but statistically significant tendency for profitability to decline with size. The reason for this is that since most non-growing and unprofitable firms tended to pertain to the smallest size-classes, the exclusion of such loss-making companies would tend to raise the average profit rate of these size-classes.

Another interesting feature which was borne out was that the inter-industry differences in average pre-tax rates of return were much lower for the largest firms than for the smaller firms; as for the post-tax rate of return on equity assets, the inter-industry differences and the dispersion of profitability for the largest firms were found to be almost negligible in every period.

The a priori reasons which could make for the similarity in the profitability experience of the largest firms are first, that large firms are relatively more likely to be subject to the discipline of the stock market; this argument is based on the fact that large firms have a more dispersed ownership of shares and in addition there was some evidence that large firms tended to raise a larger proportion of external finance than smaller firms. Second, large firms tended to be more diversified than small firms.

The persistency of rates of return over time was next examined in order for the writers to test the hypothesis whether profitability is to any degree a causal phenomenon depending, for example, on such factors as the quality of a firm's management, or on the monopoly power it enjoys, or both. The validity of the hypothesis was tested by fitting a simple linear regression model. The regression revealed that there was a fairly strong relationship between the rates of return in the two periods, when pre-tax rate of return was used as a measure of profitability. For all four industries together, r^2 was as high as 0.37 implying that profitability in the first sub-period (1948-54) provided a 37% explanation of the inter-firm variation in the profitability in the second sub-period (1954-60); it should be noted that the value of r^2 in the case of the large Engineering industry was even higher (in fact it was worked out at 0.53) and the regression coefficients were positive and highly significant in each of the major industries.

A fairly strong persistency was also revealed when post-tax rates of return on equity assets were used instead of pre-tax rates of return on net assets. The b coefficients were once again positive (although in the case of Clothing and Footwear both the b and r^2 coefficients were statistically insignificant). The values of r^2 were now lower than was the

case with the pre-tax profitability, except in the Food industry.

To overcome the problems of extreme values and those of possible non-linearity the analysis of persistency of rates of return was further investigated by considering the coefficients of rank-correlation between the ranks of rates of return (both pre-tax and post-tax) in the first sub-period and the corresponding ranks in the second sub-period. The coefficients were found to be significantly different from zero at the 1% level in each of the major industries. The rank-correlation analysis also revealed a fact similar to that revealed by the regression analysis, i.e. that the persistency is greater when pre-tax rates of return on net assets are used than when post-tax rates of return on equity assets[47] are used.

The authors' conclusion is that but for the possible effects of aggregation, profitability is not a random phenomenon and that the relative profitability of a firm in the first sub-period was an important guide to its relative profitability in the subsequent sub-period. For this conclusion to be firmly established the effects of aggregation had to be considered. To this end, rank-correlation coefficients between the rates of return in the two successive sub-periods for the sub-groups within each industry were computed. In general, it was found that there was a significant association between the profitability of firms in the two periods, a fact which implies that their previous finding of persistency in the rates of return for each of the major industries did not arise merely from aggregating sub-groups within each industry.

In closing this chapter we should mention that attempts to explain the relationship between size of firms and profitability have identified the size distribution of rates of return as embodying a negative correlation of profitability with size[48,49,50], a positive correlation[51,52,53,54], a para-

47. However, since the differences were very small the authors recognised that such differences could easily have arisen from the different taxation systems which were in force during the two sub-periods as well as from differences in gearing among companies.

48. *Dewing A.S.*: "A Statistical Test of the Success of Consolidations". The Quart. Journal of Economics, 1921.

49. *Epstein R.C.*: "Industrial Profits in the U.S.", N.B.E.R., New York, 1934.

50. *U.S. Govt. TNEC* Monograph No. 13, Washington D.C., 1941.

51. *Crum W.L.*: "The Effect of Size on Corporate Earnings and Condition", Harvard Univ., Division of Business Research Studies, No. 8 1934.

52. *Crum W. L.*, op. cit.

53. *Anthony R.N.*: "Effect of Size on Efficiency". The Harvard Business Review, 1942.

54. *Steindl J.*: "Small and Big Business". Blackwell, Oxford, 1945.

bolic relationship[55,56,57], while other studies revealed no significant relationship whatsoever[58,59,60,61,62,63,64].

3.2. CONCLUSIONS AND DISCUSSION

The existence of a systematic relationship between size and profitability has long been of interest both to economists and investors and several hypotheses have been advanced at times. It would be therefore interesting if the empirical studies bearing on this relationship could shed some light, thus confirming some of the theories advanced. Unfortunately, it cannot be said that the extant evidence is conclusive. The findings range from a negative correlation (e.g. Dewing, Epstein, Samuels) or a positive correlation (e.g. Crum, Steindl) to a parabolic relationship (e.g. Stekler, McConnell) and to the lack of any significant relationship. (Bain, Barron etc.).

The reasons for this inconsistency in conclusions might be traced to various factors, and it should be said that not all of the studies can be easily compared with each other. The degree or extent of aggregation differs in the different papers and although Singh and Whittington found that as far as their particular study was concerned their conclusions were not affected by the effects of aggregation, it is known that aggregation may lead to spurious conclusions, particularly if heteregeneous sub-groups are aggregated within each industry. Thus, if in fact there is no persistency in the rates of return within each sub-group, but there is persistency in the average rates of return of the sub-groups

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55. *McConnell J.L.:* "Corporate Earnings etc."
56. *McConnell J.L.:* "1942 Corporate Profits etc."
57. *Stekler H.O.:* "Profitability and Size of Firm".
58. *Bain J.S.*: "Barriers to New Competition" H.U.P., Mass., 1956.
59. *Barron M.J.*: "The Effect of the Size of Firm on Profitability". Business Ratios (Spring 1967).
60. *Epstein R.C.*:"Industrial Profits in 1917". The Quart. Journal of Econ. 1925.
61. *Epstein R.C.*: "Profits and Size of Firms in the Automobile Industry, 1919-27". The Amer. Econ. Review,1931.
62. *Osborn R.C.*: "Efficiency and Profitability in Relation to Size". The Harvard Business Rev.,1951.
63. *Summers H.B.*: "A Comparison of the Rates of Earnings of Large and Small-scale Industries". The Quart. Journal of Econ., 1932.
64. *U.S. TNEC* Monograph No. 15 Washington D.C. 1941.

themselves, aggregation of these sub-groups will result in persistency in the rates of return of the firms within the industry. The relative prosperity of different industries, on the other hand, may vary in different periods of time and aggregation of such industries of varying degrees of prosperity may also lead to a spurious relationship between size and profitability.

M.J. Barron found that a major source of the variance of profitability in an aggregated sample is variation between industries. This variance is hardly surprising when one takes account of such factors as differences in economies of scale, monopoly power, the distribution of demand and the distribution of rate of growth of demand between industries.

Revaluations may provide another explanation for the observed inconsistency in the conclusions reached by the various researchers, since not all of them took account of this factor. Yet it is plain, as was said in the first chapter, that if revaluations tend to cluster in a particular size-class or classes, the conclusions on the relationship size-profitability will tend to be biased. In fact Singh and Whittington showed that during the period 1954-60 there was a tendency for the incidence of revaluations to vary positively with size. If this is the case, the conclusions of Samuels-Smyth that profit rates decline with size may have been biased due to the effect of revaluations.

Small firms are known to tend to misclassify their profits because of the treatment of officers' compensation and Stekler has shown that the officers' compensation adjustment has the greatest effect on the profits of small firms. Hence, given that some researchers made an attempt to devise some defensible methods for making suitable adjustments (Alexander, McConnell) while others made no such attempts, the difference in conclusions could – at least partly – be due to the different treatment of the above-mentioned problem.

As a shortcoming of many papers one should mention the fact that it is not clear from them what number, if any, of the firms in the smallest size-classes were deficit companies, although this was found to be important in the U.S. studies. This along with the facts that the population of small firms tends to be very large relative to large and medium-sized firms and a number of such small firms tend to be deficit firms suggest that the particular composition of the sample of firms might have an important bearing on the over-all conclusions; a number of the small, deficit firms should be included in order for the sample to be "representative".

Despite the inconclusiveness of studies as regards the profits-size relationship when both deficit and profitable firms are considered, the existing empirical evidence appears fairly conclusive on the whole – at least as far as the U.S. is concerned – when only profitable firms are considered, suggesting that profitability tends to decline with size (cf. Crum, Sherman).

The variability of profit rates both over time and within particular size-classes is also of interest. Unlike the conclusions on the profitability-size relationship, the empirical evidence bearing on the variability of profit rates is fairly conclusive: it was found on the whole that variability was inversely related to size (Alexander, Stekler, Samuels-Smyth, Singh-Whittington etc.). This in turn is consistent with a priori expectations, since large firms tend to be more diversified in product and geographical markets than small firms, whereas the latter tend to be engaged in a relatively small number of trades. Larger firms being able to spread business risk are capable of reducing the variability of their over-all profit rate and thus gain greater certainty of profitability.

A further factor making for the greater variability among small firms might be that small firms tend to have fewer customers and hence there is a greater incidence of risk embodied in this dependence. In addition, large firms appear to be relatively more subject to the discipline of the stock market, first because they have a more dispersed ownership of shares, and second because there was some evidence (cf. Singh-Whittington) that large firms tended to raise a larger proportion of external finance than smaller firms. Finally, another possible explanation could be that managements of large firms tend to be more cautious. The fairly conclusive empirical evidence bearing on the variability of profit rates might have some interesting implications for the investors as well as for the management of firms.

With respect to investors greater size can be a desirable characteristic as it would imply greater certainly. Since large firms were found to have greater stability from year to year in their rates of return, an investor's future dividend payments are less likely to fluctuate violently and the company is less likely to run into financial difficulties through incurring losses.

Nevertheless, the second aspect of the "greater certainty" implication (i.e. the inter–firm variation in the rates of return is less amongst larger firms) may be of less interest to the investor for two reasons. Firstly, because the investor is in essence interested in the rate of return

on the price at which he acquired his shares, rather than the rate of return on assets. In this respect, inter-firm differences in the valuation ratios may be such as to result in virtually more variable prospective price/earnings ratios as between large firms than as between small firms. Secondly, even if it is assumed that large firms do have less inter-firm variation in prospective price/earnings ratios this will imply that the investor is more likely to receive a near-average return on the shares of randomly selected smaller firms. This in turn means that, granted that the investor has confidence in his own judgement, he might be supposed to prefer to invest in small firms, since they represent the most profitable (as well as the least profitable) prospects.

So far as the managements of firms are concerned the lower variability of profitability amongst large firms implies that managers of such firms are more likely to achieve a steady rate of return at a level approximating the industry average, rather than achieve an exceptionally high rate of profits or incur a heavy loss, i.e. the reward of size is more security and less spectacular results.

It would be interesting if such conclusions could be drawn from the empirical evidence bearing on the relationship between size and profitability. However, since the present state of this evidence is inconclusive it is rather difficult to make any generalisation. True, some researchers have attempted to point out the implications of their findings as for the managements, investors, public policy etc. (see for instance G. Whittington: the Prediction of Profitability C.U.P. 1971 p.p. 231-50), but since their findings are in conflict with others, such generalisations should be viewed with caution.

CHAPTER FOUR

PROFITABILITY AND RATE OF GROWTH

4.1. THE RELATIONSHIP BETWEEN PROFITABILITY AND GROWTH

The relationship between profitability and growth has been studied by Singh and Whittington[65]. It is argued that a firm's rate of growth depends both on its ability to grow and on its willingness to grow. Its ability to finance growth is to a considerable extent dependent upon its achieved profitability, but a firm's willingness to grow does not depend so directly on its profitability, although it is admitted that profitability does provide an incentive for growth. It is other considerations such as the state of competition, the caliber of management, the demand conditions, technological opportunities etc. which are of greater importance in this context.

It is further argued that in an expanding economy one should expect to find a positive correlation between growth and profitability since profits provide the ability to grow. But as the factors affecting the willingness to grow are likely to differ between different industries or within the same industry at different points in time, it should be expected that the magnitude and the particular form of the positive association between the two variables in question will be different in different industries or within the same industry at different points in time. In addition, there may be differences in the factors affecting the above-mentioned willingness between large and small firms.

After these a priori predictions the relationship between profitability and growth was explored by means of regression analysis. The regression models tested were of the following forms:

$$G = a + bP + \varepsilon \qquad (4.1)$$

$$G = a + b\log P + \varepsilon \qquad (4.2)$$

$$\log G = a + b\log P + \varepsilon \qquad (4.3)$$

65. *Singh A. & Whittington G.*, op. cit.

(Equations (4.2) and (4.3) required the exclusion of negative values of growth and profitability). It was found that in most cases the simple linear regression equation relating growth to profitability was the most appropriate one in the sense that it gave a better explanation (i.e. it explained a higher proportion of the variance of growth rates) when the full population was considered rather than the restricted population applying to the logarithmic equation. When the restricted population of profitable and growing firms was considered the degree of explanation was not improved when equation (4.2) was used instead of equation (4.1). The strongest result for the restricted population was yielded by equation (4.3). Despite this, their subsequent analysis referred to the simple linear equation.

Another feature which was borne out of the regression analysis was that of the two measures of profitability used in their study, i.e. pre-tax rate of return on net assets, and post-tax rate of return on equity assets, the latter provided a better explanation of growth rates than the former.

The regression coefficients (b) were positive in all cases and were on the whole higher when post-tax rates of return were used. Thus for the "all industries" group the value of b in both sub-periods (1948-54 and 1954-60) was approximately equal to 0.70 when post-tax rates were used, whereas the corresponding value when pre-tax rates were used was approximately equal to 0.40. These in turn imply that a ten-per-cent change in the pre-tax rate of return was associated with a four-per-cent change in the growth rate while an equal change in the post-tax rate of return was associated with a seven-per-cent change in the growth rate. (It should be recalled that we refer to the simple linear equation. In what follows the analysis refers to post-tax rates of return on equity assets).

The regression analysis also showed, with respect to stability over time, that for each individual industry group the regression coefficient (b) differed substantially between the two sub-periods. There were also substantial differences in the degree of explanation of variations in growth rates between the two periods, which were due to the greater dispersion of growth rates of the moderately profitable companies during the second sub-period (1954-60). The authors' conclusion is that the relationship between profitability and growth may change substantially over time within individual industries.

Since the regression analysis revealed, in addition to inter-temporal differences, that there were considerable inter-industry differences

between the regression coefficients (b) as well as in the degree of explanation of growth rates (r^2), the authors set out to further test the existence of such differences by estimating an equation embodying dummy variables of the following form:

$$G = a_1 + b_1 P' + b_2 P' D_1 + b_3 P' D_2 + a_2 D_1 + a_3 D_2 + \varepsilon \quad (4.4)$$

where P' = post-tax profitability

$$D_1 = \begin{cases} 1 \text{ for companies in engineering industry} \\ 0 \text{ for other companies} \end{cases}$$

$$D_2 = \begin{cases} 1 \text{ for companies in food industry} \\ 0 \text{ for other industries} \end{cases}$$

The equation was estimated on data for the three large industries together of which Clothing and Footwear acted as a base industry. The regression results showed that during the period 1954-60 the dummy variables were highly significant which means that the base industry was significantly different from the other two industries from the point of view of the regression coefficient (b) as well as the constant term in growth (a). During the sub-period 1948-54 Clothing and Footwear was found to be singnificantly different from Engineering as regards the regression coefficient, but differences in the (a) term seemed insignificant. Thus, this further analysis, described briefly above, corroborated their previous conclusion that inter-industry differences in the relationship between profitability and growth were statistically significant.

In order for the authors to find out to what extent, if any, the relationship between growth and profitability for the largest firms was different from that observed for the smaller-sized firms, the following two linear equations were fitted to the populations of firms with book-value of net assets greater than 2 million pounds:

$$G = a + bP' + \varepsilon \quad (4.5)$$

$$G = a_1 + b_1 P' + b_2 P' D_1 + b_3 P' D_2 + a_2 D_1 + a_3 D_2 + \varepsilon \quad (4.4)$$

The results obtained showed almost invariably that there were few significant inter-industry differences at the 5% level between the regression coefficients and this was true of all periods. Thus the conclusion was drawn that it is not possible to reject the hypothesis that the observed growth-profitability observations for the different industries

in each period came form the same population or from the same "structure".

As regards the inter-temporal differences in the regression coefficients the conclusion was similar to that for the inter-industry differences, i.e. it was found that there were very few significant inter-temporal differences.

Regression model (4.4) was fitted to small firms (i.e. firms with net assets of less than 2 million pounds) in each of the three periods. The relevant comparison revealed that the b coefficients were considerably different as between large and small firms,although the direction of differences was not always the same.

To test the statistical significance of these differences an analysis of co-variance was carried out by means of which there was tested the hypothesis that the regression equations relating to the largest and smaller-sized firms belong to the same statistical structure for the same period. The analysis of co-variance showed that for the first sub-period the F ratio was not significantly different from zero and so the hypothesis could not be rejected; but for the second sub-period and the whole period studied (1948-60) the F ratios were found to be significantly different from zero implying that with regard to these two periods the structural differences in the relationship between growth and profitability were statistically significant as between the largest and smaller-sized firms.

The analysis was carried a step further: since profitability explained only about 50% of the inter-firm variance of growth rates, thus leaving a large residual element, the authors tested the hypothesis that the residual growth rates were determined by the Law of Proportionate Effect, once the systematic influence of profitability was removed.

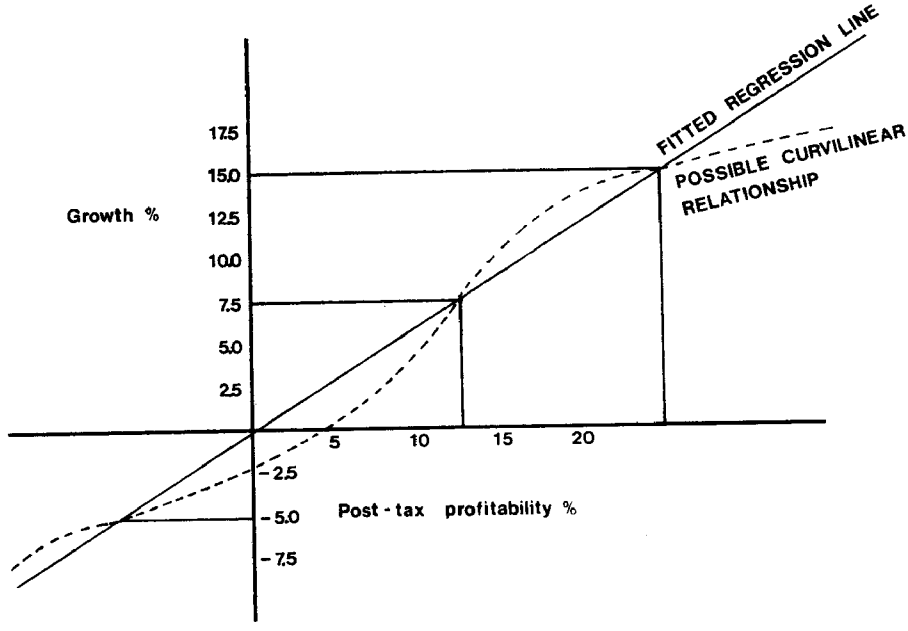
The bivariate distribution of residual growth rates by size of firms (derived form equation (4.5)) revealed that although there were no significant differences between the means of the size distribution of residual growth rates, there was significant heterogeneity of variances between size-classes. The same pattern was obtained when instead of the residuals from the simple linear equation, the size distribution of the logarithms of the residual growth rates from the log-linear equation was observed. These findings—which denied the influence of Gibrat's Law—are hardly surprising according to Eatwell[66] since the model (i.e. that the residual

66. *Eatwell J.L.*, op. cit.

growth rates are determined by the Law of Prop. Effect) is not reasonable theoretically, for it ignores the interdependence of the distribution of profit rates and growth rates through the size distribution.

The failure of the residual dustribution to conform to the predictions of Gibrat's Law pointed to the possibility of a specification error in the models used, which could arise from the fact that there is a complex non-linear relationship between growth and profitability, as opposed to a simple linear or loglinear one. As is shown in diagram 4.1 at very low predicted growth rates ($\langle -5\%$) the average residual growth was positive. From about -5% to $+7.5\%$ (the latter was approximately the level of average growth) the average residual growth rates were negative; finally, at above the level of average predicted growth (i.e. from 7.5% to 15%) the residuals were again positive and at very high predicted growth rates ($\rangle$ 15%) the residuals were again negative.

Diagram 4.1.



Source: Singh and Whittington, op. cit.

The postulated curvilinear relationship contains the reasonable implication that growth responds in varying degrees to a given change in profitability at different levels of profitability, e.g. when the profits

are average or above average it is argued that a given change in profitability may be expected to lead to much larger change in growth than when the profits are much below average.

The relationship between growth and profitability was also examined by J. Parker,[67] who gave greater emphasis to the problem of fixed assets valuations. 87 continuing companies from a wide variety of industries were studied for the period 1954/55–1960/61; the companies were selected from those which had revalued during the period studied, and a series of adjusted capital values for these companies was derived by using price indices. Profits were deflated by taking the mean of the index numbers which attempt to measure the price changes in costs and revenues.

Taking the arithmetic average of growth and profitability[68] for each company over the period studied and correlating the results, the correlation coefficient was found to be equal to 0.712, while the coefficient of regression was 0.69; the mean annual profit rate for the period was 15.9% and the growth rate 10%. These results refer to the case where a net assets definition of profitability was used.

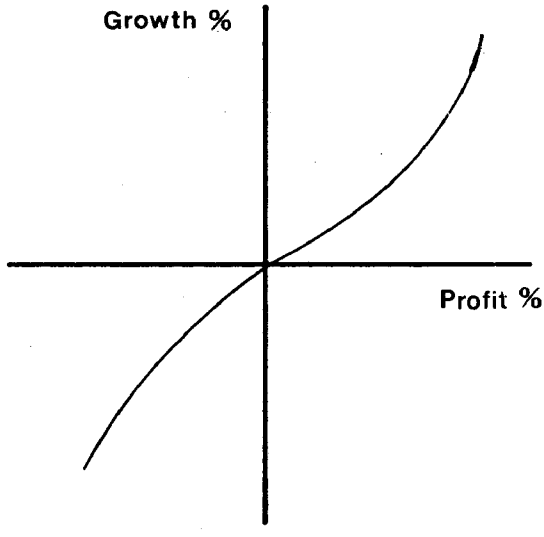
When a total assets definition of profitability was used and growth rates were plotted against profit rates[69] the relationship suggested by the scatter diagram of the data was curvilinear as is shown in diagram 4.2 (this type of relationship was not apparent when a net assets definition of profitability was used).

67. *Parker J.E.S.*: "Profitability and Growth of British Industrial Firms". The Manchester School, 1964 p.p. 113-29.

68. Growth was defined as the arithmetic mean annual % change over the period of adjusted total tangible fixed assets or adjusted total tangible net assets. Alternative definitions were used mainly to try to mitigate the effects of wide fluctuations especially of stocks. Profitability was defined for each company as the arithmetic mean annual % over the period of adjusted total gross profits, i.e. operating profits before taxation and depreciation plus dividends and interest received and other net income over adjusted total net tangible assets, i.e. total assets less goodwill and current liabilities.

69. Growth was now defined for each company as the arithmetic mean annual % change over the period of adjusted total tangible fixed assets or adjusted total tangible assets; profitability in turn was defined as the arithmetic mean annual % over the period of adjusted total gross profits as previously used (in some cases profits were adjusted to make allowance for the missing overdraft interest) over adjusted total tangible assets.

Diagram 4.2



Source: J. Parker, op. cit.

The curve shown in diagram 4.2 is very similar to that suggested by Singh and Whittington except that Parker's curve passed through the origin. When the relationship was treated as linear the correlation coefficient was 0.596 and the coefficient of regression was 0.78. The fact that the correlation coefficient was lower than that obtained on a net assets definition showed that the degree of association between the two variables on a linear assumption was less strong. Nevertheless, when the relationship was realistically treated as curvilinear and the data were plotted on bouble logarithmic graph paper, the index of correlation worked out at 0.631. This improvement from 0.596 to 0.631 implied that the non-linear relationship was the most appropriate description.

The author's conclusion is that the evidence to test the assertion that those firms which grow the fastest are the most profitable ones suggests that overall such a relationship does exist, although it is admitted that the correlation analysis does not determine cause and effect.

J. Parker compares his findings with those of T. Barna[70] whose

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70. *Barna T.*: "Investment and Growth Policies in British Industrial Firms" (A N.I.E.S.R. Occasional Paper), C.U.P., Cambridge, 1962,p.p. 12-13.

statistical analysis covers 74 firms (43 from the Electical and 31 from the Food industries) for the period 1949/50 to the date covered by the last accounts published before mid - 1959. Barna's definitions of growth and profitability were similar to those used by Parker except that Barna included "intangibles" and in addition he made no attempt to allow for the unrealistic valuation of fixed assets. Under these circumstances direct comparisons between the two papers are difficult. Barna's estimates of mean profitability and mean growth are much higher than the corresponding figures obtained by Parker who asserts that if Barna had used more realistic capital figures both his average profit and growth rates might have been lower. But as to what effect this would have had upon the correlation coefficient etc. is a matter which Parker admits cannot be finally decided.

Ed. Kuh examined a large number of models embodying a wide range of independent variables, in an attempt to establish a micro-economic theory of investment[71]. The model most similar to (4.1) was of the following form:

$$\frac{I_t}{K_t} = a + b\frac{P_t}{K_t} + \gamma\frac{S_{t-1}}{CK_{t-1}} \qquad (4.6)$$

where I = gross investment in equipment
K = gross capital stock
P = gross retained earnings
S = sales
and C is an index of capital intensity.

The regression results obtained were as follows: The constant term (a) was found equal to 0.13, the (b) parameter equal to 0.37, the (γ) paramater equal to –0.11 and the coefficient of correlation equal to 0.62.

These results in turn imply that gross investment in equipment (expressed as a percentage of gross capital stock) is positively related to gross retained earnings (expressed as a percentage of gross capital stock) but is negatively related to previous year's sales (expressed as a percentage of the product of the capital intensity index and the previous year's gross capital stock). A ten-per-cent increase in the gross retained earnings (expressed as a percentage) can be expected to result, on average, in a 3.7% increase in the gross investment in equipment (expressed as a

71. *Kuh Ed.*: "Capital Stock Growth: a Micro-econometric Approach",North Holland Publishing Co., Amsterdam 1963, p.p. 77-78.

percentage), other things being equal; on the other hand, a ten-per-cent increase in the previous year's sales (expressed as a percentage as above) will, ceteris paribus, result in a 1.1% decrease in the gross investment in equipment (expressed as a percentage).

It should be noted that the percentage of the growth variance explained by Kuh's model of continuing firms over a twenty-year period is considered particularly extraordinary and high, especially when it is compared with the results obtained by other researchers, who covered a much shorter period (see Table 4.1. below).

Finally, in closing this chapter, Table 4.1 is set out in order for the reader to be able to have a comprehensive picture of the results obtained by various researchers on the relationship between profitability and growth, so that some comparisons can be made.

T a b l e 4.1 Results of regressing growth on profitability

Period of study	Reference	b	r^2
1949 - 59	(8) (a)	0.43	0.525 = r
»	(8) (b)	0.42	0.594 = r
1963-4 to 1967-8	(33)[72]	0.24	0.064
1954-5 to 1960-1	(42) (a)	0.69	0.712
»	(42) (b)	0.59	0.78
1948 - 54	(49) (a)	0.57	0.55
»	(49) (b)	0.55	0.40
»	(49) (c)	0.84	0.61
1954 - 60	(49) (d)	0.98	0.68
»	(49) (e)	0.35	0.09
»	(49) (f)	0.70	0.35
1948 - 60	(49) (g)	0.27	0.19

Definitions:

(8) (a) 43 quoted electrical engineering companies
Profits = gross rate of return on fixed assets
(b) 31 quoted food-processing companies
Growth = gross investment in fixed assets

(33) 299 mechanical engineering companies
Profits = pre-tax return on assets

72. *Jones W.T.*: "Size, Growth and Profitability in the Mechanical Engineering Industry», N.E.D.O., London 1969 (unpublished).

(42) (a) 87 public companies, recently revalued
Profits = gross rate of return from investment at 1961 prices
(b) 87 companies, recently revalued
Profits on gross assets
(49) (a), (d) Quoted clothing and footwear companies
Profits = post-tax rate of return on equity
(b), (e) Quoted food industries. Profits as (a), (d)
(c), (f) Non-electrival engineering. Profits as (a), (d)
(g) All four industries. Profits as (a), (d)

It is worth noting that, despite the variety of definitions and samples used in the calculations of Table 4.1, the results are somewhat homogeneous.

4.2. CONCLUSIONS AND DISCUSSION

The traditional neo-classical theory of the firm does not help us very much with the relationship between profitability and growth of firms. Under its usual assumptions of perfect competition in all markets, given tastes, technology, etc., growth is thought of only as a by-product of the firms' attempt to reach the "optimum size" at which they maximize profits. Therefore under conditions of equilibrium, when all firms are assumed to have reached their optimum size, no such relationship between profitability and growth will exist, if only because there will be no attempts of firms to grow any further. Clearly, at any point of time there may be firms moving towards equilibrium and this may make for some relationship to exist on a cross-section basis, but the character, strength, and nature of this relationship will in general be indeterminate, depending on the causes of disequilibrium and the speed of adjustment (Singh - Whittington).

Since the above theory is essentially static and its assumptions are not met in real economic life, attempts have been made to explore empirically the relationship between the two variables in question; in the present chapter, there were presented some of the empirical findings available in the relevant literature.

The general picture which emerges from a survey of the empirical investigations is that these investigations do not tell us very much about the choise made by managements between the two variables, although

this choice has triggered off considerabe theoretical controversy in recent years. Most of the empirical work has concentrated on linear or log-linear single equation estimates of the relationship, but such estimates rest on an underidentified reduced form and do not reveal the complete causal structure between the two variables.

The main statistical technique which was used throughout the relevant studies was correlation. But as correlation is neutral as to causation, it might indicate that growth determines profitability or that profitability determines growth or that they react mutually upon one another. Such a comprehensive model in which growth and profitability are simultaneously determined by each other (as well as by other financial variables) would seem more plausible.

Another feature of the relevant studies is that profitability was assumed to be the independent variable and growth the dependent variable rather than the other way about. The reasons for this preference are given by the authors themselves: The former relationship seems a priori to be the most interesting and relevant one (Singh - Whittington). It is also maintained that when regressing long-term growth on long-term profitability, the former more conventional and intuitively more direct relationship is more likely to be identified than the latter; the major justification for this contention is that the variance of the error term is likely to be much smaller when using profitability as independent variable than when using growth as independent variable (Eatwell).

On a priori grounds one would expect a significant relationship to exist between the two variables, which possesses elements of dual causation: firstly profitability provides an incentive and the means for a firm's growth, in the sense that increased profitability facilitates internally financed growth and also serves as an attraction for external finance. Secondly, the rate of growth of the firm will determine the level of profitability attainable relative to that rate of expansion (E. Penrose).

Singh and Whittington state that the growth of a firm depends both on its ability and its willingness to grow. But while the profits provide the ability to finance growth, the willingness to grow depends on a number of important factors other than profitability; often these factors will explain a greater proportion of the variance of the growth rates than will profitability. The importance of these factors, on the other hand, may vary between industries, over time and between different types of firms within an industry (small–large, long established – new entrants, highly diversified – uniproduct etc.). Nevertheless, it is agrued

that the environmental parameters of the profitability–growth relationship are not likely to be distributed in such a heterogeneous way as to obscure the relationship entirely. Hence, in a cross-section of firms one would expect to observe a positive association between profitability and growth, although this relationship need not necessarily be a close one (Eatwell).

The main conclusions of the empirical investigations bearing on the relationship under consideration are as follows:

First the association between growth and profitability was found to be fairly strong with profitability explaining on the whole a large proportion of the variation in growth rates (Table 4.1).

Secondly, it was found that the post-tax rate of return on equity assets provides a much better explanation of growth than the pre-tax rate of return on net assets.

Thirdly, the regression coefficients relating growth to profitability were found to vary significantly as between different industries and over time. This in turn implies that the relationship in question may change substantially over time within individual industries; it may also have some important implications for some recent proposals relating to the theory of the firm, e.g. the proposal by Marris that an industry norm could be established for the level of profitability necessary to sustain a given level of growth of individual companies. The empirical evidence to date suggests that the establishment of such norm from historical data is impossible.

The profitability-growth relationship was examined for larger firms only and for smaller firms only and the two relationships compared with each other. It was then found that among the large firms the relationship in question did not vary significantly among industries, but the regression coefficients were considerably different between small and large firms, although the direction of differences was not consistently the same and thus no generalisations could be made.

The practical implications of the above findings are first that the conventional industrial classification is less relevant for the largest firms and second that the distinction between small and large firms is significant, so far as the analysis of growth and profitability is concerned.

The hypothesis that the residual growth rates were determined by the Law of Proportionate Effect, once the influence of a major systematic factor such as profitability was removed, was rejected; the distributions

of residual growth rates were found to be incompatible with this hypothesis. This failure suggested that perhaps the linear regression equation contains a specification error and that the relationship between growth and profitability of firms is complex and non-linear (Singh - Whittington, Parker).

CHAPTER FIVE

FIRM SIZE AND RATE OF GROWTH

5.1. THE EMPIRICAL EVIDENCE ON THE RELATIONSHIP BETWEEN SIZE AND GROWTH

The size and growth rate of a firm are respectively the static and dynamic expressions of the same economic phenomenon. Most of the studies with regard to these two variables have made an attempt to test the empirical validity of the Law of Proportionate Effect and its implications.

J. Samuels[73] examined a sample of 400 companies in existence in the year 1950/51, but of these firms only those that were in existence both at the beginning and end of the period covered (1950-60) were considered, i.e. births and deaths during the period were ignored, although the probabilities of these events are likely to be different for large and small firms. One measure of size used in the study was net assets; the net assets of companies in 1951 were compared with the net assets of the same companies in 1960 to obtain the proportional change.

Two tests were performed on the data: the first tested the existence of significant differences between the mean rates of growth of the different size-classes. The companies sampled were classified in four sizes: very large (£3 m. issued capital or over), medium-large (£1 m. issued capital to short of £3 m.) smaller-large (£0.2 m. issued capital to short of £1 m.) and small (less than £ 0.2 m. issued capital).

For the second test the firms were classified in fifteen size-classes according to their net assets in 1950/51 and 1959/60 and the regression of logarithms of size in 1959/60 on that in 1950/51 determined.

As was the case with other studies, the size distribution of firms and the distribution of proportionate change in net assets were found to be skew and it is known that such distributions tend to be lognormal after loga-

73. *Samuels J.*, op. cit.

rithmic transformation. The implication of Gibrat's Law which was tested was that large and small firms have the same average proportionate rate of growth and to this end the means and variances of the logarithms of proportionate change were calculated. It was then found that at the 5% level there was no significant difference between the variances but at the same level of probability the means of the size-classes were significantly different. Thus the findings were inconsistent with the implications of Gibrat's Law referred to above.

Another implication of Gibrat's Law was also tested, namely that the relative dispersion of the size of firms tends to increase with time and it was found that this dispersion increased from 2.89 in 1950/51 to 4.18 in 1959/60.

To test if firms regressed towards the mean size the author carried out a test on the bivariate size-disribution of firms; the test was based on a growth equation (developed by Hart and Prais[74]) which provides such a test of regression: the relationship between the variances at two dates is given by:

$$V(X_{t+1}) = b^2 V(X_t) + \sigma_\varepsilon^2 \qquad (5.1)$$

where: X_{t+1} and X_t = the logarithms of a firm's size at a base date t and any subsequent date $(t + 1)$

b = the regression coefficient

and σ_ε^2 = the residual variance

If $b < 1$, there is regression towards the mean and small firms grow at a faster proportional rate than large firms. If $b = 1$, large firms and small firms grow at the same rate (as required by Gibrat's Law). If $b > 1$, there is no regression towards the mean and the large firms grow at a faster proportional rate than the small. It was found that b was significantly greater than 1 at the 5% level which means that large firms experienced a faster proportional growth over the period studied, which is a further refutation of Gibrat's Law.

However, since the different proportional rates of growth could be due to the likelihood that the effects of mergers and take-overs were greater on large firms than on small firms, the increase in the net assets of companies was examined to determine the proportions of growth due to external growth and internal growth.

With regard to large companies it was found that when net assets

74. *Hart P.E. & Prais S.J.*, op. cit.

obtained from external growth were excluded from the total net assets of the companies in 1960/61, the proportionate rate of growth was 2.39, while the overall rate of growth was 2.66; these figures in turn implied that the annual average rate of growth was 18.4% of which 2.9% was due to amalgamations. The corresponding figures for medium-large companies worked out at 14.8% and 2.3%. This means that, even when external growth is taken account of, there is still a significant difference in the rates of growth of these two size-groups and the failure of Gibrat's Law to operate cannot be ascribed to the increasing importance of amalgamations.

Nevertheless, an examination of the importance of amalgamations on the growth of small-large firms showed that with regard to these firms they were less significant, for with an average annual growth of 10.8% only 1.2% was due to acquisitions; thus at this size level it is possible that the reason for the failure of Gibrat's Law to operate was due to the different effect of acquisitions[75].

P.E. Hart tested the empirical validity of four implications of the Law of Proportionate Effect[76]. The first implication tested was that large, medium and small firms have the same average proportionate growth. Four sets of firms were considered by calculating the means and variances of the logatithms of proportionate changes in the profits of these firms, which were subdivided into small and large.

The first set of firms consisted of 40 quoted brewing companies (subdivided into 22 small companies with less than £ 1 million issued capital and 18 large companies); the period covered was 1931/32–1936/37. The second set consisted of 36 cotton spinning companies. The dividing line between small and large companies was drawn at 100,000 spindles and the period covered was 1937–8. The third set of data was made up of 124 units classified in the drink industry, and the dividing line between small and large firms was placed at £1 m. net tangible assets and the calculations related profits in 1954 to those in 1950. Finally, the fourth set of data related to 229 unquoted firms, some private companies and some partnerships, the period studied being 1953-4. Firms

75. Since the techique adopted in order to measure the size of companies acquired was to take the net assets of these companies at their balance sheet dates, the author states that it was not possible to obtain information on the external growth of small firms, as many of their acquisitions were of private companies not quoted on the Stock Exchange.

76. *Hart P.E.*: "The Size and Growth of Firms".Economica,Febr. 1962, p.p. 29-39.

with less than £ 25,000 net assets were regarded as "small".

It was found that in all four sets there were no significant differences at the 5 per cent level between the mean growth rates of small and large firms, this finding being consistent with Gibrat's Law.

The second implication considered was that the dispersion of growth rates around the common average should be the same for firms of different sizes, but now the empirical evidence did not provide a consistent answer. For the second and fourth groups there were found no significant differences at the 5% level between the values of s^2 – measuring the variance of the logarithms of proportionate changes in profits – for small and large firms, these findings being in line with Gibrat's Law. Nevertheless, the value of s^2 for the small firms in the first set was significantly larger than that for the large firms while for the third group the value of s^2 for small firms was significantly smaller than that for large firms; both these findings are inconsistent with the above mentioned law.

The third and fourth implications considered were respectively that the distribution of proportionate growth rates is lognormal and that the relative dispersion of the sizes of firms tends to increase over time. To study these implications a bivariate size distribution of firms was constructed showing the sizes of 1981 firms at two points in time, i.e. in 1950 and 1955; the market valuation of firms' quoted securities was used as a measure of size and the size-classes were chosen so that each upper limit was double the lower limit (this in turn made logarithmic transformations easy, since in logarithms to the base 2 each class was equal to unity).The following Table constructed from the bivariate size distribution shows the growth records of the 1981 firms during the period 1950 - 55.

Table 5.1. Distribution of business units by proportionate growth.

Proportionate Growth (size in 1955 / size in 1950)	$\frac{1}{32}$	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{2}$	1	2	4	8	16	32
Number of firms	3	6	18	59	308	722	513	261	79	9	3=1981

Source: P.E. Hart,op. cit.

From the table it is apparent that there was an overall tendency for the firms to stay in the same size-class (in fact this was true of 722 firms or 36.5% of the sample), while on either side of this central tendency the distribution appeared to tail off fairly symmetrically. But as to whether this rough symmetry is sufficient to justify the third implication, the author states that this question is difficult to answer for it is not certain that the usual statistical tests of normality can be applied in the present case[77]. A graphical test showed that the distribution was not exactly lognormal but the author contends that the slight deviations from lognormality may be small enough to be explained by sampling errors and the lognormal hypothesis remains tenable.

As for the fourth implication (i.e. that the relative dispersion of the sizes of firms tends to increase over time) it was found that the evidence was consistent with the law: the variance of the 1950 distribution was 4.05 and that for 1955 was 5.51[78].

S. Hymer and P. Pashigian[79] also tested the Law of Proportionate Effect. Their sample consisted of the one thousand largest U.S. manufacturing firms as of December 1946 and the size of a firm was measured

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77. Cf. the criticisms advanced by *M. Kendall and A. Stuart* in the discussion of (28) p. 185: "if these distributions are in fact generated by stochastic processes it is not entirely clear that the usual methods of testing fit between hypothesis and observation are valid".

78. *I.G. Adelman* put forward a technique which refutes the fourth implication of Gibrat's Law and argues that the size-distribution of firms will eventually reach an equilibrium position after which there will be no tendency for its dispersion to change. Her analysis rests on adaptation of the probabilistic method which is due to Markov to the analysis of the structure which a given industry would eventually reach were certain current trends to continue. In particular, by arranging the transition probabilities into a square matrix and by operating with this matrix upon a vector representing the structure of the industry at the beginning of one period, one derives the structure for the next time interval. Repeating the process indefinitely leads to a vector which represents the equilibrium state.

The equilibrium structure is defined as that distribution for which the average number of corporations entering a given structure per period equals the average number of corporations leaving it. This concept of equilibrium does not imply that there is no movement of entreprises between strata; on the contrary it explicitly requires that firms move in and out of each class, but on the average the forces making for an increase in the number of firms in a given size-range are exactly counterbalanced by those tending to decrease it. See:
Adelman I.G.: "A Stochastic Analysis of the Size Distribution of Firms" The Journal of Amer. Stat. Association, Dec.1958 p.p. 893-904.

79. *Hymer H. & Pashigian P.*, op. cit.

by its assets in 1946; the percentage change in these assets between 1946 and 1955 was used as a measure of its growth rate. The firms sampled were classified in two-digit industries, ranked in order of size and divided into quartiles.

The mean and standard deviation for each size-class in each industry were calculated and it was found that there was no relationship between the mean growth rate and size of firm. As far as the standard deviations of the distribution of growth rates are concerned it was found that they were inversely related to the size of firms. The authors also considered the possibility that the observed pattern was spurious, i.e. the result of aggregation errors. To this end regression analysis was carried out on the three-digit industries, which confirmed the results previously obtained.

As for the theoretical implications of the findings, the authors believe that the evidence implies falling costs and that the distribution of firm sizes may well be the result not of chance but of the presence of economies of scale; their argument rests largely on the decrease of standard deviation with size of firm. Thus when curves are falling, small firms (because of their higher unit costs) will tend to be driven out of the industry but at the same time they will have an incentive to expand in order to realize further economies of scale. These two forces make for the small firm to have a greater probability of decline (because of its cost disadvantages) than does the large firm, but at the same time a greater probability of faster growth (because of the above mentioned incentive). As a consequence the dispersion of growth rates will be expected to be higher for the small firm than for the larger one, but there is no reason for average growth rates to differ; they could differ, depending on how these effects balance out, but they will not necessarily differ.

The authors also believe that the results of the square-root-of-n test lend support to their argument of economies of scale. For, if unit costs were constant (the hypothesis of increasing costs was ruled out as incompatible with the findings), a firm could be subdivided into separate and independent units (divisions), would not suffer any cost disadvantage and would lower the variance of its expected growth rate. The results of the $\frac{1}{\sqrt{n}}$ test, however, showed that large firms did not diversify as much as would be expected under the assumption of constant costs: the actual standard deviations were found to be higher than those predicted by the $\frac{1}{\sqrt{n}}$ rule. One reason why large firms would not diversify

to that extent is, according to the authors, that dividing the firm into sub-units would increase unit costs; this in turn implies the existence of economies of scale[80].

Another relevant study is that by Ed. Mansfield[81], who examined three versions of Gibrat's Law. First the version that the law holds for all firms including those that leave the industry during the relevant period (the size of such firms being regarded as zero or approximately zero). A χ^2 test was used to determine whether the frequency distributions were the same in each class; the results indicated that the version in question fails to hold, in seven of the ten cases the observed value of χ^2 exceeding the critical limit corresponding to the 5% significance level. The principal reason for this version failing to hold was that the probability of a firm's death was higher for smaller firms than for larger ones.

The second version considered was that the law holds for all firms other than those that leave the industry. Another series of χ^2 tests showed that in four out of ten cases the evidence seemed to contradict the hypothesis, since the observed value of χ^2 exceeded the limit corresponding to the 5% level. In addition, it was found that smaller firms often tended to have higher and more variable growth rates than larger firms.

The third version of the law states that it holds only for firms exceeding the minimum efficient size. This version was tested in two ways; first the slope of the regression of $\log S_{t+1}$ on $\log S_t$ was estimated and the results were found quite consistent with Gibrat's Law (the slopes never differing significantly from unity). Second, F tests were performed to determine whether the variance of growth rates was constant among firms and it was found that the variance tended to be inversely related to size in six out of the ten cases. Thus the author's conclusion is that regardless of which version one chooses, Gibrat's Law fails to hold in more than one half of cases.

The empirical validity of Gibrat's Law was also examined by Singh and Whittington in their study already referred to under footnote 12. To test whether the average proportionate growth rates are the same

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80. For criticism of their views see:
Simon H. A.: "Firm Size and Rate of Growth" (Comments). The Journal of Polit. Econ. 1964, p.p. 81-82.

81. *Mansfield Ed.*: "Entry, Gibrat's Law, Innovation and the Growth of Firms" The American Econ. Review, Dec. 1962.

for all size-classes, growth was regressed on size in two simple equations:

$$G = a + bS + \varepsilon \qquad (5.2)$$

$$\log G = a + b \log S + \log \varepsilon \qquad (5.3)$$

where G = percentage annual growth of net assets
S = opening net assets in £'000

For both equations, r^2 and the parameter b were not significantly different from zero at the 5% level. Thus the regression results suggested rejection of the two equations tested. But since the existence of a simple linear or loglinear relationship would have meant rejection of the law under investigation but the non-existence of such a relationship could not be considered confirmation of the law (because of the possibility of a more complex non-linear relationship) further tests were performed.

Calculations of the means and standard deviations of growth rates of continuing companies showed that although there were a few significant differences between the average growth rates in different size-classes, on the whole the average growth rates were found to be very similar to each other and,conversely,the number of cases of significant differences were not deemed sufficient to warrant the conclusion that the growth process of the populations of firms over the relevant period (1948-60) was inconsistent with the requirement of the law that the average growth rate should be the same for all size-classes.

However, on the side of the dispersion of growth rates things were different. There were significant differences between different size-classes in almost every industry in each period. In addition, it was found that although on the whole the dispersion declined with the size of firm, this did not occur regularly and quite often the standard deviation in the largest size-class was higher than in the size-class below it. Another feature of the pattern of dispersion was that firms above a critical size (e.g. firms with net assets of more than £1 m. in the first sub-period (1948-54) and firms with net assets of more than £ ½ m. in the second sub-period (1954-60) and the whole period) had a considerably greater homogeneity of growth rates than firms below that size. The authors concluded, therefore, that the second requirement of the law,i.e. that the dispersion of growth rates should be the same in different size-classes, was refuted by the data.

For reasons of comparability with earlier studies the means and standard deviations of the logarithms of proportionate growth were calculated to test whether there were any significant differences. It was found that the means of the logarithms of proportional growth in the

individual industries were on the whole very similar to each other for firms of different sizes, but the variance was significantly heterogeneous at a high level between size-classes.

These conclusions differed from those of Hart[82] (who found that the variance decreased with increases in size, but in most cases the means were the same for firms of all sizes) as well as from those of Samuels[83] (who found that the means increased with increases in firm size but the variances were homogeneous between size-classes).

A further test of the validity of Gibrat's Law was carried out by studying the relationship between the logarithms of firm sizes at the beginning and the end of the period; the following equation was tested[84]:

$$\log S_{t+1} = a + b\log S_t + \log \varepsilon \qquad (5.4)$$

For the whole period (1948-60) the estimate of b for the four industries together was 1.043 ($\pm$ 0.025), which was lower than that obtained by Samuels (b = 1.07 $\pm$ 0.02 for the period 1950-59) and significantly different from unity at the 10% level.

In individual industries all of the values of b were greater than unity. Another feature of the regression analysis was that b tended to be higher in the second sub-period (1954-60) than in the first (1948-54) i.e. the tendency for bigger firms to grow faster was more marked between 1954-60 than in 1948-54; it should be noted that the same conclusion was reached by Samuels[85] who, in the light of Hart's study (who produced evidence in favour of Gibrat's Law) concluded that the large firms must have started to grow faster during the second part of his study period (1956-59).

Equation (5.4.) was fitted to the restricted population of growing companies; the effect of this was to reduce the estimated value of b in every case so that the tendency for the large firms to grow relatively faster in the full population was due to the asymmetrical size-distribution

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82. *Hart P.E.*: "Studies in Profits, Business Saving and Investment in the U.K. 1920-62" G. Allen & Unwin, London 1965, Vol. I p.p. 150-180.

83. *Samuels J.*, op. cit.

84. As was said earlier in this chapter when b = 1 and the variance of ε is constant this will imply that the two basic requirements of Gibrat's Law are fulfilled (i.e. that the average and variance of the logarithms of proportionate growth be the same). If $b>1$ the large firms grow proportionately faster and the dispersion of the size of firms will increase, while if $b<1$ the smaller firms grow proportionately faster and the degree of dispersion decreases correspondingly.

85. *Samuels, J.*, op. cit.

of non-growing companies, i.e. small companies appeared proportionately more often in the category of non-growing companies, or the smaller non-growing companies had the highest negative growth rates. This along with their earlier findings lended support to the view that Gibrat's Law,which predicts that the probability of negative growth should be independent of size, did not hold.

The regression results of studies referred to are shown in Table 5.2 so that the reader can make a comparison of the values obtained.

Table 5.2 Regression parameters

	Reference	Year	b	S(b)	r	Equation form
1	(28)	1885-96	0.95	0.15	0.83	(5.1)
2	(28)	1896-1907	0.91	0.05	0.89	(5.1)
3	(28)	1907-24	1.09	0.03	0.92	(5.1)
4	(28)	1924-39	0.92	0.03	0.88	(5.1)
5	(28)	1939-50	0.75	0.02	0.85	(5.1)
6	(26)	1950-5	0.99	0.02	n.a.	(5.1)
7	(43)	1950-1 to 1959 -60	1.07	0.02	0.92	(5.1)
8	(49)	1948-54	1.025	0.016	0.94	(5.4)
9	(49)	1954-60	1.033	0.015	0.95	(5.4)
10	(49)	1948-60	1.043	0.025	0.91	(5.4)
11	(27) (a)	1958-60	0.97	0.0079	0.96	(5.4)
12	(27) (b)	1958-60	1.03	0.0052	0.97	(5.4)
13	(49)	1948-54	0.987	0.012	0.97	(5.4)
14	(49)	1954-60	1.000	0.014	0.96	(5.4)
15	(49)	1948-60	1.015	0.023	0.92	(5.4)

Samples

(28) Selected U.K. quoted companies. Size measured by stock-market value.

(26) Selected U.K. quoted companies. Size measured by stock-market value.

(27) (a) U.K. manufacturing companies, £500,000 Size measured by net assets.

(27) (b) U.K. manufacturing companies, all sizes. Size measured by net assets.

(43) 400 continuing companies
Size measured by net assets.

(49) Four selected industries, U.K. quoted companies, (rows 8,9,10 all companies, rows 13,14,15 positive growth companies only).
Source: J. Eatwell,op. cit.

It should be noted that the majority of studies on Gibrat's Law have been confined to the study of continuing firms with little analysis of the birth and death processes of firms concommitant with the growth process. This was so because the birth and death of firms imply zero size at one point in time, which cannot be readily incorporated in a model based on a logarithmic curve[86].

In conclusion, the existing empirical evidence on the validity of Gibrat's Law has shown that although this model is considered by researchers exceedingly useful tool, especially as a first approximation, not all of its properties apply to a firm's growth. In particular, there is no general agreement about the variation of proportionate growth; most studies indicate that the dispersion of growth rates is either negatively correlated with size[87,88], or is heterogeneous between size-classes with an over-all tendency toward negative correlation[89,90]. There is also no general agreement on the relationship between average proportionate rate of growth and size of firms but in most cases the mean proportionate rate of growth was found to be approximately the same for firms of all sizes.

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86. In this respect the Yule distribution is said to be undoubtedly superior to the simple lognormal distribution. The Yule distribution in turn is generated jointly by Gibrat's Law and an assumed birth process, the latter normally a constant rate of birth of new firms in the smallest size-class. In fact Simon & Bonini found that the Yule distribution gives a good fit to the size distribution of firms in the U.S. steel industry,which suggests that the Law of Proportionate Effect is present in the growth of U.S. steel firms but that some birth process is also at work.
Nevertheless, although the size distribution of firms may be observed to "look like" and possess certain characteristics of the Yule, lognormal, or Pareto distributions it is stressed by several researchers that there is no satisfactory method of objectively assessing the degree of resemblance. See (17) and:
Ijiri Y. & Simon H.A.: "Business Firm Growth and Size". The Amer. Economic Review, 1964 p. 78.

87. *Hymer H. & Pashigian P.*, op. cit.
88. *Hart P.E.*, op. cit.
89. *Eatwell J.L.*, op. cit.
90. *Singh A. & Whittington G.*, op. cit.

5.2. CONCLUSIONS AND DISCUSSION

In the present chapter studies bearing on the relationship between size and growth were surveyed. In view of the fact that the Law of Proportionate Effect as an explanation of the growth process has received a great deal of attention in recent investigations of the growth of firms both in G. Britain and the U.S.A. the survey was directly concerned with studies dealing in one way or another with the above-mentioned law.

Stated briefly, and in its simplest and strongest form the law in question claims that the probability of a firm's growing at a given rate during any particular period of time is independent of the initial size of the firm and so is the dispersion of growth rates.

The law, were it to be found empirically valid, would have important economic implications. First, it would imply that there is no "optimum size" and that there is no causal adjustment mechanism between size and growth. Second, it would suggest that a firm's past growth record has no influence on its growth rate in subsequent periods, i.e. there is no continuity in the growth pattern of firms. Third, it would have an important bearing on the matter of changes in industrial concentration over time; in particular, the concentration of any given industry will tend to increase over time, because if the large firms as well as the small firms have the same probability of growing by a given proportion, the dispersion in the size of firms will increase over time.

As was the case with earlier chapters, our survey revealed that there is no general agreement in the conclusions reached by several researchers although all of them agree that not all the implications of the law under consideration are supported by the existing empirical evidence.

The difference in conclusions might once again be due to the fact that certain factors which might have an important bearing on the growth of firms were ignored in some studies, e.g. the effects of mergers or revaluations on the growth of firms in different size-classes. In this respect it should be noted that although some authors took explicit account of these factors (see, for instance, Samuels, Singh - Whittington), in many other studies there is no statement as to how these factors were treated.

J. Samuels found that at the 5% level the variance of the logarithms of proportionate growth was not significantly different, a finding which

is consistent with Gibrat's Law. Nevertheless, at the same level of probability the means of the various size-classes were found to be significantly different, and this is inconsistent with the above law. As for the other implication of the law, namely that the relative dispersion of the size of firms tends to increase over time, the evidence lended support to the theory. An examination of the effects of mergers on firms in different size-classes, gave diverse results, e.g. it was found that the extent of amalgamations was not substantially different as between large and medium-large companies, but it was considerably less significant for small-large firms.

P.E. Hart found, unlike Samuels, that at the 5% level there were no significant differences between the mean growth rates of small and large firms. As for the dispersion of growth rates the evidence was inconclusive: in two sets of data (the author considered four sets of firms) there were found no significant differences, in one set the dispersion of growth rates of small firms was significantly larger than that for large firms and in still another set the situation was found to be the other way around. The empirical evidence was found to be consistent with the implication of the law concerning the increase in the relative dispersion of the sizes of firms over time. Nevertheless the author found it somewhat difficult to test whether the distribution of proportionate growth rates was lognormal since it is not certain that the formal statistical tests of normality can be applied to the case in question.

Hymer and Pashigian also found that there was no relationship between the mean growth rates and size of firms, but the dispersion of growth rates was found to be inversely related to size; these results were found not to be due to the effects of aggregation. The authors assert that their findings are more in line with falling costs and that the distribution of firm size may well be the result not of chance but of the existence of economies of scale.

Three versions of Gibrat's Law were examined by E. Mansfield, namely the versions that the law holds first for all firms including those that leave the industry during a given period of time, second for all firms other than those that leave the industry and third only for firms exceeding the minimum efficient size. The author's conclusion is that the law in question fails to hold regardless of which version one chooses. In addition, it was found that smaller firms tended to have higher and more variable growth rates than larger firms.

Singh and Whittington performed several tests on their data and

found that the means of growth rates of continuing companies were on the whole very much similar to each other; nevertheless, the dispersion of growth rates was found to decline with size, although this did not occur regularly. Their findings are in conflict both with those by Hart and by Samuels.

BIBLIOGRAPHY

1. *Adelman, M.A.:* The Measurement of Industrial Concentration. The Rev. of Econ. and Stat., Nov. 1951,p. 272.
2. *Adelman, I.G.:* A Stochastic Analysis of the Size Distribution of Firms. The Journal of Amer. Statistical Assoc., Dec. 1958, p.p. 893-904.
3. *Aitchison, J.and Brown, J.A.C.:* The Lognormal Distribution. C.U.P. Cambridge 1957, p. 23.
4. *Alexander, S.S.:* The Effect of Size of Manufacturing Corporation on the Distribution of the Rate of Return. The Review of Econ. and Stat., Aug. 1949, p.p. 229-35.
5. *Amey, L.R.:* The Efficiency of Business Entreprise. Allen and Unwin, London 1970, p. 34.
6. *Anthony, R.N.:* Effect of Size on Efficiency. Harvard Business Rev., 1942.
7. *Bain, J.S.*: Barriers to New Competition. H.U.P., Mass. 1956.
8. *Barna, T.:* Investment and Growth Policies in British Industrial Firms. (A N.I.E.S.R. Occasional Paper) C.U.P., Cambridge 1962, p.p. 12-13.
9. — The Replacement Cost of Fixed Assets in British Manufacturing Industry in 1955. The Journal of the Royal Stat. Society, 1957, p.p. 1-36.
10. *Barron, M.J.:* The Effect of the Size of Firm on Profitability. Business Ratios, Spring 1967.
11. *Bates, J.:* Alternative Measures of the Size of Firms. (in: *P.E. Hart*: Studies in Profits, Business Saving and Investment in the U.K. 1920-62, Vol. 1. Allen and Unwin, London 1965).
12. *Blair, J.M.:* The Relation Between Size and Efficiency of Business. The Rev. of Econ. and Stat., 1942 p.p. 125-35.
13. *Committee of Inquiry on Small Firms* (Research Report No 12): Dynamics of Small Firms. HMSO 1971, p. 41.
14. *Crum, W.L.:* Corporate Size and Earning Power. H.U.P., Cambridge, Mass. 1939.

15. *Crum, W.L.:* The Effect of Size on Corporate Earnings and Condition. Harvard University Division of Business Res. Studies. No 8 1934.
16. *Dewing, A.S.:* A Statistical Test of the Success of Consolidations. The Quart. Journal of Econ. 1921.
17. *Eatwell, J.L.:* Growth, Profitability and Size. (in: *Marris and Wood*: The Corporate Economy).
18. *Epstein, R.C.:* Industrial Profits in the U.S. N.B.E.R., N. York 1934.
19. — Profits and Size of Firms in the Automobile Industry, 1919-27. The Amer. Econ. Review, 1931.
20. *Fama, E.*: The Behaviour of Stock-market Prices. The Journal of Bus., Jan. 1965,p.p. 34-106.
21. — Random Walks in Stock-market Prices. (in: *J.M.Lishan* and *D.T.Crary*: The Investment Process. Inter. Textbook Co., Scranton, Pennsylvania, 1970).
22. *Federal Reserve System:* Financing Small Business. Report to the Committees on Banking and Currency by the Fed. Res. System, Washington D.C., U.S. Govern. Printing Office, 1958.
23. *Florence, S.:* New Measures of the Growth of Firms. The Econ. Journal, June 1957, p.p. 244-8.
24. *Gibrat, R.:* Les inégalités économiques. Sirey, Paris 1931.
25. *Harris, R. and Solly, H.:* A Survey of Large Companies. London Instit. of Econ. Affairs, 1959.
26. *Hart, P.E.:* The Size and Growth of Firms. Economica, Febr. 1962, p.p. 29-39.
27. — Studies in Profits, Business Saving and Investment in the U.K., 1920-62. G. Allen and Unwin, London, 1965 p.p. 150-80.
28. *Hart, P.E. and Prais, S.J.:* The Analysis of Business Concentration: a Statistical Approach. The Journal of the Royal Stat. Society, Ser. A, Part II, 1956, p.p. 150-81.
29. *Hendriksen, E.S.*: Accounting Theory. R. Irwin Inc., Homewood, Illin. 1970.
30. *Hymer, H. and Pashigian, P.:* Firm Size and Rate of Growth. The Journal of Polit. Economy, Dec. 1962,p.p. 556-69.
31. *Inst. of Chartered Accountants in England and Wales:* Recommendations on Accounting Principles, I.C.A., London 1970.

32. *Ijiri, Y. and Simon, H.A.:* Business Firm Growth and Size. The Amer. Econ. Rev.,1964,p.78.
33. *Jones, W.T.:* Size, Growth, and Profitability in the Mechanical Engineering Industry. N.E.D.O., London 1969 (unpublished).
34. *Kuh, E.:* Capital Stock Growth: a Micro-econometric Approach. North Holland Publishing Co., Amsterdam 1963, p.p. 77-8.
35. *Leak, H. and Maizels, A.:* The Structure of British Industry. The Journal of the Royal Stat. Society, 1945, p.p. 142-207.
36. *Leontief, W. et al.:* Studies in the Structure of the American Economy. Oxf. Univ. Press, N. York, 1953.
37. *Lishan, J.M. and Crary, D.T.:* The Investment Process. Intern. Textbook Co., Scranton, Penns., 1970.
38. *Little, I.M.D. and Rayner, A.C.:* Higgledy-Piggledy Growth Again. Brackwell, Oxford, 1966.
39. *McConnell, J.L.:* Corporate Earnings by Size of Firm. Survey of Current Business, May 1945, p.p. 6-12.
40. *Mansfield, E.:* Entry, Gibrat's Law, Innovation and the Growth of Firms. The Amer. Econ. Review, Dec. 1962.
41. *Osborn, R.C.:* Efficiency and Profitability in Relation to Size. The Harv. Bus. Rev., 1951.
42. *Parker, J.E.S.:* Profitability and Growth of British Industrial Firms. The Manchester School, 1964,p.p. 113-29.
43. *Samuels, J.:* Size and the Growth of Firms. The Rev. of Econ. Studies, 1965 p.p. 105-12.
44. *Samuels, J. and Smyth, D.:* Profits, Variability of Profits and Firm Size. Economica, May 1968.
45. *Samuels, J. and Wilkes, F.:* Management of Company Finance. Nelson, 1971.
46. *Sherman, H.J.:* Profits in the U.S. Cornell Univ. Press., Ithaca, N.Y. 1968.
47. *Simon, H.A.:* Firm Size and Rate of Growth (comments). The Journal of Polit. Econ., 1964, p.p. 81-82.
48. *Simon, H.A. and Bonini, C.:* The Size Distribution of Business Firms. The Amer. Econ. Rev., Sept. 1958, p.p. 607-17.
49. *Singh, A. and Whittington, G.* (in collaboration with *Burley H.T.*): Growth, Profitability and Valuation. C.U.P., Cambridge, 1968.
50. *Steckler, H.O.:* The Variability of Profitability with Size of Firm,

1947-58. The Journal of Amer. Stat. Assoc., Dec. 1964, p.p. 1183-93.

51. *Stekler, H.O.*: Profitability and Size of Firm. Univ. of Calif. Press, Berkeley, 1963.
52. *Steindl, J.*: Small and Big Business. Blackwell, Oxford, 1945.
53. *Summers, H.B.*: A Comparison of the Rates of Earnings of Large and Small - scale Industries. The Quart. Journ. of Economics, 1932.
54. *T.N.E.C.*: Relative Efficiency of Large,Medium-sized, and Small Firms. Monogr. No 13 & 15, Washington D.C., 1941.
55. *Weintraub, R.E.*: On Speculative Prices and Random Walks: a Denial. (in: *J.M. Lishan* & *D.T. Crary*: The Investment Process. Int. Textbook Co., Scranton, Penns., 1970).
56. *Whittington, G.*: The Prediction of Profitability. C.U.P., Cambridge, 1971.