BUREAUCRATIC LIMITS OF FIRM SIZE

Empirical Analysis Using Transaction Cost Economics

A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Business Administration

by

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February 2002

First prize winner in the EDAMBA (*European Doctoral Programmes Association in Management and Business Administration*) competition for best European doctoral thesis in 2002.

ISBN 0-493-54020-2

ABSTRACT

This thesis tests Oliver Williamson's proposition that transaction cost economics can explain the limits of firm size. Williamson suggests that diseconomies of scale are manifested through four interrelated factors: atmospheric consequences due to specialisation, bureaucratic insularity, incentive limits of the employment relation and communication distortion due to bounded rationality. Furthermore, Williamson argues that diseconomies of scale are counteracted by economies of scale and can be moderated by adoption of the multidivisional organisation form and by high internal asset specificity. Combined, these influences tend to cancel out and thus there is not a strong, directly observable, relationship between a large firm's size and performance.

A review of the relevant literature, including transaction cost economics, sociological studies of bureaucracy, information-processing perspectives on the firm, agency theory, and studies of incentives and motivation within firms, as well as empirical studies of trends in firm size and industry concentration, corroborates Williamson's theoretical framework and translates it into five hypotheses: (1) Bureaucratic failure, in the form of atmospheric consequences, bureaucratic insularity, incentive limits and communication distortion, increases with firm size; (2) Large firms exhibit economies of scale; (3) Diseconomies of scale from bureaucratic failure have a negative impact on firm performance; (4) Economies of scale increase the relative profitability of large firms over smaller firms; and (5) Diseconomies of scale are moderated by two transaction cost-related factors: organisation form and asset specificity.

The hypotheses were tested by applying structural equation models to primary and secondary cross-sectional data from 784 large US manufacturing firms. The statistical analyses confirm the hypotheses. Thus, diseconomies of scale influence the growth and profitability of firms negatively, while economies of scale and the moderating factors have positive influences. This implies that executives and directors of large firms should pay attention to bureaucratic failure.

To Charlotte, Simon and Rasmus

CONTENTS

FIGURES

TABLES

ACKNOWLEDGEMENTS

My wife Charlotte Heyden encouraged me throughout the years of effort. At dark moments she urged me to continue my research, she supported my late nights of reading, analysis and writing, and she was my main day-to-day adviser on theoretical and analytical issues. Without her, this thesis would never have been written.

My sons Simon and Rasmus Canbäck motivated me by forcing me to be a scholarly role model. To my pleasant surprise, they have stayed abreast of my progress. They now aspire to higher education, but probably outside the realms of business and economics studies.

Throughout the years, my parents Ulla and Owe Canbäck have been beacons of inspiration. From my childhood and onwards they instilled in me a respect for learning and the importance of intellectual inquiry. During the years of research, they often provided logistical assistance.

Professor Phillip Samouel, Dean of Kingston Business School, has supervised my research superbly, combining insightful feedback with patience. He based his feedback on an amazingly detailed understanding of the intricacies of the research. Furthermore, his ability to nudge me forward at the right time was immensely helpful. Dr David Price, Director of Studies of the Doctoral Programmes at Henley Management College, created a platform for me from which I could pursue this research, even though the topic did not fit naturally within existing research themes at Henley.

Finally, I am indebted to Henley Management College, which provided a stimulating research environment, and to the Marcus Wallenberg Foundation, which supported the research with a scholarship.

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1. SUMMARY

This research tests whether diseconomies of scale influence corporate performance. It uses Coasian transaction cost economics (Coase 1937) and Williamson's thinking on the nature of diseconomies of scale and the limits of firm size (Williamson 1975, 1985; Riordan and Williamson 1985) to develop a theoretical framework for describing diseconomies of scale, economies of scale, and moderating factors. It validates the framework against the relevant literature and translates it into five hypotheses. The hypotheses are tested in structural equation models against the 784 largest firms in the US manufacturing sector in 1998. The findings are consistent with Williamson's limits-of-firm-size framework.

Diseconomies of scale are a neglected area of study (see also Chapter 2). Observers from Knight ([1921] 1964) to Holmström and Tirole (1989) have pointed out that our understanding of bureaucratic failure is low. The neglect is to some extent due to a disbelief in the existence of diseconomies of scale (e.g., Florence 1933, 12; Bain 1968, 176). It is also due to a dearth of theoretical frameworks that can help inform our understanding of the nature of diseconomies of scale. However, if diseconomies of scale did not exist, then we would presumably see much larger firms than we do today (Panzar 1989, 38). No business organisation in the United States has more than one million employees[1] or more than ten hierarchical levels. No firm has ever been able successfully to compete in multiple markets with a diverse product range for an extended period of time. Common sense tells us that there are limits to firm size. Common sense does not, however, prove the point. Unfortunately, scientific inquiry has not yet focused on finding such proof.

The US manufacturing sector has, as a whole, been remarkably stable over the last century. Contrary to popular opinion, markets have on average not become more concentrated (e.g., Nutter 1951; Scherer and Ross 1990). Large firms are not increasingly dominant. Large manufacturing firms in the United States employed 16 million people in 1979 versus 11 million in 1994, while private sector employment grew from 99 to 123 million people (Council of Economic Advisers 1998; Fortune 1995a).

Williamson (1975, 117–131) found that the limits of firm size are bureaucratic in origin and can be explained by transaction cost economics (see also Chapter 3). He identified four main categories of diseconomies of scale: *atmospheric consequences* due to specialisation, *bureaucratic insularity*, *incentive limits* of the employment relation and *communication distortion*

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[1] The largest company, Wal-Mart Stores, Inc., had 910,000 employees in 1998. The largest manufacturing company, General Motors Corporation, had 594,000 employees.

due to bounded rationality. *Economies of scale*[2] in production costs and transaction costs tend to offset these diseconomies of scale (Riordan and Williamson 1985). Moreover, the disadvantages of bureaucracy can be moderated by using the *multidivisional organisation form* (M-form) and by a judicious optimisation of the degree of integration through high internal *asset specificity* (Williamson 1975, 1985). Together, these influences on firm performance form the theoretical framework used in this research.

The literature review supported the framework. There are, as far as this researcher could determine, around 60 pieces of work that deal with diseconomies of scale in a substantial manner (see Appendix A). Based on these and other more fragmentary sources, it was possible to validate Williamson's framework and his categorisation of the factors driving diseconomies of scale, economies of scale and the moderating factors, except that the literature review was inconclusive regarding economies of scale. The framework was translated into five testable hypotheses, summarised in Figure 1 (see also Chapter 4).

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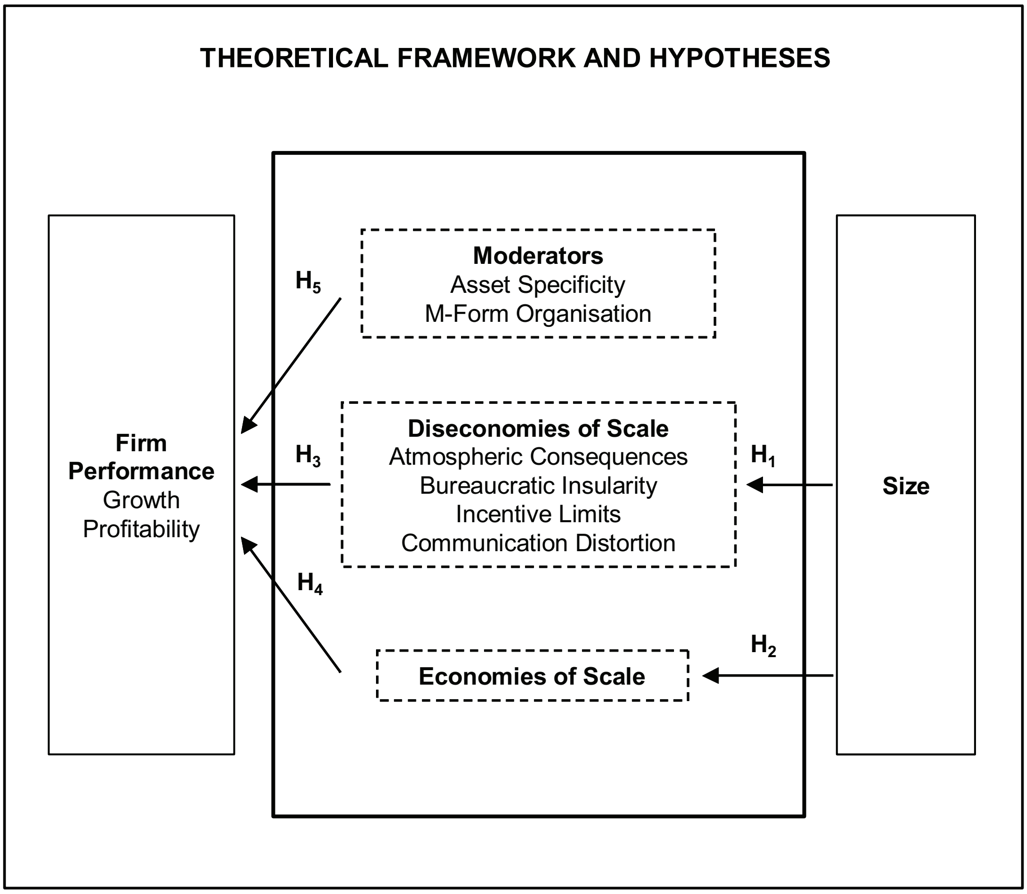
[2] A standard definition of economies of scale, taken from *The New Palgrave: A Dictionary of Economics*, is that they exist if the unit cost of producing one additional unit of output decreases. They are driven by (a) the existence of indivisible inputs, (b) set-up costs and (c) the benefits of division of labour (Eatwell, Milgate and Newman 1987, 80–81). In the case of the multi-product firm, economies of scale exist if the ray average cost decreases as output increases.

Figure 1. Theoretical Framework and Hypotheses



The first two hypotheses test the tautological statement that diseconomies of scale and economies of scale increase with firm size. The last three hypotheses test how a firm's performance is affected by the diseconomies of scale, economies of scale and moderating influences.

H_1: Bureaucratic failure, in the form of atmospheric consequences, bureaucratic insularity, incentive limits and communication distortion, increases with firm size

H_2: Large firms exhibit economies of scale

H_3: Diseconomies of scale from bureaucratic failure have a negative impact on firm performance

H_4: Economies of scale increase the relative profitability of large firms over smaller firms

H_5: Diseconomies of scale are moderated by two transaction cost-related factors: organisation form and asset specificity

The third hypothesis has four sub-hypotheses, which test each of the diseconomies of scale factors.

H_{3a}: Atmospheric consequences have a negative impact on the performance of large firms

H_{3b}: Bureaucratic insularity has a negative impact on the performance of large firms

H_{3c}: Incentive limits have a negative impact on the performance of large firms

H_{3d}: Communication distortion has a negative impact on the performance of large firms

The fifth hypothesis has two sub-hypotheses for organisation form and asset specificity, respectively.

H_{5a}: Large M-form firms perform better than large U-form firms

H_{5b}: High internal asset specificity affects a firm's performance positively

The hypotheses were tested against a sample of the 784 largest manufacturing firms in the United States in 1998, for which primary and secondary data were collected from a number of sources, including company organisation charts, official filings and annual reports, biographies of executives, historical company documents, corporate web sites, magazine articles, corporate watchdogs, Compustat and academic research. The hypotheses were operationalised based on the literature review and it proved possible to collect enough data for most of the variables to create a statistically robust sample (see also Chapter 5). Structural equation modelling (SEM) was used to create path diagrams representing the hypotheses. Two sub-models containing these path diagrams capture the relationships (see also Chapter 6): sub-model *a:* firm size and the diseconomies/economies of scale (**H_1** and **H_2**); and sub-model *b:* diseconomies/economies of scale, moderating influences and firm performance (**H_3**, **H_4** and **H_5**).

Table 1 summarises the findings for each hypothesis (see also Chapter 7). All hypotheses were confirmed except for **H_{3d}** (communication distortion), for which the result was inconclusive. The strongest negative influence from diseconomies of scale on a large firm's performance appears to be on its ability to grow, while there is less negative influence on profitability. Thus, Penrose's claim ([1959] 1995, 261–263) that diseconomies of scale reduce the growth capability of large firms, appears to be validated.

Table 1. Summary of Findings

SUMMARY OF FINDINGS[a]		
Hypothesis	**Literature Finding**	**Statistical Finding**
H_1: Bureaucratic failure, in the form of atmospheric consequences, bureaucratic insularity, incentive limits and communication distortion, increases with firm size	Confirmed	Confirmed
H_2: Large firms exhibit economies of scale	Confirmed	Confirmed
H_3: Diseconomies of scale from bureaucratic failure have a negative impact on firm performance	Confirmed	Confirmed
H_{3a}: Atmospheric consequences have a negative impact on the performance of large firms	Confirmed	Confirmed
H_{3b}: Bureaucratic insularity has a negative impact on the performance of large firms	Confirmed	Confirmed
H_{3c}: Incentive limits have a negative impact on the performance of large firms	Confirmed	Confirmed
H_{3d}: Communication distortion has a negative impact on the performance of large firms	Confirmed	Inconclusive
H_4: Economies of scale increase the relative profitability of large firms over smaller firms	Inconclusive	Confirmed
H_5: Diseconomies of scale are moderated by two transaction cost-related factors: organisation form and asset specificity	Confirmed	Confirmed
H_{5a}: Large M-form firms perform better than large U-form firms	Confirmed	Confirmed
H_{5b}: High internal asset specificity affects a firm's performance positively	Confirmed	Confirmed
[a] For simplicity, the word "confirmed" is used, although "not rejected" is more accurate.		

The implications are that diseconomies of scale are real and important contributors to a firm's performance, in a negative way. However, economies of scale can offset some of these negative consequences. Finally, the use of M-form organisation and pursuit of high internal asset specificity can moderate the negative impact of diseconomies of scale.

These findings make it possible to create conceptual cost curves and growth curves that extend neoclassical theory. The curves are found in

Chapter 7, together with cost and growth curves plotting data from the sample used in the research.

There are several practical implications (see also Chapter 8). Among them are that corporate strategies are interconnected with the organisational choices made. That is, structure does not necessarily follow strategy. In light of this, it is understandable that mergers or acquisitions often fail, especially when the rationale for the merger-and-acquisition activity is to capture revenue growth opportunities. It is also evident that the focus on corporate governance over the last decade has its benefits. Other things equal, good governance allows large corporations to expand their limits-of-firm-size horizon. Moreover, as initiatives in large corporations are increasingly team-oriented, it is not surprising that senior executives pay more attention to motivation and how to structure incentives to extract optimal effort from the employees.

In the next chapter, the research objectives are defined and the importance of the research is discussed, linking it back to perspectives on economies of scale and diseconomies of scale in neoclassical theory and transaction cost economics. The chapter then explores the definition of the firm and metrics for measuring firm size. Finally, trends in firm size and concentration in the US manufacturing sector are discussed.

2. INTRODUCTION TO THE RESEARCH

Why are large firms so small? What stops firms from effortlessly expanding into new businesses? Only fragmentary research exists today as to why the largest business organisations do not have ten, twenty or a hundred million employees rather than a few hundred thousand.

According to Arrow (1974, 55) a "tendency to increasing costs with scale of operation" due to the cost of handling information and the irreversible cost of building organisational knowledge leads to limits of firm size. Coase (1937, 397) found that these costs—labelled "diseconomies of scale" in this thesis to contrast them with "economies of scale"—are associated with the resources required to manage the firm's internal planning processes, as well as the cost of mistakes and the resulting misallocation of resources, especially under conditions of uncertainty.

The thesis builds on original research carried out in the subject area. Specifically, it tests whether Williamson's "limits of firm size" discussion in *Markets and Hierarchies: Analysis and Antitrust Implications* (1975, 117–131) and in *The Economic Institutions of Capitalism* (1985, 131–162), which extend Arrow's and Coase's arguments, are valid. The findings include a look at the nature of diseconomies of scale and factors which moderate their impact, as well as a quantification of the impact of diseconomies of scale on firm performance.

Transaction cost economics (TCE) provides the theoretical foundation for this research. There are other partial explanations of diseconomies of scale, such as those found in neoclassical economics (e.g., Mas-Colell, Whinston and Green 1995; Scherer and Ross 1990); agency theory (e.g., Pratt and Zeckhauser 1985; Jensen and Meckling 1976); growth theory (e.g., Penrose [1959] 1995); evolutionary theory (e.g., Nelson and Winter 1982); sociology (e.g., Blau and Meyer 1987); and Marxist theory (e.g., Marglin 1974). These explanations are not the focus here, although they will be used to illuminate and test particular aspects of the TCE argument described in Chapter 3.

The purpose of the research is to create a theoretically robust and empirically tested framework that can be used by executives and others to inform strategic and organisational choices for large corporations. These choices may help decision-makers achieve higher growth and profitability by minimising diseconomies of scale due to atmospheric consequences, bureaucratic insularity, incentive limits and communication distortion (as defined in Section 3.1.2); to capture economies of scale; to optimise organisational structures; and to maximise asset specificity within the corporation.

These issues are addressed empirically through a statistical analysis of the 784 largest manufacturing firms in the United States in 1998.[3] This limited analysis[4]—covering one year, one industry sector and one country—lends credence to Williamson's limits-of-firm-size argument; no aspect of his theoretical discussion is refuted. The analysis also supports Penrose's assertion ([1959] 1995, 261–263) that diseconomies of scale mainly reduce growth of large firms rather than decrease their profitability.

The remainder of this chapter describes the research objectives and their importance in more detail, defines firm size, and documents trends in firm size over the last century.

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[3] Having more than $500 million in annual revenue.

[4] The United States was chosen because it is a large and competitive market, the manufacturing sector was chosen because of the depth of earlier research and the availability of data, and a single, recent, year was chosen because much of the data was not available further back.

2.1 RESEARCH OBJECTIVES

This section gives an initial problem definition and discusses the importance of the research. It spells out why diseconomies of scale are real and pervasive, yet poorly understood. In fact, while the economics literature often includes cost curves that bend upward at large firm sizes, there are only around 60 pieces of work that explicitly discuss the nature of the diseconomies,[5] and only a few of these have attempted to quantify the diseconomies of scale.

2.1.1 Problem Definition

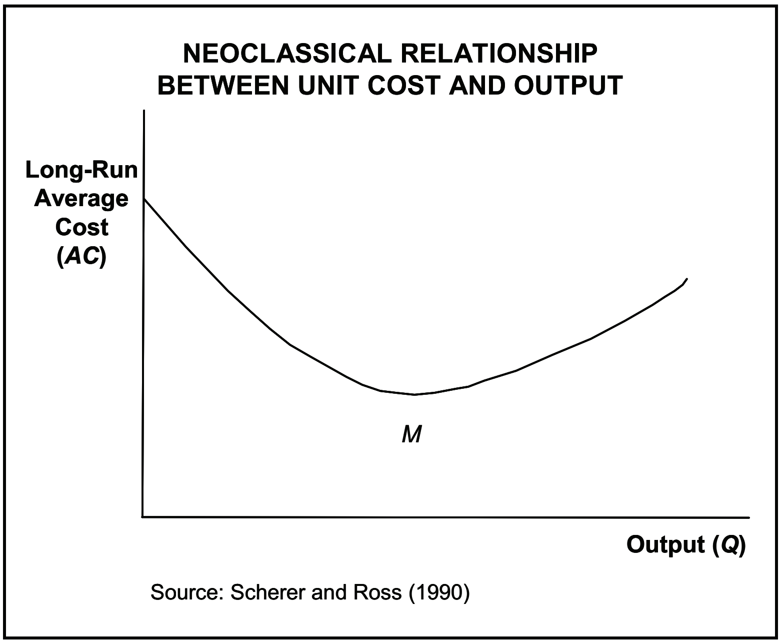
In the early 1920s, Knight ([1921] 1964, 286–287) observed that "the diminishing returns to management is a subject often referred to in economic literature, but in regard to which there is a dearth of scientific discussion". Since then, many authorities have referred to the existence of diseconomies of scale, but no systematic studies of the general issue exist. The basic dilemma is illustrated by the mismatch between theoretical expectations and real-world observations. On the one hand, if diseconomies of scale do not exist, then there should be no limits to firm growth and size. We would observe an inexorable concentration of industries and economies until only one global firm was left. The answer

[5] There is also a vast literature on the size-distribution of firms, but it generally does not discuss the specific mechanisms underlying bureaucratic failure.

to Coase's question (1937, 394): "Why is not all production carried on by one big firm?" would be: it will. Similarly, Stigler (1974, 8) wrote that "if size were a great advantage, the smaller companies would soon lose the unequal race and disappear". This is not happening. On the other hand, if a given industry has an optimum firm size, then we would expect increased fragmentation as the overall economy grows. This would be in line with Stigler's survivor-principle argument which holds that "the competition between different sizes of firms sifts out the more efficient enterprises" (1958, 55). Again, this is not happening. Lucas (1978, 509) observed that "most changes in product demand are met by changes in firm size, not by entry or exit of firms". The size distribution of firms has been remarkably stable over time for most for the last century, when measured by number of employees or as a share of the total economy (as discussed in Section 2.3).

Cost curves (Figure 2) are used in neoclassical theory to illustrate economies and diseconomies of scale (e.g., Marshall [1920] 1997, 278–292; Scherer and Ross 1990, 101).

Figure 2. Neoclassical Relationship between Unit Cost and Output

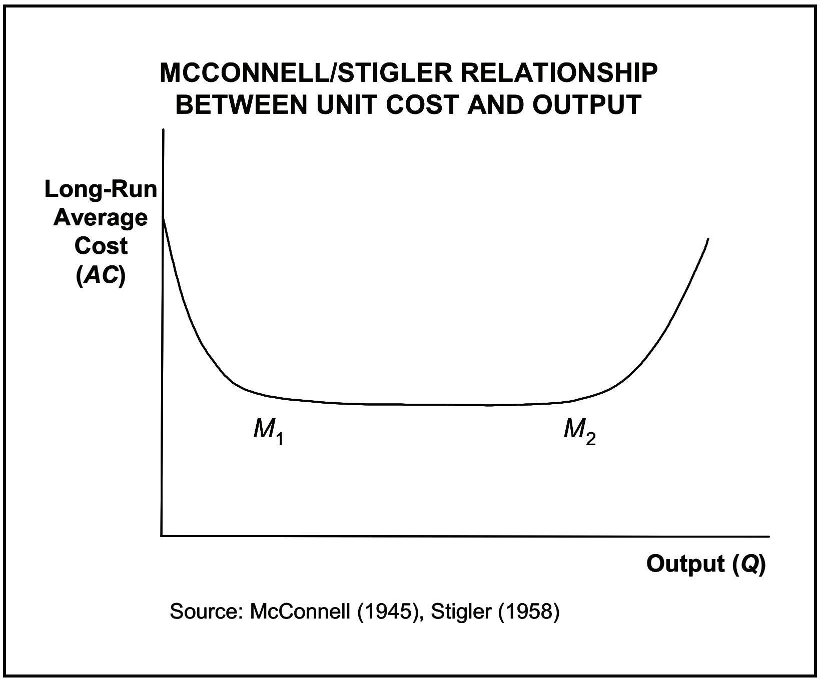


As the output *Q* increases, the average cost decreases due to economies of scale. At a certain point (*M*) the economies of scale are exhausted, while diseconomies of scale, presumably driven by diminishing returns to management (e.g., Coase 1937, 395), start to influence the unit cost. As output increases, the unit cost increases. In a competitive market, this implies an equilibrium output *M* where marginal cost not only equals marginal revenue, but also intersects long-run average cost at its minimum (e.g., Mankiw 1998, 296).

In reality, however, this is not what is observed. Rather, the cost-minimising part of the curve covers a wide range of outputs, and only at high output levels do diseconomies set in, if ever (Panzar 1989, 37–38).

McConnell's quantification (1945, 6) and Stigler's illustration (1958, 59), reproduced in Figure 3, are typical.

Figure 3. McConnell/Stigler Relationship between Unit Cost and Output



This shape of the cost curve reconciles several real-world observations. (1) It explains why large and small firms can coexist in the same industry. There is a wide range of outputs, between the points M_1 and M_2, for which the unit cost is more or less constant. (2) It is consistent with Lucas's observation (1978, 509) that, as the economy grows, existing firms tend to expand supply to meet additional demand, because most firms operate with outputs Q below the M_2 inflexion point. (3) It eliminates the supposition that economies of scale are exhausted at approximately the same point that diseconomies of scale start increasing unit cost, which is indicated with M_1 being much to the left of M_2. (4) It demonstrates that there are indeed limits to firm size due to diseconomies of scale, as shown by the increasing unit cost beyond M_2 —large firms have not expanded indefinitely.

However, if the reasoning above is correct, it is still unclear why the cost curve bends upwards at M_2. Neoclassical theory does not provide a satisfactory answer. As Simon ([1947] 1976, 292) said: “the central problem is not how to organize to produce efficiently (although this will always remain an important consideration), but how to organize to make decisions”.[6] The first part of this statement refers to the negative derivative of the cost curve at outputs smaller than M_1, where economies of scale in production have not yet been exhausted, while the second part applies to the upward slope, where diseconomies of scale due to diminishing returns to management set in beyond M_2.

Clarifying “how to organise to make decisions”—and thus the upward bend of the cost curve—will help executives optimise corporate performance. The current research investigates whether transaction cost economics can more thoroughly explain diseconomies of scale and what drives these diseconomies. It picks up on a debate that harks back to the

[6] Simon echoed the writing of Robertson (1923, 25): ”It is the economies of large-scale government rather than of large-scale technique which dictate the size of the modern business unit”. (Note: *government* here refers to *corporate organisation and governance*, not national government.)

early 1930s when Florence (1933) and Robinson (1934), respectively, argued the case against and for limits of firm size. Florence believed that optimum firm size meant maximum firm size: "the more the amount of any commodity provided the greater the efficiency" and "there is in my view no theoretical limit to the increase in the physical return obtainable by larger-scale operations" (p. 12). He argued that no organisation would be too large for a single leader to control and thought that the only reason this had not happened yet was a certain lag between what managers at the time assumed they could do and the inevitable outcome (p. 47).

In contrast, Robinson did not subscribe to this reasoning and he believed strongly in "the increasing costs of coordination required for the management of larger units" (p. 242). He argued that the existing facts—the then newly released first report on the size distribution of British firms—supported the notion that optimum firm size was less than maximum firm size (p. 256).

2.1.2 Importance of the Research

Diseconomies of scale have not been extensively studied and thus there may be a genuine gap in our understanding of the firm. Transaction cost economics may help fill this gap because the theory embeds a number of concepts relating to the limits of the firm. Filling the gap may not only affect the way we think about strategy and structure, but also help executives make more effective decisions.

Limits-of-firm-size is not a major field of study (Coase 1993a, 228; Holmström and Tirole 1989, 126). There are around 60 articles or books that deal with the topic in a meaningful way (see Chapter 3 for a review and Appendix A for a list of references). Williamson (1985, 153), for example, stated that our understanding of bureaucratic failure is low compared with what we know of market failure. Given the relative slowdown in the growth of large firms over the last 30 years (see Section 2.3), understanding why market-based transactions are slowly winning over internally-based transactions matters more than ever.

The second reason why this research is academically important is that it uses transaction cost economics in a somewhat new fashion. The 1970s were the defining years of TCE. At that time, large firms still appeared set to become ever more dominant, and TCE reflects this *Zeitgeist*. Thus, many of the theory's applications have been in antitrust cases, rather than in studies of internal organisation. Further, TCE has arguably evolved over time from a general theory for understanding industrial organisation to a tool for primarily analysing vertical integration. For example, Shelanski and Klein (1995) surveyed the empirical transaction-cost-economics literature; out of 118 journal articles published between 1976 and 1994, 87 (74 per cent) related to vertical integration, make/buy decisions, or hybrid forms of vertical integration.[7] Williamson's introductory overview of TCE in the *Handbook of Industrial Organization* (1989, 150) called vertical integration the paradigm problem of TCE. This research breaks with that tradition by looking at the firm as a whole, rather than its vertical integration characteristics.

Limits of firm size are also a real and difficult problem for business executives. The cost of suboptimal size—that is, a firm that is too large—is probably significant. For example, up to 25 per cent (Riahi-Belkaoui 1994, 35–64) of the cost of goods sold of a large manufacturing firm can be attributed to organisational slack, often embedded in communication problems, bureaucratic inefficiencies and other diseconomies of scale discussed in detail in Chapter 3. Moreover, large firms have a tendency slowly to decline and disappear (Hannah 1996, 1). Shedding light on why this is the case may be socially and privately beneficial, Hannah pointed out, because "we have made great strides in storytelling, but a clearer, surer recipe for sustained success for large corporations has remained elusive" (p. 24).

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7 Shelanski and Klein claimed that vertical integration research has declined as a share of the total over time, but a categorisation by year shows that the share is stable or may in fact have increased. 1976–1979: 5 articles, 40 per cent vertical integration; 1980–1984: 26 articles; 73 per cent vertical integration; 1985–1989: 53 articles, 72 per cent vertical integration; 1990–1994: 34 articles, 82 per cent vertical integration.

2.2 DIMENSIONS OF FIRM SIZE

This section defines size and shows the trends in firm size in the US manufacturing sector. Large manufacturing firms in the US have shrunk relative to the total manufacturing sector and the economy as whole over the last 20 to 25 years, while overall industry concentration has been rather stable over the last 100 years. Applying the survivor principle (see p. 14, above), this implies that there are indeed limits to firm size.

2.2.1 Definition of the Firm

To begin with, there are a number of definitions of what a firm is. The *first*, based on Coase (1937, 389), Penrose ([1959] 1995, 15), and Arrow (1964, 403; 1974, 33) holds that the boundary of the firm is where the internal planning mechanism is superseded by the price mechanism. That is, the firm's border is at the point where transactions are regulated by the market rather than by administration. In most cases this means that the operating firm is equivalent to the legal corporation. An important, if rare, exception is a corporation in which divisions are totally self-contained profit centres. In this case the parent company is not a firm, because the company's divisions by definition trade between themselves through market-based transfer prices.

The *second* definition is that ownership sets a firm's boundaries (e.g., Hart 1995, 5–8). With this definition, a firm is the combination of activities for which the bearers of residual risk are one and the same. One problem with this definition is that employees are not "owned", so they therefore would not be considered part of the firm. Another issue is how units such as a partly-owned subsidiary should be treated. For example, General Motors Corporation owned 82 per cent of Delphi Automotive Systems in early 1999, but Delphi would not be viewed as part of General Motors under the above definition. Still, this definition is quite similar to Coase's because employment contracts can be viewed as temporary ownership claims, and partial ownership is still uncommon even though alliances and carve-outs have grown in popularity.

A *third* definition sees the firm as a network (Richardson 1972, 884–887). McDonald's Corporation, for example, extends far beyond its corporate ownership, because it also consists of a network of thousands of franchisees over whom McDonald's have a high degree of contractual control (Rubin 1990, 134–144).[8]

The *fourth* definition is based on the firm's sphere of influence. This includes distributors, alliance partners, first- and second-tier suppliers,

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[8] 18,265 at the end of 1999.

and so on (Williamson 1985, 120–122). Toyota Motor Corporation, for example, directly employed 215,000 people in 2000, but its sphere of influence probably extended over more than one million people.

In all four cases, it is theoretically somewhat difficult to draw the boundaries of the firm and to distinguish the firm from the whole economy. Nevertheless, it is, to use the words of Kumar, Rajan and Zingales (1999, 10), possible to create an "empirical definition". For the purposes of this thesis, the firm is defined as having commonly owned assets—the ownership definition—but employees are also treated as part of the firm. This definition relates closely to Hart's definition (1995, 7), and publicly available data follow it. It is also commonly used in research (Kumar, Rajan and Zingales 1999, 11). Thus, a firm is an incorporated company (the legal entity) henceforth.

2.2.2 Definition of Size

There are various ways to measure the size of a firm. Size is most often defined as annual revenue, especially by the business press. However, this measure is basically meaningless because it tells nothing about the depth of the underlying activity. Based on this measure, the world's four largest companies were Japanese trading houses in 1994 (Fortune 1995b). They had between 7,000 and 80,000 employees, but almost no vertical integration.

A better measure of size is value added, which is more or less equivalent to revenue less externally purchased products and services. This metric gives a precise measure of activity, but it is usually not publicly available for individual firms.

Number of employees is the most widely used measure of size. A review by Kimberley claims that more than 80 per cent of academic studies use this measure (1976, 587). In line with Child’s observation (1973, 170) that “it is people who are organized”, it is not surprising that the number of employees is the most used metric for measuring firm size.

Finally, assets can define size (e.g., as described by Grossman and Hart 1986, 693–694). As with revenue, this measure may not reflect underlying activity; but for manufacturing firms, asset-to-value-added ratios are fairly homogeneous. Asset data for individual firms are usually available back to the 1890s and are therefore a practical measure in longitudinal studies.

In sum, the best measures of size are value added and number of employees, although assets can be used in certain types of studies. This research uses number of employees as the size metric because the data are available and diseconomies of scale should be associated with human frailties. Moreover, this research deals with bureaucratic failure, which in the end is the result of coordination costs. Such costs are best measured in relation to number of employees (Kumar, Rajan and Zingales 1999, 12).

The definitions are summarised in Table 2 with the suitability for the research at hand indicated by the shadings, ranging from high (black) to low (white).

Table 2. Definition of the Firm and Firm Size

DEFINITION OF THE FIRM AND FIRM SIZE				
	Firm Definition			
Size Metric	**Internal Planning (Coase)**	**Ownership**	**Network**	**Sphere of Influence**
Revenue				
Value Added				
Employees				
Assets				

2.3 TRENDS IN FIRM SIZE

The US economy is the basis for the analysis in the current research because it is large, fairly homogenous and transparent, and it has a high level of competition between firms. Within this economy, the research focuses on the manufacturing sector.[9]

Large manufacturing firms play a major role in the US economy. The Fortune industrial 500 companies controlled more than 50 per cent of corporate manufacturing assets and employed more than eleven million people in 1994, the last year for which the Fortune industrial ranking was compiled (Fortune 1995a). Their sphere of influence was approximately 40 million employees out of a total private sector workforce of 123 million. Contrary to popular belief, however, the importance of large firms is not increasing and has not done so for many years. Studies show that large manufacturing firms are holding steady as a share of value added since circa 1965 (Scherer and Ross 1990, 62). Their share of employment in the manufacturing sector has declined from around 60 per cent (1979) to around 50 per cent (1994). Moreover, as a share of the total US economy, they are in sharp decline. Large manufacturing firms employed 16 million people in 1979 versus 11 million in 1994 (Fortune 1995a, 185), while private

[9] Alternative approaches would be to study the global manufacturing sector, the total US private sector, or both. However, statistics on the global manufacturing sector are not reliable, and the non-manufacturing sectors are often highly regulated.

sector employment grew from 99 to 123 million people (Council of Economic Advisers 1998, 322) over the same time period.

Further evidence that large firms do not increasingly dominate the economy is available from a number of historical studies. Aggregate industry concentration has changed little since the early part of the last century.[10] Nutter (1951) studied the concentration trend between 1899 and 1939 and found no signs of increased aggregate concentration during this period, mainly because new, fragmented industries emerged, while older ones consolidated (pp. 21, 33). Bain (1968) found the same trend between 1931 and 1963, but with less variability between industries. Scherer and Ross (1990, 84) used Nutter's method and showed that aggregate concentration increased slightly, from 35 per cent in 1947 to 37 per cent in 1982. Similarly, Mueller and Hamm (1974, 512) found an increase in four-firm concentration from 40.5 per cent to 42.6 per cent between 1947 and 1970, with most (70 per cent) of the increase between 1947 and 1963.

Bain (1968, 87) calculated that the assets controlled by the largest 200 nonfinancial firms amounted to about 57 per cent of total nonfinancial assets in 1933.[11] He also estimated that the 300 largest nonfinancial firms

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[10] Note that there have been significant changes within individual industries.

[11] A similar study by Berle and Means ([1932] 1991) has been partly discredited. For example, Scherer and Ross (1990, 60) found that Berle and Means, based on the "meager data then available,...overestimated the relative growth of the largest enterprises".

accounted for 55 per cent of nonfinancial assets in 1962. The largest 200 firms therefore accounted for approximately 50 per cent of nonfinancial assets in 1962 (using the current researcher's estimate of the assets controlled by the 100 smallest firms in the sample). This researcher's data showed that the top 200 nonfinancial firms controlled less than 50 per cent of the total nonfinancial assets in 1994. Adelman (1978) observed a similar pattern when he studied the 117 largest manufacturing firms between 1931 and 1960. He found that concentration was the same at the beginning and at the end of the period (45 per cent). He concluded that "overall concentration in the largest manufacturing firms has remained quite stable over a period of 30 years, from 1931 to 1960". Allen (1976) updated Adelman's number to 1972 and reached the same conclusion. The current research replicated the analysis for 1994 and found the same concentration number to be 45 per cent. Both sets of longitudinal data indicate that large firms represent a stable or declining fraction of the manufacturing sector.

Finally, Bock (1978, 83) studied the share of value added contributed by the largest manufacturing firms between 1947 and 1972. There was a large increase between 1947 and 1954, and a further slight increase until 1963. Between 1963 and 1972, there was no increase. Scherer and Ross (1990, 62) confirmed the lack of increase through the end of the 1980s. Sutton

(1997, 54–55) reached a similar conclusion in a comparison of concentration in the US manufacturing sector between 1967 and 1987.

As for the future, the stock market does not expect the largest firms to outperform smaller firms. The stock market valuation of the largest firms, relative to smaller firms, has declined sharply between 1964 and 1998 (Farrell 1998). In 1964 the largest 20 firms comprised 44 per cent of total stock market capitalisation in the United States; in 1998 they accounted for 19.5 per cent. Market value primarily reflects future growth and profit expectations, and thus the market is increasingly sceptical of large firms' ability to compete with smaller firms. This could be due to industrial evolution, but if it is assumed that diseconomies of scale do not exist, then the largest 20 firms should presumably be able to compensate for a relative decline in their mature businesses by effortlessly growing new businesses.

A study of firms on the New York stock exchange (Ibbotson Associates 1999, 127–143) similarly showed that small firms outperformed large firms between 1926 and 1998. The total annual shareholder return over the period was 12.1 per cent for the largest size decile and 13.7 per cent for the second largest size decile. It increased steadily to 21.0 per cent for the smallest size decile (p. 129). The real return to shareholders after adjustment for risk (using the capital asset pricing model) was −0.28 per cent for decile 1, +0.18 per cent for decile 2 and rising steadily to +4.35 per cent for decile 10 (p. 140). Note, however, that market capitalisation was used as the definition of size in this study.

The above evidence shows that concentration in the manufacturing sector—defined as the share of value added, employment, assets or market capitalisation held by large firms—has changed little or has declined over much of the last century. The size of large manufacturing firms has kept pace with the overall growth of the manufacturing part of the economy since the 1960s in value-added terms, but has declined in employment terms since 1979 (and has declined relative to the total US corporate sector and the global corporate sector). This indicates that there is a limit to firm size and that this limit may be decreasing in absolute terms, all of which supports the research findings of this thesis.

The next chapter explores these limits of firm size through a review of the relevant literature. A theoretical framework is constructed based on transaction cost economics, and the literature is surveyed to validate the framework.

3. LITERATURE REVIEW

The literature review is divided into two parts. The first part defines the theoretical framework and discusses the transaction-cost-economics literature relating to the framework. The second part examines the evidence in transaction cost economics and other fields which supports (and occasionally contradicts) the theoretical framework. The chapter shows that a robust theoretical framework can be constructed based on transaction cost economics, and that the theoretical and empirical literature is congruent with this framework.

3.1 THEORETICAL FRAMEWORK

Transaction cost economics focuses on the boundary of the firm (Holmström and Roberts 1998, 73; Williamson 1981, 548)—that is, the distinction between what is made internally in the firm and what is bought and sold in the marketplace. The boundary can shift over time and for a number of reasons, and the current research looks at one aspect of these shifts. As firms internalise transactions, growing larger, bureaucratic diseconomies of scale appear. Thus, a firm will reach a size at which the benefit from the last internalised transaction is offset by bureaucratic failure. Two factors moderate these diseconomies of scale. First, firms can lessen the negative impact of diseconomies of scale by organising activities appropriately and by adopting good governance practices. Second, the optimal degree of integration depends on the level of asset specificity, uncertainty and transaction frequency.

Coase's article "The Nature of the Firm" (1937) establishes the basic framework. "Limits of Vertical Integration and Firm Size" in Williamson's book *Markets and Hierarchies* (1975) suggests the nature of size limits. "The Limits of Firms: Incentive and Bureaucratic Features" in Williamson's book *The Economic Institutions of Capitalism* (1985) expands on this theme and explains why the limits exist.[12] Riordan and Williamson's article "Asset Specificity and Economic Organization" (1985) augments the theoretical framework presented here by combining transaction costs with neoclassical production costs. The remainder of the section discusses the details of the argument.

3.1.1 Reasons for Limits

Coase's paper on transaction costs (1937) is the foundation of the New Institutional Economics branch of industrial organisation. Coase asked two fundamental questions "Why is there any organisation?" (p. 388) and "Why is not all production carried on by one big firm?" (p. 394). He

[12] Published earlier by Williamson in a less-developed form (1984).

answered these questions by emphasising transaction costs, which determine what is done in the market—where price is the regulating mechanism, and what is done inside the firm—where bureaucracy is the regulator. Coase pointed out that "the distinguishing mark of the firm is the supersession of the price mechanism" (p. 389). To Coase, all transactions carry a cost, whether it is an external market transaction cost or one that accrues from an internal bureaucratic transaction. "The limit to the size of the firm would be set when the scope of its operations had expanded to a point at which the costs of organizing additional transactions within the firm exceeded the costs of carrying out the same transactions through the market or within another firm" (Coase 1993b, 48).

According to Coase, the most important market transaction costs are the cost of determining the price of a product or service; the cost of negotiating and creating the contract; and the cost of information failure. The most important internal transaction costs are associated with the administrative cost of determining what, when and how to produce; the cost of resource misallocation, because planning will never be perfect; and the cost of lack of motivation on employees' parts, given that motivation is lower in large organisations. In any given industry, the relative magnitude of market and internal transaction costs will determine what is done where.

Coase thus created a theoretical framework which potentially explains why firms have size limits. However, this is only true if there are diminishing returns to management within the firm (Penrose [1959] 1995, 19). Williamson (1975, 130) later argued that this is the case, asking his own rhetorical question: "Why can't a large firm do everything that a collection of small firms can do and more?" (Williamson 1984, 736). Williamson pointed out that the incentive structure within a firm has to differ from market incentives. Even if a firm tries to emulate the high-powered incentives of the market, there are unavoidable side effects, and the cost for setting up incentives can be high. In other words, combining small firms into a large firm will never result in an entity that operates in the same way as when independent small firms respond directly to the market.

3.1.2 Nature of Limits

Williamson (1975, 126–130) found that the limits of firm size are bureaucratic in origin and can be explained by transaction cost economics. He identified four main categories of diseconomies of scale: atmospheric consequences due to specialisation, bureaucratic insularity, incentive limits of the employment relation and communication distortion due to bounded rationality.

Williamson's categories are similar to those Coase described in 1937. Coase talked about the determination (or planning) cost, the resource misallocation cost and the cost of lack of motivation. Williamson's first and second categories correspond broadly to the determination cost; the third category to the demotivation cost, and the fourth category to the resource misallocation cost. Williamson's categories are, however, more specific and allow for easier operationalisation as is shown in Chapters 5 and 6. The four categories are detailed below:

Atmospheric consequences. According to Williamson (1975, 128–129), as firms expand there will be increased specialisation, but also less commitment on the part of employees. In such firms, the employees often have a hard time understanding the purpose of corporate activities, as well as the small contribution each of them makes to the whole. Thus, alienation is more likely to occur in large firms.

Bureaucratic insularity. Williamson (1975) argued that as firms increase in size, senior managers are less accountable to the lower ranks of the organisation (p. 127) and to shareholders (p. 142). They thus become insulated from reality and will, given opportunism, strive to maximise their personal benefits rather than overall corporate performance. According to Williamson, this problem is most acute in organisations with well-established procedures and rules and in which management is well-entrenched. The argument resembles that of agency theory (Jensen and Meckling 1976; Jensen 1989), which holds that corporate managers tend to emphasise size over profitability, maintaining excess cash flow within the firm rather than distributing it to a more efficient capital market (a lengthier comparison of agency theory and transaction cost economics appears in Section 3.2.1.3). As a consequence, large firms tend towards organisational slack, and resources are misallocated. If this is correct we would expect, for example, to see wider diversification of large firms and lower profits.

Incentive limits of the employment relation. Williamson (1975, 129–130) argued that the structure of incentives large firms offer employees is limited by a number of factors. First, large bonus payments may threaten senior managers. Second, performance-related bonuses may encourage less-than-optimal employee behaviour in large firms. Therefore, large firms tend to base incentives on tenure and position rather than on merit. Such limitations may especially affect executive positions and product development functions, putting large firms at a disadvantage when compared with smaller enterprises in which employees are often given a direct stake in the success of the firm through bonuses, share participation, and stock options.

Communication distortion due to bounded rationality. Because a single manager has cognitive limits and cannot understand every aspect of a complex organisation, it is impossible to expand a firm without adding hierarchical layers. Information passed between layers inevitably becomes distorted. This reduces the ability of high-level executives to make decisions based on facts and negatively impacts their ability to strategise and respond directly to the market. In an earlier article (1967), Williamson found that even under static conditions (no uncertainty) there is a loss of control. He developed a mathematical model to demonstrate that loss of control is a critical factor in limiting firm size, and that there is no need to assume rising factor costs in order to explain such limits (pp. 127–130). His model showed that the number of employees can not expand indefinitely unless span of control can be expanded indefinitely. Moreover, he applied data from 500 of the largest US firms to the model, showing that the optimal number of hierarchical levels was between four and seven. Beyond this, control loss leads to "a static limit on firm size" (p. 135).

Williamson pointed out a number of consequences for these four diseconomies of scale.[13]

[13] Williamson's descriptions are confusing. They are scattered throughout the chapters referenced, inserted between theory and examples. The consequences discussed here are this researcher's attempt to clarify Williamson's descriptions.

- Large firms tend to procure internally when facing a make-or-buy decision (1975, 119–120).
- They have excessive compliance procedures and compliance-related jobs tend to proliferate. Thus, policing costs, such as the cost of audits, can be disproportionately high (1975, 120).
- Projects tend to persist, even though they clearly are failures (1975, 121–122).
- Information is often consciously manipulated to further individual or sub-unit goals (1975, 122–124).
- Asset utilisation is lower because high-powered market incentives do not exist (1985, 137–138).
- Transfer prices do not reflect reality, and cost determination suffers (1985, 138–140).
- Research and development productivity is lower (1985, 141–144).

- Large firms often operate at a suboptimal level by trying to manage the unmanageable, forgiving mistakes, and politicising decisions (1985, 148–152).

Table 3 outlines the links between limiting factors and the consequences listed above.

Table 3. Links between Limiting Factors and Consequences

LINKS BETWEEN LIMITING FACTORS AND CONSEQUENCES				
	Factors			
Consequences	**Atmospheric Consequences**	**Bureaucratic Insularity**	**Incentive Limits**	**Communication Distortion**
Internal procurement	Moderate	Strong	Strong	
Excessive compliance procedures	Strong	Strong	Strong	Strong
Project persistence	Strong	Strong	Moderate	
Conscious manipulation of information		Strong		Strong
Low asset utilisation	Strong			Strong
Poor internal costing			Strong	Strong
Low R&D productivity	Strong	Moderate	Strong	Strong
Dysfunctional management decisions	Strong	Strong		Moderate

Each of the factors which limit size appears to have several negative consequences for firm performance. Given the strength of many of these links, it is plausible to assume that a large firm will exhibit lower relative growth and profitability than a smaller firm with the same product and market mix.

3.1.3 Economies of Scale

Transaction cost economics does not usually deal with economies of scale, which are more often associated with neoclassical production costs. However, Riordan and Williamson (1985) made an explicit attempt to reconcile neoclassical theory and transaction cost economics and showed, among other things (see also pp. 43–44, below), that economies of scale are evident in both production costs (p. 371) and transaction costs (p. 373), and that both can be kept internal to a firm if the asset specificity is positive. That is, the economies of scale can be reaped by the individual firm and are not necessarily available to all participants in a market (pp. 367–369).

3.1.4 Moderating Influences on Firm-Size Limits

While the four categories relating to diseconomies of scale theoretically impose size limits on firms, two moderating factors tend to offset diseconomies of scale: organisation form and degree of integration. Both are central to transaction cost economics, and in order to test the validity of the diseconomies-of-scale argument, it is necessary to account for these factors.

Organisation form. Williamson (1975, 117) recognised that diseconomies of scale can be reduced by organising appropriately. Based on Chandler's pioneering work (e.g., 1962) on the evolution of the American corporation, Williamson argued that the M-form organisation lowers internal transaction costs compared to the U-form organisation.[14] It does so for a key reason: The M-form allows most senior executives to focus on high-level issues rather than day-to-day operational details, making the whole greater than the sum of its parts (p. 137). Thus, large firms organised according to the M-form should perform better than similar U-form firms.

Degree of integration. Williamson showed that three factors play a fundamental role in determining the degree of integration: *uncertainty*, *frequency of transactions* and *asset specificity,* under conditions of bounded rationality (Simon [1947] 1976, xxvi–xxxi) and opportunism (Williamson 1993).

High uncertainty, such as business-cycle volatility or rapid technological shifts, often leads to more internal transactions; it is difficult and prohibitively expensive to create contracts which cover all possible outcomes. Thus, with higher uncertainty, firms tend to internalise activities. In addition, if the transactions are frequent they tend to be

[14] Often referred to as "functional organisation" by other authorities, including Chandler.

managed internally because the repeated market contracting cost usually is higher than the internal bureaucratic cost.

While uncertainty and frequency play some role in creating transaction costs, Williamson considered asset specificity the most important driver of integration (e.g., Riordan and Williamson 1985, 366). Asset specificity is relatively independent of the other factors that affect firm-size limits (p. 368), and therefore the current research focuses on it.

With high asset specificity, market transactions become expensive. Asset specificity refers to physical, human, site, or dedicated assets (Williamson 1985, 55), which have a specific use and cannot easily be transferred.[15] Opportunistic behaviour can be expected if the asset is part of a market transaction. For example, a supplier invests in specific tooling equipment dedicated to one customer. Over time, the customer will be able to put pressure on the supplier because the supplier has no alternative use for the investment. The supplier ultimately lowers its price to the variable cost of production in order to cover fixed costs. But by owning the asset, a firm's incentive to cheat disappears, and the cost of creating contractual safeguards is reduced (Williamson 1985, 32–35).

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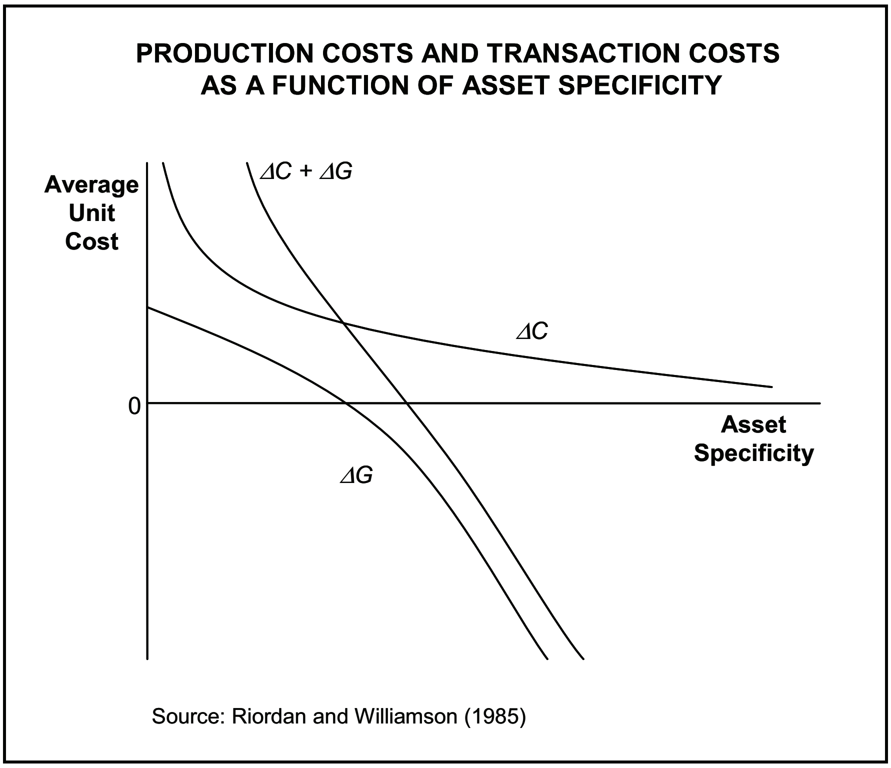
[15] Williamson (1996, 59–60) added brand name capital and temporal specificity.

Neoclassical production costs also exhibit diseconomies as a function of asset specificity (Riordan and Williamson 1985, 369):

> The diseconomies are arguably great where asset specificity is slight, since the outside supplier here can produce to the needs of a wide variety of buyers using the same (large scale) production technology. As asset specificity increases, however, the outside supplier specializes his investment relative to the buyer. This is the meaning of redeployability. As these assets become highly unique, moreover, the firm can essentially replicate the investments of an outside supplier without penalty. The firm and market production technology thus become indistinguishable at this stage.

This is illustrated in Figure 4, in which the differential production cost (ΔC) and transaction cost (ΔG) for markets and hierarchies are shown as a function of asset specificity. The curves show that markets have a large production cost advantage when asset specificity is low, but it approaches zero for high asset specificity (ΔC). For transaction costs, the market has an advantage for low asset specificity and a disadvantage for high asset specificity (ΔG).

Figure 4. Production Costs and Transaction Costs as a Function of Asset Specificity



The implication of the asset-specificity argument, from both a transaction- and production-cost perspective, is that firms with high asset specificity will not reach the limits of size as quickly as those with low specificity. Thus, Riordan and Williamson found that "larger firms are more integrated than smaller rivals" (p. 376).

In closing, a framework based on transaction cost economics has been constructed which establishes a rationale for firm-size limits. Four factors—atmospheric consequences, bureaucratic insularity, incentive limits and communication distortion—make it difficult for firms to expand indefinitely. These negative influences can be offset by economies of scale, and they can be moderated by the choice of an appropriate organisational form and by increasing internal asset specificity. The framework is next tested against the literature.

3.2 EVIDENCE

In general, there exists only limited research on diseconomies of scale. This is somewhat surprising, because many authorities point out that analysing the limits of firm size is critical to our understanding of the modern economy. Fortunately, the relevant literature yields fragments of evidence that not only confirm the existence of diseconomies of scale, but also explicate various features of bureaucratic failure. The composite picture derived from a review of this literature supports the theoretical framework developed in the previous section, and the hypotheses articulated later in the thesis (see Chapter 4).

This section begins with a review of the literature relating to diseconomies of scale and a comparison with Williamson's theoretical framework. The following part reviews the various perspectives on the relationship between economies of scale and diseconomies of scale. Next, the section discusses the support in the literature for the moderating factors. The fourth part briefly reviews what impact, if any, the choice of industry has on a firm's performance. Finally, the literature findings are summarised in a concluding part.

3.2.1 Diseconomies of Scale

The literature relating to firm-size limits does not follow Williamson's categorisation. Thus, the relevant studies are reviewed by general topic and author, covering bureaucracy and its negative effect on size, information loss, agency theory, and employee incentive problems. At the end of the section the arguments are summarised and related back to Williamson's four sources of diseconomies of scale.

3.2.1.1 Bureaucracy: Negative Consequences of Size

A number of sociological studies describe negative consequences of size which correlate well with Williamson's propositions in Section 3.1. Pugh et al. (1969) and Child (1973), among others, showed that size leads to bureaucracy. Large firms are usually highly bureaucratised through formalisation, and to the extent that bureaucracies breed diseconomies, this limits the growth of such firms. Williamson made a similar point: "almost surely, the added costs of bureaucracy are responsible for limitations in firm size" (1996, 266). According to Blau and Meyer the diseconomies of bureaucracy fall into three major categories: (1) excessive rigidity, (2) conservatism/resistance to change, and (3) perpetuation of social-class differences (1987, 139–161).

Of these, the first one is relevant here because conservatism is essentially a subcategory of rigidity, and social-class differences fall outside the scope of this research. Excessive rigidity appears as organisations formalise work practices through bureaucratic procedures (Merton 1957, 197–200). Problems are solved by adding structure and the firm reaches a point at which the added structure costs more than the problem solved; Blau and Meyer referred to this as the "problem—organisation—problem—more organisation" spiral of bureaucratic growth (1987, 147). These researchers showed that factors external to the firm, such as increased number of customers or number of tasks to be performed, have little to do with increased bureaucracy. In the end, the added policies and procedures of bureaucracy stifle flexibility.

Crozier (1964) also emphasised rigidity as the most important dysfunction of bureaucracy. In fact, he viewed the bureaucratic organisational model as inherently inefficient, especially under conditions of uncertainty. Managers become increasingly insulated from reality, while lower levels of the organisation experience alienation. As Stinchcombe (1965) demonstrated, one consequence of such rigidity is that firms tend to maintain the organisation form they had when they were created.

Pondy (1969) studied administrative intensity in different industries and what causes variations in intensity. He found a positive correlation between size of administration and firm size when he included a measure of ownership-management separation. This is in line with Williamson's notion of bureaucratic insularity: the larger the organisation is, the more managers are shielded from reality, and the more distant the owners are from daily operations.

Using a demographical research approach, Carroll and Hannan (2000, 289–290) argued that older firms exhibit organisational inertia and find it increasingly difficult to adapt to external changes: "…old organizations are disadvantaged compared to younger ones in changing environments. Alternatively, accumulating rules, routines, and structures might simply impose an overhead cost that reduces the efficiency of organizations even in stable environments".

A similar logic based on institutional economics can be found in Olson (1982). His theory holds that as the institutional structure of a country ages, growth-retarding organisations such as an increasingly complex legal system, special-interest groups and nongovernmental watchdog organisations will become increasingly abundant. The theory and empiry specifically predict that older countries with stable institutions will exhibit lower economic growth (p. 77). If this logic holds for corporations as well, then older firms will experience less growth.

3.2.1.2 Information Loss and Rigidity

A few studies from the firm-as-information-processor school of thought relate to diseconomies of scale. (Several studies within this school relate to the size distribution of firms, but do not discuss the nature of the diseconomies of scale at length. See Sutton (1997, 43–48) and Axtell (1999, 4–5) for summaries.) Arrow (1974) found that employees in large organisations tend to be highly specialised. Thus, coordination through communication becomes increasingly important. Because information flows carry a cost, organisations code (through formal or informal rules) the information available. Coding economises on resources, but it also leads to information loss and rigidity (p. 55). This means (1) that the more hierarchical levels there are, the more information loss or distortion results; and (2) the older the firm is, the higher the rigidity.

Simon ([1947] 1976) made a similar point. Based on his concept of bounded rationality—"human behavior is *intendedly* rational, but only *limited* so" (p. xxviii)—he found that information degrades as communication lines are extended. Geanakoplos and Milgrom (1991) added to this perspective by noting that there are inevitable signal delays in an organisation. The more hierarchical levels to be traversed, the longer and more frequent the delays are. Summarising the lessons learnt during a career as a corporate executive, Barnard ([1938] 1968) argued that the size of unit organisations is "restricted very narrowly by the necessities of communication" (p. 110) and that "the size of executive organizations is limited generally by the same conditions that govern the size of unit organizations" (p. 112).[16]

Control-loss problems may contribute to diseconomies of scale as well. McAfee and McMillan (1995) argued that people in organisations exploit information asymmetries to their advantage (or in Williamson's words (1993), they are opportunistic). Dispersion of knowledge within the organisation combined with individual self-interest make conflict of interest and sub-goal pursuit inevitable. McAfee and McMillan noted, among other things, that efficiency falls as the hierarchy expands, and that "long" hierarchies are not viable in competitive industries (p. 401). Qian (1994), similarly found that in long hierarchies, employees do not contribute with a high level of effort. Employees have incomplete information about their role in the enterprise and thus suffer from a lack of motivation. Moreover, managers will need to monitor employee effort, leading to higher costs and further resistance or lack of commitment. However, Mookherjee and Reichelstein (2001) made the case that long hierarchies, under certain restrictive conditions (p. 4), do not lead to control loss: "provided the required conditions on contracting sequence,

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[16] That is, the mechanism which determines how large a department can be, also determines how large the firm can be.

verifiability of subcontracts and unlimited liability of intermediate agents hold, our model questions the common notion that larger, more complex hierarchies are less efficient owing to 'control losses' with respect to incentives or coordination" (p. 4). It is unclear, however, whether these conditions are met by real-world firms.

3.2.1.3 Agency Theory

An early version of agency theory argued that very large firms do not strive for profit maximisation. According to Monsen and Downs, such firms need to build "bureaucratic management structures to cope with their administrative problems. But such structures inevitably introduce certain conflicts of interest between men in different positions within them. These conflicts arise because the goals of middle and lower management are different from those of top management. The introduction of these additional goals into the firm's decision-making process also leads to systematic deviations from profit-maximizing behavior" (1965, 222). Monsen and Downs furthermore found that the motives of managers differ from those of owners. Managers tend to maximise personal income, while owners maximise profits. It is impossible for owners of large firms to control the behaviour of managers. Consequently, profit maximisation does not occur. The outcome is akin to what Williamson labelled bureaucratic insularity.

Silver and Auster (1969) argued that the “divergences of interests within the firm and the costs of dealing with them” (p. 277) mean that “the entrepreneur’s time is a limitational factor” (p. 280). Employees typically “shirk their duties unless the employer takes steps to prevent this” (p. 278). As a result, senior executives will have less time for strategising and entrepreneurialism, all other things being equal. Silver and Auster furthermore made two predictions based on this argument: (1) the higher the labour content is of an industry’s value added, the sooner the total cost curve will turn up, meaning such industries will be more fragmented; and (2) the more supervision employees require, the lower the industry concentration ratio.

More recently, Jensen has deepened and extended these arguments (e.g., Jensen and Meckling 1976; Jensen 1986, 1988, 1989, 2000). He defined agency costs as the sum of the monitoring expenditures by the principal, the bonding expenditures by the agent, and the residual loss. The magnitude of agency costs depends on a number of factors, including the transparency of the firm’s activities and the market for managerial talent. Jensen did not, contrary to Monsen and Downs or Silver and Auster, explicitly state that agency costs increase with the size of the firm. Jensen demonstrated, however, that managers emphasise firm size over profitability: “Managers have incentives to cause their firms to grow beyond optimal size. Growth increases managers' power by increasing the resources under their control. It is also associated with increases in managers' compensation" (1986, 323). He looked at the profitability of diversified firms, noting that they are less profitable than focused firms.

Agency theory and transaction cost economics are similar in many respects and it is not surprising that the two theories lead to the same conclusions. However, some authorities contend that agency theory is a special case of TCE and thus does not capture all the costs associated with transactions. Specifically, Williamson (1985, 20–21) and Mahoney (1992, 566) argued that agency costs correspond to the *ex post* costs of TCE. Meanwhile, TCE works with both *ex ante* and *ex post* costs.[17] Table 4 compares the two theories.

Table 4. Comparison of Agency Costs and Transaction Costs

COMPARISON OF AGENCY COSTS AND TRANSACTION COSTS		
Transaction Costs		
Ex ante	***Ex post***	**Agency Costs**
• Search and information costs • Drafting, bargaining and decision costs • Safeguarding costs	• Monitoring and enforcement costs • Adaptation and haggling costs • Bonding costs • Maladaptation costs	• Monitoring expenditures of the principal • Bonding expenditures by the agent • Residual losses

[17] In contrast, Williamson (1988, 570) argued that agency costs correspond to TCE's *ex ante* costs.

Other critics have pointed out that agency theory poorly explains the boundaries of the firm (Kumar, Rajan, and Zingales 1999, 5). Hart (1995, 20), for example, noted that "the principal–agent view is consistent with there being one huge firm in the world, consisting of a large number of divisions linked by optimal incentive contracts; but it is also consistent with there being many small, independent firms linked by optimal arm's-length contracts". For that reason, TCE provides a more nuanced foundation for the current research.

3.2.1.4 Employee Incentives and Lack of Motivation

A number of authorities have argued that job satisfaction is lower in large organisations and at large work establishments. Employees in large firms are paid significantly more than those in small firms. The reason often given for this disparity is that higher compensation makes up for a less-satisfying work environment (Brown, Hamilton and Medoff 1990, 29).

Scherer's work (1976) is representative of the extensive research conducted at the establishment level. In a review of the literature, including his own original research, he concluded that worker satisfaction was 30 per cent lower in large establishments[18] compared to small establishments (p. 109).

[18] More than 500 employees.

Meanwhile, compensation was more than 15 per cent higher for equivalent job descriptions (p. 119). He argued that because establishment size is correlated to firm size, the effects of alienation in large firms appear to be significant. Later work, sponsored by the Federal Trade Commission in the United States, confirmed these findings (Kwoka 1980).

Brown, Hamilton and Medoff (1990) found that large firms pay a wage premium of 10–15 per cent over small firms when adjustments have been made for other effects such as unionisation and skill levels (p. 42). They did not conclude that this difference is necessarily related to alienation, but regardless of the cause, large firms seem to pay substantially higher wages than smaller ones.

In addition, span-of-control problems make it increasingly costly to extend incentive contracts to employees as firms grow (Rasmusen and Zenger 1990, 69). Thus, large firms favour fixed-wage contracts based on tenure rather than performance and make extensive use of monitoring to control productivity. In contrast, smaller firms link pay and performance closely (p. 80). As a result, the larger firms have a fairly narrow spread of salaries and do not attract top talent; smaller firms may employ both superior and inferior talent, but they reward individuals accordingly. Rasmusen and Zenger’s data strongly supported these conclusions, especially in functions with indivisible work, where success is dependent on joint contributions by several individuals (e.g., in research and development). The closer match between performance and pay in small firms puts large firms at a disadvantage, in line with Williamson's incentive limits as a source of diseconomies of scale. Olson (1982, 31) noted that: "in the absence of selective incentives, the incentive for group action diminishes as group size increases". A similar argument was made by Axtell (1999), who, based on agent-based computational modelling, found that the number of free riders in a firm grows with firm size and that the limits of firm size are set at the point where the advantages of joint production (i.e., economies of scale) are smaller than the disadvantages of having many free riders in the firms whose work effort cannot be effectively monitored (p. 54): "We have interpreted firm growth and demise as a process in which agents are attracted to high-income firms, these firms grow, and once they become large get over-run with free-riders."

Many authorities point out that R&D productivity is significantly lower in large firms. Cooper (1964) surprised business leaders and academics with his article "R&D Is More Efficient in Small Companies". Based on 25 interviews with managers at large and small firms, he argued that small firms have three to ten times higher productivity in development than large firms. The key reasons: (1) small firms are able to hire better people because they can offer more tailored incentives; (2) engineers in small firms are more cost-conscious; and (3) internal communication and coordination is more effective in small firms. These reasons match three of Williamson's four sources of diseconomies: incentive limits, atmospheric consequences and communication distortion.

Later work has confirmed Cooper's anecdotal evidence both theoretically and empirically. Arrow (1983) demonstrated that large firms will invest suboptimally in development because of information loss, and that small firms have a particular advantage in novel areas of research. Schmookler (1972) found that large firms (more than 5000 employees) trail small firms in the number of patented inventions, the percentage of patented inventions used commercially and the number of significant inventions (p. 39). Yet they spend more than twice the resources per patent (p. 37). Schmookler listed four reasons for the higher effectiveness and efficiency of small firms in R&D: a better understanding of the problem to be solved, greater cost-consciousness, a more hospitable atmosphere for creative contributions and superior quality of technical personnel (p. 45). Thus, Schmookler quantified and confirmed Cooper's initial evidence, noting that "big firms tend to provide a haven for the mediocre in search of anonymity" (p. 43). In addition, Zenger (1989, 1994) studied employment contracts in R&D in high technology. He found that organisational diseconomies of scale overwhelm technological economies of scale in

R&D. His statistical analysis of Silicon Valley firms showed that small firms attract better talent than large firms, motivate employees to try harder and tend to better tie compensation to performance (1994, 725).

Finally, leading anti-bigness ideologues have provided plenty of anecdotal evidence for such arguments, although they are lacking in formal findings. Peters (1992) supported the notion that R&D is less effective in large organisations. He argued that large firms are massively overstaffed in development and that there is little correlation between size of R&D budget and output, offering several case examples as proof. Brock (1987) argued that bigness retards technological advance because large firms are overly risk averse.

Peters, who since the early 1980s has crusaded against large firms, has discussed diseconomies of scale in several books and articles. His views were summarised in "Rethinking scale" (1992). Peters contended there that decentralisation is necessary for large firms, but very few are as decentralised as they can and should be. Without decentralisation, they are not adaptable enough to respond to changes in the marketplace: "If big is so damn good, then why is almost everyone big working overtime to emulate small?" (p. 13). Moreover, Peters argued that any firm would be well advised to reduce vertical integration, although he does not offer evidence for why this is true. Overall, he found that the bureaucratic distortions of traditional firms lead to lower profitability and growth. In contrast, successful firms mimic the market as much as possible. These ideas are in line with Williamson's description of firm limits, except for the notion that firms should always reduce vertical integration.

Schumacher (1989, 245) identified the lack of motivation in large organisations as the key disadvantage of size, providing a useful summary: "for a large organisation, with its bureaucracies, its remote and impersonal controls, its many abstract rules and regulations, and above all the relative incomprehensibility that stems from its very size, motivation is the central problem".

3.2.1.5 Reconciliation with the "Limits of Firm Size" Framework

The above observations on diseconomies of scale do not map perfectly to Williamson's four sources of diseconomies of scale. Some are similar to his sources, others to his outcomes. Table 5 shows that Williamson's framework is strongly supported. The most important contrary evidence is Mookherjee and Reichelstein's finding (2001) that long hierarchies do not necessarily lead to control loss, and Brown, Hamilton and Medoff's discussion (1990) of the reason for labour cost differentials between large and small firms. They noticed the differential, but found no link to motivation.

Table 5. Sources of Limits of Firm Size

SOURCES OF LIMITS OF FIRM SIZE			
Atmospheric Consequences	**Bureaucratic Insularity**	**Incentive Limits**	**Communication Distortion**
Arrow (1974): Rigidity to change	Blau and Meyer (1987): Excessive rigidity	Axtell (1999): Free-rider problem	Arrow (1974): Specialisation leads to poor communication
Blau and Meyer (1987): Excessive rigidity	Brock (1987): Risk aversion	Blau and Meyer (1987): Excessive rigidity	Arrow (1983): Information loss in R&D
Brown, Hamilton and Medoff (1990): Unexplained wage differential	Carroll and Hannan (2000): Firm age leads to insularity	Cooper (1964): R&D incentives	Barnard ([1938] 1968): Communication losses
Child (1973): Insularity	Child (1973): Insularity	Crozier (1964): Rigidity	Cooper (1964): R&D coordination
Cooper (1964): R&D cost control	Crozier (1964): Rigidity	Olson (1982):Absence of selective incentives	Geanakoplos and Milgrom (1991): Information signal delays
Crozier (1964): Alienation	Jensen (1986): Firms larger than optimum	Peters (1992): Low productivity in R&D	McAfee and McMillan (1995): Lower efficiency
Kwoka (1980): Low job satisfaction in large firms	Merton (1957): Rigidity	Rasmusen and Zenger (1990): Employment contracts	Mookherjee and Reichelstein (2001): No control loss under certain restrictive conditions
Merton (1957): Rigidity	Monsen and Downs (1965): Different owner/manager objectives	Schmookler (1972): Quality of R&D employees	Simon ([1947] 1976): Processing bottlenecks
Pugh et al. (1969): Insularity from reality	Olson (1982): Rigidity	Silver and Auster (1969): Limits to entrepreneurship	
Qian (1994): Monitoring costs/inadequate effort levels	Pondy (1969): Increase in administration	Williamson (1996): Weaker incentives in bureaucracies	
Scherer (1976): Low job satisfaction in large firms	Pugh et al. (1969): Insularity from reality	Zenger (1989, 1994): Employment contract disincentives in R&D	
Schmookler (1972): R&D cost consciousness; Climate for innovation	Schmookler (1972): Understanding market needs in R&D		
Schumacher (1989): Low motivation	Stinchcombe (1965): Perpetuation of organisation form		
	Williamson (1996): Bureaucratic rigidity		

3.2.2 Economies of Scale

This brings us to economies of scale. According to some TCE-authorities (Masten 1982; North and Wallis 1994), these should not be incorporated into the framework because they are independent of the choice of market or hierarchy, once technological indivisibilities are captured within the firm. That is, economies of scale will be reaped regardless of whether all production is carried out in one firm or in many firms. Thus, the intuitively appealing notion that the existence of economies of scale offsets size disadvantages is, according to these authorities, incorrect. This is at odds with Riordan and Williamson's argument (1985) discussed in Section 3.1.3.

The argument has never been tested directly. However, since the 1950s, extensive research has covered the nature and magnitude of economies of scale in production costs, much of it emanating from the structure–conduct–performance school of thought. This work has been explicated in a number of books, and the findings will only be briefly summarised here. In general, the research shows that economies of scale do not play a major role in explaining firm size.

Bain pioneered this line of research in the 1950s and subsequently revolutionised the study of industry and firm behaviour with his book *Industrial Organization* (1968). "The Rationale of Concentration—Efficiency and Other Considerations" from that book reviews the scale-economies argument. Bain divided the analysis into plant- and firm-level analyses. At the plant level, economies of scale are exploited by specialising the work force and management, and by using dedicated machinery. Each plant has a minimum optimal scale and beyond this scale few additional economies of scale can be exploited. Bain found that in a study of twenty industries (all within the manufacturing sector), only two (automobiles and typewriters) showed significant economies of scale: "in a preponderance of cases, plant scale curves tend to be at least moderately flat (and sometimes very flat)...in the bulk of cases, then, the relative flatness of plant scale curves virtually diminishes the importance of plant scale economies" (pp. 192–193). In other words, there is scant evidence at the plant level for benefits of size.

At the firm level, Bain's study showed that economies of scale derive from benefits of large-scale management, a large distribution system and purchasing power.[19] He then noted that these firm-level economies of scale are elusive, if they exist at all. His research indicated that "where economies of the multi-plant firm are encountered, they are ordinarily quite slight in magnitude...the unit costs...are typically only 1 or 2 per cent below those of a firm with one plant of minimum optimal scale". Of the twenty industries studied, Bain was able to quantify firm-level economies of scale for twelve industries. Of these twelve industries, none exhibited even moderate scale effects (p. 195).

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[19] Bain does not mention R&D and marketing, possibly because these functions were less important in the early 1950s.

Bain (1978) later summarised his argument as follows: "It is not true that existing degrees of concentration are adequately explained simply as the result of adjustments to attain maximum efficiency in production and distribution...Industries probably tend to be 'more concentrated than necessary' for efficiency—and the larger firms bigger than necessary" (p. 94).

Scherer and Ross provided an overview of the economies of scale debate in "The Determinants of Market Structure: Economies of Scale" (1990). They underscored that it is difficult to draw simple conclusions about the relationship between size and returns. In general, they found that economies of scale are exhausted at a surprisingly small firm size.[20] In a study of twelve industries, they found that market concentration could not be explained by minimally efficient scale considerations. The largest firms in the twelve industries were between two and ten times larger than economies of scale necessitated. Scherer and Ross argued that to the extent that economies of scale accrue for large firms in those industries, they derive from savings in overhead costs (including R&D and marketing) and fixed costs in tangible assets. The economies of scale in overhead are similar to the governance-cost scale economies discussed by Riordan and Williamson (1985, 373), indicating some support for their proposition.

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[20] They made the same argument at the product and plant level.

A number of theoretical studies (Ijiri and Simon 1964; Lucas 1978; Nelson and Winter 1982; Simon and Bonini 1958) have demonstrated that large firms evolve stochastically, regardless of economies of scale, for the simple reason that they beat the competition over time. Losers disappear, and winners grow at differential rates depending on how many times they won and how much time this took. Given this logic, firms are large because they are winners, not because they realise economies of scale. Based on realistic assumptions about industry growth rates, variance in firm profitability and so on, simulations have yielded firm-size distributions similar to those observed in real life. As Ijiri and Simon put it: "the observed distributions are radically different from those we would expect from explanations based on static cost curves...there appear to be no existing models other than the stochastic ones that make specific predictions of the shapes of the distribution" (p. 78).

An empirical test of the stochastic evolution model was carried out by Rumelt and Wensley (1981), who looked at whether high market share led to high profitability, or whether successful firms with high profitability, also achieve high market share. They concluded that "scale economies and/or market power are much less important than stochastic growth processes" (p. 2). Note that the stochastic-growth-process argument also implies that older firms will be more profitable than younger firms. Again, the older firms which still exist are survivors, while younger firms include both winners and losers.

Finally, Peters argued that economies of scale do not exist any more—if they ever existed. In his words: "technology and brainware's dominance is taking the scale out of everything" (1992, 14). Adams and Brock (1986), in case studies of the steel industry, automotive industry and conglomerates, found no evidence that size leads to production scale economies at the firm level. They claimed that it is "the quintessential myth of America's corporate culture that industrial giantism is the handmaiden of economic efficiency" (p. xiii).

In sum, these studies found only slight scale effects. The evidence in the literature review is therefore inconclusive with regard to the argument made by Riordan and Williamson (1985), that economies of scale offset diseconomies of scale.

3.2.3 Moderating Factors

This section reviews the literature to validate Williamson's moderating factors: organisation form and degree of integration. It also discusses, and dismisses, a third moderating factor: financial synergies. The literature review lends strong support to Williamson's framework.

3.2.3.1 Organisation Form

Chandler has argued, in a series of well-known studies (Chandler 1962, 1977, 1982, 1990, 1992; Chandler and Daems 1980), that large firms evolve from functional structures to multidivisional structures as they grow in size and scope of activities. In Chandler's view, the functional (unitary) form is not able to achieve the necessary coordination to be successful in the marketplace; functional economies of scale are too small to make up for this deficiency. Thus, as firms became more diverse in the early twentieth century they adapted the multidivisional form pioneered by E. I. du Pont de Nemours & Company and General Motors Corporation. This line of reasoning is supported by most authorities, including Peters (1992), who found that decentralisation brings major benefits to large firms. Three important quantitative studies illustrate Chandler's argument:

Fligstein (1985, 385–386) showed that between 1919 and 1979, the number of large firms[21] with the multidivisional form went from none to 84 per cent. He estimated that the spread of the multidivisional form is mainly due to the increase of multi-product strategies, in line with Chandler's argument. Armour and Teece (1978) quantified the difference in profits between functional- and multidivisional-form firms in the petrochemical sector, and summarised as follows: "We find strong support for the M-

[21] The 131 (120) largest manufacturing firms by assets in 1919 (1979).

form hypothesis. In the 1955–1968 period the multidivisional structure significantly influenced (at better than the 99-per cent level) the rate of return on stockholders' equity, raising it on average by about two percentage points...realized by the average functional form firm" (pp. 116–117). Teece (1981) studied eighteen manufacturing industries and two retail industries. He found that the multidivisional form outperformed the functional form by an average of 2.37 percentage points (p. 188). He concluded: "the M-form innovation has been shown to display a statistically significant impact on firm performance" (p. 190). These authorities are typical of the strong support for Williamson's view that organisational structure matters and that correct organisational choices can alleviate the effects of diseconomies of scale.

3.2.3.2 Degree of Integration

There is an extensive literature on vertical and lateral integration based on transaction cost economics and other theories. Mahoney (1989, 1992) and Shelanski and Klein (1995) provide summaries. Two issues are relevant here:

- Do asset specificity, uncertainty and transaction frequency explain the degree of vertical integration?

- Does Williamson's framework extend to integration in general?

Asset specificity has repeatedly been shown to be the primary determinant of vertical integration. A number of empirical studies confirm this (e.g., Masten 1984; Masten, Meehan and Snyder 1989, 1991; Monteverde and Teece 1982; Joskow 1993; Klier 1993; Krickx 1988). Uncertainty and frequency are less important. First, they only contribute to vertical integration in conjunction with asset specificity. Second, the empirical evidence does not hold up well in statistical analyses. Walker and Weber's (1984, 1987) results are typical. They found that volume uncertainty had some impact on the decision to vertically integrate and that technological uncertainty had no impact on vertical integration. Transaction frequency has, unfortunately, not been studied explicitly, perhaps because it is not independent from various types of asset specificity. Piecemeal evidence from other studies suggests that it is even less important than uncertainty when asset specificity is part of the analysis (e.g., Mahoney 1992, 571). Finally, Holmström and Roberts (1998, 79) found that both uncertainty and transaction frequency are less important factors than asset specificity.

As for the second issue, Williamson's framework appears to extend to integration in general. Grossman and Hart (1986) and Teece (1976, 1980, 1982) illustrate the use of TCE in lateral relationships. Asset specificity influences integration from a geographic reach, product breadth, and vertical depth point of view. Teece (1976) showed that multinational firms only exist because the combination of asset specificity and opportunism leads to moral hazard, which is difficult to contain in market transactions. Without, for example, human asset specificity, a firm could just as easily license its technology to a firm in another country, reaping the benefits of development. Tsokhas (1986) illustrated this in a case study of the Australian mining industry. Other studies have shown that market diversity reduces profitability (e.g., Bane and Neubauer 1981). Thus, there is support for Coase's 1932 view[22] that the distinction between vertical and lateral integration is without value (1993c, 40).

A number of studies of product breadth show that asset specificity plays a major role in explaining the success and failure of diversification. Rumelt (1974) found a strong correlation between profitability and human asset specificity—in this case the degree to which a firm draws on common core skills or resources (pp. 121–127). In two studies of the Fortune 500 list of American firms, he demonstrated that focused firms derive three to four percentage points higher return on capital than highly diversified firms. Subsequent studies "have merely extended or marginally modified Rumelt's (1974) original findings" (Ramanujam and Varadarajan

[22] Letter to Ronald Fowler, 24 March 1932.

1989, 539). In sum, asset specificity seems to explain integration in general, not only vertical integration.

3.2.3.3 Financial Synergies

A potential third moderating influence discussed by Williamson (1986) is the presumably efficient internal capital markets of large firms, which allows them to realise financial synergies. Bhidé (1990), however, refuted this line of reasoning and showed that the improvement in efficiency of external capital markets since the 1960s helps explain the trend away from diversification: "Investor power, which goes along with capital market sophistication, has reduced the ability of managers to preserve an inefficient organizational form". Comment and Jarrell (1995, 82–83) reached the same conclusion based on an exhaustive statistical analysis of two thousand firms listed either on the New York Stock Exchange or on the American Stock Exchange between 1978 and 1989.

There does not appear to be a strong reason to expand Williamson's framework with this moderating influence. For the purposes of the current research the financial synergies are therefore excluded.

3.2.3.4 Reconciliation with the "Limits of Firm Size" Framework

Table 6 summarises the moderating influences on diseconomies of scale. There is again strong support for Williamson's framework. The choice of M-form organisation was found to influence firm performance positively. The determinant of degree of integration has been narrowed down to asset specificity, while uncertainty and transaction frequency were found to be less important. Financial synergies do not, however, moderate diseconomies of scale—at least not in the United States where the external capital markets are relatively efficient.

Table 6. Potential Moderators of Diseconomies of Scale

POTENTIAL MODERATORS OF DISECONOMIES OF SCALE		
M-Form Organisation	**Asset Specificity**	**Financial Synergies**
Armour and Teece (1978): M-form increases ROE Chandler (e.g., 1962), Chandler and Daems (1980): M-form alleviates coordination and control problems Fligstein (1985): Multi-product coordination favours M-form Peters (1992): Decentralisation is critical to firm performance Teece (1981): M-form firms are significantly better performers than U-form firms	Bane and Neubauer (1981): Market diversity reduces profitability Coase (1993c): No distinction between vertical and lateral integration Grossman and Hart (1986), Teece (e.g., 1976): TCE applies to lateral integration Mahoney (1992), Holmström and Roberts (1998): Uncertainty and frequency not important Masten (1984), Masten et al. (1989, 1991), Monteverde and Teece (1982), Joskow (1993), Klier (1993), Krickx (1988): Asset specificity more important than uncertainty and frequency Rumelt (1974): Product diversity reduces asset specificity Teece (1976), Tsokhas (1986): Asset specificity influences geographic reach Walker and Weber (1984, 1987): Volume uncertainty is weak factor	Bhidé (1990): Internal capital markets not efficient Comment and Jarrell (1995): Financial synergies not relevant

3.2.4 Industry Influence

Finally, industry influence is not part of the TCE proposition regarding limits of firm size, except indirectly (e.g., industries with high R&D-intensity should show significant diseconomies of scale because incentive limits are important in such industries). A number of studies have shown that there is weak correlation between profitability and which industry or industries a manufacturing firm participates in. Schmalensee (1985) suggested methods for disaggregating business-unit performance into industry, corporate-parent and market-share effects. Rumelt (1991) applied the method to manufacturing firms and found that industry effects accounted for 8 per cent of the explained variance in profitability. McGahan and Porter (1997) found a 19-per cent industry effect for all sectors of the economy, but only 9 per cent of explained variance in profitability for firms in the manufacturing sector (similar to Rumelt's findings). Thus, industry appears to influence profitability in the non-manufacturing sector, but only slightly in the manufacturing sector. The same appears to be true for firm growth. Hall (1986, 9) found, in an analysis of the relationship between firm growth and size in the US manufacturing sector, that the results were only marginally influenced by the use of industry dummies.

The implication for the current research is that industry influences should not be included as a variable in the statistical analyses.

3.2.5 Conclusion

This literature review indicates that the TCE framework for firm-size limits is fairly robust. Most of the authorities support Williamson's framework, and the mechanisms behind diseconomies of scale have been validated. The findings regarding economies of scale are somewhat inconclusive. The two transaction cost-based moderating influences on diseconomies of scale have both been validated. M-form firms outperform U-form firms, at least in the manufacturing sector. Asset specificity emerges as the most important driver of both vertical and lateral integration.

Past research indicates that the sources of diseconomies are more important in certain contexts. For example, atmospheric consequences and incentive limits are especially severe in R&D-intense industries. Communication distortion, meanwhile, is most common in diverse firms and volatile industries. It is now possible to assess how important these effects are, as well as how large a firm has to be before the effects materialise. Assessing the importance of effects is at this point necessarily qualitative, based on the collective judgement derived from the literature review for each source of diseconomies of scale, economies of scale and the moderating factors. Table 7 summarises this judgement. “Good/Poor” indicates that if, for example, a firm has no problem with incentive limits, then performance (measured as financial results) will be comparatively good. “Importance” indicates if the effect is strong or weak. The “Impact Size” parameter roughly indicates at what size (number of employees) the effect sets in. For example, the literature review indicates that the incentive disadvantage in R&D for large firms appears to be strong for firms with more than 500 employees in the R&D function (see pp. 58–59, above). "Context" shows which types of firms are most sensitive to the effects of diseconomies of scale, economies of scale and the moderating factors.

Table 7. Extended TCE-Based "Limits of Firm Size" Framework

EXTENDED TCE-BASED "LIMITS OF FIRM SIZE" FRAMEWORK							
	Sources of Limits of Firm Size					**Moderators**	
Financial Results	**Atmos-pheric Conse-quences**	**Bureau-cratic Insularity**	**Incentive Limits**	**Commu-nication Distortion**	**Econo-mies of Scale**	**Organ-isation Form**	**Degree of Integra-tion**
Good	Low	Low	Low	Low	High	M-form	High
Poor	High	High	High	High	Low	U-form	Low
Importance	Fair	Fair	Fair in general; high in, e.g., R&D	High	Incon-clusive	High	Asset specifi-city high; uncer-tainty low; fre-quency negli-gible
Impact Size: Small (<1,000) Medium Large (>10,000)	 Weak Fair Strong	 Weak Fair Strong	 Weak Strong Strong	 Strong Strong Strong	 Strong Fair Weak	 Strong Strong Strong	 Strong Strong Strong
Context	R&D-intense	Manage-ment/ board relation	R&D-intense	Diverse firms; unpredict-ability	Over-head-intense		

The table reveals, based on Williamson's framework and the literature review, that all factors (except possibly economies of scale) should have a material influence on the performance of large firms. The following chapter builds on this finding as it translates the framework into five testable hypotheses.

4. THEORETICAL FRAMEWORK AND RESEARCH HYPOTHESES

The previous chapter covered the theoretical and empirical studies—particularly Williamson's categorisation (1975, 117–131) of diseconomies of scale—that inform the current research. This chapter now translates the findings so far into five hypotheses. The hypotheses guide the quantitative tests performed in the statistical analyses, presented in Chapter 6. In the following, each individual hypothesis is first stated, and then discussed. At the end of the chapter, the hypotheses are summarised and linked.

H_1: Bureaucratic failure, in the form of atmospheric consequences, bureaucratic insularity, incentive limits and communication distortion, increases with firm size

Diseconomies of scale are bureaucratic in nature and are not easily observed. They exist because there are diminishing returns to management and because large firms cannot fully replicate the high-powered incentives that exist in the market—leading to bureaucratic failure, the opposite of market failure. Based on Williamson's categorisation, there are four types of diseconomies of scale: atmospheric consequences due to specialisation, bureaucratic insularity, incentive limits of the employment relation and communication distortion due to bounded rationality. The first hypothesis postulates that these diseconomies of scale increase with firm size.

H_2: Large firms exhibit economies of scale

The theory around economies of scale is logically broken into two parts (**H_2** and **H_4**). The second hypothesis posits that ray marginal cost decreases with firm output. This could be seen as a tautological statement, but as was shown in Chapter 3, large firms do not necessarily benefit from economies of scale. First, some authorities hold that economies of scale are exhausted at relatively small firm sizes and thus the cost curve should be flat for large firms. Second, it could be that economies of scale are available to all participants in a market. Given these two arguments, it is important to test whether economies of scale exist at all. That is, does ray marginal cost decline with increased output? The hypothesis says nothing about whether economies of scale have a material influence on firm performance, which is expressed in the fourth hypothesis.

H_3: Diseconomies of scale from bureaucratic failure have a negative impact on firm performance

As was shown in Chapter 2, the average size of large manufacturing firms in the United States has declined since the 1960s, relative to the total economy. Thus, as large firms have become more productive they have, on average, not been able to compensate fully for the per-unit decline in value added by expanding into new geographic markets (reach), new product areas (breadth), or by increasing vertical integration (depth). In line with Stigler's survivor principle (see p. 14, above) this indicates that the diseconomies of scale have a material, negative influence on firm performance. The four types of diseconomies are exhibited through lower profitability and/or slower growth of the largest firms relative to smaller firms, other things—such as risk—being equal.

Given this general assumption, it is also possible posit that each of the four types of diseconomies will have a negative impact on the performance of large firms. In the statistical analyses, the third hypothesis is broken down into four sub-hypotheses (see also pp. 119–120, below) concerning the negative impact on firm performance of atmospheric consequences ($\mathbf{H_{3a}}$), bureaucratic insularity ($\mathbf{H_{3b}}$), incentive limits ($\mathbf{H_{3c}}$) and communication distortion ($\mathbf{H_{3d}}$).

H_4: Economies of scale increase the relative profitability of large firms over smaller firms

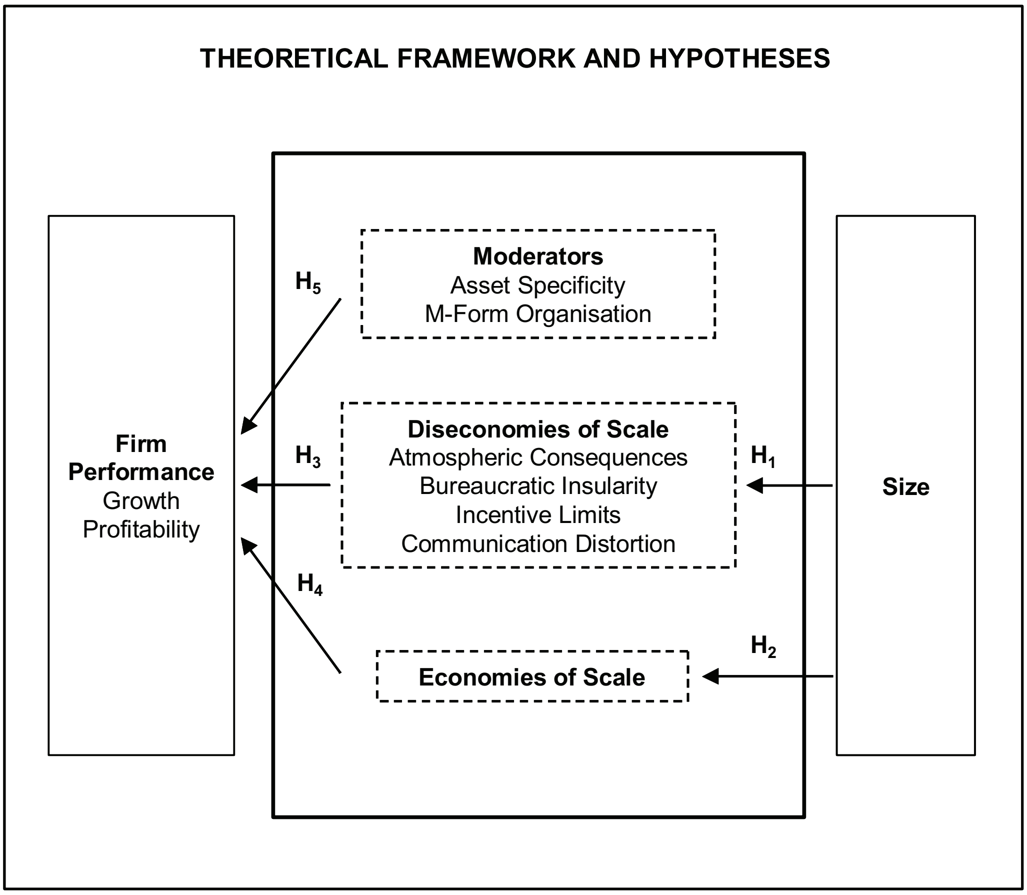
According to TCE, unit production and transaction costs decrease with increasing scale. However, the benefits of scale may be reaped by all participants in a market, large or small, if the market is efficient. The theoretical framework holds that this is not the case and that most economies of scale will be proprietary to the firm in which they reside. Thus, the hypothesis is that large firms have higher relative profitability than small firms, other things being equal. (Note that the theoretical framework says nothing about whether large firms grow faster than small firms.)

H_5: Diseconomies of scale are moderated by two transaction cost-related factors: organisation form and asset specificity

The theoretical framework holds that it is possible for firms to moderate the negative impact of diseconomies of scale. Transaction cost economics shows that large firms benefit from multidivisional structures, while unitary structures impede performance. Moreover, conscious choices about the degree of integration can affect performance. In particular, firms with a high degree of internal asset specificity will outperform those with low internal asset specificity. Therefore, for the purposes of the statistical analyses, the following sub-hypotheses are posited (see also p. 120, below): large M-form firms perform better than large U-form firms (**H_{5a}**); and high internal asset specificity affects performance positively (**H_{5b}**).

In sum, the performance of a firm depends on three influences. To begin with, four size-related factors contribute to diseconomies of scale and determine the firm's size limit. Second, economies of scale increase with firm size. Finally, two factors, M-form organisation and high asset specificity, can moderate the diseconomies of scale. The hypotheses are summarised in Figure 5, which also includes the theoretical framework derived from Williamson (see Section 3.1).

Figure 5. Theoretical Framework and Hypotheses



The question remains: are the hypothesised effects large enough materially to influence the performance of a large firm? Only an empirical analysis, in which the framework and hypotheses are operationalised, will answer this. The next two chapters focus on this operationalisation—first by describing the approach to the quantitative analysis, the data collected and the measures taken to ensure reliability in the statistical analyses (Chapter 5), and then by presenting the results of said analyses (Chapter 6).

5. METHODOLOGY

This chapter turns the attention from the literature review and the development of hypotheses to the empirical analysis. The first section discusses the positivist approach taken in the analysis and the implications of choosing between statistical methods. The second section moves from this general discussion to the specifics of the data used and the quality of the data. It finds that the data are suitable for the structural equation modelling employed in Chapter 6.

5.1 APPROACH TO QUANTITATIVE ANALYSIS

This section gives a general impression of the analytical approach and the method chosen for the statistical analysis. It begins with a discussion of why a positive, quantitative approach was chosen and what the inherent limitations of such an approach are. It then proceeds with an overview of the use of statistical methods in similar research to explain why structural equation modelling was used in the current research. Moreover, the limitations of structural equation modelling are discussed. Finally, the section compares two software packages suitable for the structural equation modelling—Amos and LISREL—and lays out the argument for why Amos was chosen.

5.1.1 Research Philosophy

The positivist approach taken here emphasises universal understanding in Runkel and McGrath's terms (1972, 81–89). They made the distinction between research aimed at explaining particular phenomena and research explaining universal phenomena. Typically, the former type of research uses field studies or experiments, while the latter often uses surveys and theory. According to their framework, any given research study inevitably is a trade-off between generalisability—do the findings apply in general, or do they only explain the situation at hand?—precision—is it reasonable to believe that the findings are accurate?—and realism—do the findings correspond well with the underlying reality? "Sadly, these are desirable but not simultaneously attainable; all three—realism, precision, and generality—*cannot* be maximized at the same time" (p. 115). This thesis aims to draw general conclusions even if precision and realism are reduced.

One could take a phenomenological approach to the research, basing it on case studies and other qualitative methods. Cooper (1964) did so in his often-quoted study of R&D productivity in large and small firms. However, the current research relies on a positivist approach for reasons found in Easterby-Smith, Thorpe and Lowe (1991, 23): This kind of approach allows for more independence from the observations; because individual or group behaviour are not the concern of this research, little additional insight can be gained from action research or other studies in the field. Value-freedom is important because existing studies of limits of firm size are themselves value-laden. Causality can be deduced from the proposed data set and manipulation, and concepts can be operationalised to suit a positivist approach. The problem lends itself to reductionism because the influences in the theoretical framework can be disaggregated and independently operationalised. Moreover, as noted earlier, it should be possible to draw generalisable conclusions based on the fairly large sample detailed in Section 5.2. Finally, it is easier to make the necessary cross-industry comparisons with a positivist approach.

This methodological choice means the work focuses on the facts (Easterby-Smith, Thorpe and Lowe 1991, 27). Thus, much care was taken with the data set and the emphasis is on looking for facts and causality rather than underlying meaning (in a phenomenological sense). The hypotheses were formulated before the quantitative research was carried out, rather than deduced from the data. In addition, a large sample was used and concepts were operationalised so that they could be measured.

There are no studies of this general type on the particular issue of diseconomies of scale. However, generalised studies on, for example, the profit impact of an M-form organisation or the link between size, structure and complexity are widely quoted in the literature (e.g., Rumelt 1974; Ramanujam and Varadarajan 1989). This indicates that the generalised approach may add substantial value to the study of limits of firm size. An added benefit is that data are available to support a generalised study.

Note that several studies have aimed at describing precisely particular aspects of limits of firm size, as discussed in Chapter 3. Zenger's (1989) study of incentive limits in Silicon Valley is a good example. Several case studies also provide realistic views of what these limits look like in action, but in the end they have had only limited impact on academic thinking. The notable exceptions can be found in the work on institutions in society based on TCE, in which North was able to merge insights from case studies with a framework for institutional change (e.g., North 1985, 1987, 1992; North and Thomas 1973). Chandler's (e.g., 1962, 1977, 1990) work on the evolution of large firms has also had major impact on the thinking regarding bureaucracies.

5.1.2 Statistical Technique

This section describes the statistical technique chosen based on empirical research precedents, the nature of the statistical task at hand, and the specific structural equation modelling software available.

5.1.2.1 Empirical Precedents

As discussed earlier, general statistical analyses of diseconomies of scale have not been attempted before, except for simple direct comparisons between firm size and performance. There are, however, a number of empirical studies of particular aspects of the limits of firm size or of general TCE problems. These offer guidance on the choice of statistical methods for the current research and the operationalisation of variables. There are two basic types of quantitative statistical analysis: older, non-regression-based analyses and newer, regression-based analyses. This section considers the statistical approaches taken in a number of these studies. The intent is not to discuss particular findings, but rather to inform the choice of statistical method for the current research.

Early inquiries (e.g., McConnell 1945; Stigler 1958) into relationships between profitability and firm size made simple comparisons between the dependent variable (profitability) and independent variable (size), using histograms with the size-bracket as the categorising variable. At best, these analyses indicated that relationships between the variables existed, but because they did not include modern tests of statistical significance, they left many questions unanswered.

Later, researchers including Rumelt (1974), Teece (1981) and Palepu (1985), used comparisons of samples to demonstrate statistical significance. Their methods ranged from simple comparisons of average profitability for two samples, to sophisticated tests of the statistical significance of the differences using parametric (*t*-test) and non-parametric (median and Mann-Whitney *U*-test) methods (Palepu 1985, 245–246). However, these techniques probably did not extract the full information content of the samples. For example, Rumelt later used a regression technique when he updated his analysis of diversification and structure (Rumelt 1982).

Yet another statistical approach is to study the amount of variance extracted. Schmalensee (1985) used analysis of variance (ANOVA), arguing that: ”This study employs a simple analysis of variance framework that allows us to focus on the existence and importance of firm, market, and market share effects without having to deal simultaneously with specific hypotheses and measurement issues related to their determinants”. Put differently, analysis of variance is an excellent tool for exploratory analysis. Other examples of related studies employing ANOVA include Rumelt (1991) and McGahan and Porter (1997).

Finally, most statistical analyses over the last 35 years relating to aspects of diseconomies of scale have used multivariate regression techniques (Armour and Teece 1978; Aw and Batra 1998; Child 1973; Comment and Jarrell 1995; Fligstein 1985; Kwoka 1980; Levy 1981; Lucas 1978; Mahoney 1989; Masten 1984; Masten, Meehan and Snyder 1989, 1991; Olson 1982;

Pondy 1969; Pugh et al. 1969; Rasmusen and Zenger 1990; Rumelt 1982; Rumelt and Wensley 1981; Walker and Weber 1984, 1987; Zenger 1994). They ranged from simple regressions to complex structural equation models, and were used for both exploratory and confirmatory analyses.

This brief overview indicates that researchers have increasingly used sophisticated statistical techniques, usually leading to multivariate methods of analysis. Stigler's survivor principle (see p. 14, above) suggests that the added complexity of using these techniques is more than compensated for by the added insights they bring; otherwise researchers would not continue to employ them and the techniques would not survive. It is also true that the simpler techniques have more or less disappeared from the literature as statistical methods have evolved and computing power available to researchers has increased.

5.1.2.2 Selection of Statistical Technique

The current research uses multivariate analysis. As early as 1966, Gatty argued that "for the purposes of…any…applied field, most of our tools are, or should be, multivariate. One is pushed to a conclusion that unless a…problem is treated as a multivariate problem, it is treated superficially" (1966, 158). Or as Hardyck and Petrinovich put it ten years later:

"Multivariate analysis methods will predominate in the future…" (1976, 7). This has been born out over the last 25 years.

Among different multivariate techniques, structural equation modelling (SEM) was picked based on Hair et al.'s classification scheme for choosing among techniques (1998, 20–21) and a review of the pertinent literature on SEM (Bollen 1989, 1–9; Kelloway 1998, 2–3; Maruyama 1998, 20–24). SEM is the most appropriate technique when multiple relationships between dependent and independent variables are studied. Moreover, SEM is well suited for confirmatory analysis and allows for efficient hypothesis testing, especially of complex models. Finally, SEM allows for the use of latent, unobserved variables. As will be discussed in Chapter 6, these three attributes are important in the current research.

Structural equation modelling must be used judiciously, however. A number of criticisms of this technique have been summarised by Maruyama (1998, 272–278). SEM cannot be used to confirm a model. It can only fail to disprove it. This makes replicability important, and this is a key reason for using publicly available data in the statistical analyses described in Chapter 6. Related to this is the risk of inferring causality where none exists. Strong correlation does not imply causality. For this reason, the path diagrams used in the next chapter reveal causalities based on theory, not on a study of correlation.

In addition, incorrect operationalisation and naming of variables (especially latent variables) can lead to erroneous conclusions. In Maruyama's words, "giving something a name does not necessarily make it what we call it or ensure that we understand the thing we have named" (p. 273). This is certainly a valid point for the present work. For example, incentive limits were operationalised, based on the theory, with relative R&D expense. But does this mean that the SEM model truly captures incentive limits, or does it merely capture relative R&D expense?

Finally, SEM has often been used for model development rather than model confirmation. The current research has tried to avoid this by using path diagrams that have been derived directly from the theoretical framework, as expressed in the hypotheses.

5.1.2.3 Amos versus LISREL

Amos was used in the current research, instead of the more recognised LISREL SEM software package.[23] LISREL certainly has a much larger installed base and thousands of references in the literature. Amos is less well known and has only been cited in 56 references as of the year 2000, according to its vendor (SmallWaters 2000). Amos, however, is much

[23] Information on Amos is available at http://www.smallwaters.com.

easier to use for the occasional statistician because it is based on interactive, graphical path diagrams; it is gaining ground among researchers for this reason. More important, Amos has one attribute that serves this particular research effort well: its ability to handle missing values in the data collected.

LISREL uses pair-wise or list-wise deletion to handle missing data. Amos, on the other hand, uses full-information maximum likelihood (FIML) estimation, arguably a leading-edge technique (Arbuckle 1996). When data are missing completely at random, the list-wise or pair-wise deletion methods employed by LISREL are asymptotically equivalent to FIML, but the standard errors of the parameter estimates can be considerably larger for LISREL. This means that Amos makes more efficient use of the observations, a critical consideration in the current research because the number of large firms is limited and the sample size could not be expanded infinitely. Moreover, if data are not missing at random, the Amos FIML estimates tend to be less biased than when pair-wise or list-wise deletions are used. Note that FIML does not impute missing values; instead Amos calculates the likelihood of the parameters based on each observed case.

The major advantage of LISREL is that it sometimes handles ordinal data more correctly with polychoric or polyserial correlations. As is discussed in Chapter 6, two variables are ordinal in this research.[24] The only way Amos can handle ordinals is by treating them as continuous variables, which often leads to biased estimates, or by importing the covariance matrix from another SEM package, which eliminates the advantage of FIML estimation. The bias when treating ordinals as continuous variables is usually towards underestimates of coefficients and overestimates of standard errors and chi-square (Bollen 1989, 433–446). This suggests that Amos in most cases will underestimate a model's fit. There is no suitable remedy for this in the present case (and usually not in other cases).

LISREL's weighted-least-square (WLS) approach with polychoric or polyserial correlations handles ordinals well if the underlying distributions are normal. This is definitely the case for one of the ordinals in the current research, and may be the case for the other ordinal.[25] Yet some critics have argued that effective use of polychoric and polyserial correlation requires 2000 to 5000 observations (Yung and Bentler 1994), a number well beyond the sample available here. Indeed, Jöreskog and Sörbom, the creators of LISREL, concur with this opinion: "A poorly estimated asymptotic covariance matrix, such as estimated from a small sample, can do more harm than good, when used with WLS. If the sample

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[24] The variables describe the level of vertical integration and divisionalisation. That is, they affect the TCE-based moderators (asset specificity and M-form), but do not relate to diseconomies of scale.

[25] See further discussion in Footnote 39 (p. 166) and Footnote 41 (p. 171), below.

size is not sufficiently large to produce an accurate estimate of the asymptotic covariance matrix, it is probably better to use ML" (1996, 239).

Thus, one can either use Amos and treat ordinal data as continuous data, or use LISREL with a sample size that is too small—neither of which are optimal approaches. For the purposes of this research, a choice was made to use Amos because of its other positive attributes, but no attempt was made to compare which software package would handle the ordinal data best, or if this really would make a difference. The choice is in line with Wothke[26] (1997), who recommends that for sample sizes smaller than 2000, "your best bet would be to treat the ordinal data as continuous", and with Hayduk (1996, 213), who claims that the continuous-data assumption is of little practical significance: "ordinal variables have continued to receive considerable attention, though the problems may not be as serious as popular opinion suggests."

Finally, choosing Amos and the existence of missing data made two more choices automatic. Alternative estimation techniques such as generalised least squares and asymptotically distribution-free (ADF) estimation could not be used, because they do not allow missing data. ADF might otherwise have been useful, because it handles non-normality well. In addition,

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[26] Co-creator of Amos.

Amos does not allow bootstrapping when data are missing. Bootstrapping might otherwise have increased the reliability of the analysis, because it reduces the impact of non-normality. Fortunately, as will be discussed in Section 5.2.3, non-normality is not a major issue in the current analyses.

5.2 DATA OVERVIEW

This section discusses the data used in the statistical model. The first part of the section defines the variables and discusses data sources. The following part tests the sample data for inconsistencies and outliers and then reviews the sample sizes. The final part transforms the variables using commonly accepted transformation techniques and then tests the data for heteroscedasticity, linearity and other potential problems. The conclusion is that the sample data are reasonably well-behaved and are suitable for further analysis.

Throughout this section, reference is made to two sub-models: (*a*) the relationship between size and diseconomies of scale and economies of scale; and (*b*) the impact of diseconomies of scale, economies of scale and moderating factors on firm performance. These sub-models are used in the statistical analyses in Chapter 6.

5.2.1 Definitions and Sources

The conducted analyses were cross-sectional. Data were collected for publicly traded manufacturing firms (SIC codes 10–39) with headquarters in the US and with sales of more than $500 million. The benchmark period was 1998. All data are available for downloading at http://canback.com/ henley.htm in the files *Source98.xls* and *Source98.sav*.

1998 saw high economic growth, but it was not a peak in the business cycle. Table 8 shows key indicators for the time period surrounding the year and the rank of the indicator for the time period 1961–2000.

Table 8. Select Economic Indicators for the United States

SELECT ECONOMIC INDICATORS FOR THE UNITED STATES						
Indicator	**1996**	**1997**	**1998**	**1999**	**2000**	**’61–’00 Rank**
GDP Growth (%)	3.6	4.4	4.3	4.1	4.1	Medium: 15 of 40
Mfg. GDP Growth (%)	2.4	5.4	4.1	6.1	4.1	Medium: 14 of 40
Mfg. Return on Equity (%)	16.7	16.7	15.8	16.4	15.1	High: 7 of 40
Mfg. Capacity Utilisation (%)	81.6	82.7	81.4	80.6	80.7	Medium: 20 of 40
Inflation (%)	3.0	2.3	1.6	2.2	3.4	Low: 34 of 40
Source: Council of Economic Advisers (2002)						

The analyses ultimately involved 14 variables. Of these, 9 were direct variables and 5 were calculated from other direct variables. For example, the calculated variable **ROE** was determined by dividing two direct variables: **Net Income** and **Equity**. Direct, on the other hand, implies that the variable was taken directly from one of the data sources. To create the 5 calculated variables, an additional 10 direct variables were used. Thus, the analyses encompassed a total of 19 (9+10) direct variables. Moreover, 44 other variables were collected although they were not used in the final analysis.

Primary and secondary data were collected from several sources, including company organisation charts, official filings such as 10-Ks and proxy statements,[27] annual reports, biographies of executives, historical company documents, corporate web sites, articles in *Business Week* and *Fortune*, corporate watchdogs such as the Investor Responsibility Research Center (IRRC), Compustat and academic research.

Table 9 depicts the 14 variables used. Specific information about the variables appears under each analysis section in Chapter 6.

Table 9. Overview of Variables Used in the Analyses

OVERVIEW OF VARIABLES USED IN THE ANALYSES						
Use[a]	**Name**[b]	**Label**[c]	**Type**	**Description**	**Metric**	**Sources**
Size (*a*)	empl	Employees[d]	Direct	No. of employees	’000	Compustat
Diseconomies of Scale (*a*, *b*)	ulabour	Atmospheric Consequences	Calculated	Unit labour cost defined as labour cost ⁄ employees [ulabour = labour ⁄ empl]	$’000	
Diseconomies of Scale (*a*, *b*)	tenure	Leadership Tenure	Direct	Average years of employment with firm for officers	Years	10-Ks, proxy statements. annual reports, corporate web sites, executive biographies
Diseconomies of Scale (*a*, *b*)	age	Company Age	Direct	Years since founding of company	Years	10-Ks, proxy statements. annual reports, corporate web sites, historical sources

27 Filings with the United States Securities and Exchange Commission: the 10-K is the full annual report and usually differs in content from the company’s shareholder annual report; proxy statements (report DEF 14A) contain information pertaining to voting at security holders’ meetings (annual meetings or special meetings). Available from EDGAR at http://www.sec.gov/.

Use[a]	Name[b]	Label[c]	Type	Description	Metric	Sources
Diseconomies of Scale (*a, b*)	rd	Incentive Limits	Calculated	Research and development expense ⁄ Sales [rd = rdexp ⁄ sales]	%	
Diseconomies of Scale (*a*, *b*)	levels	Communication Distortion	Direct	No. of hierarchical levels	#	Annual reports, corporate web sites, 10-Ks, company organisation charts
Economies of Scale (*a, b*)	fixhigh	Economies of Scale	Calculated	Defined as (fixed cost)^2 ⁄ sales [fixhigh = fixexp^2 ⁄ sales]	$M	
Moderators (*b*)	foreign	Geographic Reach	Direct	% of sales derived outside the United States	%	Compustat, annual reports, 10-Ks
Moderators (*b*)	dr	Product Breadth	Calculated	Defined as the diversification ratio (1 − Rumelt's specialisation ratio) = % of sales not related to the company's core activities [dr = 1 − sr]	%	
Moderators (*b*)	vert	Vertical Depth	Direct	2 = Very high; 1 = High; 0 = Average or low	Ordinal	10-Ks, annual reports, corporate web sites, Compustat
Moderators (*b*)	govern	Governance	Direct	Qualitative rankings	Index	*Business Week*, IRRC, *Fortune*
Moderators (*b*)	div	Divisionalisation	Direct	2 = Divisionalised; 1 = Hybrid; 0 = Unitary	Ordinal	10-Ks, proxy statements, annual reports, corporate web sites
Performance (*b*)	growth	Growth[d]	Direct	5-year compound annual growth rate (1993–1998)	%	Compustat
Performance (*b*)	eva	Profitability[d]	Calculated	Economic value added defined as return on equity (ROE) less cost of equity (COE) [eva = roe − coe]	%	

[a] *a* and *b* in the "Use" column indicate whether the variable is used in sub-models *a* or *b*
[b] The "Name" column shows the name given to the variable in SPSS and in Amos
[c] The "Label" column shows the label given to the variable in SPSS and in Amos
[d] Appendix B discusses other definitions of size and performance

Table 10 below gives further definitions for those variables that were calculated from other (direct) variables. The table includes the 10 additional direct variables discussed above, as well as variables used to support the main analyses in Chapter 6 (see also Appendix B).

Table 10. Overview of Supporting Variables

OVERVIEW OF SUPPORTING VARIABLES						
Use[a]	**Name[b]**	**Label[c]**	**Type**	**Description**	**Metric**	**Sources**
Diseconomies of Scale (*a, b*)	labour	Labour	Direct	Labour cost	$M	Compustat
Diseconomies of Scale (*a, b*)	rdexp	R&D	Direct	Research and development expense	$M	Compustat
Diseconomies of Scale (*a, b*)	sales	Sales	Direct	Revenue	$M	Compustat
Economies of Scale (*a, b*)	fixexp	Fixed Cost	Calculated	Fixed cost defined as SG&A + depreciation + interest [fixexp = sgaexp + depr + int]	$M	
Economies of Scale (*a, b*)	sgaexp	SG&A	Direct	Selling, general and administrative expense	$M	Compustat
Economies of Scale (*a, b*)	depr	Depreciation	Direct	Depreciation	$M	Compustat
Economies of scale (*a, b*)	int	Interest	Direct	Interest expense	%	Compustat
Moderators (*b*)	sr	Specialisation Ratio	Calculated	Defined as share of sales derived from core business = core sales ⁄ sales [sr = csales ⁄ sales]	%	
Moderators (*b*)	csales	Core Sales	Direct	Core sales defined as sales derived from the firm's main SIC code	$M	Compustat, annual reports, 10-Ks, corporate web sites
Moderators (*b*)	vi	VI%	Calculated	Vertical integration defined as value added ⁄ factor costs [vi = va ⁄ factor]		
Moderators (*b*)	factor	Factor Costs	Calculated	Factor costs defined as sales − net income + cost of equity · equity [sales − ni + (coe · equity)]		

Use[a]	Name[b]	Label[c]	Type	Description	Metric	Sources
Moderators (*b*)	as	AS	Calculated	Composite asset specificity defined as the product of geographic reach, product breadth, and vertical depth [as = −(1 + foreign)(1 + dr)(3 + vert)]		
Performance (*b*)	roe	ROE	Calculated	Return on equity = net income ⁄ equity [roe = ni ⁄ equity]	%	
Performance (*b*)	ni	Net Income	Direct	Net income	$M	Compustat
Performance (*b*)	equity	Equity	Direct	Book value of equity	$M	Compustat
Performance (*b*)	coe	COE	Calculated	Cost of equity[d] defined as COE = risk free rate + risk premium · (0.371 + (0.635β)) [coe = 5.4% + (8.0% · (0.371 + (0.635 beta)))]	%	
Performance (*b*)	beta	Beta	Direct	Beta	ratio	Compustat

[a] *a* and *b* in the "Use" column indicate whether the variable is used in sub-models *a* or *b*
[b] The "Name" column shows the name given to the variable in SPSS and in Amos
[c] The "Label" column shows the label given to the variable in SPSS and in Amos
[d] Formula taken from Ibbotson Associates (1999)

5.2.2 Inconsistent Data, Outliers and Effective Sample Sizes

The original sample contained 901 firm records, derived from Compustat. Of these, ninety were eliminated because the firms were based outside the United States, did not contain revenue numbers, or ceased to exist during or immediately after 1998. Thirteen records were eliminated because they contained so-called Pre-FASB data.[28] The thirteen firms with pre-FASB

[28] Compustat presents two (or more) records for some companies, with financial data in one record based on non-consolidated statements and the other(s) based on consolidated statements. The non-consolidated statements are referred to as "Pre-FASB", and were not included in the analyses because the results of the consolidated concern were the object of the study here.

data also had regular records that were kept in the sample. Four firms with revenues less than $500 million were eliminated. Six limited partnerships were eliminated because their records did not contain enough information to be of interest. Six firms had duplicate records. One firm had recently been spun out from its corporate parent and did not provide meaningful data. Thus, the final sample contained 784 firm records.

For these 784 records, each variable was first screened for inconsistent data; then outliers were eliminated if a rationale for exclusion was found. The following are examples of inconsistent data found in the records: negative equity, zero foreign sales of well-known international companies, negative beta and negative market value.

Outliers were identified by standardising the variables and then identifying those records which fell more than three standard deviations from the mean, in line with Hair et al. (1998, 65). Those outliers for which the data made sense were kept, while, again, inconsistent data were eliminated. All changes to the original database described above can be found in the file *Source98.xls* at http://canback.com/henley.htm. Table 11 shows the number of outliers retained in the database.

Table 11. Overview of Outliers

OVERVIEW OF OUTLIERS		
Variable	**No. of Outliers before Screening**	**No. of Outliers after Screening**
Employees	0	0
Atmospheric Consequences	2	2
Leadership Tenure	0	0
Company Age	2	2
Incentive Limits	0	0
Communication Distortion	3	3
Economies of Scale	9	8
Geographic Reach	0	0
Product Breadth	20	20
Vertical Depth	not meaningful (ordinal)	
Governance	4	4
Divisionalisation	not meaningful (ordinal)	
Growth	9	6
Profitability	5	4

Multivariate outliers were detected using DeCarlo's macro (1997) *normtest.sps* for SPSS. This macro calculates, among other things, the Mahalanobis D^2 measure. Missing values were assigned the mean for the variable. The results are summarised in Table 12.

Table 12. Multivariate Outliers

MULTIVARIATE OUTLIERS		
	No. of Outliers before Screening	**No. of Outliers after Screening**
Sub-Model *a*	4	4
Sub-Model *b*	7	7

Eleven cases could have been considered outliers, if a significance exceeding 0.01 was used as the hurdle for critical *F*. However, in none of the cases was there a compelling reason to exclude the observation.

Tables 13 and 14 show the effective sample sizes for the two sub-models after the screening.

Table 13. Effective Sample Sizes for Sub-Model a

EFFECTIVE SAMPLE SIZES FOR SUB-MODEL *A*							
	Employees	Atmospheric Consequences	Leadership Tenure	Company Age	Incentive Limits	Communication Distortion	Economies of Scale
Employees	784						
Atmospheric Consequences	146	146					
Leadership Tenure	163	57	163				
Company Age	638	145	153	638			
Incentive Limits	489	108	111	419	489		
Communication Distortion	386	137	123	347	258	386	
Economies of Scale	752	143	155	612	473	374	752

Table 14. Effective Sample Sizes for Sub-Model b

EFFECTIVE SAMPLE SIZES FOR SUB-MODEL *B*													
	Atmospheric Consequences	Leadership Tenure	Company Age	Incentive Limits	Communication Distortion	Economies of Scale	Geographic Reach	Product Breadth	Vertical Depth	Governance	Divisionalisation	Growth	Profitability
Atmospheric Consequences	146												
Leadership Tenure	57	163											
Company Age	145	153	638										
Incentive Limits	108	111	419	489									
Communication Distortion	137	123	347	258	386								
Economies of Scale	143	155	612	473	374	752							
Geographic Reach	134	143	553	412	343	642	663						
Product Breadth	131	152	565	423	348	650	594	670					
Vertical Depth	133	152	569	424	350	655	596	670	675				
Governance	73	74	214	162	172	223	205	209	211	229			
Divisionalisation	135	119	337	252	372	364	333	340	341	166	375		
Growth	143	157	614	472	374	725	644	646	651	228	363	756	
Profitability	145	162	636	489	384	751	663	670	674	229	373	753	781

The tables show that all variables except for 2 had more than 200 observations; 9 out of 14 variables had more than 400 observations (see the diagonals). On average, sub-model *a* contained 480 observations and sub-model *b* contained 517 observations. The fairly low number of observations for **Atmospheric Consequences** (146) and **Leadership Tenure** (163) reduces the integrity of the upcoming analyses, but far from a point where they become meaningless.

According to Hair et al. (1998, 604–605), four criteria determine an appropriate sample size. When maximum likelihood estimation is used, as here, a minimum sample size of 100 to 150 is recommended. Sample sizes of more than 400 or 500 often become “too sensitive”. Hair et al. recommends a sample size of 200 as a starting point. In addition, the sample size should be at least five times the number of parameters estimated. The most important sub-model in this analysis (*b*) had 13 variables and thus a maximum of 91 parameters (13 variances and 78 covariances) were estimated, requiring at least 455 observations—close to the 396 average number of observations actually available. More observations are required if misspecification is suspected or if data are strongly non-normal (not the case here, as was shown in Section 5.2.3). Sub-model *a* met the requirement more easily (28 parameters, 140 observations required, 455 average number of observations available).

The sample-size tables also indicate that most covariances had a reasonable number of observations. Again, Hair et al. (1998, 604–605) recommends a minimum of 100 to 150 observations. In sub-model *b,* only **Atmospheric Consequences / Leadership Tenure** (57)**, Atmospheric Consequences / Governance** (73) and **Leadership Tenure / Governance** (74) had less than 100 observations, while 17 of 78 covariances had less than 150 observations. There was an average of 353 observations per covariance in sub-model *b*. Sub-model *a* included 7 of 21 covariances with less than 150 observations and one came with less than 100: **Atmospheric Consequences / Leadership Tenure** (57). There were an average of 295 observations per covariance in sub-model *a*.

Because a significant number of observations were missing, their randomness had to be tested. The test was made by calculating dichotomised variable correlations. Each variable (except for **Employees,** which had no missing values) was recoded with the value 1 if the data existed, and 0 if the data was missing (Hair et al. 1998, 60). Table 15 shows the resulting correlations. For low correlations, the data can be considered missing completely at random (MCAR)—and most correlations were low in this analysis. Two correlations exceeded 0.4, signifying moderate non-randomness; one correlation exceeded 0.9, signifying strong non-randomness. The strong non-randomness of **Communication Distortion /**

Divisionalisation is unsurprising: the data were collected simultaneously for the two variables.

Table 15. Multivariate Test for Missing Completely at Random (MCAR)

MULTIVARIATE TEST FOR MISSING COMPLETELY AT RANDOM (MCAR)

	Atmospheric Consequences	Leadership Tenure	Company Age	Incentive Limits	Communication Distortion	Economies of Scale	Geographic Reach	Product Breadth	Vertical Depth	Governance	Divisionalisation	Growth	Profitability
Atmospheric Consequences	1												
Leadership Tenure	0.22	1											
Company Age	0.22	0.16	1										
Incentive Limits	0.11	0.06	0.14	1									
Communication Distortion	0.43	0.27	0.22	0.09	1								
Economies of Scale	0.05	−0.02	0.00	0.05	0.05	1							
Geographic Reach	0.10	0.04	0.12	−0.01	0.12	0.11	1						
Product Breadth	0.06	0.11	0.18	0.04	0.13	0.13	0.27	1					
Vertical Depth	0.07	0.11	0.19	0.02	0.13	0.14	0.26	0.97	1				
Governance	0.22	0.18	0.20	0.11	0.33	0.05	0.09	0.11	0.11	1			
Divisionalisation	0.43	0.26	0.21	0.10	0.96	0.06	0.11	0.14	0.13	0.32	1		
Growth	0.04	0.00	−0.02	0.01	0.02	0.00	0.09	0.00	0.00	0.11	0.02	1	
Profitability	−0.02	−0.02	0.02	0.08	−0.02	0.20	0.15	0.15	0.09	0.04	−0.02	−0.01	1

Note: Figures show dichotomised correlations

5.2.3 Data Transformation, Non-Normality, Heteroscedasticity and Linearity

Most continuous variables were transformed to reach more univariate normal distributions. This was done by studying histograms for each variable and by analysing the skewness and kurtosis statistics. A Kolmogorov-Smirnov (with the Lilliefors modification) normality test was also performed. Those variables that deviated significantly from normal distribution were transformed. The transformations were based on the standard approach of using the square root for mild non-normality, the logarithm for moderate non-normality, and the inverse for severe non-normality. In addition, in some instances the arctangent transformation was used to reduce kurtosis. Table 16 summarises the transformations used. While the use of transformations increases the accuracy of the test statistics, it sometimes makes it more difficult to interpret the results for each variable because scales change and the variable itself make take on a new meaning (Hair et al. 1998, 78). The current research is not concerned with the variables' scales and thus the data transformations on balance benefit the statistical analysis.

Table 16. Overview of Transformation Formulas

OVERVIEW OF TRANSFORMATION FORMULAS	
Variable	**Transformation**
Employees	atan(0.67(sqrt(ln(Employees · 1000)) − mean)∕sdev); mean = 2.9956; sdev = 0.18056
Atmospheric Consequences	sqrt(Atmospheric Consequences)
Leadership Tenure	none
Company Age	none
Incentive Limits	ln(Incentive Limits + 0.001)
Communication Distortion	ln(Communication Distortion)
Economies of Scale	ln(Economies of Scale)
Geographic Reach	ln(1 + Geographic Reach)
Product Breadth	ln(1 + Product Breadth)
Vertical Depth	none
Governance	−1000∕Governance
Divisionalisation	none
Growth	atan(0.5(ln(Growth + 0.35) + 0.9)∕sdev); sdev = 0.30597
Profitability	atan(0.9(Profitability − 2.432)∕sdev); sdev = 17.847

The skewness, kurtosis and Kolmogorov-Smirnov statistics are listed below in Tables 17 and 18. In general, the variables exhibited mild to severe skewness and kurtosis before the transformations, while most of them were normal at the 5 per cent confidence level after transformations. Table 17 shows the statistics before transformation. Most untransformed variables were non-normal at the 1 per cent probability level ($z<2.58$). The Kolmogorov-Smirnov z was larger than the often-used benchmark 2.0 for 7 of 12 variables.

Table 17. Univariate Normality Statistics for Untransformed Variables

UNIVARIATE NORMALITY STATISTICS FOR UNTRANSFORMED VARIABLES							
	Skewness			**Kurtosis**			**Kolmogorov-Smirnov *z***
Variable	**Statistic**	**SE**	***z***	**Statistic**	**SE**	***z***	
Employees	8.78	0.09	100.50	115.40	0.17	661.68	8.96
Atmospheric Consequences	0.32	0.20	1.61	0.23	0.40	0.58	0.60
Leadership Tenure	0.19	0.19	0.99	−0.74	0.38	1.96	0.83
Company Age	0.74	0.10	7.63	2.06	0.19	10.67	1.35
Incentive Limits	2.60	0.11	23.51	8.14	0.22	36.94	4.94
Communication Distortion	0.24	0.12	1.91	−0.05	0.25	0.20	1.10
Economies of Scale	5.48	0.09	61.45	35.68	0.18	200.39	9.54
Geographic Reach	0.77	0.09	8.16	0.24	0.19	1.26	3.55
Product Breadth	0.37	0.09	3.91	−1.25	0.19	6.63	4.99
Vertical Depth	not meaningful (ordinal)						
Governance	0.96	0.16	5.95	1.22	0.32	3.81	1.46
Divisionalisation	not meaningful (ordinal)						
Growth	2.11	0.09	23.68	9.52	0.18	53.60	3.72
Profitability	−0.04	0.09	0.51	5.13	0.17	29.33	2.74
Note: SE = Standard Error							

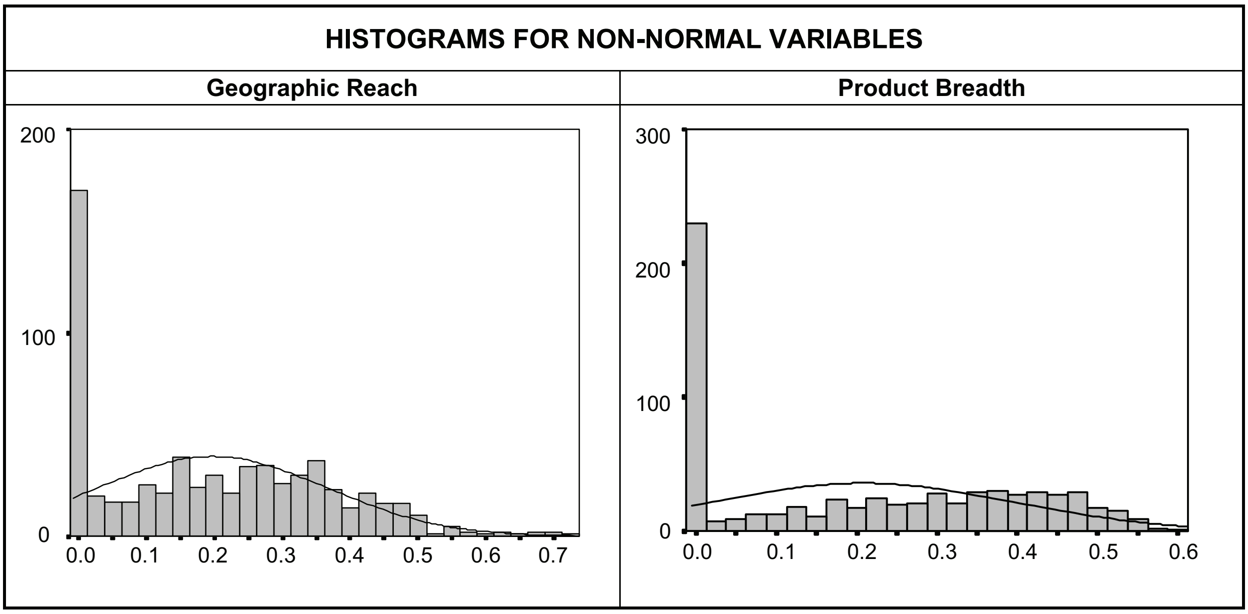
Table 18 shows the statistics after transformation. All variables, except for **Geographic Reach** and **Product Breadth,** had Kolmogorov-Smirnov *z* below (or close) to 2; the skewness *z* and kurtosis *z* were usually less than 2.58. Thus, the variables were close to normally distributed.

Table 18. Univariate Normality Statistics for Transformed Variables

UNIVARIATE NORMALITY STATISTICS FOR TRANSFORMED VARIABLES							
	Skewness			Kurtosis			Kolmogorov-Smirnov *z*
Variable	Statistic	SE	*z*	Statistic	SE	*z*	
Employees	0.16	0.09	1.86	−0.80	0.17	4.59	1.28
Atmospheric Consequences	−0.07	0.20	0.32	0.11	0.40	0.29	0.59
Leadership Tenure	−0.33	0.19	1.76	−0.55	0.38	1.45	0.85
Company Age	−0.23	0.10	2.37	−0.22	0.19	1.12	2.25
Incentive Limits	−0.02	0.11	0.20	−0.39	0.22	1.78	0.76
Communication Distortion	−0.08	0.12	0.63	0.04	0.25	0.16	0.71
Economies of Scale	0.28	0.09	3.17	0.07	0.18	0.42	0.82
Geographic Reach	0.77	0.09	8.16	0.24	0.19	1.26	3.37
Product Breadth	0.37	0.09	3.91	−1.25	0.19	6.63	5.24
Vertical Depth	not meaningful (ordinal)						
Governance	−0.05	0.16	0.28	0.23	0.32	0.73	0.64
Divisionalisation	not meaningful (ordinal)						
Growth	−0.10	0.09	1.08	0.15	0.18	0.86	0.84
Profitability	0.21	0.09	2.38	−0.16	0.17	0.93	0.57

Note that neither **Geographic Reach** nor **Product Breadth** could be further improved because they had severely non-normal distributions (Figure 6).

Figure 6. Histograms for Non-Normal Variables



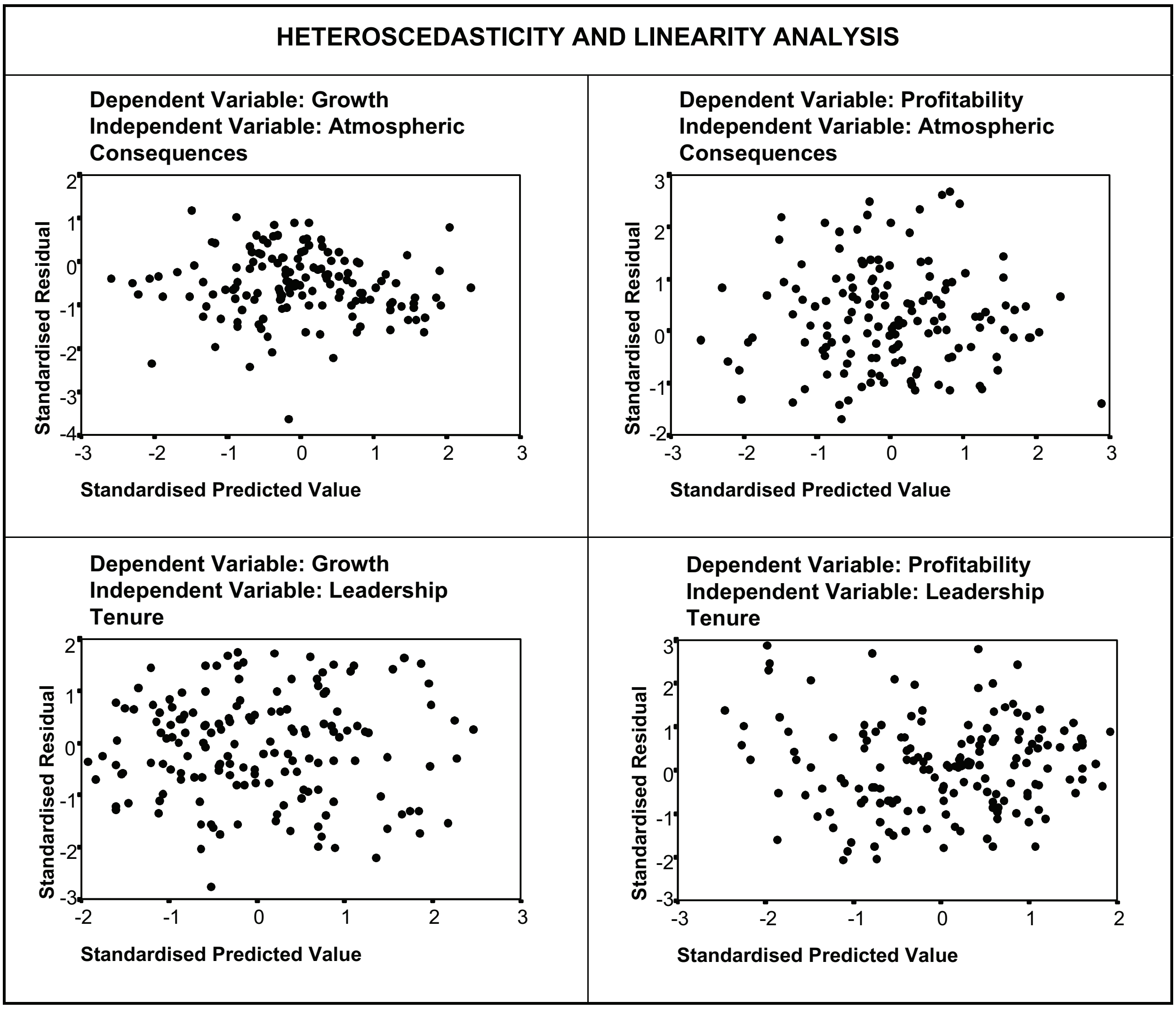
Transformations for non-normality often reduce heteroscedasticity and improve linearity. To test for heteroscedasticity and linearity after the transformations, the standardised residuals were plotted against the standardised predicted values for each pair of variables used in the analyses in the next chapter.

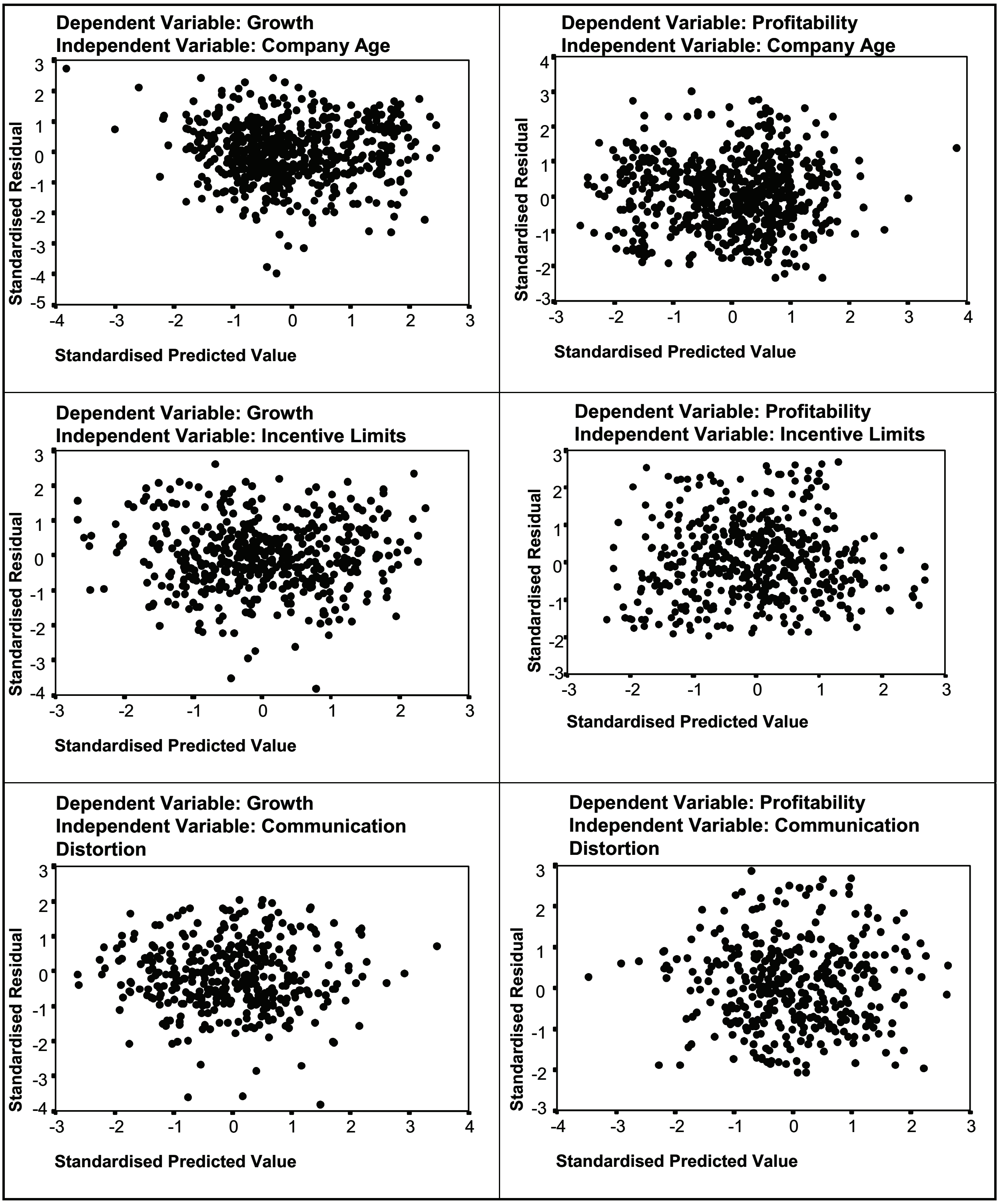
Figure 7 shows scatterplots for the most important pairs of variables in sub-model *b*. None of the plots indicate significant heteroscedasticity or non-linearity as evidenced by the lack of patterns[29] in the plots, except for **Product Breadth / Growth**, **Product Breadth / Profitability**, **Geographic Reach / Growth** and **Geographic Reach / Profitability** (see also Figure 6).

[29] A pattern could, for example, be a plot where the points are inside a triangle or cone, indicating heteroscedasticity, or a plot where the points follow a curve, indicating non-linearity.

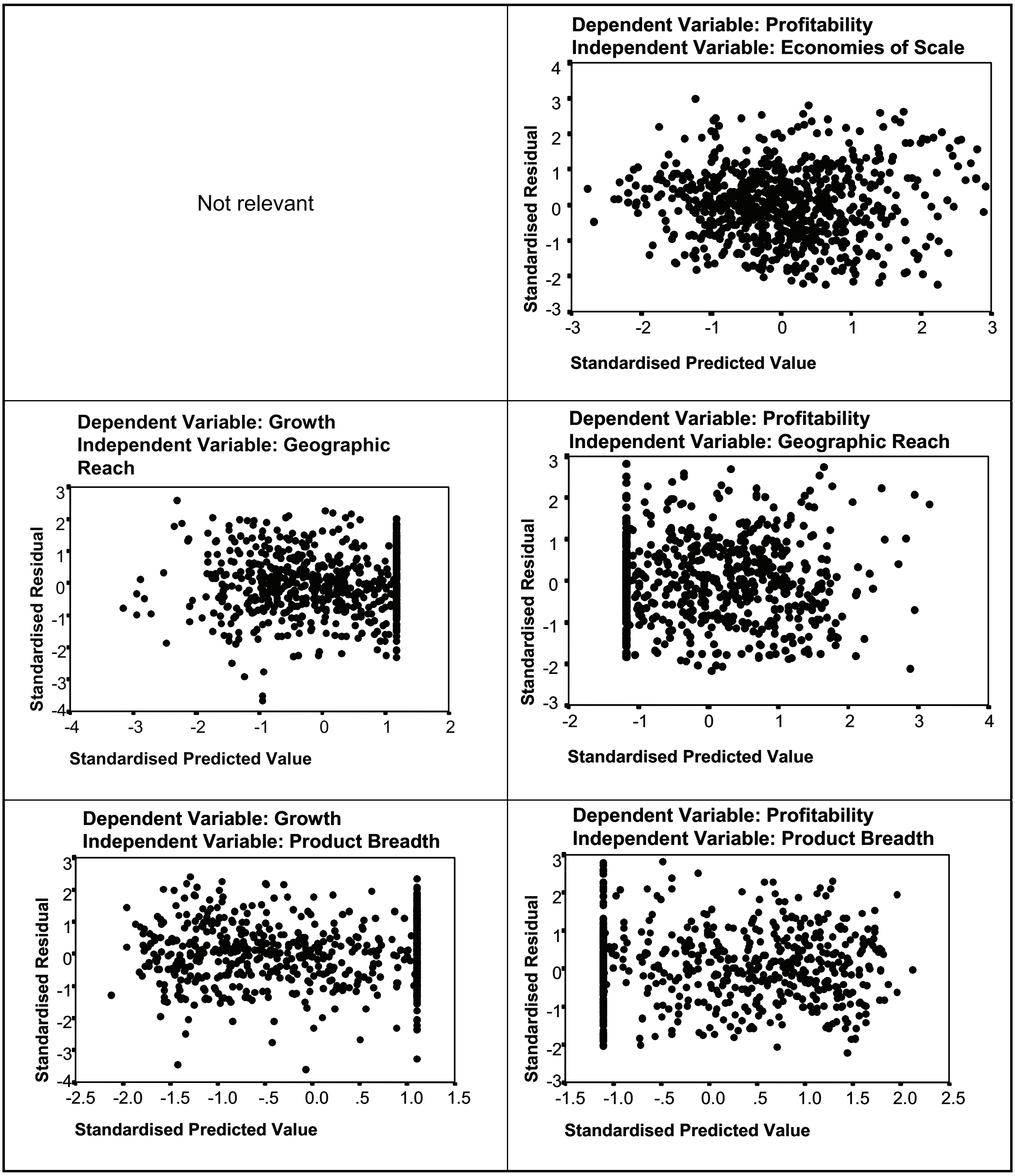
Box's *M*, the standard test for assessing heteroscedasticity, was calculated for these four covariances. Table 19 shows that only **Geographic Reach / Profitability** had a problematic significance when the standard benchmark of 0.01 was used (Hair et al. 1998, 328).

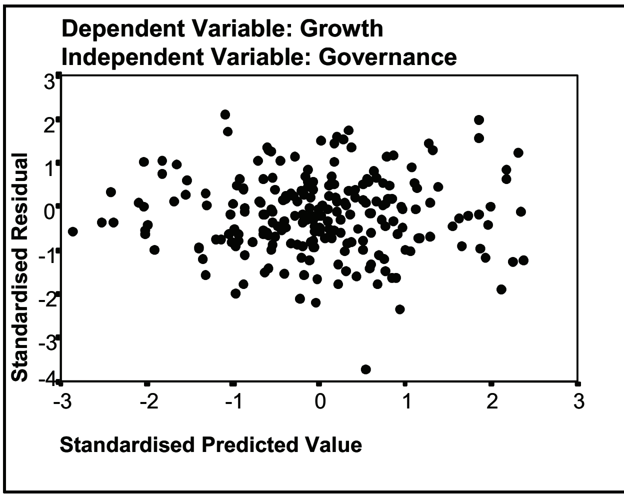
Figure 7. Heteroscedasticity and Linearity Analysis





Dependent Variable: Growth
Independent Variable: Company Age
Standardised Residual
Standardised Predicted Value
Dependent Variable: Profitability
Independent Variable: Company Age
Standardised Residual
Standardised Predicted Value
Dependent Variable: Growth
Independent Variable: Incentive Limits
Standardised Residual
Standardised Predicted Value
Dependent Variable: Profitability
Independent Variable: Incentive Limits
Standardised Residual
Standardised Predicted Value
Dependent Variable: Growth
Independent Variable: Communication Distortion
Standardised Residual
Standardised Predicted Value
Dependent Variable: Profitability
Independent Variable: Communication Distortion
Standardised Residual
Standardised Predicted Value


Not relevant
Dependent Variable: Profitability
Independent Variable: Economies of Scale
Standardised Residual
Standardised Predicted Value
Dependent Variable: Growth
Independent Variable: Geographic Reach
Standardised Residual
Standardised Predicted Value
Dependent Variable: Profitability
Independent Variable: Geographic Reach
Standardised Residual
Standardised Predicted Value
Dependent Variable: Growth
Independent Variable: Product Breadth
Standardised Residual
Standardised Predicted Value
Dependent Variable: Profitability
Independent Variable: Product Breadth
Standardised Residual
Standardised Predicted Value



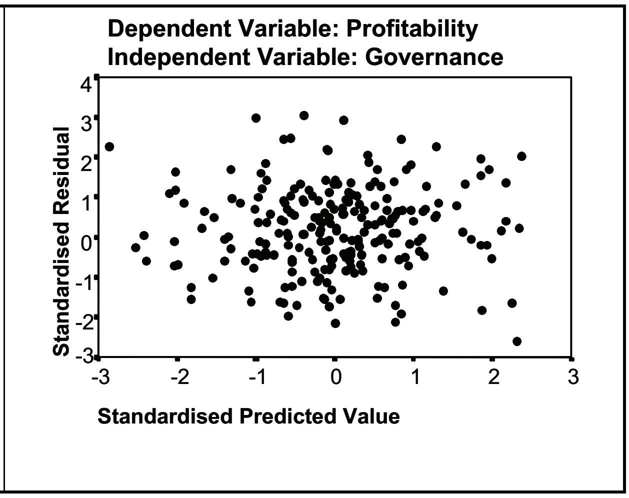


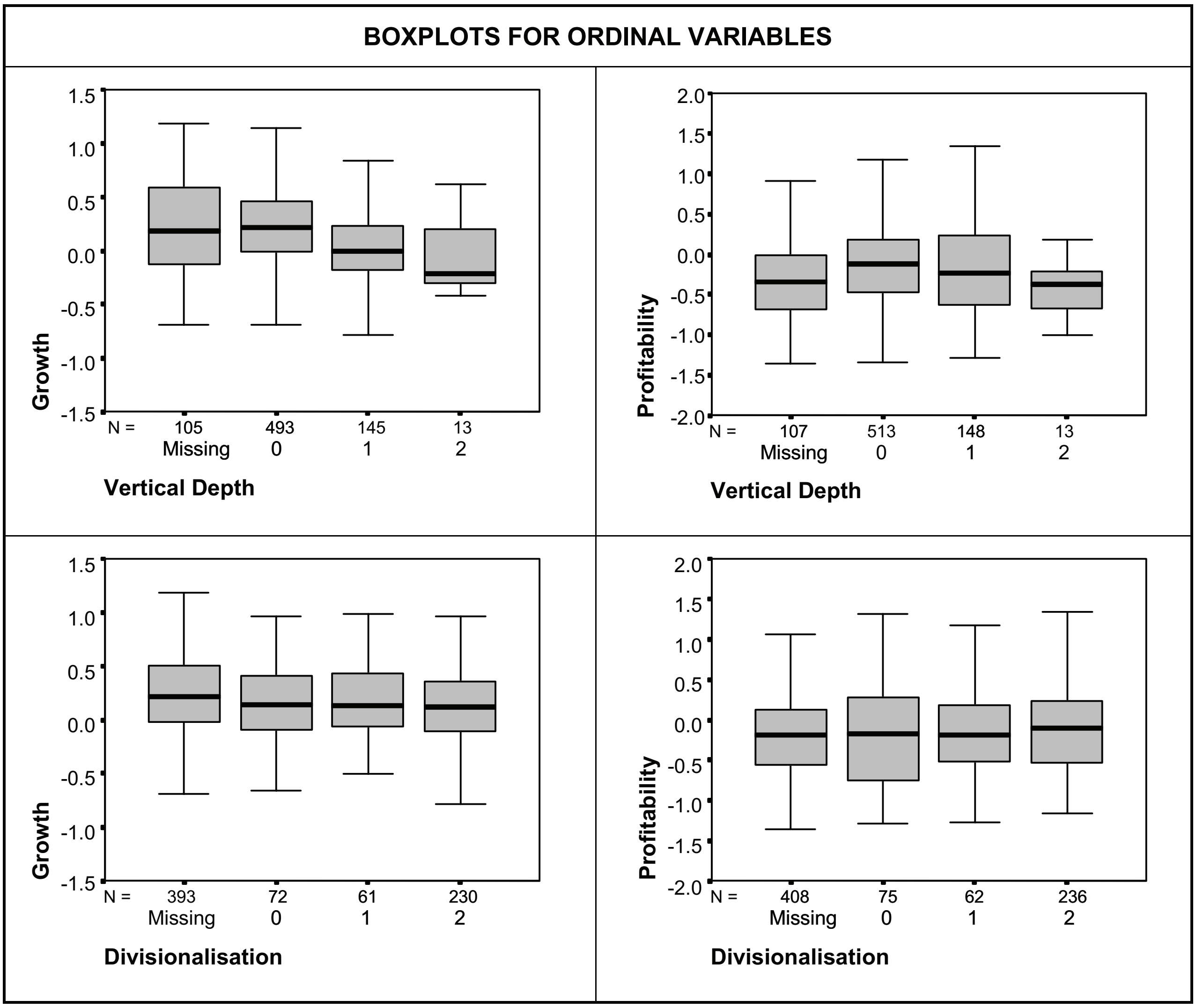
Table 19. Box's M *Test for Heteroscedastic Variables*

BOX'S *M* TEST FOR HETEROSCEDASTIC VARIABLES				
	Geographic Reach		**Product Breadth**	
	Growth	**Profitability**	**Growth**	**Profitability**
Box's *M*	2.22	23.28	2.52	8.23
Significance	0.91	0.001	0.88	0.24

All 76 scatterplots (sub-model *a*: 21 plots; *b*: 55 plots) are available in the SPSS output file *Heteroscedasticity.spo* at http://canback.com/henley.htm.

One last issue regarding the quality of the data had to be resolved: checking whether the ordinal variables **Vertical Depth** and **Divisionalisation** had uniform variance across the ordinal values and the missing values. The boxplots in Figure 8 show that the dependent variables **Growth** and **Profitability** were normally distributed across ordinal values (as indicated by the symmetrical boxes and whiskers), except for **Vertical Depth** = 2, which only had 13 observations. Moreover, the dependent variables appear to be well-behaved across ordinal values in the sense that the averages were the same or the slope was in one direction, and variances were similar in size. Nothing in these boxplots indicates problems with the data.

Figure 8. Boxplots for Ordinal Variables



A Levene test revealed, however, that the variances were homogeneous across the ordinal values for **Growth**, but not for **Profitability** (Table 20).

Table 20. Levene Test for Ordinal Variables

LEVENE TEST FOR ORDINAL VARIABLES				
	Vertical Depth		Divisionalisation	
	Growth	Profitability	Growth	Profitability
Levene statistic	0.161	4.093	0.190	3.890
Significance	0.852	0.017	0.827	0.021

This suggested that **Profitability** should be transformed, but doing this reduced normality and homoscedasticity even more than in the earlier tests. Thus, no adjustment was made. Note, also, that the Levene test for **Vertical Depth** is misleading because there were only 13 observations for **Vertical Depth** = 2. By recoding 2 to 1, the test improves markedly to a significance of more than 0.05.

It should now be apparent that despite issues such as many missing values, non-normality of certain variables and some heteroscedasticity, the data are sufficiently robust for the structural equation models. The next chapter turns to the structural equation models. At this point, it has been shown that a robust framework based on transaction cost economics can be constructed, that the framework is supported in the literature, and that data are available and well behaved so that the five hypotheses can be tested.

6. RESULTS

This chapter describes the structural equation models used to test the hypotheses. The philosophy of the approach has been to use as simple models and definitions as possible and to use the theoretical framework without alterations. The focus is on practical significance, rather than statistical significance, as discussed by Hair et al. (1998, 22): "Many researchers become myopic in focusing solely on the achieved significance of the results without understanding their interpretations, good or bad. A researcher must instead look not only at the statistical significance of the results but also at their practical significance". Here, the analyses are used in a confirmatory sense. That is, the model is derived from the literature review and there is no attempt to explore new relations between variables based on the outcome of the analyses. This means that the correlations and conclusions probably are weaker than they need be in a statistical sense. Thus, the purpose of the statistical analyses is not to optimise test statistics, but rather to gain insights into the nature of diseconomies of scale. These insights were gained, as is hopefully demonstrated.

The chapter is divided into the following main sections: "Sub-Model *a*; Relationship between Firm Size and Diseconomies of Scale and Economies of Scale" determines whether the theorised diseconomies of scale are driven by size ($\mathbf{H_1}$) and whether there is a link between size and economies of scale (**H_2**); "Sub-Model *b*: Relationship between Diseconomies of Scale, Economies of Scale, Moderating Factors and Firm Performance" establishes the impact of diseconomies of scale on firm performance (**H_3**), the influence of economies of scale on firm performance (**H_4**) and the relationship between firm performance and the moderating factors organisation form and asset specificity (**H_5**). Below is a recap of the hypotheses articulated in Chapter 4:

H_1: Bureaucratic failure, in the form of atmospheric consequences, bureaucratic insularity, incentive limits and communication distortion, increases with firm size

H_2: Large firms exhibit economies of scale

H_3: Diseconomies of scale from bureaucratic failure have a negative impact on firm performance

H_{3a}: Atmospheric consequences have a negative impact on the performance of large firms

H_{3b}: Bureaucratic insularity has a negative impact on the performance of large firms

H_{3c}: Incentive limits have a negative impact on the performance of large firms

H_{3d}: Communication distortion has a negative impact on the performance of large firms

H_4: Economies of scale increase the relative profitability of large firms over smaller firms

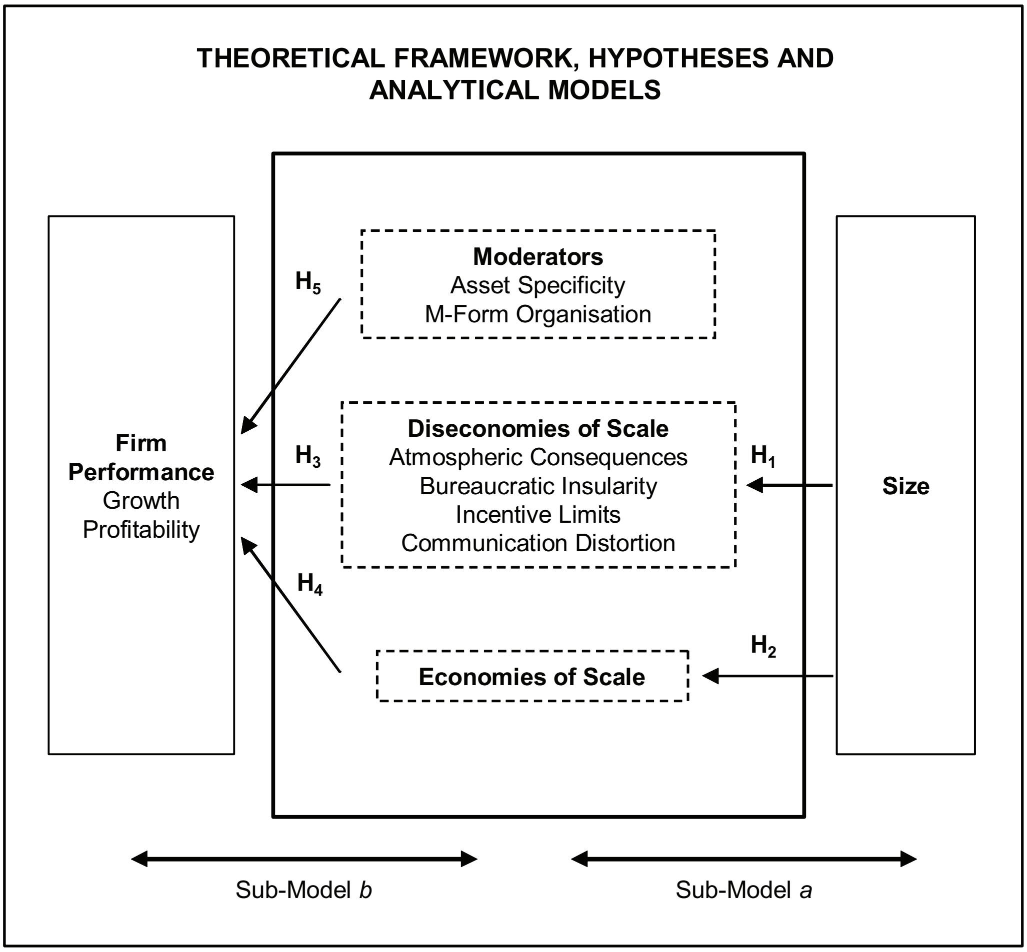
H_5: Diseconomies of scale are moderated by two transaction cost-related factors: organisation form and asset specificity

H_{5a}: Large M-form firms perform better than large U-form firms

H_{5b}: High internal asset specificity affects a firm's performance positively

Figure 9 summarises the hypotheses graphically. As is seen, the expectation is that as the overall relationship between firm performance and size is deconstructed, insights into the true nature of managerial diseconomies of scale will be gained.

Figure 9. Theoretical Framework, Hypotheses and Analytical Models



The path diagrams follow the standard SEM nomenclature (e.g., Arbuckle and Wothke 1999, 135) with rectangles representing observed variables, ovals representing latent variables, curved lines representing correlations and arrows representing causal links. The error terms include both errors and influences from variables exogenous to the model.

Throughout the chapter, the hypotheses were evaluated against commonly used test statistics. Critical ratios were calculated for the regression coefficients and the significance thresholds of 10%, 5%, 1% and 0.1% probability were applied. Squared multiple correlations were used to evaluate how much of the dependent variables' variance were explained by the independent variables. The normed chi-square statistic (chi-square divided by degrees of freedom) was calculated to evaluate a model's overall goodness of fit. Excellent fit was defined as values smaller than 2, good fit for values between 2 and 5, and acceptable fit for values between 5 and 10 (see also Footnote 33 (p. 137), below). However, this test was not strictly applied because the measure of overall fit deteriorates quickly if individual relationships in the model have low significance. A model with poor overall fit can still be used for practical interpretation, especially in confirmatory analysis. In addition, the normed fit index (NFI) was used to evaluate how closely a given model fit the saturated model. A value less than 0.9 indicated a poor fit. Finally, a parsimonious fit index (PFI) was used occasionally to compare models. This is a relative index and a higher relative ratio indicates a more parsimonious fit when two models are compared.

It is now time to turn to the actual structural equation models, starting with sub-model *a*.

6.1 SUB-MODEL *A*: RELATIONSHIP BETWEEN FIRM SIZE AND DISECONOMIES OF SCALE AND ECONOMIES OF SCALE

This section tests sub-model *a,* which explores one aspect of the theoretical framework. Sub-model *a* shows the relationship between a firm's size and the hypothesised diseconomies of scale and economies of scale, as defined in the first and second hypotheses:

H_1: Bureaucratic failure, in the form of atmospheric consequences, bureaucratic insularity, incentive limits and communication distortion, increases with firm size

H_2: Large firms exhibit economies of scale

At this point, nothing is said about the importance of the diseconomies of scale and economies of scale. That is, while firm size may lead to diseconomies and economies of scale, this does not necessarily imply that firm performance is influenced. That relationship is explored in sub-model *b* in Section 6.2.

6.1.1 Diseconomies of Scale

Chapter 3 showed that there are four types of scale-related diseconomies: atmospheric consequences, bureaucratic insularity, incentive limits and communication distortion. Each of these factors is analysed in this section with the aim to determine whether it is driven by firm size. Each factor is first analysed individually (Sections 6.1.1.1–6.1.1.4). The last section (6.1.1.5) then explores the integrated relationship between firm size and diseconomies of scale. In addition, more precise definitions of variables are given and some variables collected as part of the research, but not included in the final analysis, are discussed.

6.1.1.1 Atmospheric Consequences

Based on the reasoning in Section 3.2.1.4, atmospheric consequences should exhibit themselves as alienation, which in turn requires firms to pay higher wages in order to keep their employees. Thus, unit labour cost (defined as total labour cost divided by number of employees) should be a good indicator of atmospheric consequences (see also Scherer's research (1976) discussed on pp. 55–56, above). Unfortunately, it proved difficult to collect these data for the 784 firms. Labour cost data for 1998 were only available for 52 firms in Compustat and annual reports; an additional 43 cases where calculated by taking available labour cost data from 1991 till 1997 (mostly from 1997) and extrapolating them to 1998. This was done by calculating unit labour cost for the observed year and then inflating this figure by the annual average increase in compensation for the whole sample. Finally 51 cases were estimated in a similar way using pre-1991 data, but only for firms which had a stable business mix over time that could be cross-checked against other data such as R&D expense and selling, administrative and general expense. The estimates were also corroborated by comparing the firm's unit labour cost with its industry unit labour costs.

Attempts were made (1) to run a separate regression and (2) carefully to impute additional observations as suggested by, for example, Jöreskog and Sörbom (1996, 78). First, the regression was run with unit labour cost as dependent variable and with industry unit labour cost, sales per employee, relative R&D expense and foreign revenue share of total revenue as independent variables. Second, LISREL was used to impute values for the missing data (Amos does not have imputational capability). The results in both cases were too erratic to warrant inclusion in the sample, even though they would have increased the sample size from 146 to 435 and 399 observations, respectively, for atmospheric consequences.

Figure 10 shows that unit labour cost increases with the size of the firm, in line with earlier research described in the literature review (Chapter 3). However, only 3% of the variance is accounted for. (Here, and in the following path diagrams, the figure above a causal link shows the standardised regression coefficient, and the figure above the dependent variable shows the squared multiple correlation.)

Figure 10. Atmospheric Consequences versus Size

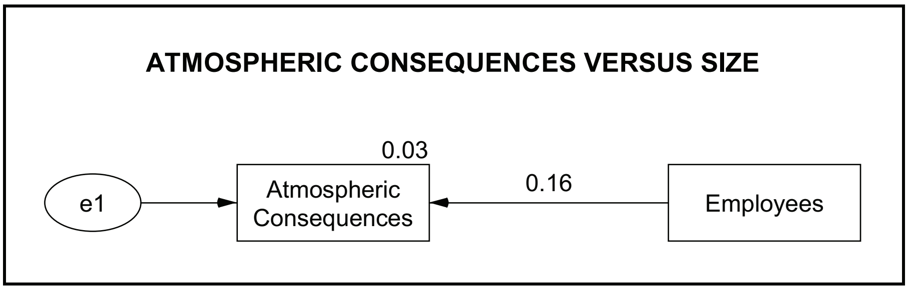


Table 21 shows that the regression coefficient approaches significance at the 5% level (a critical ratio of 1.885 implies a 5.9% significance).

Table 21. Regression Weight for Atmospheric Consequences versus Size

REGRESSION WEIGHT FOR ATMOSPHERIC CONSEQUENCES VERSUS SIZE				
	Std. Coeff.	**Unstd. Coeff.**	**SE**	**CR**
Employees → Atmospheric Consequences	0.160	0.317	0.168	1.885†

† p<10%, * p<5%, ** p<1%, *** p<0.1% (two-tailed)
Note: SE = Standard Error; CR = Critical Ratio

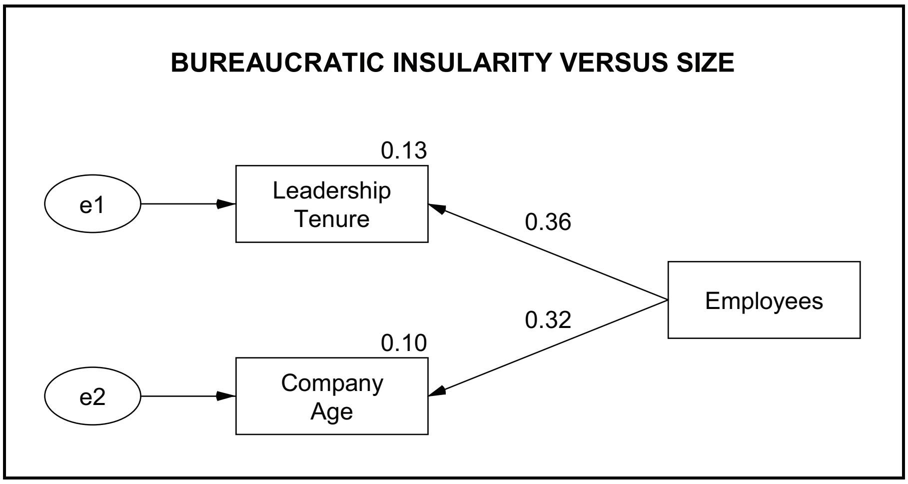
Thus, to the extent that unit labour cost is a good proxy for atmospheric consequences, large firms seem to suffer mildly from atmospheric consequences. The conclusion was the same when control variables (**Incentive Limits**, **Geographic Reach**) were introduced. Not much can be said from a practical point of view at this point.

6.1.1.2 Bureaucratic Insularity

Bureaucratic insularity was defined as executives' propensity to become increasingly isolated from market opportunities and from the lower levels of the organisation as the firm grows and procedures and processes are added to the organisational fabric. Indicators of bureaucratic insularity could be the compensation of senior executives (because a prediction is that executives will maximise their own gains rather than shareholder gains), the age of the firm (because older firms should have built up more of the insulating mechanisms), the tenure of the firm's CEO and officers (because high tenure should lead to higher insularity), or the share of free cash flow being reinvested in the business with sub-standard (below cost-of-capital) returns.

The choice was made to use the firm's age (**Company Age**) and officers' average tenure (**Leadership Tenure**) as indicators. Executive compensation proved impossible to define in a meaningful way, as did cash flow reinvestment, while CEO tenure was uncorrelated with other variables.

Figure 11. Bureaucratic Insularity versus Size



The path diagram in Figure 11 shows a strong relationship between **Leadership Tenure** and **Employees** and between **Company Age** and **Employees**. The regression weights (Table 22) are significant beyond the 0.1% level.

Table 22. Regression Weights for Bureaucratic Insularity versus Size

REGRESSION WEIGHTS FOR BUREAUCRATIC INSULARITY VERSUS SIZE				
	Std. Coeff.	**Unstd. Coeff.**	**SE**	**CR**
Employees → Leadership Tenure	0.364	0.695	0.139	4.992***
Employees → Company Age	0.321	1.634	0.191	8.560***
*** p<0.1% (two-tailed)				

The relationship between **Employees** and **Company Age** is in reality even stronger, because almost all large firms are old, leading to heteroscedasticity. This is evidenced by running the model with the large firm sub-sample (392 largest firms). The critical ratio for **Employees →**

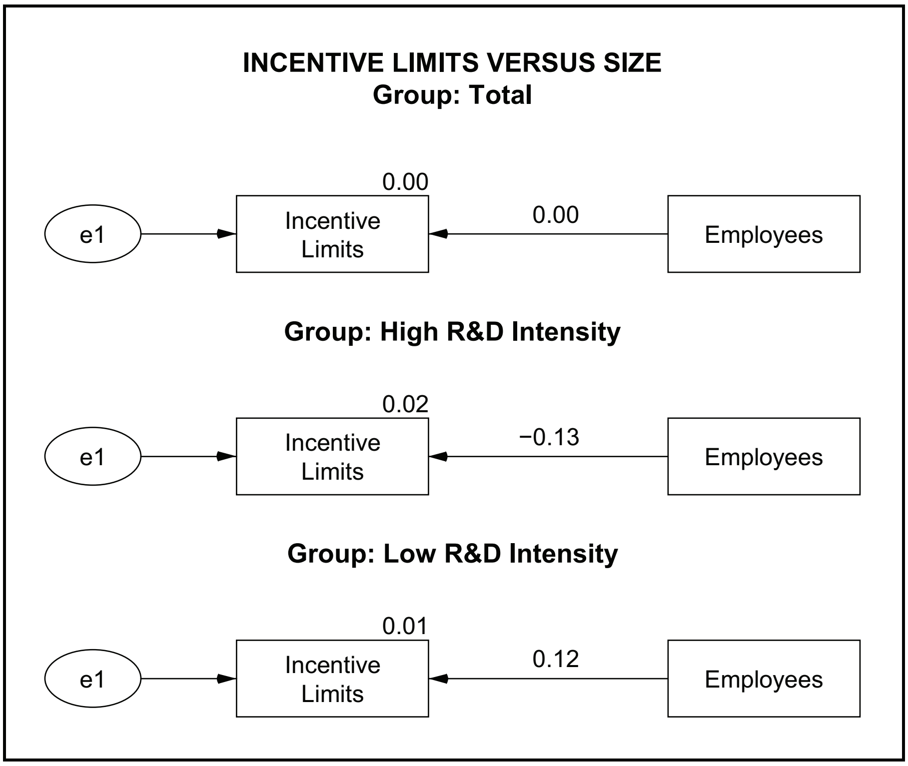
Company Age drops from 8.560 for all firms to 3.336 for large firms. In practical terms, it is possible to conclude that bureaucratic insularity increases with firm size and that the theoretical predictions are valid.

6.1.1.3 Incentive Limits

The third factor driving diseconomies of scale is incentive limits. As discussed in Chapter 3, incentive limits are most serious in firms with indivisible tasks such as product development, were the outcome of activities is dependent on the collaboration of many individuals and the contribution of each individual is hard to measure. Two indicators were tested: (1) the research and development intensity, measured as R&D expense divided by sales; and (2) general and administrative costs, measured as SG&A expense less advertising expense, divided by sales. The assumption behind the latter definition is that the bulk of general and administrative activities are indivisible (e.g., general management tasks). The two indicators have a fairly high correlation (52%). However, **R&D%** has 489 observations, while **SG&A% − Adv%** only has 177 observations and thus **R&D%** was chosen as the better indicator.

In the analysis of the relationship between incentive limits and size, the approach is different from the one taken in the preceding two sections. Large firms should try to avoid incentive limits. Consequently, one would expect a negative regression coefficient for **Employees → R&D%**. This should be especially true for firms in R&D-intense environments. The three graphs in Figure 12 show this to be case. The first diagram shows the regression for the whole sample of 784 firms. The second regression includes only those firms with higher than average R&D intensity (245 firms). The third regression includes those firms with lower than average R&D intensity (244 firms).[30]

Figure 12. Incentive Limits versus Size



[30] 295 companies did not report their R&D expense.

The regression weights are reported in Table 23. The critical ratio for the difference between the regression coefficient **Employees → Incentive Limits** for the high R&D-intensity and the low R&D-intensity sub-samples is 2.721. That is, the difference is significant at better than the 1% level and one can conclude that firms in R&D-intense industries tend to be relatively smaller. This lends support to the hypothesised impact of incentive limits because large firms tend to avoid R&D-intense industries.

Table 23. Regression Weights for Incentive Limits versus Size

REGRESSION WEIGHTS FOR INCENTIVE LIMITS VERSUS SIZE				
	Std. Coeff.	**Unstd. Coeff.**	**SE**	**CR**
Total Sample: Employees → Incentive Limits	0.000	0.000	0.104	0.003
High R&D-Intensity Sub-Sample: Employees → Incentive Limits	−0.127	−0.165	0.082	−2.000*
Low R&D-Intensity Sub-Sample: Employees → Incentive Limits	0.118	0.169	0.091	1.860†
† p<10%, * p<5% (two-tailed)				

The practical implication is that large firms suffer from incentive limits, in line with the theoretical prediction.

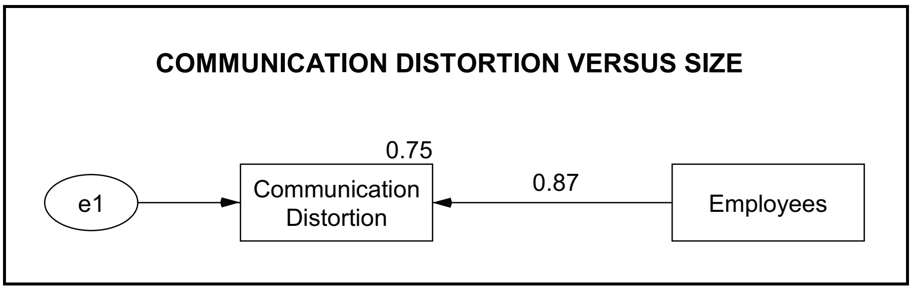
6.1.1.4 Communication Distortion

The fourth and final factor contributing to diseconomies of scale is communication distortion. Communication distortion can be defined as the length of the communications process through the organisational hierarchy, or as the time it takes for decisions to go from issue identification to resolution. The first definition has usually been operationalised with the number of hierarchical levels within the firm and this is the definition used here as well. Unfortunately, it proved impossible to operationalise the second definition.

A number of studies, including Child (1973), demonstrate that the number of hierarchical levels increases logarithmically with the number of employees. The current research reached the same conclusion by studying the organisational structure of 386 firms within the total sample of 784 firms. They had an average of 7.9 hierarchical levels and a standard deviation of 0.8 levels. No firm had more than 10 levels.

As expected, there is a strong dependency between number of employees and the number of levels, as is shown in Figure 13.

Figure 13. Communication Distortion versus Size



The critical ratio is very high (Table 24). Additional regressions were run with control variables such as organisational form (**M-Form**), but no such control variable proved to be important.

Table 24. Regression Weight for Communication Distortion versus Size

REGRESSION WEIGHT FOR COMMUNICATION DISTORTION VERSUS SIZE				
	Std. Coeff.	Unstd. Coeff.	SE	CR
Employees → Communication Distortion	0.866	0.177	0.005	34.017***
*** p<0.1% (two-tailed)				

The next section combines the variables discussed so far into an integrated model for understanding diseconomies of scale, using latent variables in a structural equation model.

6.1.1.5 Integrated Model for the Relationship between Diseconomies of Scale and Size

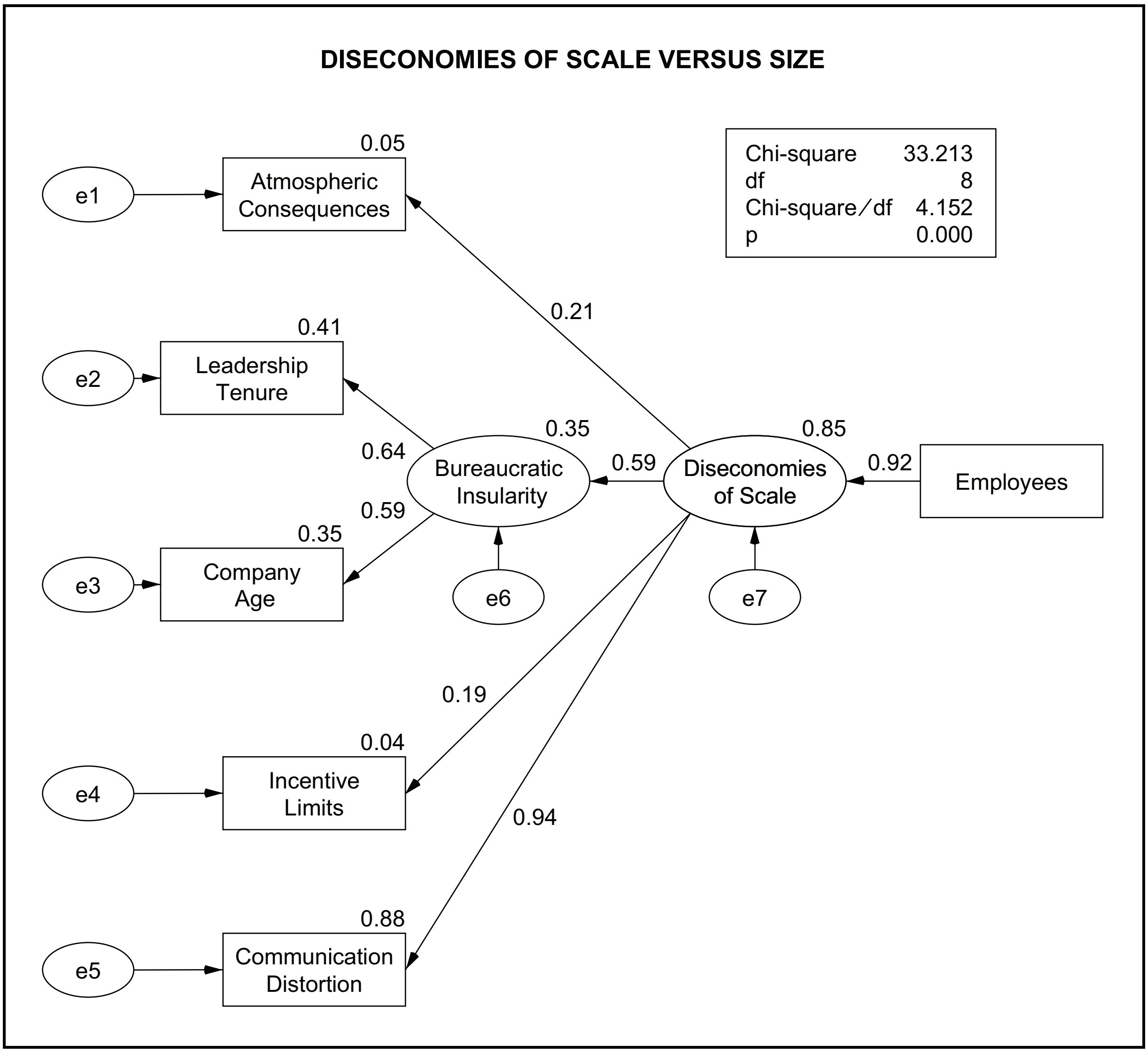
At this juncture, it appears likely that the four factors driving diseconomies of scale according to transaction cost economics do indeed increase with firm size. It is instructive to test this further by combining atmospheric consequences, bureaucratic insularity, incentive limits and communication distortion in one model to see how they collectively relate to firm size. This is the first true structural equation model of the analysis because two latent variables are introduced: **Diseconomies of Scale** and

Bureaucratic Insularity (so far, the analyses were run as standard univariate linear regressions).

Figure 14 shows the structural equation model (partially[31] corresponding to sub-model *a* in Figure 9). **Incentive Limits** has **Leadership Tenure** and **Company Age** as indicators. **Diseconomies of Scale** is a latent variable constrained on the one hand by **Employees**, on the other hand by the four factors driving diseconomies of scale. It should be noted that **Incentive Limits**, which in the previous section was analysed differently than the other three factors, has been modified in the model below. Because incentive limits are most pronounced in R&D-intense industries, this had to be taken into account. This was done by multiplying the original **Incentive Limits** variable by a dummy factor of 1 for high R&D intensity and 0 for low R&D intensity. (This is the only place in the thesis where this alternative indicator for **Incentive Limits** is used.)

[31] The other part of sub-model *a* is analysed in Section 6.1.2.

Figure 14. Diseconomies of Scale versus Size



A matrix representation of the path diagram is provided in Figure 15.[32] It follows the notational conventions developed by Jöreskog and Sörbom (see, e.g., Hair et al. 1998, 648–652).

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[32] The matrix equations are mathematically equivalent to the path diagram in Figure 14, but differ in the arrangement of variables. The reason for this is that the path diagram does not make a clear distinction between the path diagram and the measurement model. The formal representation in the matrixes makes this distinction and it leads to a different layout of the path diagram. This layout increases the number of variables and makes the diagram unnecessarily complex, without changing the underlying equations. Thus, simplified path diagrams are used throughout the thesis.

Figure 15. Matrix Representation of Diseconomies of Scale versus Size

MATRIX REPRESENTATION OF DISECONOMIES OF SCALE VERSUS SIZE

ξ_1 = Employees

X_1 = empl

η_1 = Diseconomies of Scale
η_2 = Atmospheric Consequences
η_3 = Bureaucratic Insularity
η_4 = Incentive Limits
η_5 = Communication Distortion

Y_1 = ulabour
Y_2 = tenure
Y_3 = age
Y_4 = rd
Y_5 = levels

$$\begin{bmatrix}\eta_1\\\eta_2\\\eta_3\\\eta_4\\\eta_5\end{bmatrix} = \begin{bmatrix}\gamma_{11}\\ \\ \\ \\ \\ \end{bmatrix}\cdot\xi_1 + \begin{bmatrix} \\ \beta_{21}\\\beta_{31}\\\beta_{41}\\\beta_{51}\end{bmatrix}\cdot\eta_1 + \begin{bmatrix}\zeta_1\\ \\ \zeta_3\\ \\ \\ \end{bmatrix}$$

$$X_1 = \xi_1$$

$$\begin{bmatrix}Y_1\\Y_2\\Y_3\\Y_4\\Y_5\end{bmatrix} = \begin{bmatrix}1 & & & & \\ & \lambda^Y_{23} & & & \\ & \lambda^Y_{33} & & & \\ & & & 1 & \\ & & & & 1\end{bmatrix}\begin{bmatrix}\eta_1\\\eta_2\\\eta_3\\\eta_4\\\eta_5\end{bmatrix} + \begin{bmatrix} \\ \varepsilon_2\\\varepsilon_3\\ \\ \\ \end{bmatrix}$$

$$\mathbf{\Psi} = \mathbf{0}$$

$$\mathbf{\Theta}^{\varepsilon} = \mathbf{0}$$

The path diagram in Figure 14 shows the standardised regression weights and the squared multiple correlations. All the regression weights are positive. This shows that the relationships have the hypothesised sign: increasing size leads to increasing diseconomies of scale and all four factors contribute to this increase. The squared multiple correlations vary significantly though, from 0.04 to 0.88.

Table 25 shows that the critical ratios are significant at better than the 5% level for all regression coefficients available (two coefficients were set to 1 to constrain the model). Furthermore, the model has a normed chi-square of 4.152, indicating a good fit,[33] and the normed fit index (NFI) is 0.995, well above the threshold of 0.900.[34]

Table 25. Regression Weights for Diseconomies of Scale versus Size

REGRESSION WEIGHTS FOR DISECONOMIES OF SCALE VERSUS SIZE				
	Std. Coeff	**Unstd. Coeff.**	**SE**	**CR**
Employees → Diseconomies of Scale	0.924	0.333	0.138	2.424*
Diseconomies of Scale → Atmospheric Consequences	0.212	1		
Diseconomies of Scale → Bureaucratic Insularity	0.589	1.981	0.901	2.197*
Diseconomies of Scale → Incentive Limits	0.189	0.072	0.035	2.082*
Diseconomies of Scale → Communication Distortion	0.938	0.534	0.220	2.424*
Bureaucratic Insularity → Leadership Tenure	0.642	1		
Bureaucratic Insularity → Company Age	0.594	2.491	0.526	4.733***
* p<5%, *** p<0.1% (two-tailed)				

The first hypothesis

H_1: Bureaucratic failure, in the form of atmospheric consequences, bureaucratic insularity, incentive limits and communication distortion, increases with firm size

[33] Excellent fit is defined as normed chi-square (chi-square / degrees of freedom) <2, good fit < 5, and acceptable fit < 10. This is in line with Kelloway (1998, 28) and Hair et al. (1998, 623).

[34] Recommended by Hair et al. (1998, 635–636).

is now expressed as: If $\gamma_{11}>0$, then $\mathbf{H_1}$ cannot be rejected. The standardised coefficient is $\gamma_{11} = 0.92$ and the significance is better than the 5% level, supporting the hypothesis. The practical statistical significance is good because of the strength of most of the relationships and the high explanatory power of the analysis.

6.1.2 Economies of Scale

The literature survey was inconclusive regarding the effects of economies of scale. The reasons were that while it is easy to conjecture that average cost per unit of output falls with firm size, the scale effects may be exhausted at fairly small firm sizes and they may apply to entire industries rather than individual firms (because information travels fast and easily between firms). Thus the choice of market or hierarchy may not matter. This conclusion is somewhat at odds with the theory developed in this research, as was noted in Section 3.2.2. It is therefore instructive to incorporate economies of scale in the model to see whether there are any scale effects.

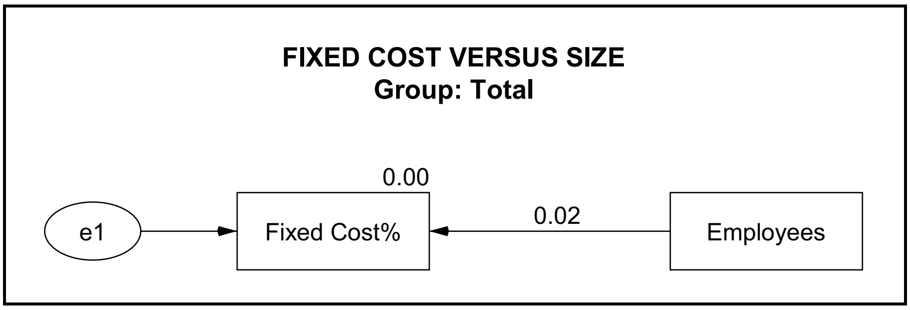
Two indicators were tested. Both build on the assumption that economies of scale exist when relative fixed costs are high. The chosen definition was to take fixed and semi-fixed costs from the income statement and divide these by total factor costs (including purchased goods and services). Factor costs differ slightly from revenue because they are the sum of all inputs, including cost of equity, regardless of if the sum of these inputs is larger or smaller than revenue. This definition is equivalent to revenue less net income plus cost of equity. By using factor costs rather than sales, spurious business cycle effects due to yearly fluctuations in net income are eliminated. The observed variable **Fixed Cost%** was consequently defined as (**SG&A + Depreciation + Interest**)/**Factor Costs**. The definition assumes that fixed costs are composed of more than the contribution from fixed assets. Specifically, the level of SG&A expense (including R&D) is not easily varied and can be considered fixed. The definition is equivalent to Penrose's definition ([1959] 1995, 89–95).

The second definition, which was discarded, was to use the classical definition of fixed assets divided by sales. This definition had no statistical significance, lending some credence to the argument made by Scherer and Ross (1990) that if economies of scale exist, then they apply primarily to bureaucratic costs (see also p. 64, above) and not to neoclassical production costs.

Figure 16 shows the relationship between number of employees and relative fixed cost. The significance of the regression coefficient is negligible (with a critical ratio of 0.506), possibly because there are countervailing forces at work, or because economies of scale do not exist.

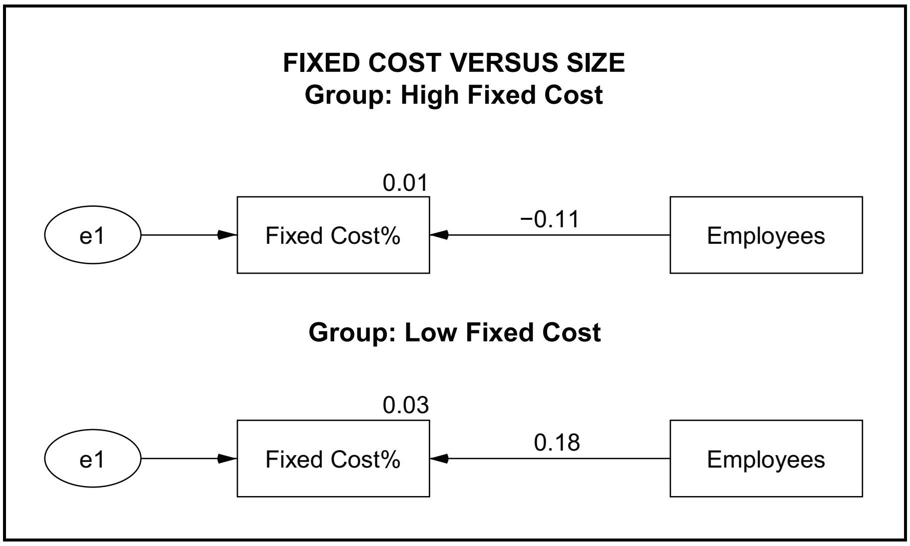
The countervailing forces argument is that economies of scale on the one hand lead large firms to be active in fixed cost-intense industries; on the other hand, these very firms would realise the benefits of scale and thus have lower relative fixed costs.

Figure 16. Fixed Cost versus Size: Total Sample



With a similar logic as was employed in the case of incentive limits, it is possible to test which of the two arguments is correct. If there are no economies of scale then, two sub-samples consisting of (1) firms active in high fixed-cost industries, and (2) firms active in low fixed-cost industries, should not differ, while the opposite is true if economies of scale exist. Figure 17 shows the path diagrams for these sub-samples with high fixed-cost industries defined as those 377 firms with the highest fixed-cost ratio, and low fixed-cost industries being the 376 remaining firms (with an additional 31 firms having missing values). This categorisation is not totally accurate because it would be better to use the fixed-cost intensity of the entire industries to determine whether a firm is active in high or low fixed-cost industries. Data were not available for this refinement.

Figure 17. Fixed Cost versus Size: High Fixed-Cost and Low Fixed-Cost Sub-Samples



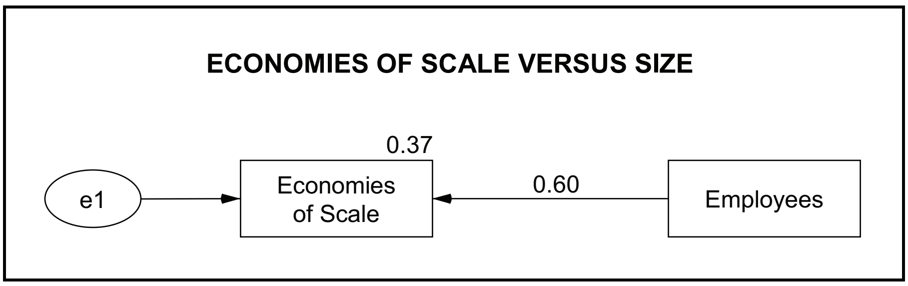
The regression coefficients differ for the two subsets and the critical ratio for the difference is 3.472, implying significance better than the 0.1% level. The regression weights for the total sample and the sub-samples are shown in Table 26. The conclusion is that large firms have lower relative fixed cost when operating in fixed cost-intense industries.

Table 26. Regression Weights for Fixed Cost versus Size

REGRESSION WEIGHTS FOR FIXED COST VERSUS SIZE				
	Std. Coeff.	Unstd. Coeff.	SE	CR
Total Sample: Employees → Fixed Cost%	0.018	0.004	0.008	0.506
High Fixed-Cost Sub-Sample: Employees → Fixed Cost%	−0.107	−0.017	0.008	−2.096*
Low Fixed-Cost Sub-Sample: Employees → Fixed Cost%	0.176	0.015	0.004	3.469***
* p<5%, *** p<0.1% (two-tailed)				

A problem with the approach taken above is that the two sub-samples reduce the number of observations too much for the variables **Atmospheric Consequences** and **Leadership Tenure**, which already in the total sample have uncomfortably few observations. Rather than performing the structural equation analysis on the two subsets defined above, the variable **Fixed Cost%** was replaced with **Economies of Scale**. **Economies of Scale** was constructed using the following logic: economies of scale are large for those firms which simultaneously are active in high fixed cost environments and have high (absolute) fixed costs. Thus, the variable **Economies of Scale** multiplies the fixed cost ratio with the absolute level of fixed cost (**Economies of Scale = Fixed Cost% · Fixed Cost**). The relationship between economies of scale and firm size is shown in Figure 18.

Figure 18. Economies of Scale versus Size



Not surprisingly, the regression coefficient is highly significant at better than the 0.1% level (Table 27).

Table 27. Regression Weight for Economies of Scale versus Size

REGRESSION WEIGHT FOR ECONOMIES OF SCALE VERSUS SIZE				
	Std. Coeff.	**Unstd. Coeff.**	**SE**	**CR**
Employees → Economies of Scale	0.605	1.797	0.086	20.800***
*** p<0.1% (two-tailed)				

The matrix representation in Figure 15 (p. 136, above) can now be expanded to include economies of scale by adding $\eta_6 = \gamma_{61}\xi_1 + \zeta_6$ to $\boldsymbol{\eta} = \boldsymbol{\Gamma}^x\boldsymbol{\xi} + \mathbf{B}\boldsymbol{\eta} + \boldsymbol{\zeta}$ and $Y_6 = \eta_6$ to $\mathbf{Y} = \boldsymbol{\Lambda}^y\boldsymbol{\eta} + \boldsymbol{\varepsilon}$. This completes the matrix representation of sub-model *a*.

At this point, the argument that economies of scale exist among large firms (hypothesis two) cannot be rejected because $\gamma_{61}>0$, with better than 0.1% significance and

H_2: Large firms exhibit economies of scale

is confirmed. The practical significance is also good because of the strength of the relationship.

The analysis next continues with the structural equation models for sub-model *b*.

6.2 SUB-MODEL *B*: RELATIONSHIP BETWEEN DISECONOMIES OF SCALE, ECONOMIES OF SCALE, MODERATING FACTORS AND FIRM PERFORMANCE

This section explores various aspects of sub-model *b,* which is the most important part of the current research. It starts by testing the relationship between a firm's financial performance and the diseconomies-of-scale factors (Section 6.2.1). It then adds economies of scale to the model to test whether they do influence firm performance positively, as predicted by the theoretical framework (Section 6.2.2). Next, the moderating factors (M-form organisation and high asset specificity) are included in the sub-model (Section 6.2.3). The final section (6.2.4) discusses the full sub-model and introduces alternative specifications to achieve parsimony. The statistical findings are shown to be congruent with the TCE framework.

6.2.1 Diseconomies of Scale and Their Impact on Firm Performance

Similar to the treatment of sub-model *a* in Section 6.1.1, this section first discusses each of the diseconomies-of-scale factors individually, and then combines them in an integrated model to test the relationship between diseconomies of scale and firm performance. The individual analyses should be seen as initial indications of dependencies and will guide the design of the integrated model. Four sections (6.2.1.1–6.2.1.4) discuss atmospheric consequences, bureaucratic insularity, incentive limits and communication distortion, respectively. The fifth section (6.2.1.5) tests the integrated model.

6.2.1.1 Atmospheric Consequences

Figure 19 shows that **Atmospheric Consequences** have a negative influence on **Growth** and have no material influence on **Profitability**. **Atmospheric Consequences** explains 11% of the variance in **Growth**.

Figure 19. Firm Performance versus Atmospheric Consequences

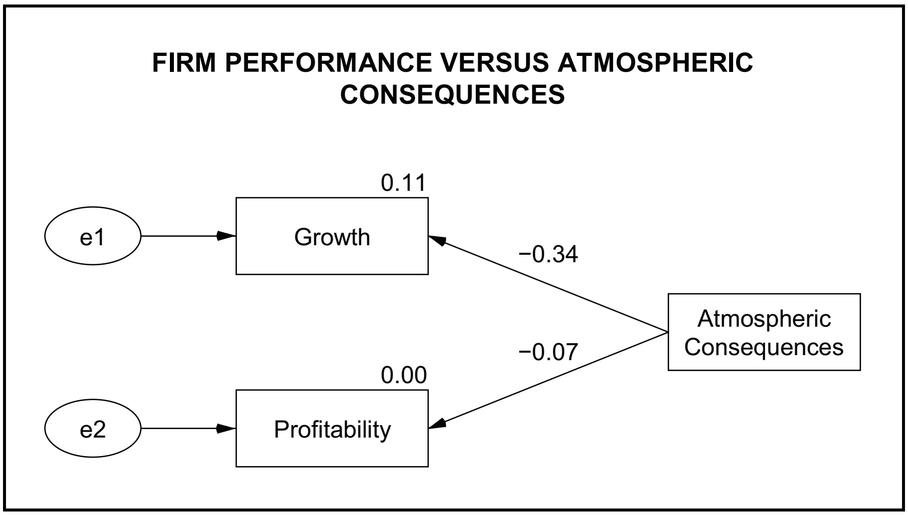


Table 28 shows that the regression coefficient for **Atmospheric Consequences → Growth** is significant beyond the 0.1% level. The results were similar for two sub-samples; the largest 392 firms and the smallest 392 firms (the critical ratio for the differences were 0.129 for **Atmospheric**

Consequences → Growth and −0.570 for **Atmospheric Consequences → Profitability**).

Table 28. Regression Weights for Firm Performance versus Atmospheric Consequences

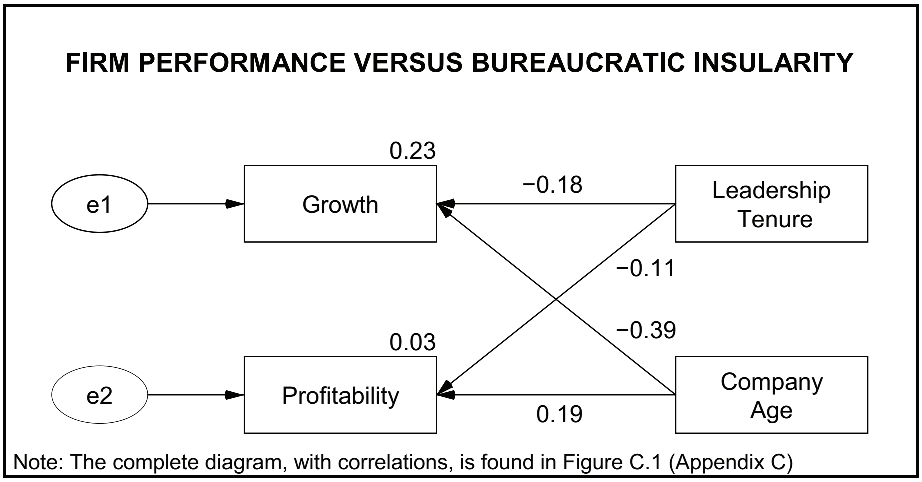
REGRESSION WEIGHTS FOR FIRM PERFORMANCE VERSUS ATMOSPHERIC CONSEQUENCES				
	Std. Coeff.	**Unstd. Coeff.**	**SE**	**CR**
Atmospheric Consequences → Growth	−0.337	−0.139	0.030	−4.691***
Atmospheric Consequences → Profitability	−0.069	−0.040	0.040	−1.010
*** p<0.1% (two-tailed)				

The practical implication is that atmospheric consequences influence growth negatively and may have the same influence on profitability.

6.2.1.2 Bureaucratic Insularity

The discussion in Section 6.1.1.2 showed that bureaucratic insularity can be indicated by leadership tenure and firm age. The path diagram in Figure 20 shows that both these indicators exhibit strong negative influences on growth and that tenure also influences profitability negatively. However, firm age has a positive influence on profitability. It can be hypothesised that this is because of survivor bias, as discussed earlier (see pp. 65–66, above). That is, the firms in the sample are by definition survivors and thus can be expected to show higher profitability than non-surviving firms. This implies that firms that have survived over a long time period should be more profitable than young firms because younger firms (usually in younger industries) include a more heterogeneous mix of performers. This hypothesis is tested in Section 6.2.1.5, where the larger, integrated model is analysed using latent variables.

Figure 20. Firm Performance versus Bureaucratic Insularity



At this point, the analysis suggests support for Penrose's ([1959] 1995, 261–263) assertion that diseconomies of scale are mainly related to difficulties of growth. **Bureaucratic Insularity** (indicated by **Leadership Tenure** and **Company Age**) explains 23% of the variance in **Growth**, but only 3% of the variance in **Profitability**. For **Growth**, the regression weights are significant at better than the 5% level (Table 29).

Table 29. Regression Weights for Firm Performance versus Bureaucratic Insularity

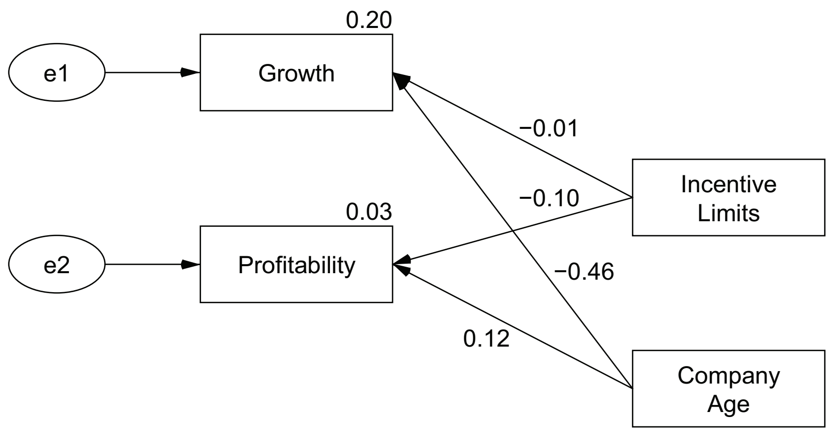
REGRESSION WEIGHTS FOR FIRM PERFORMANCE VERSUS BUREAUCRATIC INSULARITY				
	Std. Coeff.	**Unstd. Coeff.**	**SE**	**CR**
Leadership Tenure → Growth	−0.177	−0.070	0.029	−2.431*
Leadership Tenure → Profitability	−0.114	−0.063	0.044	−1.445
Company Age → Growth	−0.386	−0.056	0.007	−8.498***
Company Age → Profitability	0.190	0.039	0.010	3.832***
* p<5%, *** p<0.1% (two-tailed)				

6.2.1.3 Incentive Limits

Do incentive limits have an impact on a firm's performance (indicated as before through **Growth** and **Profitability**)? In this analysis, **Company Age** was introduced as a control variable because older firms tend to be active in mature industries. Figure 21 indicates a modest impact.

Figure 21. Firm Performance versus Incentive Limits

FIRM PERFORMANCE VERSUS INCENTIVE LIMITS



Note: The complete diagram, with correlations, is found in Figure C.2 (Appendix C)

The regression shows a negative impact of incentive limits on profitability (at better than the 5% significance level). The impact on growth is negligible (Table 30).

Table 30. Regression Weights for Firm Performance versus Incentive Limits

REGRESSION WEIGHTS FOR FIRM PERFORMANCE VERSUS INCENTIVE LIMITS				
	Std. Coeff.	**Unstd. Coeff.**	**SE**	**CR**
Incentive Limits → Growth	−0.010	−0.003	0.014	−0.235
Incentive Limits → Profitability	−0.102	−0.047	0.021	−2.193*
Company Age → Growth	−0.455	−0.066	0.005	−12.195***
Company Age → Profitability	0.121	0.025	0.008	2.962**
* p<5%, ** p<1%, *** p<0.1% (two-tailed)				

There should be a difference between the high R&D-intensity and the low-R&D% intensity sub-samples. The **R&D% → Profitability** standardised coefficient is −0.134 for the high R&D-intensity sub-sample and 0.130 for the low R&D-intensity sub-sample, in support of the theory. The critical ratio for this difference is 2.853 and the significance is better than the 1% level. There is considerable support for the hypothesis (**H_{3c}**), that incentive limits affect performance by having a negative impact on profitability.

6.2.1.4 Communication Distortion

In isolation, communication distortion does not have a significant impact on firm performance as is evidenced by the regression in Figure 22. Less than 2% of the variance in growth and profitability are accounted for.

Figure 22. Firm Performance versus Communication Distortion

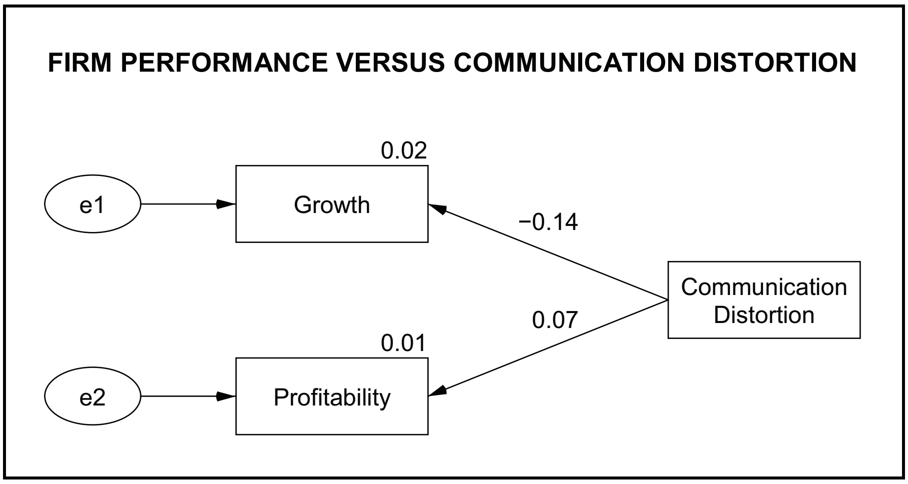


Table 31 shows that only the negative impact on growth is statistically significant (at better than the 1% level), but it is hard to draw any practical conclusions at this stage.

Table 31. Regression Weights for Firm Performance versus Communication Distortion

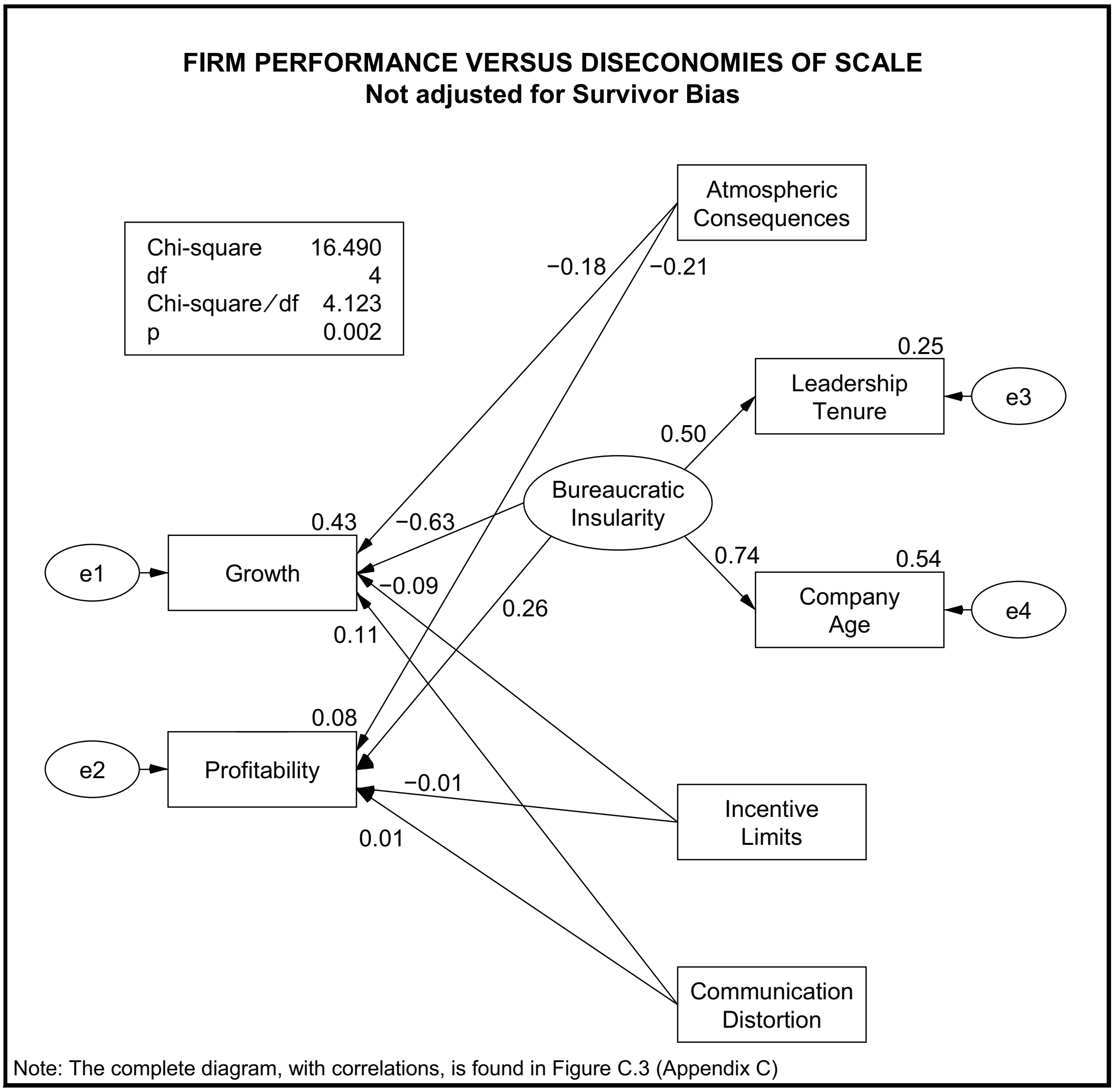
REGRESSION WEIGHTS FOR FIRM PERFORMANCE VERSUS COMMUNICATION DISTORTION				
	Std. Coeff.	**Unstd. Coeff.**	**SE**	**CR**
Communication Distortion → Growth	−0.136	−0.484	0.180	−2.688**
Communication Distortion → Profitability	0.075	0.372	0.251	1.481
** p<1% (two-tailed)				

The next section (6.2.1.5) combines the variables into an integrated model for understanding the relationship between firm performance and diseconomies of scale.

6.2.1.5 Integrated Model for the Relationship between Firm Performance and Diseconomies of Scale

It is now time to put together an integrated diseconomies-of-scale model, bearing in mind economies of scale and the moderating factors (M-form organisation and asset specificity) have not yet been introduced, nor has survivor bias. The path diagram in Figure 23 shows the design which tests the third hypothesis and its four sub-hypotheses. The latent variable **Bureaucratic Insularity** is again used and is indicated by **Leadership Tenure** and **Company Age**.

Figure 23. Firm Performance versus Diseconomies of Scale: Not Adjusted for Survivor Bias



The model has a chi-square of 16.490 and 4 degrees of freedom, leading to a normed chi-square of 4.123 (a good fit). The normed fit index (NFI) is 0.997, well beyond any reasonable requirement, and the parsimonious fit index (PFI) is 0.143.

Table 32 shows the regression weights with standard errors and critical ratios.

Table 32. Regression Weights for Firm Performance versus Diseconomies of Scale: Not Adjusted for Survivor Bias

REGRESSION WEIGHTS FOR FIRM PERFORMANCE VERSUS DISECONOMIES OF SCALE Not Adjusted for Survivor Bias				
	Std. Coeff.	**Unstd. Coeff.**	**SE**	**CR**
Atmospheric Consequences → Growth	−0.179	−0.071	0.044	−1.644†
Atmospheric Consequences → Profitability	−0.210	−0.118	0.056	−2.117*
Bureaucratic Insularity → Growth	−0.626	−0.123	0.042	−2.947**
Bureaucratic Insularity → Profitability	0.261	0.072	0.035	2.072*
Bureaucratic Insularity → Leadership Tenure	0.502	0.249	0.049	5.037***
Bureaucratic Insularity → Company Age	0.737	1.000		
Incentive Limits → Growth	−0.087	−0.028	0.034	−0.824
Incentive Limits → Profitability	−0.009	−0.004	0.035	−0.114
Communication Distortion → Growth	0.113	0.399	0.317	1.259
Communication Distortion → Profitability	0.008	0.042	0.344	0.121
† p<10%, * p<5%, ** p<1%, *** p<0.1% (two-tailed)				

Bureaucratic insularity has a strong negative impact on growth (**Bureaucratic Insularity → Growth** = −0.63) and is significant at better than the 1% level (critical ratio = −2.947), while it has a significant positive impact on profitability (**Bureaucratic Insularity → Profitability** = 0.26) before the adjustment for survivor bias. Communication distortion has a non-significant (less than 10% level) positive impact on both growth and profitability (critical ratio = 1.259 and 0.121, respectively). Atmospheric consequences have a negative impact on both growth (**Atmospheric Consequences → Growth** = −0.18) and profitability (**Atmospheric Consequences → Profitability** = −0.21) with significance better than the

10% level (critical ratios −1.650 and −2.117 respectively). It should be remembered that **Atmospheric Consequences** has few (146) observations. Finally, incentive limits have a negative impact on profitability with a low significance (critical ratio = −0.824) and there is a negative, non-significant, impact on growth (critical ratio = −0.114). The regression coefficients thus are either directionally in line with the hypothesis for each factor, or they are insignificant (except for **Bureaucratic Insularity → Profitability**).[35] In no case was there a statistically significant contradiction of the hypothesis. Finally, the squared multiple correlation is a high 0.425 for **Growth** and a low 0.077 for **Profitability**.

A second path diagram was constructed to take survivor bias into account. This was done by introducing a link between **Company Age** and **Profitability,** as was explained in Section 6.2.1.2. This model is less parsimonious (PFI = 0.107) and has a slightly higher normed chi-square (4.670) than the non-adjusted model. Yet it is probably a more realistic representation of the underlying theory and hypotheses and it will be used in the later analyses.

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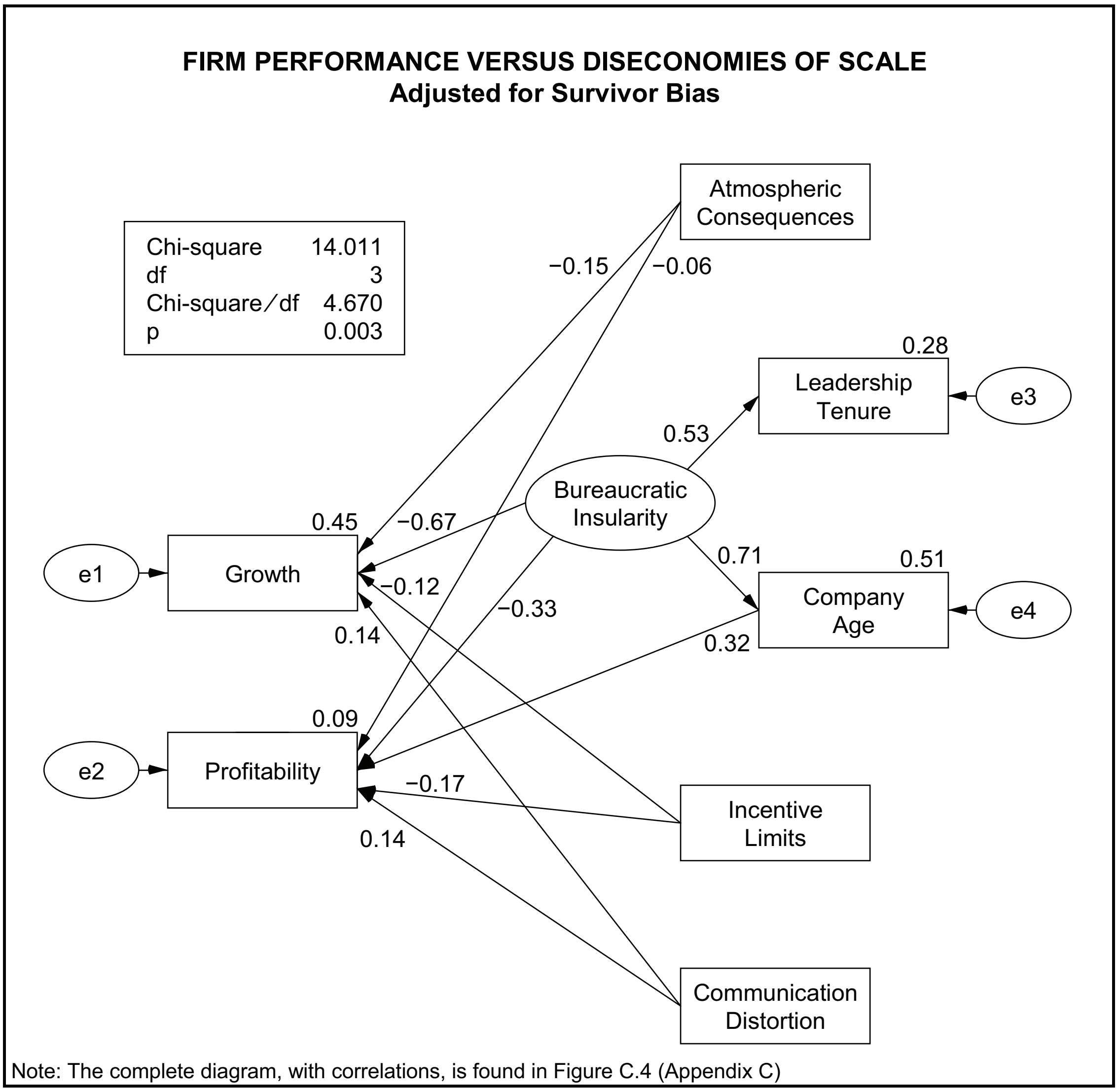
[35] The correlations between the diseconomies of scale factors also have the expected signs (see Appendix C).

Figure 24. Firm Performance versus Diseconomies of Scale: Adjusted for Survivor Bias



The regression coefficients, standard errors and critical ratios are reported in Table 33. Without repeating the discussion from the previous path diagram, it should be noted that bureaucratic insularity now has the hypothesised (but non-significant) negative impact on profitability. The survivor bias (**Company Age → Profitability** = 0.32) has a positive coefficient and is close to significant at the 10% level, in line with expectations.

Table 33. Regression Weights for Firm Performance versus Diseconomies of Scale: Adjusted for Survivor Bias

REGRESSION WEIGHTS FOR FIRM PERFORMANCE VERSUS DISECONOMIES OF SCALE Adjusted for Survivor Bias				
	Std. Coeff.	**Unstd. Coeff.**	**SE**	**CR**
Atmospheric Consequences → Growth	−0.150	−0.060	0.049	−1.227
Atmospheric Consequences → Profitability	−0.061	−0.034	0.075	−0.455
Bureaucratic Insularity → Growth	−0.671	−0.137	0.048	−2.883**
Bureaucratic Insularity → Profitability	−0.329	−0.094	0.110	−0.855
Bureaucratic Insularity → Leadership Tenure	0.532	0.274	0.051	5.391***
Bureaucratic Insularity → Company Age	0.713	1.000		
Company Age → Profitability	0.320	0.065	0.041	1.599
Incentive Limits → Growth	−0.116	−0.038	0.038	−0.995
Incentive Limits → Profitability	−0.166	−0.076	0.058	−1.304
Communication Distortion → Growth	0.140	0.493	0.350	1.410
Communication Distortion → Profitability	0.138	0.685	0.531	1.290
** p<1%, *** p<0.1% (two-tailed)				

Thus, a test of the third hypothesis

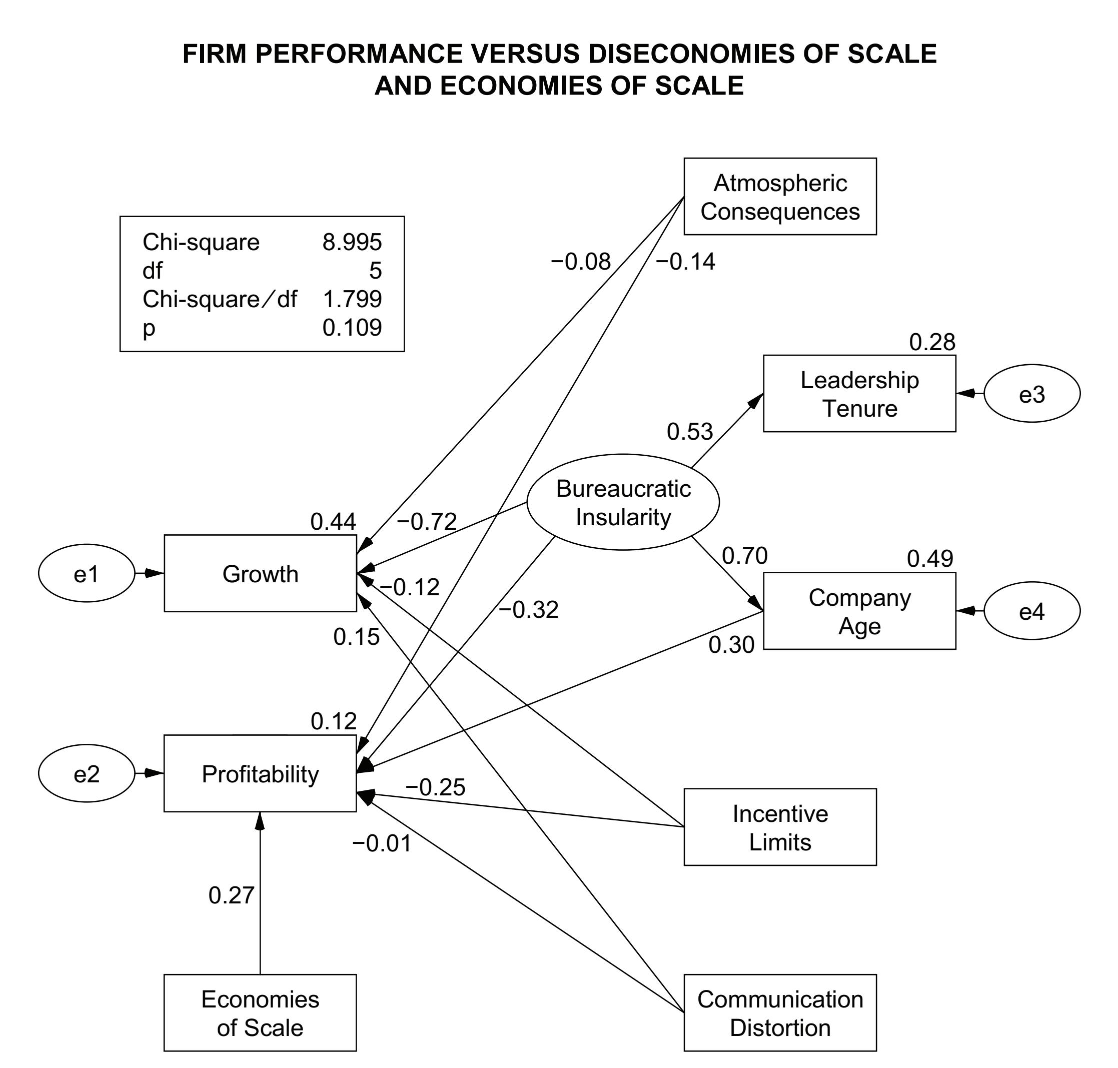
H_3: Diseconomies of scale from bureaucratic failure have a negative impact on firm performance

shows that it can not be refuted (the sub-hypotheses are discussed in Section 6.2.4). The practical interpretation is that it is impossible to confirm the hypothesis at this point, but nothing contradicts it either.

6.2.2 Economies of Scale

The next step is to study the impact of economies of scale on profitability (there is no hypothesised impact on the other indicator of firm performance: growth). This was done by adding diseconomies of scale to the path diagram containing diseconomies of scale. The path diagram in Figure 25 shows the results. Chi-square is 8.995 and with 5 degrees of freedom the normed chi-square ratio is 1.799, indicating an excellent fit ($p = 0.109$). The normed fit index (NFI) is an excellent 0.999 and the parsimonious fit index (PFI) is 0.139, which is slightly better than for the previous model (Figure 24) which only incorporated diseconomies of scale. The squared multiple correlation is 0.44 for **Growth** and 0.12 for **Profitability**.

Figure 25. Firm Performance versus Diseconomies of Scale and Economies of Scale



Note: The complete diagram, with correlations, is found in Figure C.5 (Appendix C)

Table 34 reports the regression coefficients. All coefficients have the hypothesised sign except for **Communication Distortion → Growth**. This aberration could be because the theory does not specify any relationship between economies of scale and growth—only between economies of scale and profitability. If such an atheoretical relationship exists, then communication distortion's positive impact on growth could be due to the unobserved positive relationship between economies of scale and growth. This was tested separately. The standardised regression coefficient was 0.00 for **Economies of Scale → Growth** and it remained at 0.15 for **Communication Distortion → Growth** with this respecification of the model. Fit measures deteriorated slightly. Thus, the structural equation model in Figure 25 appears to be correctly specified because economies of scale do not influence growth, as hypothesised.

The regression coefficients mostly do not have high significance. The exceptions are **Bureaucratic Insularity → Growth** and **Bureaucratic Insularity → Leadership Tenure** which are significant at better than the 0.1% level, **Economies of Scale → Profitability** at better than 1% and **Incentive Limits → Profitability** and **Company Age → Profitability** at better than 10%. All other coefficients have the predicted sign except for **Communication Distortion → Growth**.

Table 34. Regression Weights for Firm Performance versus Diseconomies of Scale and Economies of Scale

REGRESSION WEIGHTS FOR FIRM PERFORMANCE VERSUS DISECONOMIES OF SCALE AND ECONOMIES OF SCALE				
	Std. Coeff.	**Unstd. Coeff.**	**SE**	**CR**
Atmospheric Consequences → Growth	−0.079	−0.031	0.051	−0.621
Atmospheric Consequences → Profitability	−0.142	−0.079	0.073	−1.085
Bureaucratic Insularity → Growth	−0.715	−0.150	0.045	−3.364***
Bureaucratic Insularity → Profitability	−0.318	−0.093	0.110	−0.850
Bureaucratic Insularity → Leadership Tenure	0.530	0.279	0.049	5.650***
Bureaucratic Insularity → Company Age	0.698	1.000		
Company Age → Profitability	0.301	0.062	0.038	1.658†
Incentive Limits → Growth	−0.117	−0.038	0.034	−1.110
Incentive Limits → Profitability	−0.247	−0.112	0.064	−1.749†
Communication Distortion → Growth	0.150	0.538	0.364	1.478
Communication Distortion → Profitability	−0.009	−0.047	0.511	−0.092
Economies of Scale → Profitability	0.267	0.094	0.030	3.188**
† p<10%, ** p<1%, *** p<0.1% (two-tailed)				

The introduction of economies of scale into the model leads to the following preliminary findings. Hypothesis four

H_4: Economies of scale increase the relative profitability of large firms over smaller firms

is supported. At a practical level, the analysis above indicates that diseconomies of scale and economies of scale play an important role in explaining firm performance. Individual relationships in the model are sometimes weak, but the overall assessment is nevertheless that the significance is high.

An interpretation of the statistical results is that firms are able to maintain specific knowledge internally and that the flow of ideas and methods in external markets is not efficient enough to make economies of scale available to all industry participants. A further test of this was made by splitting the sample by the age of firms. The assumption was that older firms, active in older, well-structured industries where information presumably flows efficiently, would not benefit from economies of scale. Younger firms, active in less mature industries, would, if they are larger than their competitors, reap the benefits because knowledge should be easier to keep proprietary to the firm. If this was true, then Riordan and Williamson's theoretical prediction (1985) that economies of scale affect firm performance could be questioned. A comparison of the sub-samples indicates that this is not the case. The two sub-samples have almost identical regression coefficients for **Economies of Scale → Profitability** (0.291 for the old sub-sample, 0.292 for the young sub-sample) and the critical ratio for the difference is a negligible −0.115.

The next step is to incorporate the potential effects of moderating factors into the model. While additional insights are gained from this, it should also be noted that the model becomes less statistically robust as variables are added—especially because some of the variables are non-normal—and the model fit will deteriorate. At the same time though, the practical significance increases.

6.2.3 Moderating Factors

At this stage the final two variables are introduced into the model: the moderating factors organisational form and asset specificity.

6.2.3.1 M-Form Organisation

Williamson (1970, 120–139) argued that the large multidivisional firm (M-form) on average outperforms the large unitary firm (U-form). Williamson’s definition of M-form was (pp. 120–121):

1. The responsibility for operating decisions is assigned to…operating divisions or quasifirms.
2. The elite staff attached to the general office performs both advisory and auditing functions…
3. The general office is principally concerned with strategic decisions…
4. …separation of the general office from operations…
5. The resulting structure displays both rationality and synergy…the whole is greater than the sum of the parts.

This definition can be operationalised with two indicators. The first describes the ability of a firm to effectively to divide the tasks performed by senior executives and their staffs, as well as the division of responsibility between the board of directors and executive management (pp. 138–139)—what today often is referred to as governance.[36] The second variable measures whether the organisational structure is multidivisional or functional, or somewhere in between.

The governance indicator was operationalised as **Governance**, based on CalPERS's definitions (1999).[37] CalPERS evaluates corporate governance using financial results (three-year shareholder returns and EVA) and a corporate governance screening procedure which assesses the quality of governance. For the current purposes the governance screen is of interest, so that co-linearity with the dependent variables is avoided. The screen uses 25 criteria divided into four main categories: "Board Composition/Structure", "Director Compensation/Stock Holdings", "Management" and "Anti-Takeover Devices".

The data were taken from three sources: (1) *Business Week's* annual survey of corporate governance (Byrne 2000). *Business Week* measures six attributes of governance and of these, four were used in **Governance** because they correspond reasonably well to the CalPERS criteria, while

[36] A fuller treatment of this dual relationship is found in Bolton and Scharfstein (1998).

[37] CalPERS (California Public Employees' Retirement System) is arguably the world's leading authority on governance issues.

two (relating to the quality of the board members) where excluded. (2) The compilation of governance data for 1,500 companies published by the Investor Responsibility Research Center (IRRC 1999).[38] (3) *Fortune's* annual ranking of America's most admired companies (Colvin 2000) in which three variables (of eight) relate to CalPERS's governance criteria. The three sources were merged into a single index. No attempt was made independently to validate the definitions and underlying research, except for using this researcher's general understanding of the quality of governance at those firms surveyed. This crude test corroborated the data.

The organisational structure indicator was operationalised as **Divisionalisation**. The indicator is ordinal with 2 representing a clean, multidivisional structure, 1 representing a mixture of multidivisional and unitary structures and 0 representing unitary structures. The classification was done by this researcher using annual reports, corporate web sites, company organisation charts and 10-Ks. The data collection approach was similar to Rumelt's (1974, 43), with three factors influencing the judgments made: titles of senior executives, descriptions of large operating units and the reporting or lack of reporting of operating unit financials. For example, if senior executives at headquarters have titles such as Senior Vice President of Business Development and similar staff descriptions, while

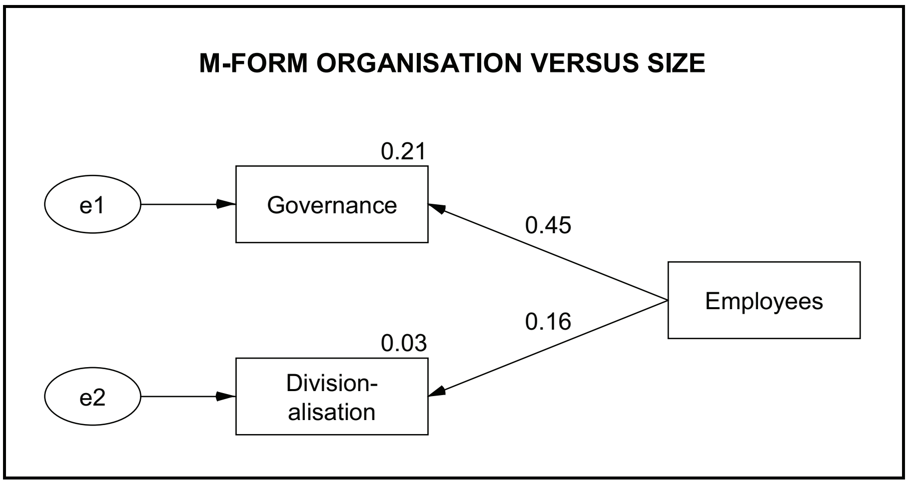
[38] CalPERS subcontracts the governance screening to IRRC.

senior executives of the operating units are called President, Operating Unit, then this would suggest a multidivisional structure. Conversely, if a firm does not discuss its operating units as autonomous businesses and there is no financial reporting for business units, then this would suggest a unitary structure.

Governance has 229 observations, mainly among the largest 400 firms in the sample and **Divisionalisation** was randomly collected for 375 firms.

Figure 26 shows that quality of governance and use of divisionalisation increase with firm size.

Figure 26. M-Form Organisation versus Size



Employees → Governance has a critical ratio of 7.701 with better than 0.1% significance and **Employees → Divisionalisation** has a critical ratio of 3.230, approaching better than 0.1% significance (Table 35). It should be remembered that **Divisionalisation** is an ordinal variable and Amos treats it as continuous. Results would perhaps be more accurate if polyserial correlations were used and the squared multiple correlation would then increase somewhat, while the significance would be better than the 0.1% level.[39]

Table 35. Regression Weights for Firm Performance versus Diseconomies of Scale, Economies of Scale and M-form Organisation

REGRESSION WEIGHTS FOR FIRM PERFORMANCE VERSUS DISECONOMIES OF SCALE, ECONOMIES OF SCALE AND M-FORM ORGANISATION				
	Std. Coeff.	**Unstd. Coeff.**	**SE**	**CR**
Employees → Governance	0.454	0.545	0.071	7.701***
Employees → Divisionalisation	0.165	0.257	0.080	3.230**
** p<1%, *** p<0.1% (two-tailed)				

Turning to the prediction that M-form organisation improves firm performance, the latent variable **M-Form** was introduced into the sub-model *b* path diagram together with the indicators **Governance** and **Divisionalisation**. The results are shown in Figure 27. M-form organisation has a significant, positive impact on both growth and profitability with most of the impact emanating from governance. This is not surprising because, as was discussed in the literature survey (p. 67,

39 This analysis was performed using LISREL which allows for polyserial correlation analysis. The regression coefficient increased to 0.20 from 0.16 and the squared multiple correlation to 0.049 from 0.025. However, the use of polyserial correlations assumes that the underlying distribution of the indicator is normal, which may not be the case here (see also discussion in Section 5.1.2.3).

above), the positive impact of divisionalisation was exploited more than 25 years ago.

Figure 27. Firm Performance versus Diseconomies of Scale, Economies of Scale and M-Form Organisation

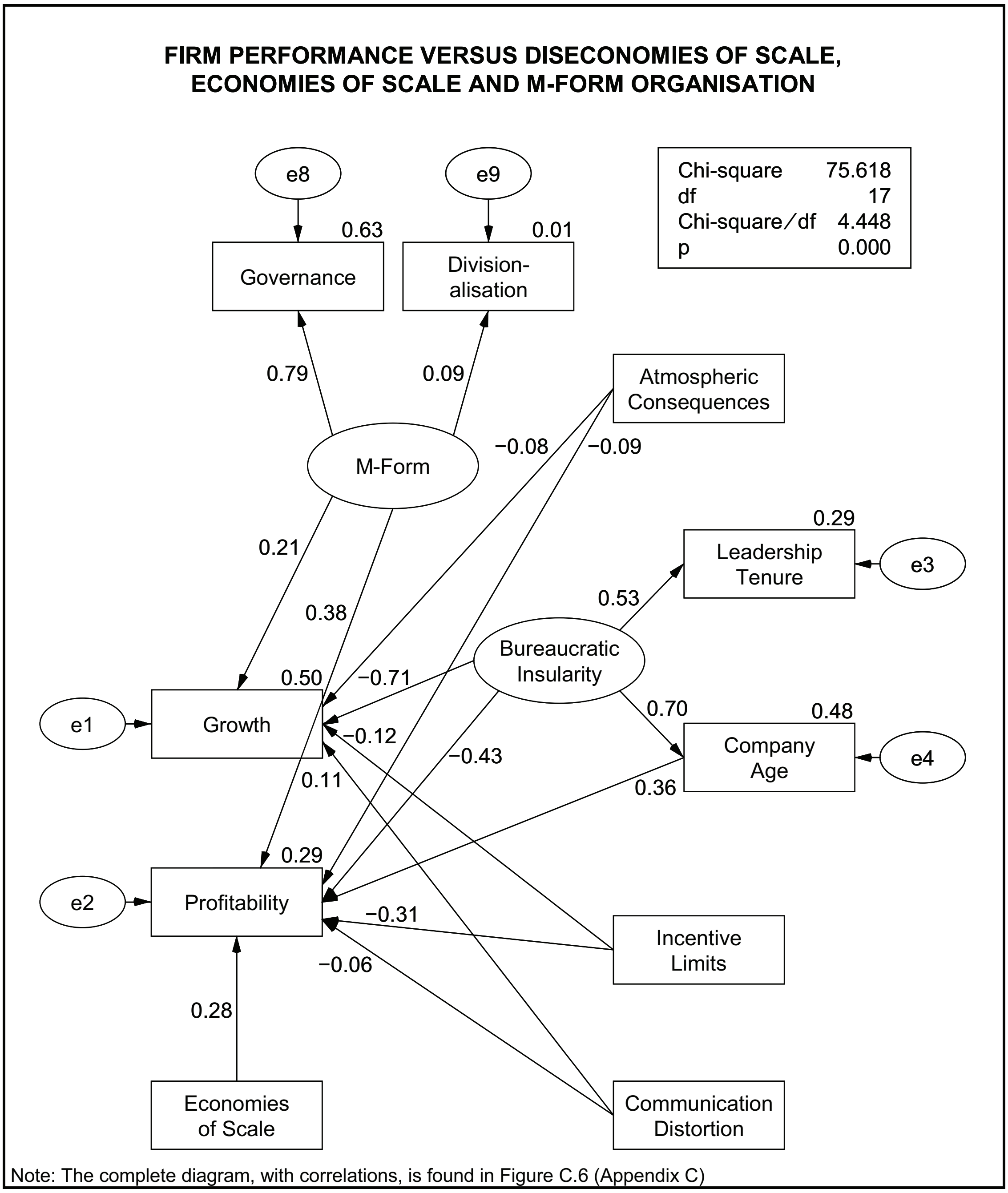


Table 36 shows similar results as in earlier analyses, with all coefficients (except for **Communication Distortion → Growth)** having the predicted sign and with critical ratios ranging from highly significant to non-significant. The standardised regression coefficients are fairly large for **M-Form → Growth** (0.21) and **M-Form → Profitability** (0.38), but the statistical significance is low. The practical significance is good though, because a good part of the variance in firm performance is explained and all relationships (with one exception) support the underlying theoretical framework.

Table 36. Regression Weights for Firm Performance versus Diseconomies of Scale, Economies of Scale and M-Form Organisation

REGRESSION WEIGHTS FOR FIRM PERFORMANCE VERSUS DISECONOMIES OF SCALE, ECONOMIES OF SCALE AND M-FORM ORGANISATION				
	Std. Coeff.	**Unstd. Coeff.**	**SE**	**CR**
Atmospheric Consequences → Growth	−0.080	−0.032	0.048	−0.669
Atmospheric Consequences → Profitability	−0.085	−0.048	0.071	−0.674
Bureaucratic Insularity → Growth	−0.706	−0.149	0.044	−3.412***
Bureaucratic Insularity → Profitability	−0.433	−0.127	0.106	−1.192
Bureaucratic Insularity → Leadership Tenure	0.534	0.282	0.049	5.709***
Bureaucratic Insularity → Company Age	0.696	1.000		
Company Age → Profitability	0.355	0.073	0.038	1.934†
Incentive Limits → Growth	−0.124	−0.040	0.032	−1.253
Incentive Limits → Profitability	−0.312	−0.142	0.062	−2.296*
Communication Distortion → Growth	0.108	0.395	0.407	0.971
Communication Distortion → Profitability	−0.062	−0.316	0.746	−0.423
Economies of Scale → Profitability	0.284	0.100	0.035	2.835**
M-Form → Growth	0.207	0.170	0.228	0.747
M-Form → Profitability	0.385	0.439	0.578	0.760
M-Form → Governance	0.792	1.000		
M-Form → Divisionalisation	0.091	0.156	0.184	0.852
† p<10%, * p<5%, ** p<1%, *** p<0.1% (two-tailed)				

6.2.3.2 High Internal Asset Specificity

The last variable to be introduced is asset specificity. As was discussed in the literature survey (Chapter 3), firms can, according to transaction cost economics, moderate diseconomies of scale by increasing their internal asset specificity. Asset specificity was measured in three ways: product breadth, geographic reach and vertical depth. Each of these was operationalised.

Product breadth was defined in several ways. In the end, Rumelt's (1974, 14–15) specialisation ratio was used because it is commonly accepted (Ramanujam and Varadarajan 1989, 539) and it minimises information loss. It also has the benefit of not being based on this researcher's judgement. To avoid confusion, product breadth was operationalised as a diversification ratio equal to 1 − specialisation ratio (so that the indicator increases when product breadth increases). The specialisation ratio is defined as SR = (sales from the largest business unit) / (total firm sales). Alternative measures (available at http://canback.com/henley.htm in the file *Asset Specificity.xls*) are (1) number of business segments the firm is active in; (2) number of SICs the firm is active in; (3) Rumelt's relatedness ratio (pp. 15–16): RR = (sales from the largest business unit plus other business units with related activities) / (total firm sales); (4) Rumelt's five category classification of firms into single, dominant-unrelated, dominant, related and unrelated businesses (p. 31); and (5) a Herfindahl index of corporate diversity. Measures 1, 2 and 4 are based on categorical data and are as such less rich on information than the other measures. Measures 3 and 5 are continuous but less accurate than the specialisation ratio for the current purpose.

Geographic reach was measured as the per cent of sales derived from foreign countries. No other measures were available from Compustat or other sources and the measure appears to be logical. Sullivan (1994), in an overview of how geographic reach is measured, showed that all 17 studies in his sample used this measure: "glaring in its consistency is the inevitable use of foreign sales as a percentage of total sales (FSTS) as the sole estimator" (pp. 327, 330).

Vertical depth was more problematic to define, however. Vertical integration has been studied empirically many times (Shelanski and Klein 1995). The best measure (described by D'Aveni and Ravenscraft (1994)) is arguably to quantify the amount of internal forward or backward transfers by line of business. Unfortunately such data were not available for individual firms. Another measure often used is value added (factor costs other than purchased goods) divided by sales. This measure has been criticised because it is sensitive to current year profitability; spuriously high or low profitability increases or decreases vertical integration (Levy

1981, 86). A modification to this ratio is to adjust the nominator by using cost of equity rather than net income and the denominator by using factor costs, as defined earlier (i.e., **VI% = Value Added / Factor Costs**). Even with this adjustment the definition is open to criticism.[40] For example, large US petrochemical companies are among the most vertically integrated firms in the world, ranging in activities from exploration, to production, to refining, to retailing. Their vertical integration ratios, with this definition, are among the lowest, however (e.g., ExxonMobil has a vertical integration of 19.1%, against 41.3% for the total sample).

Instead, the vertical integration variable was based on a qualitative assessment by the researcher, similar to Armour and Teece's (1980, 472) and Harrigan's (1986, 538–540) methodologies. The 784 firms were classified based on their degree of vertical integration with **Vertical Depth** equal to 2 for firms with very high vertical integration (13 firms), 1 for highly integrated firms (145 firms) and 0 for firms with normal or low integration (512 firms).[41] No judgement was passed on 114 firms. Vertically integrated firms were mainly found among resource-based companies and among aerospace contractors. The data are available in the file *Asset Specificity.xls* at http://canback.com/henley.htm. The polyserial

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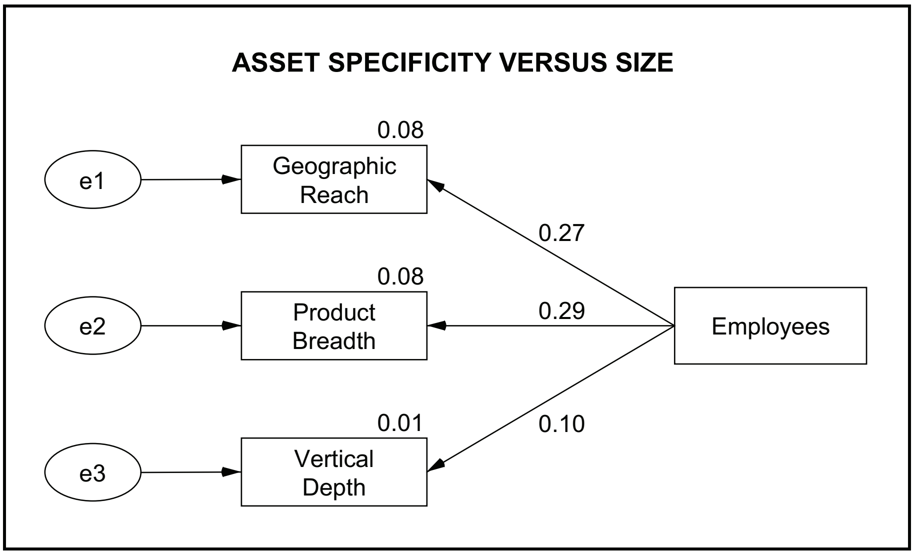
[40] Furthermore, there were only 146 observations of the vertical integration ratio in the sample.

[41] The underlying actual distribution of **Vertical Depth** is most likely normal, because **VI%** is normally distributed, and **Vertical Depth** should have the same distributional characteristics (see discussion in Section 5.1.2.3).

correlation between **Vertical Depth** and **VI%** was −0.418, which seems to confirm the criticism of the use of the value added-to-factor costs ratio.

Figure 28 shows the relationship between product breadth, geographic reach, vertical depth and firm size.

Figure 28. Asset Specificity versus Size



Large size on average leads to less asset specificity along all three dimensions even though only a small part of the variance is explained. The critical ratios in Table 37 show significance better than 5% for **Vertical Depth**[42] and better than 0.1% for **Product Breadth** and **Geographic Reach**.

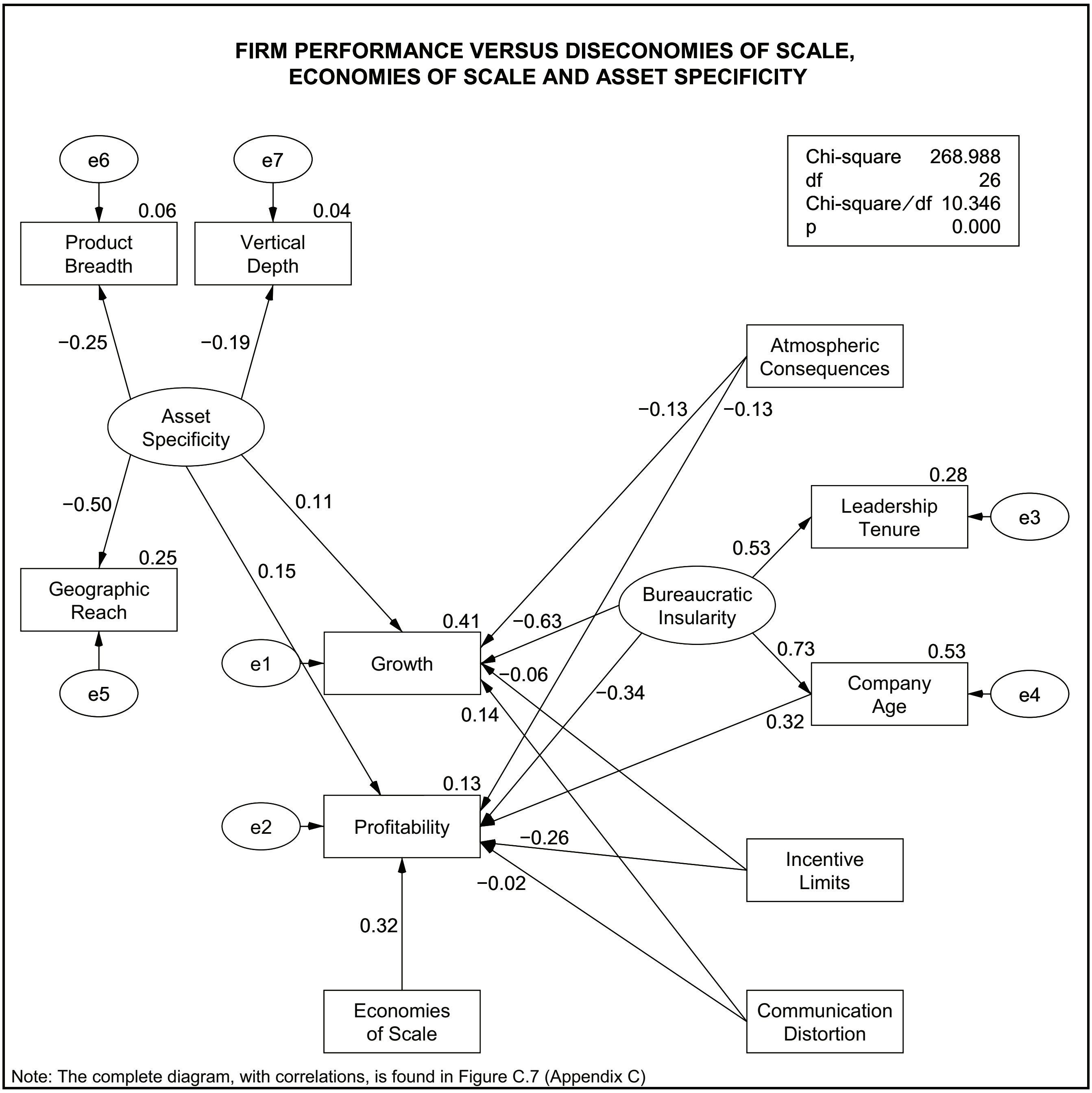
42 A perhaps more appropriate polyserial correlation between **Vertical Depth** and **Employees** calculated with LISREL (Amos does not calculate polyserial correlations) increases the significance of **Vertical Depth → Employees** beyond the 0.1% level (critical ratio 3.406).

Table 37. Regression Weights for Asset Specificity versus Size

REGRESSION WEIGHTS FOR ASSET SPECIFICITY VERSUS SIZE				
	Std. Coeff.	**Unstd. Coeff.**	**SE**	**CR**
Employees → Geographic Reach	0.274	0.104	0.014	7.706***
Employees → Product Breadth	0.285	0.090	0.012	7.342***
Employees → Vertical Depth	0.096	0.090	0.036	2.498*
* p<5%, *** p<0.1% (two-tailed)				

It is now possible to complete the model and do the final test of whether degree of asset specificity affects profitability and growth. Again, a latent variable, **Asset Specificity**, is introduced to capture the total impact of asset specificity. Figure 29 shows the path diagram.

Figure 29. Firm Performance versus Diseconomies of Scale, Economies of Scale and Asset Specificity



High asset specificity appears to have a positive impact on profitability and growth and the three indicators for asset specificity have the hypothesised signs, but the significance is relatively low and at best approaching the 5% level (Table 38).

Table 38. Regression Weights for Firm Performance versus Diseconomies, Economies of Scale and Asset Specificity

REGRESSION WEIGHTS FOR FIRM PERFORMANCE VERSUS DISECONOMIES, ECONOMIES OF SCALE AND ASSET SPECIFICITY				
	Std. Coeff.	**Unstd. Coeff.**	**SE**	**CR**
Atmospheric Consequences → Growth	−0.134	−0.053	0.043	−1.236*
Atmospheric Consequences → Profitability	−0.132	−0.074	0.067	−1.103
Bureaucratic Insularity → Growth	−0.633	−0.126	0.038	−3.315***
Bureaucratic Insularity → Profitability	−0.336	−0.094	0.106	−0.885
Bureaucratic Insularity → Leadership Tenure	0.529	0.266	0.050	5.308***
Bureaucratic Insularity → Company Age	0.731	1.000		
Company Age → Profitability	0.318	0.065	0.044	1.478
Incentive Limits → Growth	−0.061	−0.020	0.029	−0.673
Incentive Limits → Profitability	−0.262	−0.119	0.060	−1.984*
Communication Distortion → Growth	0.136	0.483	0.310	1.558
Communication Distortion → Profitability	−0.020	−0.100	0.517	−0.194
Economies of Scale → Profitability	0.319	0.117	0.048	2.445*
Asset Specificity → Growth	0.113	1		
Asset Specificity → Profitability	0.150	1.864	1.677	1.112
Asset Specificity → Geographic Reach	−0.499	−1.937	0.998	−1.942†
Asset Specificity → Product Breadth	−0.253	−1.097	0.587	−1.868†
Asset Specificity → Vertical Depth	−0.188	−2.084	1.193	−1.747†
† p<10%, * p<5%, *** p<0.1% (two-tailed)				

While the hypothesis regarding asset specificity is supported, the strong non-normal distribution of the three indicators (**Vertical Depth** is an ordinal, **Geographic Reach** and **Product Breadth** are highly skewed (see pp. 110–111, above)) reduces the statistical accuracy of the analysis. Another way to test the impact of asset specificity may be the following: Instead of using the latent variable **Asset Specificity**, the single indicator **AS** is introduced. **AS** is defined as the normalised product of the three dimensions of asset specificity (**AS** = ln((1 + **Product Depth**)(1 + **Geographic Reach**)(3 + **Vertical Depth**))). This indicator has 594 observations and is much closer to normally distributed (Kolmogorov-Smirnov z = 1.477). **AS → Growth** = 0.15 (standardised) with a significance better than 0.1% and **AS → Profitability** = 0.089 (standardised) with a significance better than 5%. The squared multiple correlations remain almost the same. It is therefore fair to conclude that high asset specificity does indeed lead to better firm performance. The practical interpretation is the same as for M-form organisation in the previous section.

6.2.4 Complete Sub-Model *b*

At this point it is possible to analyse the complete sub-model *b*. One additional variable, industry, could have been included, but was left out for two reasons. First, Section 3.2.4 showed that a firm's industry does not influence results significantly, at least not in the manufacturing sector. Second, it proved impossible to collect relevant variables to test this proposition and thus industry has been left as an exogenous factor, included in the error terms. Attempts were made to relate each firm to its industry's averages, but this proved impossible to do because most firms are active in several industries. In the end, the industry-adjusted constructs did not improve the statistical analysis. This is in line with

Rumelt's finding (1974, 98) that "industry corrected results were not only elusive, but essentially unattainable and possibly meaningless".

6.2.4.1 Basic Model

The complete sub-model *b* is shown in Figure 30. The structural equation model explains 44% of the variance in growth and 34% of the variance in profitability. This has, however, been achieved by adding variables. Even though the complete model reflects the underlying theory and the hypotheses and can be viewed as a confirmatory model, it is equally true that it is unwieldy. The normed chi-square ratio is a reasonable 9.252 (397.823/43) and the normed fit index is 0.966 (above the 0.900 often recommended). Figure 31 shows a matrix representation of the path diagram in Figure 30.

Figure 30. Complete Sub-Model b: *Includes Diseconomies of Scale, Economies of Scale and Moderating Factors*

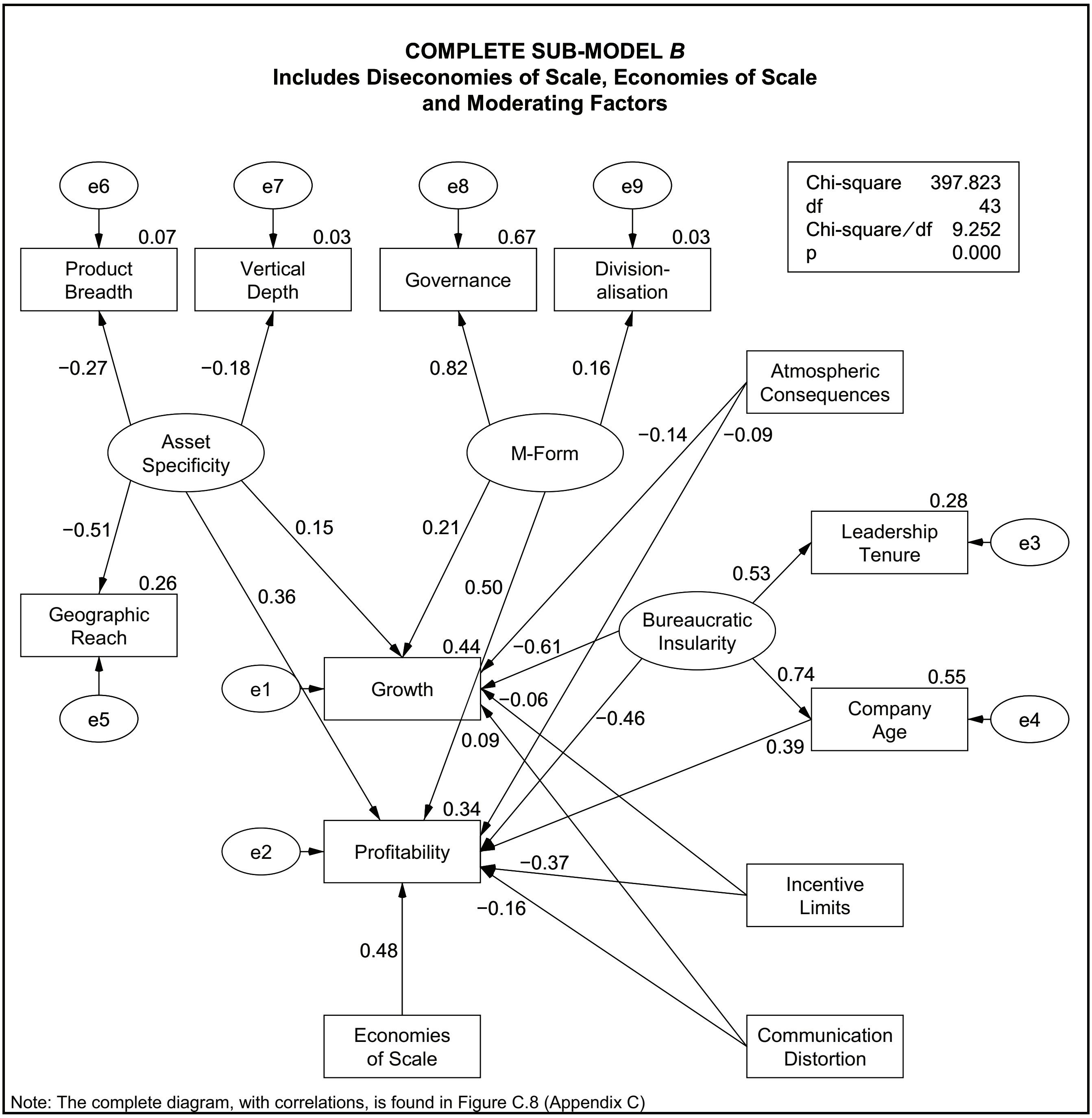


Figure 31. Matrix Representation of Complete Sub-Model b

MATRIX REPRESENTATION OF COMPLETE SUB-MODEL *B*

ξ_1 = Atmospheric Consequences
ξ_2 = Bureaucratic Insularity
ξ_3 = Incentive Limits
ξ_4 = Communication Distortion
ξ_5 = Economies of Scale
ξ_6 = Asset Specificity
ξ_7 = M – Form

X_1 = ulabour
X_2 = tenure
X_3 = age
X_4 = rd
X_5 = levels
X_6 = fixhigh
X_7 = foreign
X_8 = dr
X_9 = vert
X_A = govern
X_B = div

η_1 = Growth
η_2 = Profitability

Y_1 = growth
Y_2 = eva

$$\begin{bmatrix}\eta_1\\ \eta_2\end{bmatrix} = \begin{bmatrix}\gamma_{11} & \gamma_{12} & \gamma_{13} & \gamma_{14} & & \gamma_{16} & \gamma_{17}\\ \gamma_{21} & \gamma_{22} & \gamma_{23} & \gamma_{24} & \gamma_{25} & \gamma_{26} & \gamma_{27}\end{bmatrix}\begin{bmatrix}\xi_1\\ \xi_2\\ \xi_3\\ \xi_4\\ \xi_5\\ \xi_6\\ \xi_7\end{bmatrix} + \mathbf{0}\cdot\begin{bmatrix}\eta_1\\ \eta_2\end{bmatrix} + \begin{bmatrix}\zeta_1\\ \zeta_2\end{bmatrix}$$

$$\begin{bmatrix}X_1\\ X_2\\ X_3\\ X_4\\ X_5\\ X_6\\ X_7\\ X_8\\ X_9\\ X_A\\ X_B\end{bmatrix} = \begin{bmatrix}1 & & & & & & \\ & \lambda^X_{22} & & & & & \\ & \lambda^X_{32} & & & & & \\ & & 1 & & & & \\ & & & 1 & & & \\ & & & & 1 & & \\ & & & & & \lambda^X_{76} & \\ & & & & & \lambda^X_{86} & \\ & & & & & \lambda^X_{96} & \lambda^X_{97}\\ & & & & & & \lambda^X_{A7}\\ & & & & & & \lambda^X_{B7}\end{bmatrix}\begin{bmatrix}\xi_1\\ \xi_2\\ \xi_3\\ \xi_4\\ \xi_5\\ \xi_6\\ \xi_7\end{bmatrix} + \begin{bmatrix} \\ \delta_2\\ \delta_3\\ \\ \\ \\ \delta_7\\ \delta_8\\ \delta_9\\ \delta_A\\ \delta_B\end{bmatrix}$$

$$\begin{bmatrix}Y_1\\ Y_2\end{bmatrix} = \begin{bmatrix}1 & \\ & 1\end{bmatrix}\begin{bmatrix}\eta_1\\ \eta_2\end{bmatrix} + \begin{bmatrix}\varepsilon_1\\ \varepsilon_2\end{bmatrix}$$

$$\mathbf{\Phi} = \begin{bmatrix} - & & & & & & \\ \Phi_{21} & - & & & & & \\ \Phi_{31} & \Phi_{32} & - & & & & \\ \Phi_{41} & \Phi_{42} & \Phi_{43} & - & & & \\ \Phi_{51} & \Phi_{52} & \Phi_{53} & \Phi_{54} & - & & \\ & & & & \Phi_{65} & - & \\ & & & \Phi_{74} & & \Phi_{76} & - \end{bmatrix}$$

$$\mathbf{\Psi} = \begin{bmatrix} - & \\ \Psi_{21} & - \end{bmatrix} \qquad \mathbf{\Theta}^{\delta} = \mathbf{0}$$

The regression coefficients (Table 39) are still of the hypothesised sign (except for the non-significant **Communication Distortion → Growth**) and many coefficients are significant at the 5% or better level (compared to earlier, the significance has dropped because so many variables are included that each individual coefficient cannot have a high significance).

Table 39. Regression Weights for Complete Sub-Model b: *Includes Diseconomies of Scale, Economies of Scale and Moderating Factors*

REGRESSION WEIGHTS FOR COMPLETE SUB-MODEL *B* Includes Diseconomies of Scale, Economies of Scale and Moderating Factors				
	Std. Coeff.	**Unstd. Coeff.**	**SE**	**CR**
Atmospheric Consequences → Growth	−0.142	−0.057	0.041	−1.417
Atmospheric Consequences → Profitability	−0.087	−0.049	0.066	−0.746
Bureaucratic Insularity → Growth	−0.609	−0.120	0.036	−3.348***
Bureaucratic Insularity → Profitability	−0.465	−0.128	0.103	−1.244
Bureaucratic Insularity → Leadership Tenure	0.531	0.263	0.050	5.244***
Bureaucratic Insularity → Company Age	0.740	1.000		
Company Age → Profitability	0.386	0.079	0.047	1.689†
Incentive Limits → Growth	−0.059	−0.019	0.027	−0.706
Incentive Limits → Profitability	−0.375	−0.170	0.063	−2.688**
Communication Distortion → Growth	0.092	0.333	0.312	1.067
Communication Distortion → Profitability	−0.157	−0.793	0.833	−0.952
Economies of Scale → Profitability	0.483	0.176	0.079	2.232*
Asset Specificity → Growth	0.149	1.000		
Asset Specificity → Profitability	0.365	3.431	2.213	1.550
Asset Specificity → Geographic Reach	−0.507	−1.487	0.675	−2.201*
Asset Specificity → Product Breadth	−0.268	−0.880	0.421	−2.091*
Asset Specificity → Vertical Depth	−0.179	−1.510	0.806	−1.872†
M-Form → Growth	0.213	0.168	0.117	1.427
M-Form → Profitability	0.498	0.548	0.409	1.339
M-Form → Governance	0.819	1.000		
M-Form → Divisionalisation	0.163	0.270	0.169	1.596
† p<10%, * p<5%, ** p<1%, *** p<0.1% (two-tailed)				

The hypotheses relating to sub-model *b* have now been tested:

H_{3a}: Atmospheric consequences have a negative impact on the performance of large firms.

Neither confirmed nor rejected. The regression coefficients have the hypothesised sign ($\gamma_{11} = -0.14$ and $\gamma_{21} = -0.09$), but are not significant.

H_{3b}: Bureaucratic insularity has a negative impact on the performance of large firms

Confirmed. Bureaucratic insularity has a strong negative impact on growth ($\gamma_{12} = -0.61$) with a significance better than 0.1%. It also has a strong negative impact on profitability ($\gamma_{22} = -0.46$), but without meeting threshold levels of significance.

H_{3c}: Incentive limits have a negative impact on the performance of large firms

Confirmed. Incentive limits have a strong negative impact on profitability ($\gamma_{23} = -0.37$) with better than 1% significance. The impact on growth is also negative ($\gamma_{13} = -0.06$), but the significance is low.

H_{3d}: Communication distortion has a negative impact on the performance of large firms

Neither confirmed nor rejected. Communication distortion has a non-significant positive impact on growth ($\gamma_{14} = 0.09$), contrary to the hypothesis, and a non-significant negative impact on profitability ($\gamma_{24} = -0.16$), in line with the hypothesis. The inconclusive nature of the finding may, however, agree with Mookherjee and Reichelstein (2001).

H_4: Economies of scale increase the relative profitability of large firms over smaller firms

Confirmed. The presence of economies of scale have a strong positive influence on firm profitability ($\gamma_{25} = 0.48$) at a significance better than the 5% level.

H_{5a}: Large M-form firms perform better than large U-form firms

Possibly confirmed. M-form appears to lead to both higher growth ($\gamma_{17} = 0.21$) and higher profitability ($\gamma_{27} = 0.50$). The significance is low in both cases though, mainly because **Divisionalisation** reduces the significance.

H_{5b}: High internal asset specificity affects a firm's performance positively

Confirmed. Asset specificity has the predicted positive impact on both growth (γ_{16} = 0.15) and profitability (γ_{26} = 0.36), but the significance is low. The non-normal nature of the indicators probably leads to a large underestimate of significance. Using the **AS** indicator, the significance is better than the 1% level for growth and 10% level for profitability.

The practical significance is quite high at this point. The fit between the theoretical framework and the statistical analysis for sub-model *b* is in some ways surprisingly good, even though the test statistics vary in strength.

6.2.4.2 Competing and Parsimonious Models

First, alternative models were tested to see if a competing model with better fit could be constructed. Second, the chosen model was pruned for parsimony so that only the important variables and relationships were maintained. Hair et al. (1998, 614–616) and Bollen (1989, 289–305) underpin the respecification approach used in the current research.

As the matrix representation in Figure 31 shows, the complete sub-model *b* includes almost all possible causal relationships and correlations for diseconomies of scale and economies of scale. The search for parsimony therefore focused on testing changes in the relationships between the moderating factors and diseconomies of scale by changing the last two rows in the **Φ** matrix. In words, this means that correlations were added or deleted to the model in Figure 31: Alternative 1: a correlation was added between **M-form** and **Atmospheric Consequences**. The logic behind this is that employees in M-form firms presumably are more motivated than employees in U-form firms because they work in smaller organisational units and with better governance. Alternative 2: a correlation was added between **M-form** and **Bureaucratic Insularity** because individual units in an M-form firm should be more exposed to the surrounding market and less isolated from external pressures. Alternative 3: both the above correlations were added. Alternative 4: the correlation between **M-form** and **Communication Distortion** was deleted. The logic for this is that the adoption of M-form organisation may not be driven by communication distortion, but rather by other, exogenous factors such as established practices in a given industry. These added or deleted correlations are theoretically plausible, but not theoretically prescribed.

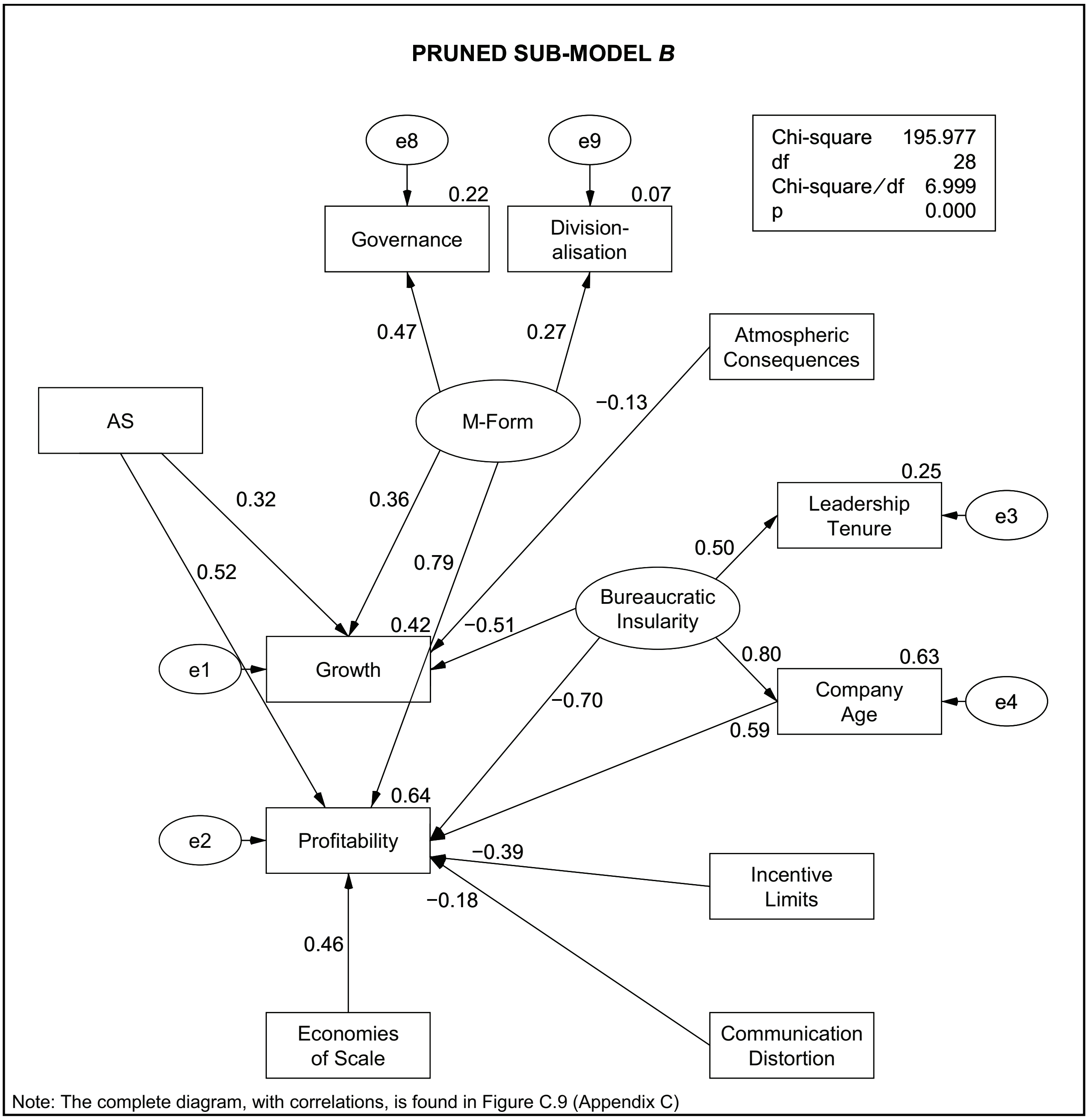
Table 40. Comparison of Parsimony for Competing Models

COMPARISON OF PARSIMONY FOR COMPETING MODELS			
Alt.	**Description**	**Normed Chi-Square**	**Parsimonious Fit Index (PFI)**
	(chosen model)	9.252	0.473
1	Φ_{71} added	9.465	0.462
2	Φ_{72} added	9.414	0.462
3	Φ_{71} and Φ_{72} added	9.642	0.451
4	Φ_{74} deleted	8.799	0.484

Table 40 demonstrates that the alternative models are similar to the chosen model. Alternative 4 is the only model with a better fit and parsimony, but only marginally so. It was nevertheless rejected because the exclusion of the correlation between **M-Form** and **Communication Distortion** does not agree well with the theory.

The second step was to reduce the number of relationships in the model. This builds on the assumption that while the theoretical predictions captured in the hypotheses may be correct, they are not significant for certain relationships and thus the theory should be modified. The pruned model in Figure 32 uses the **AS** indicator defined in Section 6.2.3.2. The pruned model also eliminates the non-significant regression coefficients and correlations for the four diseconomies of scale factors. The squared multiple correlation for **Profitability** improves dramatically from 0.34 to 0.64 (again because **AS** is more well-behaved than the three individual measures (**Product Depth**, **Geographic Reach** and **Vertical Depth**) of asset specificity), while it remains the same for **Growth** (0.44 versus 0.42).

Figure 32. Pruned Sub-Model b



The normed chi-square improves from 9.252 to 6.999 and the normed fit index is slightly higher at 0.980 versus 0.966. The parsimonious fit ratio is 0.424 compared to 0.473. The regression coefficients in Table 41 show that all coefficients have the hypothesised sign and all, except one, are significant at better than the 10% level.

Table 41. Regression Weights for Pruned Sub-Model b

REGRESSION WEIGHTS FOR PRUNED SUB-MODEL *B*				
	Std. Coeff.	**Unstd. Coeff.**	**SE**	**CR**
Atmospheric Consequences → Growth	−0.131	−0.053	0.028	−1.926†
Bureaucratic Insularity → Growth	−0.508	−0.092	0.013	−6.961***
Bureaucratic Insularity → Profitability	−0.695	−0.179	0.102	−1.754†
Bureaucratic Insularity → Leadership Tenure	0.500	0.231	0.045	5.107***
Bureaucratic Insularity → Company Age	0.797	1.000		
Company Age → Profitability	0.588	0.120	0.064	1.870†
Incentive Limits → Profitability	−0.391	−0.178	0.047	−3.806***
Communication Distortion → Profitability	−0.182	−0.921	0.739	−1.247
Economies of Scale → Profitability	0.459	0.166	0.053	3.111**
AS → Growth	0.318	0.386	0.120	3.231**
AS → Profitability	0.525	0.902	0.433	2.081*
M-Form → Growth	0.355	0.479	0.247	1.940†
M-Form → Profitability	0.786	1.499	0.859	1.746†
M-Form → Governance	0.474	1.000		
M-Form → Divisionalisation	0.270	0.769	0.222	3.468***
† p<10%, * p<5%, ** p<1%, *** p<0.1% (two-tailed)				

The validity of the hypotheses has been strengthened. $\mathbf{H_{3a}}$ is now confirmed at the 10% level, $\mathbf{H_{3b}}$ is (even more) strongly supported, $\mathbf{H_{3c}}$ is (more) strongly confirmed, $\mathbf{H_{3d}}$ has increased its significance, but is still not at the 10% level, $\mathbf{H_{4}}$ is strongly supported, $\mathbf{H_{5a}}$ is supported at the 10% level, while $\mathbf{H_{5b}}$ is strongly supported.[43]

Finally, the 784 observations were randomly divided in two groups to test whether similar results are achieved for different samples. The procedure

[43] Full descriptions of the hypotheses are found on pages 119–120.

was repeated eight times and the critical ratios of the differences were compiled for the main-effects model. Out of 104 possible differences, the analysis indicated sixteen instances of differences significant at better than the 10% level, of which ten where significant at better than the 5% level, of which two were significant at better than the 1% level. This leads to the conclusion that the results are homogenous across samples. Table 42 shows the results by regression coefficient for the main-effects model. No single relationship appears to differ systematically between samples.

Table 42. Occurrence of Significant Critical Ratios of Differences during Random Sample Test

OCCURRENCE OF SIGNIFICANT CRITICAL RATIOS OF DIFFERENCES DURING RANDOM SAMPLE TEST					
	Number of Observations				
Regression Coefficient	No Significant Difference	Better than 10% Sign.	Of Which Better than 5% Sign.	Of Which Better than 1% Sign.	Total
Atmospheric Consequences → Growth	5	3	1	1	8
Bureaucratic Insularity → Growth	7	1	1	0	8
Bureaucratic Insularity → Profitability	8	0	0	0	8
Bureaucratic Insularity → Tenure	5	3	3	0	8
Company Age → Profitability	8	0	0	0	8
Incentive Limits → Profitability	7	1	0	0	8
Communication Distortion → Profitability	5	3	1	0	8
Economies of Scale → Profitability	8	0	0	0	8
AS → Growth	7	1	0	0	8
AS → Profitability	7	1	1	0	8
M-Form → Growth	6	2	2	1	8
M-Form → Profitability	7	1	1	0	8
M-Form → Divisionalisation	8	0	0	0	8
Total	*88*	*16*	*10*	*2*	*104*

The next section summarises the findings from the statistical analyses of the two sub-models and evaluates the five hypotheses.

6.3 SUMMARY OF FINDINGS FROM STRUCTURAL EQUATION MODELS

Table 43 shows the hypotheses and their associated findings. As was seen throughout this chapter, most of the hypotheses were confirmed. The findings seem to be robust for a number of reasons. The data were screened and tested extensively (Chapter 5). They were found to be well-behaved in most respects. The path diagrams confirm well with the underlying theory. The indicators appear to reflect the unobserved phenomena fairly well. Finally, the results were similar when random sub-samples were used. It should be remembered though that the findings apply only to one economic sector (manufacturing), in one country (the United States), in one year (1998).

Table 43. Summary of Statistical Findings

SUMMARY OF STATISTICAL FINDINGS[a]				
Hypothesis	**Test**	**Result**	**CR and Sign.**	**Interpretation**
H_1: Bureaucratic failure, in the form of atmospheric consequences, bureaucratic insularity, incentive limits and communication distortion, increases with firm size	$\gamma_{11}(a) > 0$	$\gamma_{11}(a) = +0.92$	+2.424 (p<1%)	Confirmed
H_2: Large firms exhibit economies of scale	$\gamma_{61}(a) > 0$	$\gamma_{61}(a) = +0.60$	+20.800 (p<0.1%)	Confirmed
H_{3a}: Atmospheric consequences have a negative impact on the performance of large firms	$\gamma_{11}(b) < 0$ $\gamma_{21}(b) < 0$	$\gamma_{11}(b) = -0.13$ –	−1.926 (p<10%) –	Confirmed
H_{3b}: Bureaucratic insularity has a negative impact on the performance of large firms	$\gamma_{12}(b) < 0$ $\gamma_{22}(b) < 0$	$\gamma_{12}(b) = -0.51$ $\gamma_{22}(b) = -0.70$	−6.961 (p<0.1%) −1.754 (p<10%)	Confirmed
H_{3c}: Incentive limits have a negative impact on the performance of large firms	$\gamma_{13}(b) < 0$ $\gamma_{23}(b) < 0$	– $\gamma_{23}(b) = -0.39$	– −3.806 (p<0.1%)	Confirmed
H_{3d}: Communication distortion has a negative impact on the performance of large firms	$\gamma_{14}(b) < 0$ $\gamma_{24}(b) < 0$	– $\gamma_{24}(b) = -0.18$	– −1.247 (p=21.2%)	Inconclusive
H_4: Economies of scale increase the relative profitability of large firms over smaller firms	$\gamma_{25}(b) < 0$	$\gamma_{25}(b) = +0.46$	+3.111 (p<1%)	Confirmed
H_{5a}: Large M-form firms perform better than large U-form firms	$\gamma_{17}(b) > 0$ $\gamma_{27}(b) > 0$	$\gamma_{17}(b) = +0.36$ $\gamma_{27}(b) = +0.79$	+1.940 (p<10%) +1.746 (p<10%)	Confirmed
H_{5b}: High internal asset specificity affects a firm's performance positively	$\gamma_{16}(b) > 0$ $\gamma_{26}(b) > 0$	$\gamma_{16}(b) = +0.32$ $\gamma_{26}(b) = +0.52$	+3.231 (p<1%) +2.081 (p<5%)	Confirmed
[a] For simplicity, the word ”confirmed” is used, although ”not rejected” is more accurate.				

The practical significance of the statistical analyses is that both sub-model *a* and sub-model *b* validate the theoretical framework. Both the main analyses and the supporting analyses that tested particular aspects of the theory (e.g., the separate analysis of the relationship between economies of scale and growth in Section 6.2.2) are in line with the theoretical predictions. It is not surprising that some of the relationships are weak because executives have a tendency to exploit obvious opportunities for improvement. Yet, most of the posited relationships in the theoretical framework are non-trivial. Thus, the statistical analyses have delivered practical insights.

Next, Chapter 7 explores the practical implications of the literature review and the statistical analyses and ties the findings to the cost curves discussed in Chapter 2. It also discusses the limitations of the research and suggests avenues for further research.

7. INTERPRETATION AND DISCUSSION

Diseconomies of scale appear to be real. The literature overview discussed the theoretical underpinnings of this thesis, indicating that a wide range of theoretical development and empirical research, quantitative and qualitative, supports pieces of the current theoretical predictions. The statistical analysis section took a broader and more general approach to testing the hypotheses, and nothing uncovered there disproved them. The analyses also showed that diseconomies of scale vary in magnitude and impact, and economies of scale and the moderating factors are important when we try to understand the limits of the firm.

In the first section, the findings are summarised and interpreted by linking them back to the cost curves discussed in Chapter 2 (pp. 14–17, above). By doing this, the results from the somewhat unwieldy statistical analysis can be presented in an effective shorthand. It is shown that the findings are consistent with neoclassical theory and with transaction cost economics. Building on this set of modified cost curves, further implications are discussed, including the relative importance of the various factors that affect a firm's limits. The second section discusses the limitations of the research, while the final section suggests paths for further research.

7.1 SUMMARY OF FINDINGS

The findings regarding the hypotheses are summarised in Table 44:

Table 44. Summary of Findings

SUMMARY OF FINDINGS[a]		
Hypothesis	**Literature Finding**	**Statistical Finding**
H_1: Bureaucratic failure, in the form of atmospheric consequences, bureaucratic insularity, incentive limits and communication distortion, increases with firm size	Confirmed	Confirmed
H_2: Large firms exhibit economies of scale	Confirmed	Confirmed
H_3: Diseconomies of scale from bureaucratic failure have a negative impact on firm performance	Confirmed	Confirmed
H_{3a}: Atmospheric consequences have a negative impact on the performance of large firms	Confirmed	Confirmed
H_{3b}: Bureaucratic insularity has a negative impact on the performance of large firms	Confirmed	Confirmed
H_{3c}: Incentive limits have a negative impact on the performance of large firms	Confirmed	Confirmed
H_{3d}: Communication distortion has a negative impact on the performance of large firms	Confirmed	Inconclusive
H_4: Economies of scale increase the relative profitability of large firms over smaller firms	Inconclusive	Confirmed
H_5: Diseconomies of scale are moderated by two transaction cost-related factors: organisation form and asset specificity	Confirmed	Confirmed
H_{5a}: Large M-form firms perform better than large U-form firms	Confirmed	Confirmed
H_{5b}: High internal asset specificity affects a firm's performance positively	Confirmed	Confirmed
[a] For simplicity, the word ”confirmed” is used, although ”not rejected” is more accurate.		

As is shown, the theoretical framework is supported by both the literature and the statistical findings. It is now possible to interpret the findings by returning to the neoclassical cost curves. First, the cost curve shown in Figure 3 is modified to reflect the characteristics of diseconomies of scale, economies of scale and the moderating factors. Second, a similar curve is constructed for firm growth. Third, these two curves are combined to show the overall impact of these two factors on firm performance.

Average cost. To begin with, the elongated U-shaped average total cost curve[44] used in neoclassical theory can be split into two parts: the average production cost curve and the average transaction cost curve. Not much evidence exists for what the relative magnitude of production and transaction costs is. However, Wallis and North (1986) attempted to quantify the relative contribution each type of cost makes to the overall economy. They found that the transaction-cost part of the economy grew from 25 per cent to 50 per cent of gross national product between 1890 and 1970 (p. 121). This suggests that an even split is a reasonable assumption.

The modified cost curves are depicted in a stylised fashion in Figure 33. The top graph shows a curve for average production cost (AC_P) consistent with the findings in the current research. One characteristic of the curve is important: the curve has a negative slope for all levels of firm output (Q). This agrees with the view that economies of scale can be kept proprietary to the firms that reap them. It also agrees with the statistical finding that economies of scale are not exhausted at small firm sizes.

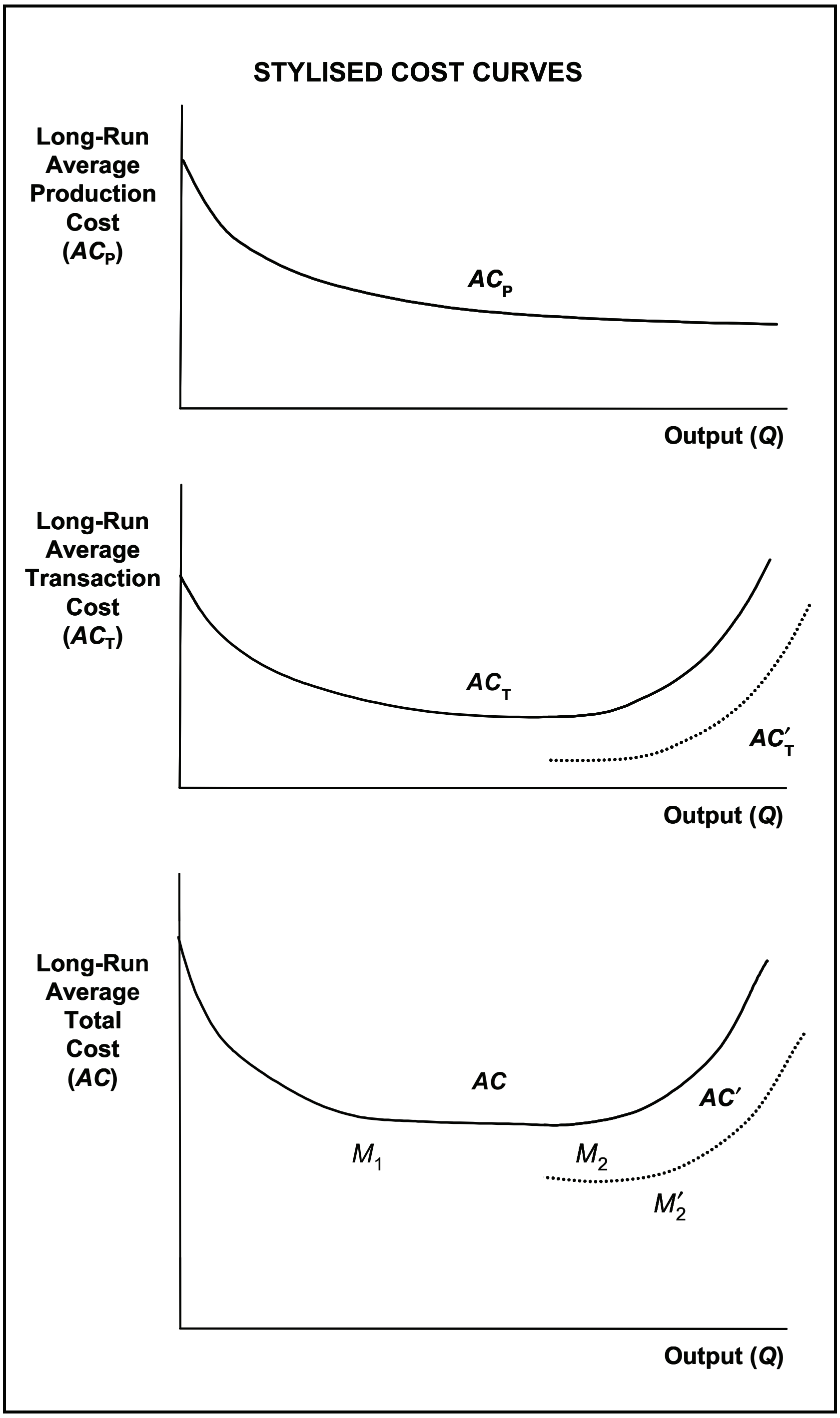
[44] It would be more stringent to talk about ray average total costs because the firms analysed are usually multi-product firms, but simplicity wins.

The middle graph in Figure 33 shows the average transaction cost curve (AC_{T}). The negative slope for smaller firms, indicating bureaucratic economies of scale, is supported in the literature review (but was not tested in the statistical analysis). The positive slope for larger firms, indicating diseconomies of scale and bureaucratic failure, is supported by both the literature and by the statistical analysis.

The middle graph also shows a shifted and slightly tilted average transaction cost curve (AC'_{T}). The curve reflects the positive contribution from the moderating factors. AC'_{T} is supported by the literature and by the statistical analysis. This analysis indicates that the shift can be quite large.

Finally, the bottom graph in Figure 33 shows the average total cost curve (AC), with a shifted curve AC' for the moderators ($AC = AC_{\mathrm{P}} + AC_{\mathrm{T}}$; $AC' = AC_{\mathrm{P}} + AC'_{\mathrm{T}}$). The curve resembles the neoclassical curve in Figure 3. The question now is: where along this curve do firms operate? The statistical analyses suggest that, on average, the largest firms in the sample operate at outputs somewhere close to M'_2 in the upward-sloping region of AC'. That is, they show some diseconomies of scale, but they also benefit from economies of scale and they manage to take advantage of the moderating factors.

Figure 33. Stylised Cost Curves

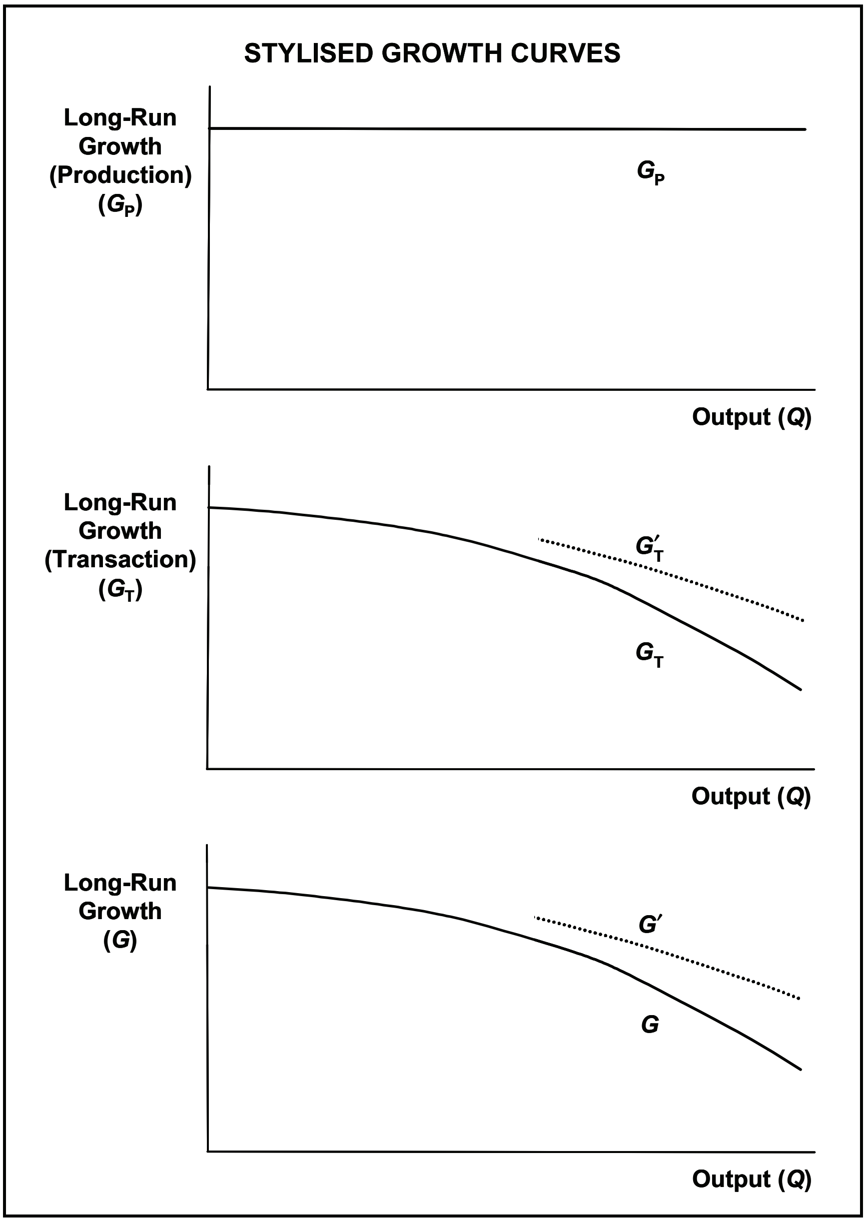


Growth. The underlying logic of the cost curves can also be applied to firm growth. Figure 34 shows the same set of graphs as above for the relationship between firm growth and output. The top graph illustrates the relationship between growth and output, under the hypothetical assumption that firms only have neoclassical production costs (G_{P}). Neither the literature nor the statistical analysis indicated an influence (see pp. 158–159, above) and thus the graph shows a constant relationship.

The middle graph in Figure 34 portrays the growth curve resulting from bureaucratic, transaction cost-based, failure (G_{T}). The literature and the statistical analysis make it fair to assume that G_{T} should be monotonously declining for increasing outputs. Again, the moderating influences can shift the curve, which is illustrated by G'_{T} in the graph. The statistical analysis indicates that the shift is smaller than in the case of average costs (AC').

The bottom graph in Figure 34 convolutes the production- and transaction-cost contributions to growth into overall growth (G). The graph shows that the growth capacity of firms is steadily declining as a function of output, but it can be moderated (G'). Interestingly, this interpretation of the research contradicts Gibrat's law of proportional effects (1931, 74–81), which will be discussed later in this section.

Figure 34. Stylised Growth Curves



Performance. Finally, it is instructive to combine the cost and growth curves to see how they jointly contribute to a firm's performance (Figure 35). Other factors also contribute to firm performance and the graph shows the partial contribution to performance.[45] By convoluting the average total cost (*AC*) and growth (*G*) curves, the partial performance curve Ψ results.[46] Several, perhaps speculative, interpretations can be derived from the graph: (1) Firms operating at small outputs suffer from a lack of economies of scale and this is most likely not compensated for by the higher relative growth achievable by smaller firms. Thus, the slope $k_1 > 0$. (2) There is an area where performance is fairly independent of firm size. On the one hand, economies of scale should lead to steadily lower costs. On the other hand, diminishing growth prospects reduce performance. On balance, the analyses show that $k_2 < 0$, but only slightly so. (3) As diseconomies of scale due to bureaucratic failure set in, the combined negative contribution of increasing transaction costs and lower growth far outweigh economies of scale. Thus, $k_3 < 0$. (4) The moderating factors shift the performance curve outwards from Ψ to Ψ' and $k_3 < k_3' < 0$, while $M_2' > M_2$. That is, if firms judiciously apply the moderating factors, then bureaucratic failure will set in at a larger level of output and the impact from the failure will be less severe.

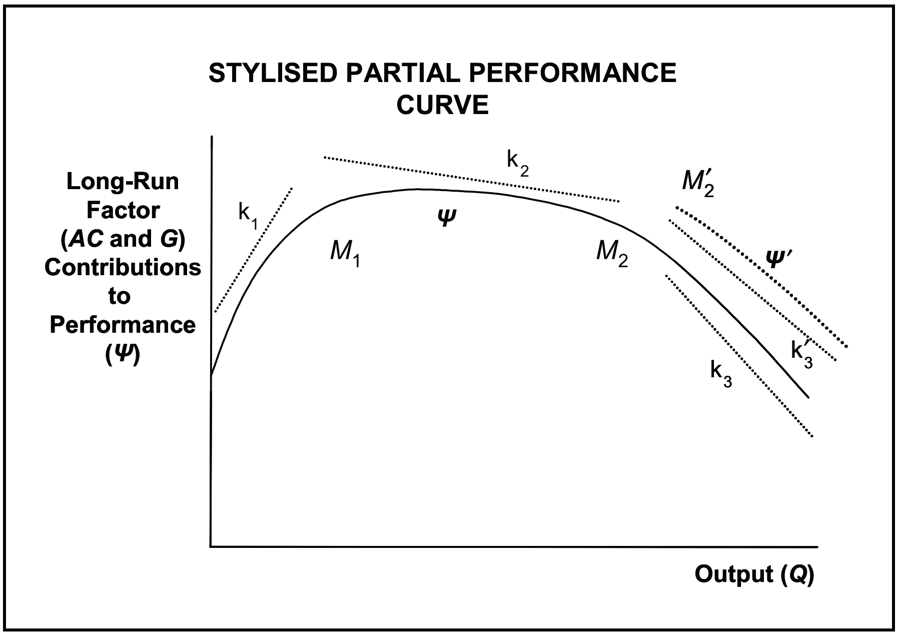
---

[45] Total performance (Ψ_{TOT}) is a function of, profitability(π), growth(G), risk(β) and other factors (ε): $\Psi_{TOT} = f(\pi, G, \beta, \varepsilon) = f(TR - TC, G, \beta, \varepsilon) = f(TR - AC \cdot Q, G, \beta, \varepsilon)$.

[46] The result from this convolution should not be taken for granted, but the statistical analysis showed that *AC* and *G* are reasonably independent and that they should have similar weights.

The four interpretations above are supported by the literature review; while the last three are supported by the statistical analysis (the statistical analysis did not explore what happens at small firm sizes).

Figure 35. Stylised Partial Performance Curve

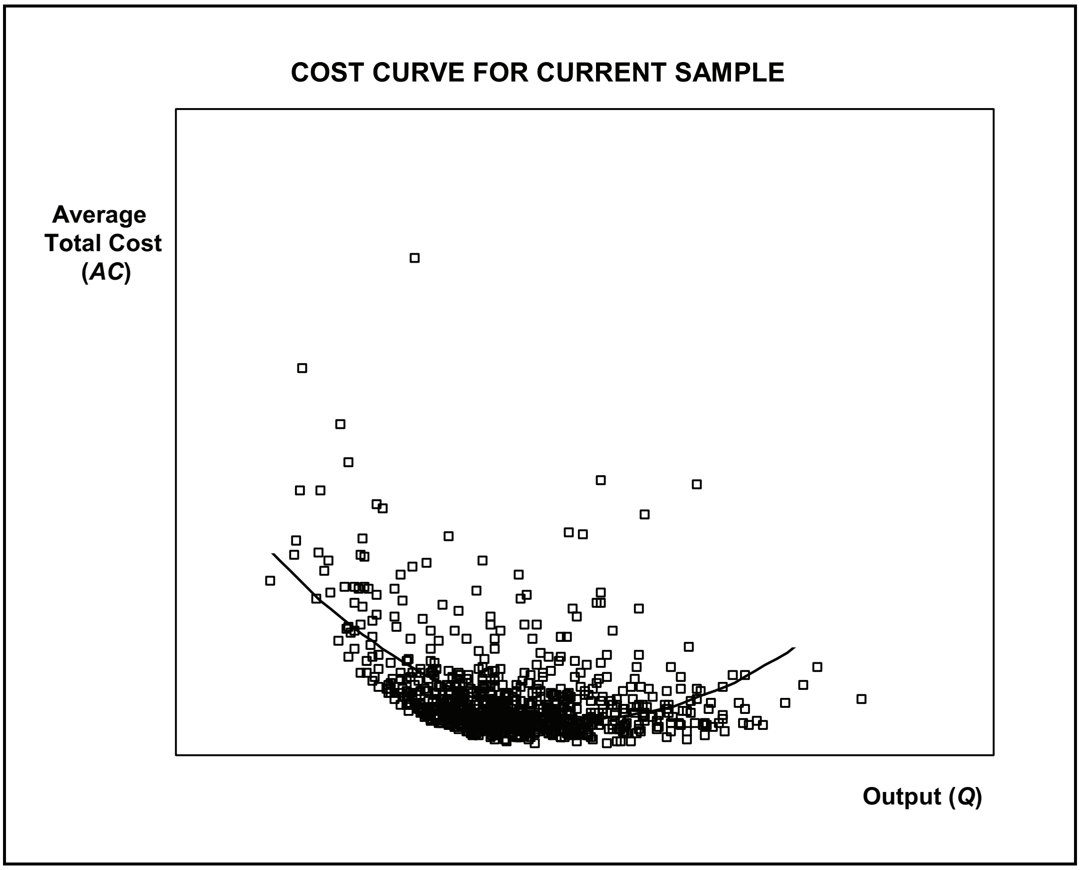


The set of curves discussed above agree well with neoclassical theory (e.g., Panzar 1989) and transaction cost economics (e.g., Williamson 1975), individually. The curves also agree with the joined perspectives on production and transaction costs expressed by, for example, Riordan and Williamson (1985) and Wallis and North (1986). What may make them interesting is the unbundling of the production cost and transaction cost contributions to firm performance, and the attempt to transform the research findings into rough estimates of the shapes of the curves.

The conceptual curves depicted in Figures 33 to 35 can also be used to show the shape of the data in the sample of 784 firms. This was done with three analyses which replicated the cost (*AC*), growth (*G*) and partial performance (Ψ) curves. Figures 36 to 38 show the resulting graphs, which are surprisingly similar to the conceptual curves. It should be remembered though, that the scatterplots presented are somewhat simplistic. They use the sample data as is and no attempt was made to include control variables or to make other corrections. The underlying assumptions and SPSS scatterplots are found at http://canback.com/henley.htm in the file *Curves.spo*.

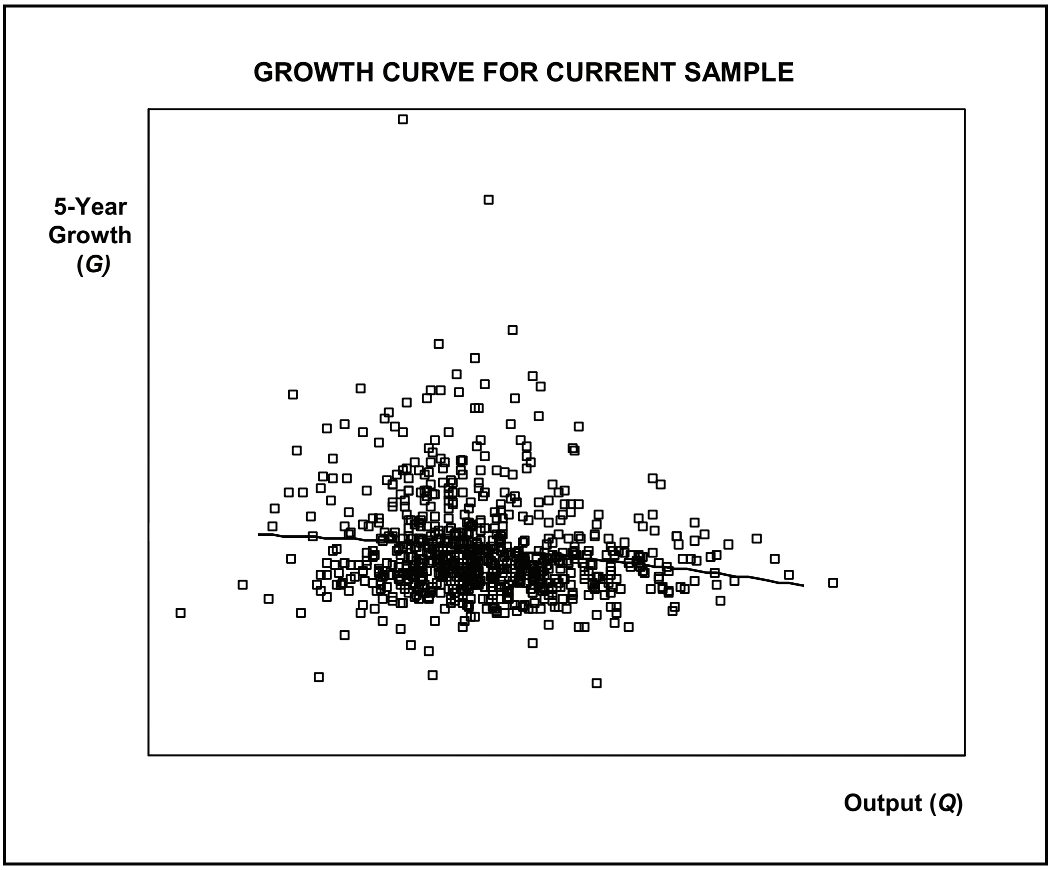
First, Figure 36 reports the results for the cost curve (*AC*), which plots average total cost (average factor costs, defined in Table 10, was used as the proxy) against output (firm size was used as the proxy). A quadratic regression line has been added to show the underlying trend in the data. The data conform well to the conceptual *AC* curve in Figure 33.

Figure 36. Cost Curve for Current Sample



Second, growth data (5-year growth, defined in Table 9) were plotted against output (Figure 37). Again, the curve has the predicted shape and the quadratic regression line is similar to the conceptual *G* curve in Figure 34. The plot points are quite scattered though, and firms seem to have considerable leeway to deviate from the growth rate prescribed by their size.

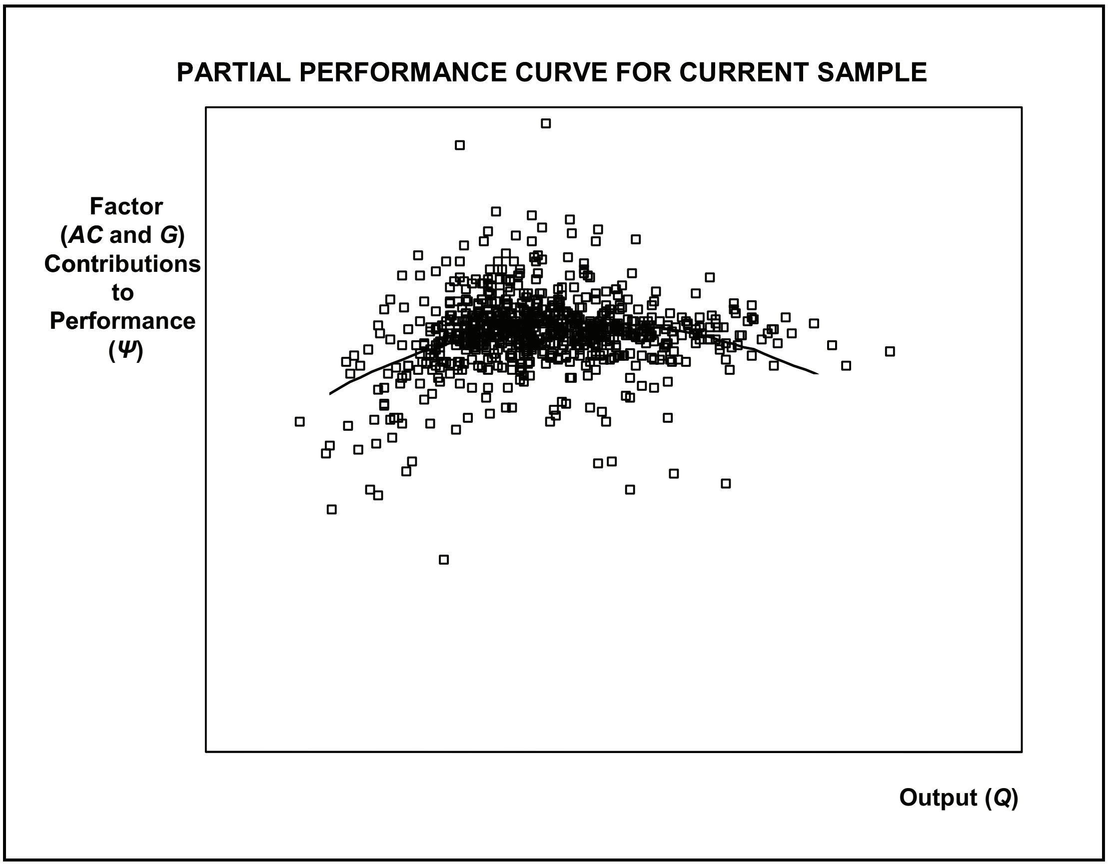
Figure 37. Growth Curve for Current Sample



Third, the joint contribution to firm performance by the two factors is shown in Figure 38. The average cost and growth data have been weighted and added ($\Psi = -0.6AC + 0.4G$, normalised). The weights for the current sample came from an analysis of the relative contribution of *AC* and *G* to Tobin's *Q*, a commonly used composite measure of a firm's performance (e.g., Brainard and Tobin 1968; Lang and Stulz 1993).

The performance curve (Ψ) is not unlike the conceptual curve shown in Figure 35. There is significant variation around the trend line, but overall the data conform to the theoretical and empirical predictions.

Figure 38. Partial Performance Curve for Current Sample



These results now make it possible to prescribe certain remedies for underperforming large firms, especially when poor performance stems from low growth. Consider the impact of diseconomies of scale: Bureaucratic insularity at both the institutional and individual levels appears to be endemic in large firms, leading to low growth and low profitability. Incentive limits negatively influence both growth and profitability. Atmospheric consequences have a moderately negative impact on growth, while communication distortion does not seem to be an important source of diseconomies of scale.

Economies of scale can offset this to some extent; indeed, large firms tend to exist in industries in which economies of scale are important. Moreover, the negative effects of diseconomies of scale can be moderated by paying attention to governance and organisational issues and by increasing asset specificity. These factors more or less offset the diseconomies of scale for large firms, resulting in a low overall correlation between performance and size.

The diseconomies of scale exhibit a stronger negative influence on growth than on profitability. This may indicate that Penrose's suggestion that the limits of a firm are related to dynamic factors rather than static factors is correct (see p. 12, above). A large firm will find it relatively easy to maximise profitability, but difficult to spur growth. An extension of this argument is that Gibrat's law of proportional effects (1931, 77) may not be valid for growth and firm size, in line with corporate demography research (Carroll and Hannan 2000, 315–319) and the findings of Sutton (1997).

One way of expressing the impact of diseconomies of scale is to calculate the market value of the largest firms if the diseconomies of scale did not exist (and the economies of scale and moderating factors stayed the same). The largest 100 firms in the sample had a combined market capitalisation of 4.8 trillion dollars at the end of 1998, out of a total 6.7 trillion dollars for the whole sample of 784 firms. If diseconomies of scale were reduced to zero, then the expected growth of these firms would increase significantly (around 4 percentage points) and the profitability would be somewhat higher (around 0.5 percentage point). The combined effect (all other things equal) might be an increase in market capitalisation from 4.8 trillion dollars to 5.4 trillion dollars. It would also imply a higher growth in productivity and a commensurate increase in the growth of GDP related to the US manufacturing sector, up to 0.7 annual percentage points.[47] This is a crude estimate and it only serves to illustrate orders of magnitude.

[47] This was calculated by taking the large companies' contribution to the US GDP in 1998 (around $650 billion; total GDP was $8,790 billion), and then increasing this number based on the increase in Tobin's *Q*, estimated under the assumption of no diseconomies of scale. The estimate is a static assessment and the true impact is most likely lower.

7.2 LIMITATIONS OF THE RESEARCH

The current research is limited by a number of factors. Some of the variables were not properly operationalised (for example vertical depth). Other, more targeted, studies have used better definitions, but replicating those definitions here would have expanded the work too much (generalisability was prioritised over precision). As a result, simple, but somewhat less reliable, definitions were used.

The selection of data also had a number of limitations. Potential industry effects—while hypothesised to be small—were not incorporated. Data were only collected for the manufacturing sector (strictly manufacturing, construction, and mining). This sector represents only 22 per cent of the US economy (26 per cent of the private sector) and includes less than half of all large firms. In addition, international comparisons were not made and longitudinal comparisons proved difficult to make.

Furthermore, no competing theories were introduced (see p. 11, above). Although the transaction-cost-economics approach to studying diseconomies of scale has yielded some insights, other theoretical approaches may also contribute to the bureaucratic failure debate.

Finally, the statistical analyses consciously sacrificed precision at certain points. For example, ordinal values were not analysed with polyserial and polychoric correlations (see Section 5.1.2.3) and the influence of asset specificity was not fully explored because these data were not normally distributed. The model was therefore not optimised to extract the maximum explanatory power.

7.3 FURTHER RESEARCH

Four avenues for further research may provide clarification and further insights:

1. Proving the existence of diseconomies of scale by studying a more narrowly defined problem such as focusing on an industry rather than a whole economic sector. For example, earlier studies have explored similar issues in the petrochemicals (Armour and Teece 1978), the automotive (Masten, Meehan and Snyder 1989; Monteverde and Teece 1982) and the information technology industries (Rasmusen and Zenger 1990; Zenger 1989, 1994). It may be worthwhile to build on this body of knowledge and test particular aspects of the current work.

2. Expanding the analysis across geography and time. In particular, a longitudinal study over a full business cycle would most likely lead to more robust findings.

3. Finding better ways to operationalise unobserved diseconomies of scale, perhaps by using panel data from primary research. Specifically, communication distortion is often discussed qualitatively in the literature, but the operationalisation of this concept remains elusive. In this and other research efforts, the number of hierarchical levels in the organisation was used as an indicator. It is not clear, however, why

information would be more distorted when it flows inside the firm, than when it flows a similar distance in the market.

4. Replicating the current research with better statistical approaches and a larger sample, with a particular eye towards industry effects. Industry effects have proven difficult to quantify in general, but recent advances in analytical techniques by, for example, McGahan and Porter (1997), show that it may be possible to quantify these effects.

These suggestions are positivist and universal in nature. Clearly, other approaches such as a phenomenological perspective can add insights into the nature of diseconomies of scale.

The concluding chapter which now follows builds on the findings discussed above and combines them with the researcher’s own experience as a management consultant to large corporations.

8. CONCLUSION

Over the years, I have often been struck by how inefficient and dysfunctional large corporations can be. Yet at the same time most of them are immensely successful and deliver outstanding value to their customers, while they perform well in the stock market. I base these paradoxical comments on my interaction with large corporations, their executives and employees during almost twenty years as a management consultant at McKinsey & Company and Monitor Group. I struggled with the paradox for many years and tried privately to reconcile the advantages and disadvantages of large-scale organisation. In 1991, I happened to come across Coase's "The Nature of the Firm" (1937). After reading a twice-faxed copy of the article on a (slow) bus between the terminal and an airplane at Stuttgart airport, I became convinced that I could use transaction cost economics to improve upon my advice to large corporations, especially when working on strategic and organisational development issues. This in turn led to the ambition to do formal research on the limits of firm size. The research has confirmed many of my real-life observations. Large corporations are inefficient in many ways, but for good reasons. The benefits of large organisations are substantial, but there are inescapable drawbacks as well.

The thesis demonstrates the need for research on limits of firm size, creates a framework for thinking about the problem and indicates—based on the literature survey and the statistical analysis—that there are real and quantifiable diseconomies of size.

The heart of the research is a transaction cost economics-based framework which combines four distinctive aspects of Williamson's theory: (1) the sources of firm-size limits: atmospheric consequences due to specialisation, bureaucratic insularity, incentive limits of the employment relation and communication distortion due to bounded rationality; (2) the impact economies of scale have at the firm level; (3) the importance of organisational form in reducing diseconomies; and (4) the positive influence of high internal asset specificity on both transaction-cost and production-cost diseconomies. The qualitative and quantitative analyses conducted confirm the explanatory and predictive power of the theory. As such, the research contributes to our understanding of the mechanisms behind bureaucratic failure.

There are a number of real-life implications of the research. First, strategy and structure appear to be intimately linked. Executives at large corporations have to grapple with real trade-offs when they consider expansion. Certain growth strategies are easier to execute than others, and the choice of organisation has major implications for which strategies make sense. Indeed, structure does not necessarily follow strategy; strategy and structure inform each other continuously and forever.

Second, much of the rationale for mergers and acquisitions seems to be weak, at best. Proponents of mergers typically argue that the resulting larger entity after a merger will realise economies of scale, benefiting customers and shareholders; in addition, they claim that growth will be accelerated through the introduction of new products and services that were previously too expensive to develop. But the analysis here shows that although some economies of scale may be realised, they are likely to be offset by diseconomies of scale. Furthermore, there is no evidence that larger, merged entities innovate more and grow faster. Instead, the opposite appears to be true: innovation and growth declines, on average. This is particularly true in knowledge-intensive industries like pharmaceuticals. To be sure, mergers and acquisitions often do make sense. But executives need to think through how to minimise diseconomies of scale, as well as to maximise moderating influences, when post-merger integration is carried out.

Third, boards of directors may want to emphasise the importance of executive renewal and the elimination of rigid processes to stimulate growth. Old, large firms with entrenched management often find themselves with a fundamental dilemma. There is no indication that they can achieve above-average, profitable growth. They must choose either to pay out excess cash flow to shareholders (as is often done) or to try to find ways to break the firm's bureaucratic insularity. Maximising the quality of governance, which is part of the board's fiduciary duties, appears to be an important lever for maximising the value of large corporations.

Fourth, firms that strive for high internal asset specificity appear to be better off than those that expand reach, breadth, or depth. This does not imply that single-product or single-geography strategies are optimal (because this reduces growth in the long run), but it does imply that any expansion strategy should strive for high asset specificity and that some firms are best off reducing their scope of activities. By and large, anecdotal and empirical evidence suggests that this has happened over the last 20 to 30 years. "Focus on the core business" and "outsourcing" have been hallmarks of restructuring programs for many years, and the current research verifies that this is often a valid strategy.

Finally, in a world in which companies increasingly try to sell solutions rather than basic products and services, incentive limits have become real and problematic. In businesses that involve team selling or large product-development efforts, attention should be paid to creating well-functioning incentive schemes for employees. The superior productivity of research and development in small firms, in which incentives are tailored to individual performance, demonstrates why effective incentive schemes matter.

It may be that the average large firm has neither a competitive advantage nor a disadvantage when compared with small and mid-size firms. However, the individual large firm will prosper or fade depending on how well it manages diseconomies of scale.

APPENDIX A: LITERATURE REFERENCES PERTAINING TO DISECONOMIES OF SCALE

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APPENDIX B: CORRELATION ANALYSES

Below follow two correlation analyses to support the structural equation models. The purpose was to find whether the chosen definitions of size and firm performance are meaningful from a statistical point-of-view. For example, it could be that size measured as number of employees did not correlate with other definitions such as revenue or assets. SPSS was used for the correlation analyses. The appendix shows that robust and relevant definitions can be construed for each variable.

DEFINITION OF SIZE

In line with the definitions of size in Section 2.2 ("Dimensions of Firm Size") number of employees (**Employees**), revenue (**Sales**), net assets (**Net Assets**) and value added (**Value Added**), where correlated against each other. These size-related variables are defined in Table B.1.

Table B.1. Size Variables

SIZE VARIABLES						
Use	**Name**[a]	**Label**[b]	**Type**	**Description**	**Metric**	**Sources**
Size	empl	Employees	Direct	No. of employees	’000	Compustat
Size	sales	Sales	Direct	Sales	$M	Compustat
Size	va	Value Added	Calculated	Value added defined as sales less cost of purchased goods and services ≈ EBIT + labour cost + depreciation [va = ebit + labour + depr]	$M	
Size	na	Net Assets	Calculated	Net assets defined as total assets less current assets plus current liabilities [na = ta − ca + cl]	$M	
Size	ebit	EBIT	Direct	Earnings before interest and tax	$M	Compustat
Size	ta	Total Assets	Direct	Total assets	$M	Compustat
Size	ca	Current Assets	Direct	Current assets	$M	Compustat
Size	cl	Current Liabilities	Direct	Current liabilities	$M	Compustat

[a] The “Name” column shows the name given to the variable in SPSS and in Amos
[b] The “Label” column shows the label given to the variable in SPSS and in Amos

Unsurprisingly, the four definitions are highly correlated (at better than 1% significance), as is seen in Table B.2.

Table B.2. Correlations between Various Definitions of Size

CORRELATIONS BETWEEN VARIOUS DEFINITIONS OF SIZE					
		Employees	**Sales**	**Value Added**	**Net Assets**
Employees	Correlation	1			
	Sign. (2-tailed)				
	N	784			
Sales	Correlation	0.844**	1		
	Sign. (2-tailed)	0.000			
	N	784	784		
Value Added	Correlation	0.923**	0.964**	1	
	Sign. (2-tailed)	0.000	0.000		
	N	146	146	146	
Net Assets	Correlation	0.724**	0.877**	0.925**	1
	Sign. (2-tailed)	0.000	0.000	0.000	
	N	744	744	139	744

** Indicates correlations significant at the 1% level (2-tailed)

Based on the high correlations above, it was decided to perform the structural equation analyses using one definition of size. The number of employees was chosen to represent size because it is available for all firms in the sample; it follows Child's (1973) logic described in Section 2.2.2; it has been used extensively in other studies of size-related issues (e.g., Hall 1986, 5–6; Kumar, Rajan and Zingales 1999, 12); and it is highly correlated with the other variables. Section 2.2.2 also showed that sales is an unsuitable measure and a separate analysis (not included in this thesis) concluded that value added is too highly correlated with profitability to be a good measure.

DEFINITION OF FIRM PERFORMANCE

Quantitative measures of firm performance include profitability measures such as gross margin, net margin (i.e., return on sales), return on equity, economic value added (i.e., return on equity less cost of equity), return on capital employed; cash flow measures such as free cash flow over sales; and growth measures such as 1-, 3-, 5- and 10-year historical revenue growth.

Ideally, forward-looking measures such as expected profitability, cash flow and growth should be used to measure a firm's performance because the current operating conditions (such as number of hierarchical levels or organisation form) will influence future performance. However, the only way to get such data without relying on analyst estimates is to perform the analyses on a sample older than 5 years. This would significantly reduce the number of variables in the model because most nonfinancial data are not available five years back in time. Thus, the decision was made to use current and historical data. The definitions are shown in Table B.3.

Table B.3. Performance Variables

PERFORMANCE VARIABLES						
Use	**Name**[a]	**Label**[b]	**Type**	**Description**	**Metric**	**Sources**
Performance	ros	ROS	Calculated	Return on sales = net income ⁄ sales	%	Compustat
Performance	roe	ROE	Calculated	Return on equity = net income ⁄ equity [roe = ni ⁄ equity]	%	
Performance	eva	Profitability	Calculated	Economic value added defined as return on equity (ROE) less cost of equity (COE) [eva = roe − coe]	%	
Performance	fcf	Free Cash Flow%	Calculated	Relative free cash flow defined as free cash flow ⁄ sales [fcf = fcftot ⁄ sales]	%	
Performance	growth3	Growth3	Direct	3-year compound annual sales growth	%	Compustat
Performance	growth	Growth	Direct	5-year compound annual sales growth	%	Compustat
Performance	growth10	Growth10	Direct	10-year compound annual sales growth	%	Compustat
Performance	fcftot	Free Cash Flow	Direct	Free cash flow	$M	Compustat

[a] The "Name" column shows the name given to the variable in SPSS and in Amos
[b] The "Label" column shows the label given to the variable in SPSS and in Amos

Table B.4 shows the correlations between the seven alternative definitions of firm performance. Return on sales (**ROS**), return on equity (**ROE**) and economic value added (**Profitability**)[48] are highly correlated (better than 1% significance). Economic value added was chosen as the operationalisation of profitability because it most accurately measures profitability and is available for all but two firms.

[48] The variable could have been named **EVA**, but since this variable was chosen to represent profitability in the statistical analyses, the generic variable name **Profitability** is used already here.

Growth measures show similarly high correlations. The best measure was 5-year growth (**Growth**)[49] because it has higher correlation with 3- and 10-year growth than they have with 5- and 10-, and 3- and 5-year growth, respectively. It also has a large number of observations (756). Free cash flow (**FCF%**) was not chosen as a measure of performance because it is too prone to fluctuations between years. [50]

Table B.4. Correlations between Various Definitions of Firm Performance

CORRELATIONS BETWEEN VARIOUS DEFINITIONS OF FIRM PERFORMANCE								
		ROS	**ROE**	**Profita-bility**	**FCF%**	**Growth3**	**Growth**	**Growth10**
ROS	Correlation	1						
	Sign. (2-tailed)							
	N	784						
ROE	Correlation	0.683**	1					
	Sign. (2-tailed)	0.000						
	N	782	782					
Profita-bility	Correlation	0.682**	0.993**	1				
	Sign. (2-tailed)	0.000	0.000					
	N	781	781	781				
FCF%	Correlation	0.370**	0.332**	0.331**	1			
	Sign. (2-tailed)	0.000	0.000	0.000				
	N	750	750	749	750			
Growth3	Correlation	0.055	0.020	0.002	−0.017	1		
	Sign. (2-tailed)	0.124	0.570	0.948	0.635			
	N	777	775	774	744	777		
Growth	Correlation	0.040	−0.007	−0.039	0.012	0.879**	1	
	Sign. (2-tailed)	0.272	0.854	0.280	0.745	0.000		
	N	756	754	753	725	756	756	
Growth10	Correlation	−0.020	−0.059	−0.098*	0.063	0.719**	0.858**	1
	Sign. (2-tailed)	0.605	0.126	0.011	0.111	0.000	0.000	
	N	671	669	668	643	671	668	671

* Indicates correlations significant at the 5% level (2-tailed)
** Indicates correlations significant at the 1% level (2-tailed)

49 Again, 5-year growth is labelled **Growth**, and not **Growth5** since it was chosen as the indicator of firm growth.

50 An additional benefit of using **Profitability** and **Growth** is that they correspond to Penrose's ([1959] 1995) distinction between static economies (pp. 89–99) and diseconomies (pp. 12–13) of size (i.e., **Profitability**) and dynamic economies (pp. 99–101) and diseconomies (pp. 212–214) of growth (i.e., **Growth**).

It is worth noting (but is not surprising) that profitability and growth are uncorrelated (−0.04), and that free cash flow is uncorrelated with growth (0.01) and somewhat correlated with profitability (0.33).

APPENDIX C: COMPLETE PATH DIAGRAMS, INCLUDING CORRELATIONS

Figure C.1. Firm Performance versus Bureaucratic Insularity

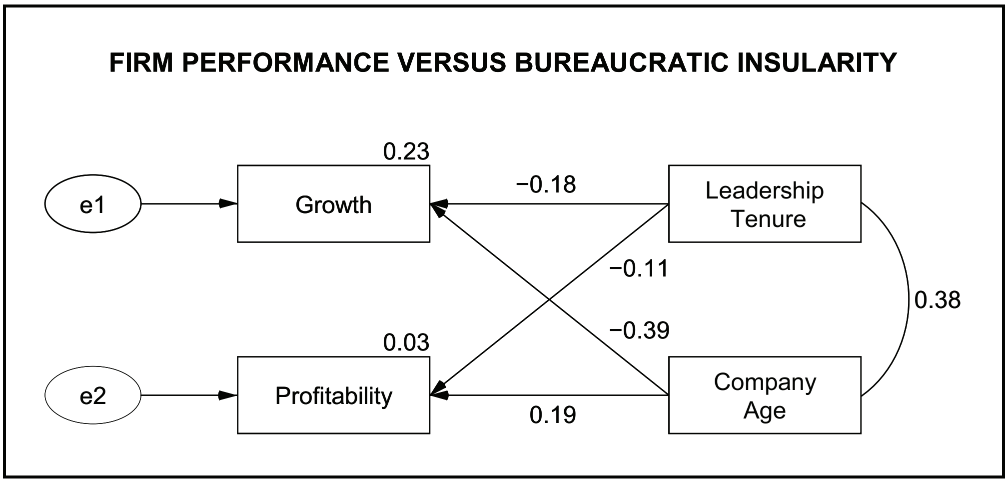


Figure C.2. Firm Performance versus Incentive Limits

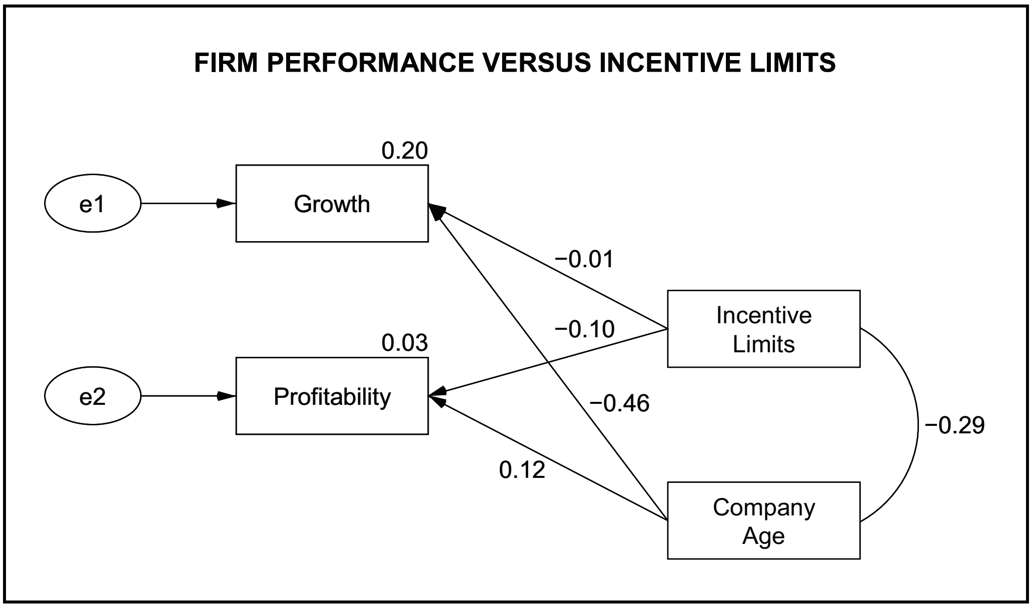


Figure C.3. Firm Performance versus Diseconomies of Scale: Not Adjusted for Survivor Bias

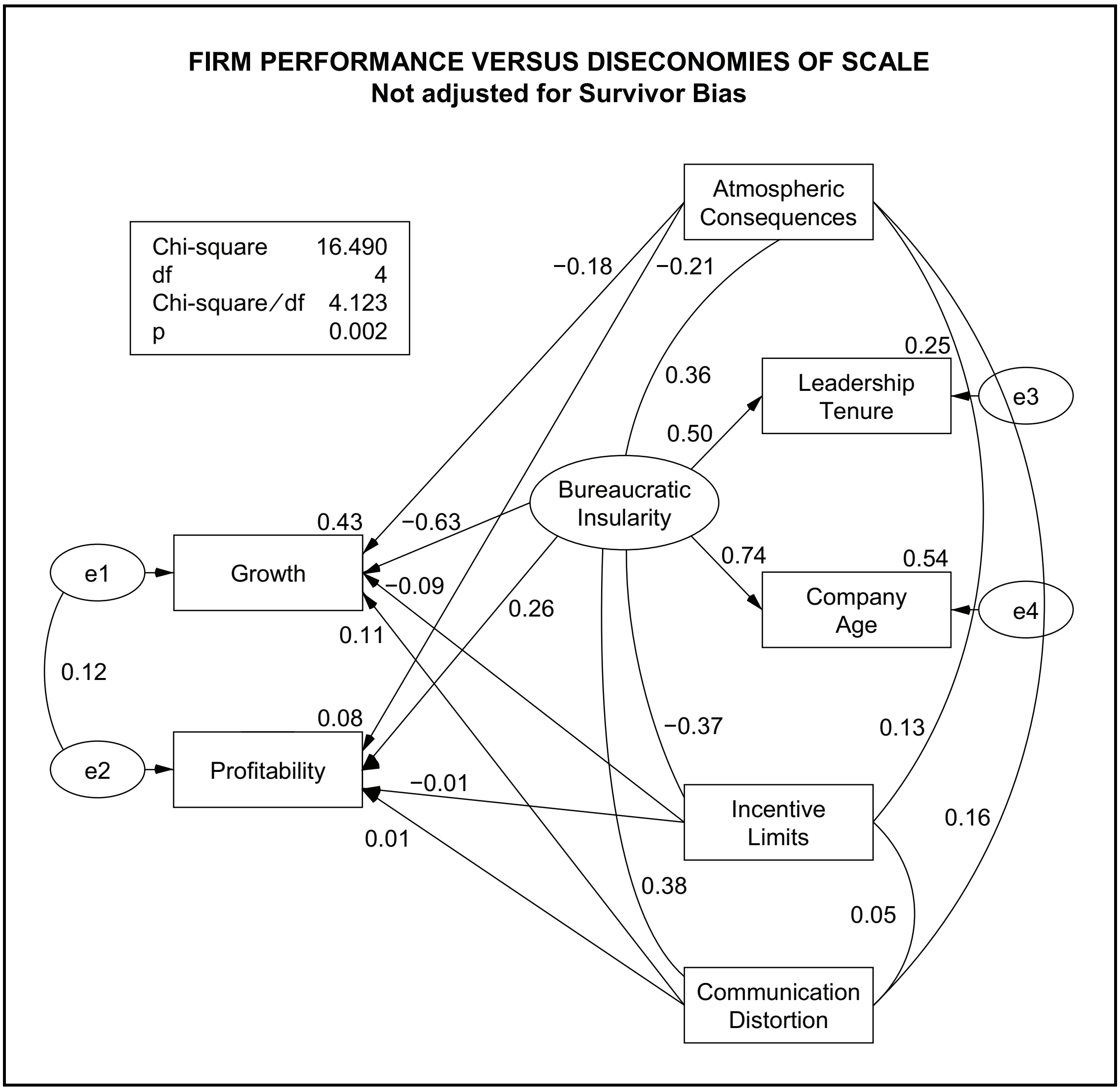


Figure C.4. Firm Performance versus Diseconomies of Scale: Adjusted for Survivor Bias

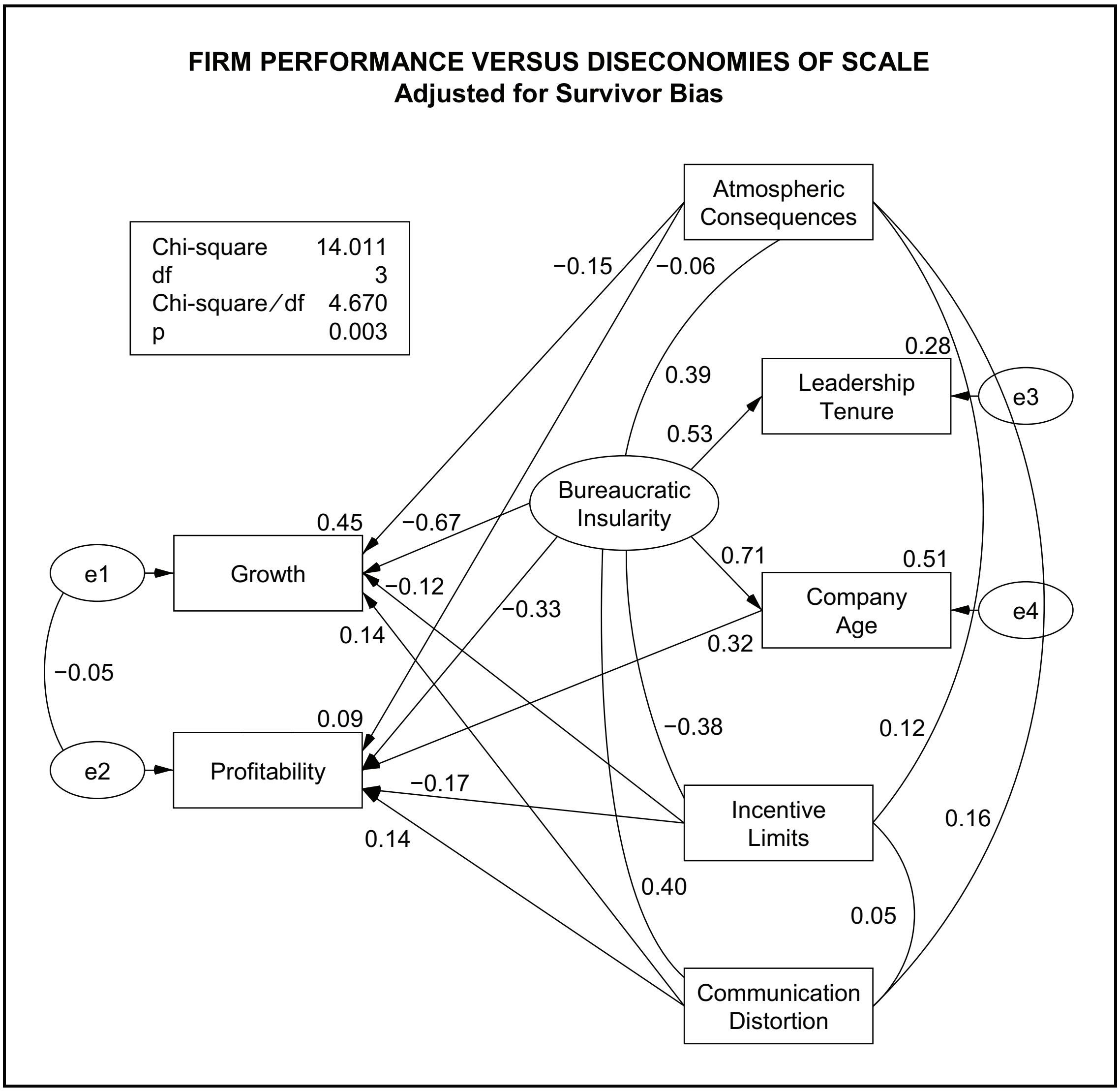


Figure C.5. Firm Performance versus Diseconomies of Scale and Economies of Scale

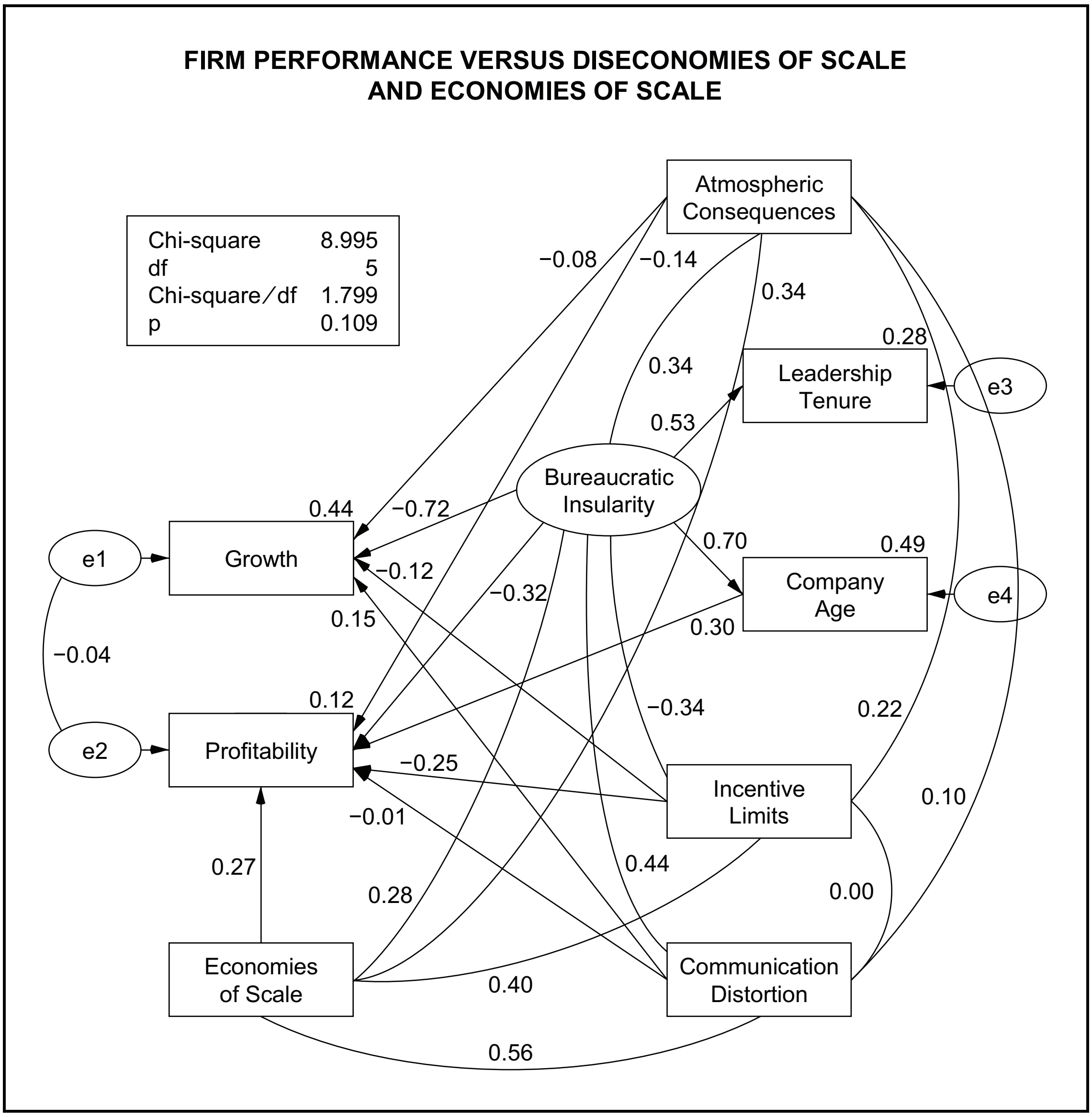


Figure C.6. Firm Performance versus Diseconomies of Scale, Economies of Scale and M-Form Organisation

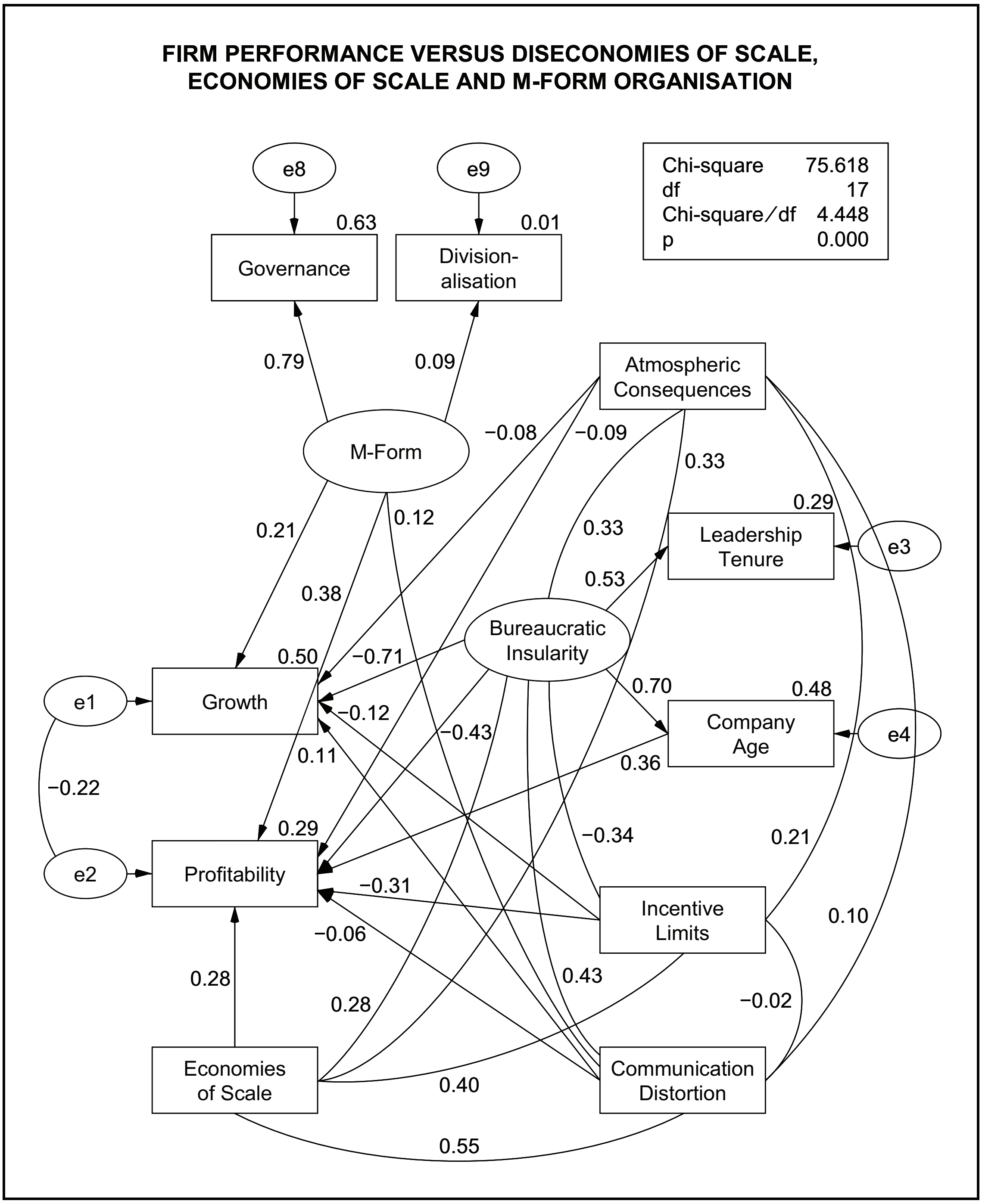


Figure C.7. Firm Performance versus Diseconomies of Scale, Economies of Scale and Asset Specificity

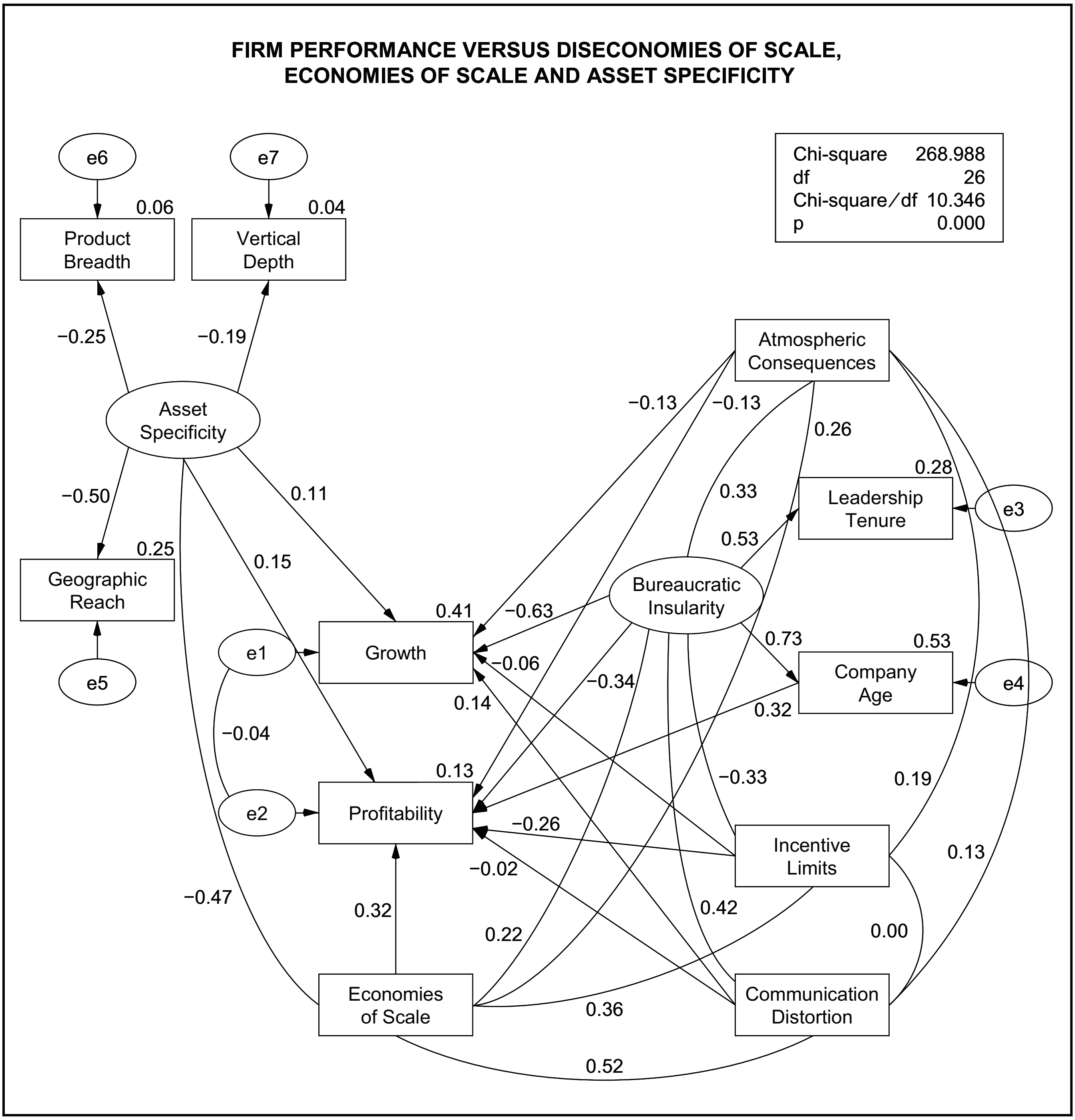


Figure C.8. Complete Sub-Model b: *Includes Diseconomies of Scale, Economies of Scale and Moderating Factors*

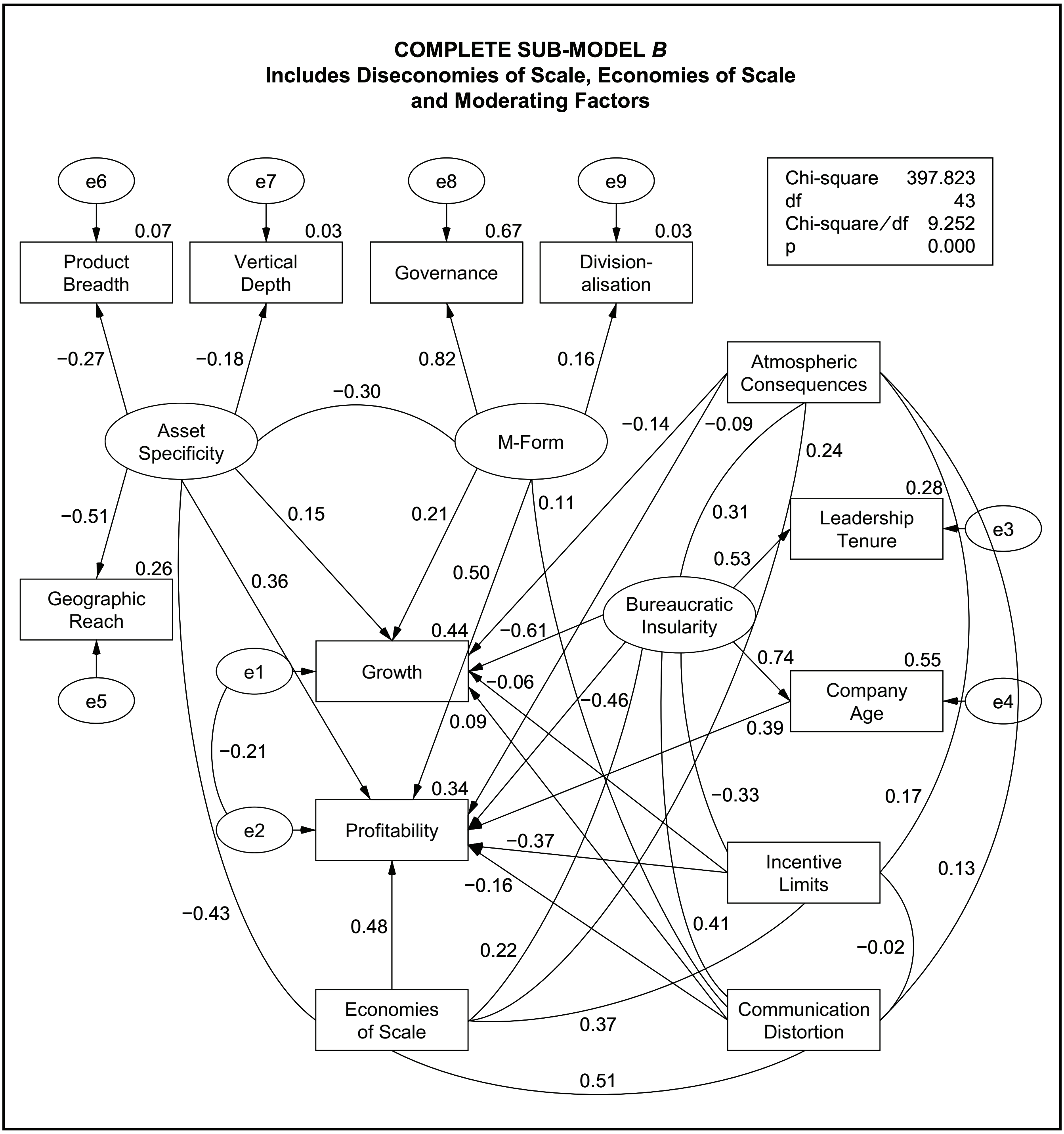
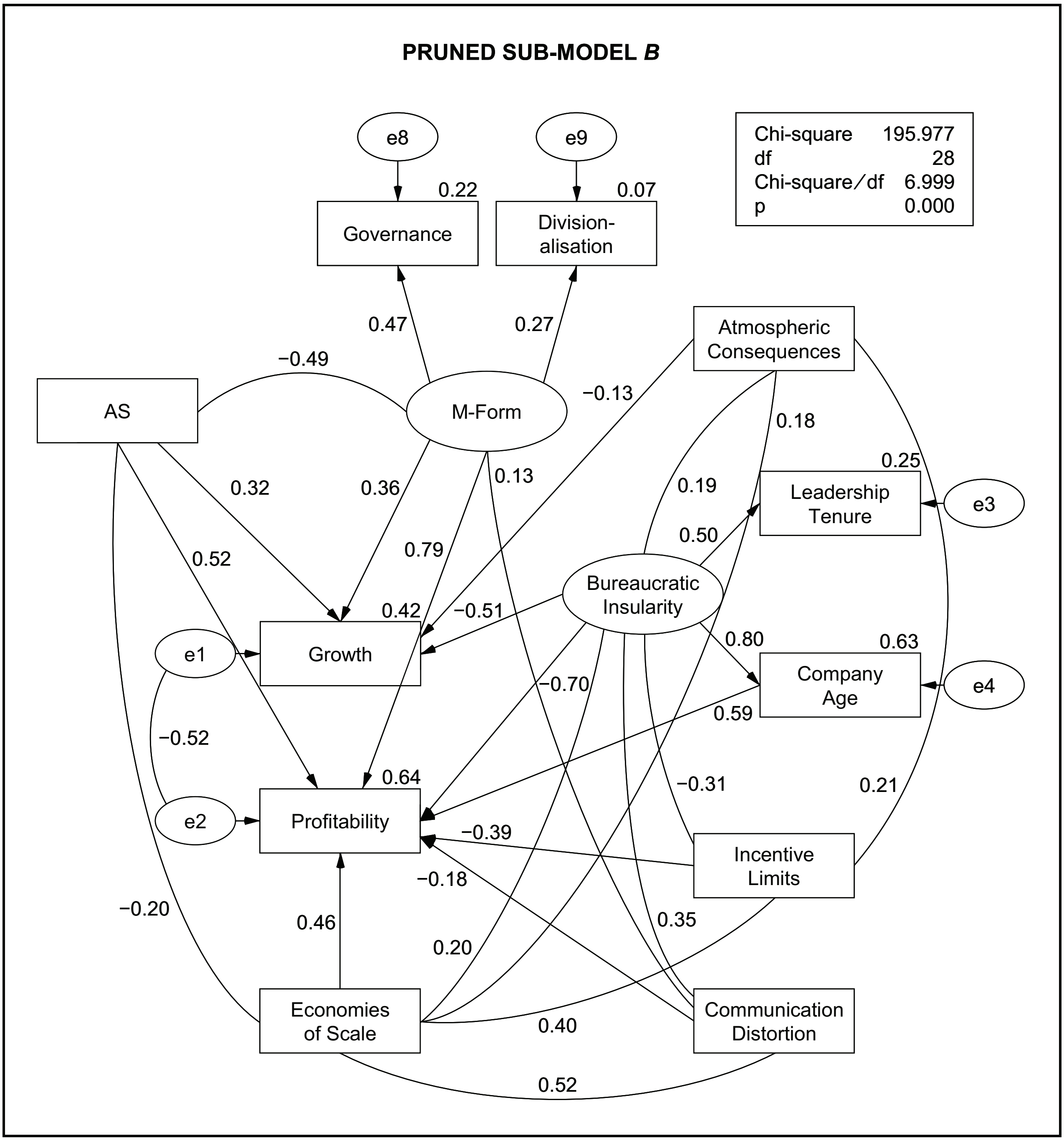


Figure C.9. Pruned Sub-Model b



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NAME INDEX

SUBJECT INDEX